

NC-213

2001 ANNUAL PROGRESS REPORTS

Published: January 2002

MARKETING AND DELIVERY OF QUALITY CEREALS AND OILSEEDS

Officers

Chairman..... Mark E. Casada, University of Idaho, Moscow, IA
Vice Chairman Lloyd Bullerman, University of Nebraska, NE
SecretaryDirk Maier, Prude University, IN
Past ChairmanR. Terry Arbogast, CMAVE, Gainesville, FL
Industry Advisory Committee ChairmanJim Stitzlein, Consolidated Grain & Barge Co., New Berlin, IL
CSRS/USDA Representative Damanna Ramkishan (Ram) Rao, Washington, D.C.
Administrative Advisor..... Steven A. Slack, OARDC/OSU, Wooster, OH
Coordinator F. William Ravlin, OARDC/OSU, Wooster, OH

Participating Stations

Arkansas Agricultural Experiment Station, Fayetteville..... Wayne Yang
Idaho Agricultural Experiment Station, Moscow..... Mark E. Casada
Illinois Agricultural Experiment Station, Urbana Karen Bender
Indiana Agricultural Experiment Station, (Purdue) W. Lafayette..... Dirk E. Maier
Iowa Agricultural Experiment Station, AmesCharles R. Hurburgh, Jr.
Kansas Agricultural Experiment Station, Manhattan..... Timothy J. Herrman
Michigan Agricultural Experiment Station, East Lansing Perry K.W. Ng
Minnesota Agricultural Experiment Station, St. Paul (T.B.D.)
Montana Agricultural Experiment Station, Bozeman Florence V. Dunkel
Nebraska Agricultural Experiment Station, Lincoln..... Lloyd B. Bullerman
North Dakota Agricultural Experiment Station, Fargo Charlene Wolf-Hall
Ohio Agricultural Research & Development Center, Wooster Richard C. Pratt
Texas Agricultural Experiment Station, College Station Lloyd W. Rooney
Wisconsin Agricultural Experiment Station, Madison..... Sundaram Gunasekaran
Beltsville Agricultural Research Center (BARC), Beltsville Stephen R. Delwiche
Market and Trade Economics, ERS/USDA, Washington, D.C. (T.B.D.)
Grain Inspection, Packers, and Stockyard Administration, USDA, Kansas City..... Steve Tanner
National Center for Agricultural Utilization Research, ARS/USDA, Peoria..... Donald T. Wicklow
Grain Marketing and Production Research Center, ARS/USDA, Manhattan..... Donald E. Koeltzow
Center For Medical, Agricultural and Veterinary Entomology..... Terry Arbogast
Consolidated Grain & Barge Company, New Berlin..... Jim Stitzlein
The Andersons, Inc. Robert Smigelski

Representatives

Table of Contents

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

Assess quality characteristics related to dry milling performance of corn hybrids from grow-out trials performed by producers in northeast Kansas: 2) Mill a subset (60 samples) of corn samples and measure grit yield and other performance indicators; and, 3) Examine the statistical relationship between testing techniques (objective 1) and corn dry mill yield (objective 2). (Kansas State University)

Maintain a database of grain quality information. (Iowa State University)

Provide grain quality data for soybean and corn variety trials. (Iowa State University)

Characterize and identify corn hybrids and experimental (exotic) germplasm with superior end-use properties for wet milling, dry milling, and alkaline cooking (for tortillas and corn snacks). (University of Nebraska-Lincoln)

Develop and maintain a database of intrinsic quality properties and end use value of corn hybrids and soybean varieties for Indiana. (Purdue University)

Determine the effects of genetic traits, climatic factors, agronomic practices, pest populations, machine harvesting, and drying on the quality of cereals and oilseeds. (OARDC/The Ohio State University)

Evaluate physical, chemical and processing properties of sorghum and develop improved food quality sorghums. (Texas A & M University)

Improve corn resistance to *Aspergillus flavus* and aflatoxin. (USDA, Peoria, Illinois)

Analyze the protein variability among individual kernels within a head, between plants, locations within a field, fields, and cultivars. These results will enable us to: 1) Assess the best sampling strategy for identifying protein variability during harvest and 2) Establish realistic goals for controlling wheat quality variation through segregation. (Kansas State University)

Maximize the value of new hard white (HDWH) wheat cultivars developed by the Kansas Agricultural Experiment Station. Recent activities include: 1) Conduct farmer focus groups to assess reasons for deciding whether or not to plant HDWH and 2) Improve hard white wheat yield and quality through identifying the blend of two varieties (Trego and Betty) that optimizes agronomic and processing performance. (Kansas State University)

The main goal of this project is to use the system simulation approach to improve the efficiency and economics of the receiving operation at commercial grain elevators. (Purdue University)

Investigate the microbial ecology and epidemiology of *Aspergillus flavus* in midwestern crop field soils and the biocontrol potential of sclerotial mycoparasites. (USDA, Peoria, Illinois)

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

Develop and evaluate automatic grain aeration control strategies for maintaining grain quality and controlling insects during storage. (USDA, Manhattan, Kansas)

The primary objective of our work in 2001 was to compare the relative allowable storage time of corn hybrids that contain higher than normal amounts of oil to the allowable storage time for parent hybrids that contain normal amounts of oil and to compare the allowable storage time for corn hybrids that contain the Bt gene to the allowable storage time for similar corn hybrids that do not contain the Bt gene. (University of Minnesota)

The goal of this project is to evaluate, under field conditions, the use of carbon dioxide detectors to monitor for spoilage of corn prior to the time that spoilage would be detected by traditional methods. Our hypothesis is that CO₂ monitors can efficiently detect grain in the early stages of spoilage. The first objective was to determine the parameters for monitoring changes in CO₂ concentrations within a grain bin. The second objective was to determine the relationship between a fungal biomass growing in a grain bin and the early detection of CO₂. (Purdue University)

To determine seasonal trends in grain temperature and capture rates of two stored-product beetles, *Typhaea stercorea* (L.) and *Tribolium castaneum* (Herbst) in farm storage bins, and to examine the association between grain temperature and trap catch, before and after elimination of seasonal trends. (USDA, Gainesville, Florida)

To promote the technology transfer of the Electronic Grain Probe Insect Counter (EGPIC) System for monitoring infestations in stored-products. (USDA, Gainesville, Florida)

Indian meal moth infestations in processed cereal products during storage could be managed with little or no use of conventional pesticides if there was a greater recognition and use of the moth's innate vulnerabilities. Slowing or preventing the growth of infesting larvae is a simple strategy that can decrease the amount of commodity damage and decrease the need for pesticide intervention. (USDA, Gainesville, Florida)

Evaluate resistance of Montana-grown hard red spring, hard red winter, hard white, and soft white wheat varieties to Montana strains of storage insects. (In 2002-3, this project will also address NC 213 Objective A, specifically to determine the effects of genetic traits, climatic factors, agronomic practices on the quality of cereals, that is the ability of hard wheat varieties to resist insect attack during long-term storage.) (Montana State University)

Determine the effects of preservatives and fungicides on growth and mycotoxin production by selected molds. (University of Nebraska)

To determine the fungicidal and mortality effect of ozone in an integrated pest management system to prevent molds, mycotoxins and insects in stored products. (Purdue University)

Identify technical, social, economic, and institutional constraints that impede segregation of GM-based VE crops and create system analysis and management tools to assist in the adoption of VE grain handling and marketing strategies. (Kansas State University)

Develop new bio-rational residual and fumigative applications for stored grain, oilseeds and other post-harvest commodities from natural materials as novel management strategies for stored product insects. (Montana State University)

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

Conduct basic and applied research in the biochemistry and technology of grain sorghum to identify and evaluate the biochemical components that govern processing, digestibility, and susceptibility to mold. The information is used to improve sorghum quality and utilization for increasing domestic and export markets. (USDA, Manhattan, Kansas)

Develop fast reliable methods for the identification of quality traits of wheat starches. (USDA, Manhattan, Kansas)

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. (USDA, Manhattan, Kansas)

Apply spectroscopic imaging to grain quality analysis. (Iowa State University)

Optimize performance of near-infrared analyzers in network situations. (Iowa State University)

Develop near-infrared calibrations for identification of genetically modified grains. (Iowa State University)

Develop procedures for rapid measurement of grain subunits. (Iowa State University)

Develop methods to characterize cereal proteins and/or protein fractions. Develop methods to identify components related to end-use properties. (USDA, Manhattan, Kansas)

Examine milling properties, dough characteristics, protein functionality, and baking properties of soft white wheat. (Michigan State University)

Optimize performance and computational capabilities of near-infrared analyzers. (Iowa State University, USDA – GIPSA, GIQUAL)

Develop near-infrared applications in on-line of mobile situations. (Iowa State University, USDA – GIPSA, GIQUAL)

Examine high molecular weight glutenin subunits (HMW-GS) from the D-genome progenitor of bread wheat *Aegilops (Triticum) tauschii*. (USDA, Manhattan, Kansas)

Develop sensors, instrumentation, and procedures for objective grading, on-line measurement, and end-use property assessment of single kernels or bulk samples. (USDA, Manhattan, Kansas)

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. (University of Illinois)

Determine and identify specific chemical and physical factors in corn and changes in processing conditions which influence corn wet milling, dry milling or alkaline processing yields. (University of Nebraska-Lincoln)

Identify technical, social, economic, and institutional constraints that impede segregation of GM-based VE crops and to create system analysis and management tools to assist in the adoption of VE grain handling and marketing strategies. (Kansas State University)

Identify fungi-grain interrelationships, which may regulate invasion and damage of grain by storage fungi, and identify volatiles associated with unacceptable odors in grain. (USDA, Manhattan, Kansas)

The objective of this project is to evaluate the use of the Solvita[®] test kit for measuring the susceptibility of shelled corn to invasion by storage mold. The test kit was developed by Woods End[®] Research Laboratory for the measurement of compost maturity and soil biological respiration. It includes a plastic “paddle” that can be inserted into the sample being tested (see sketch in Figure 1 below). A portion of the paddle is covered with an indicator gel that changes color in response to increases in the percentage of carbon dioxide (CO₂) in the container. In these tests, the paddle was inserted into a sealed container at the appropriate time (Figure 1, right). Fungi growing on the shelled corn in the jar produce CO₂ and as the CO₂ level in the jar increases, the gel indicator changes color. There are five different colors and therefore five levels of CO₂ can be measured. (Purdue University)

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. (University of Nebraska)

Study incidences and levels of contamination of *Fusarium* spp., fumonisins, moniliformin, deoxynivalenol and zearalenone in corn and wheat intended for processing into human foods. Determine effects of processing on *Fusarium* spp., fumonisins, moniliformin, deoxynivalenol and zearalenone by monitoring the survival of the organism and the toxins. (University of Nebraska)

To evaluate methods to treat *Fusarium* head blight (FHB) infected barley in order to prevent *Fusarium* growth and mycotoxin production during malting. (North Dakota State University)

OBJECTIVE D *Determine the economic impact of improving the quality of cereals and oilseeds.*

Perform a commercial scale (50,000 bu) evaluation of a quality based marketing system of hard red winter (HRW) wheat with one Mexican flour milling company by performing the following tasks. (Kansas State University)

Assist in the development of quality system certification processes for the grain market.
(Iowa State University)

Examine the institutional issues raised by the Starlink incident and develop recommendations for developing effective institutional mechanisms for promoting transparency in grading of genetically modified crops. (Michigan State University)

Development of producer education programs for biotechnology grains. (Iowa State University)

Development of producer education programs for biotechnology grains. (Kansas State University)

NC-213 Progress Report for 2001

From: Kansas State University
Department of Grain Science and Industry

By: Herrman, T.J.
Lee, K.M.

NC-213 Objective: A Procedure: 1a

Project Objectives: 1) Assess quality characteristics related to dry milling performance of corn hybrids from grow-out trials performed by producers in northeast Kansas: 2) Mill a subset (60 samples) of corn samples and measure grit yield and other performance indicators; and, 3) Examine the statistical relationship between testing techniques (objective 1) and corn dry mill yield (objective 2).

Title: Corn Dry Milling Quality Assessment for Value-Enhanced Marketing

Results for 2001: NIRT spectral data, Stenvert grinding data, and physical quality data including density, test weight, and kernel size were collected from the 2000 and 2001 crop year. SOPs for the Stenvert grinding test were developed.

Plans for 2002: Develop corn dry milling capability, begin building a NIRT calibration for corn dry milling grit yield, and develop models for predicting hammer mill energy consumption and grit yield using test results.

Issues: Establish a quality-testing program for corn hybrids grown in Kansas, Nebraska, and Missouri by performing the following two functions: 1) Evaluate corn hybrids on an annual basis for farmers in this tri-state region and 2) Validate and, in some cases, develops tests that predict end-use performance for evaluating corn hybrids.

As farmers engage in value-enhanced marketing activities, they need objective test results about corn dry milling quality. The commercial dry milling industry refuses to share these data, thus, a need for Land Grant University evaluation of corn hybrids has become necessary.

Impacts: As an outcome of this work, producer groups will select corn hybrids that possess superior dry milling performance.

Funding Sources:
Kansas Corn Commission

Contacts:
Tim Herrman, Department of Grain Science and Industry, 785 532-4082, tjh@wheat.ksu.edu

Stenvert Hardness Test

Tempering/Drying

1. Run the sample through the NIR Grainspec to determine the moisture, protein, oil, starch, and density content of the corn. The corn should be equilibrated to $12.6\% \pm 0.8\%$ moisture.
2. If the corn is not within 0.8% moisture of 12.6% then tempering or drying of the corn is needed. For tempering the corn use a hot plate and add water to the bottom of the desiccator. For drying the corn remove the water from the desiccator. The graph below gives a good indication of the amount of time needed to equilibrate the corn to 12.6% moisture.
3. Let the hot plate and desiccator warm up for 30 minutes before inserting the corn. After the system is warmed up measure the corn weight (150g) and record it. Spread the corn on a sieve and place it in the desiccator for the desired time from the graph.
4. After the corn is removed weigh the sample and calculate the % moisture added or removed. Place the corn in a zip lock bag and let stand for 16-18 hours. This allows the moisture to soak into the entire kernel. Check the moisture content again prior to milling with the Stenvert Hammer Mill.

Milling

1. The Stenvert Hammer Mill should be fitted with a 2-mm aperture screen and a plastic tube calibrated to a volume of 17ml fitted to the mill exit.
2. Place 20 grams of corn of known moisture content in the hopper, with the slide shut.
3. Turn the speed control to 3600 rpm (tachometer will read 360). Pull out the slide to admit the wheat to the milling chamber and simultaneously start a stopwatch.
4. Turn the tube gently as it fills with ground corn and stop the watch when the base or the ground material reaches the calibration mark on the tube. Continue to collect the remainder of the ground material. The time to grind is an index of resistance to grinding.
5. Stop the mill and clean out the milling chamber with a brush and clear the holes in the grid between samples.
6. Measure the total column height of freshly ground grain. The total column height is an index of packing.
7. The ratio of coarse to fine particles by volume. Measure the column height of the fine particles and to obtain the coarse subtract the fine particle column height from the total column height. The ratio is expressed in Vol. C/F.
8. The ratio of coarse to fine particles as determined by weight with the coarse particles larger than 700-microns and fine particles smaller than 500-microns. The ratio is expressed in Wt. C/F.

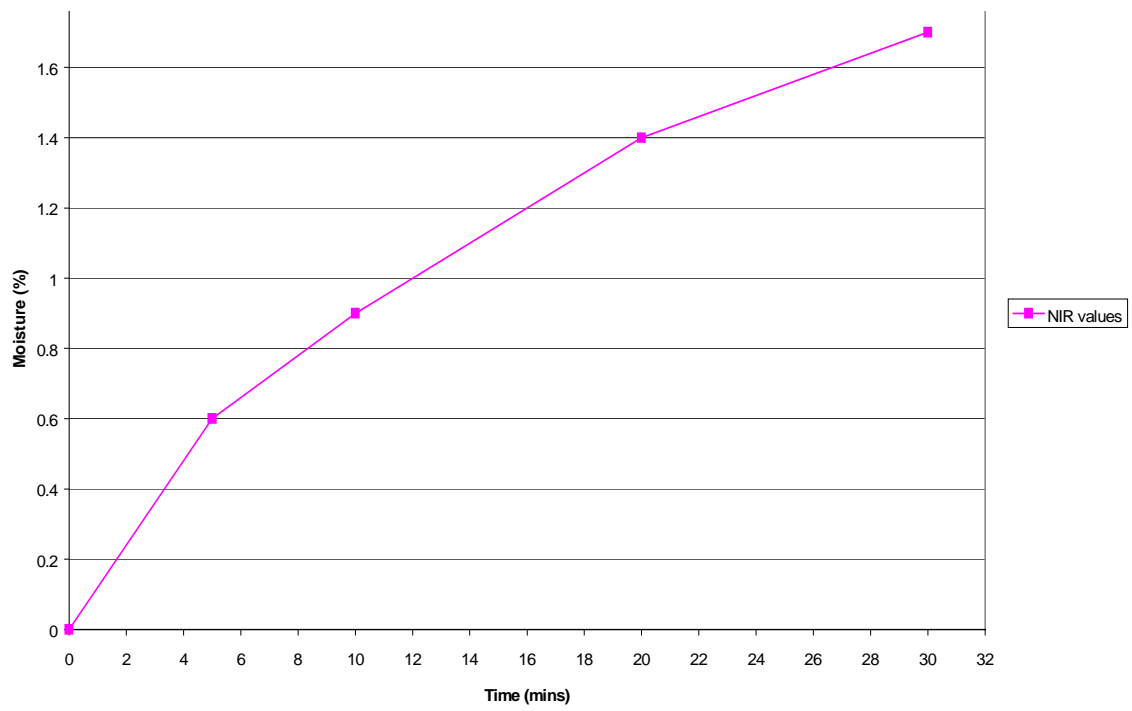


Figure 1. Temper moisture curve to prepare corn samples for Stenvert grinding test.

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural & Biosystems Engineering

By: Hurburgh, C.R. Jr.
Moizzudin, S.

NC 213 Objective: A Procedure: 1a

Project Objectives: Maintain a database of grain quality information.

Results for 2001: Since 1986, Iowa State University (ISU) and the American Soybean Association (ASA) have been surveying the quality of new crop soybean harvests. In response to a mailed request producers, representing all 29 soybean production states, provided samples of 2001 crop soybeans for analysis. Samples were analyzed for protein and oil contents using an Infratec near-infrared instrument (Foss North America, Eden Prairie, Minn.). From other sources, data on the yield and physical quality (U.S. Grade factors) of U.S. soybeans has been collected. Data was organized by state and region (groups of states). This is the same procedure that has been utilized for the 16 years of the survey.

The United States produced a record 2.92 billion bushels (79.5 million metric tons) of soybeans according to the November 1 USDA production estimates. Soybean yields, at 39.4 bushels per acre, were the second highest recorded and harvested acreage was at an all time high, exceeding the previous record set in 2000 by 2%. Yields were, however, on the 25-year trendline of increases.

Composition data are given in Table 1. Average U.S. protein and oil contents are almost exactly on the long-term averages of 35% protein and 19% oil. These soybeans will produce – again on average – 43.4 lbs of 48% protein meal and 10.8 lbs of oil per bushel. However, the long-term trend of increasing yield with consistent protein and oil was maintained.

Averages are not totally representative of the 2001 crop. The variability (standard deviation) within states, regions, and the U.S. was the largest in the 17 years of the survey. The north to south protein pattern (lower north, higher south) was also abnormally large (over 3 percentage points). Both situations can be attributed to variable climate patterns. Early rains delayed northern planting; mid-season dry weather retarded development. Early frost was experienced, which deprived soybeans of the late season growth that often increases protein content. According to trade experts, moisture content of harvested soybeans was also highly variable, related to maturity. Moistures will be around 12.5%-13.0% this year, slightly higher than historical averages.

Crop variability will cause differences among export cargoes. These will not be as large as those among states, but depending on the origin of grain for a shipment, there will be some fluctuation in composition. Requesting soybeans from specific locations may not be cost effective, however.

As the domestic market moves toward testing and pricing based on composition, actual component specifications in export contracts may become necessary.

Previous work on corn was published.

Plans for 2002: Continue the survey.

Publications:

Singh, S., L.A. Johnson, L.M. Pollak and C.R. Hurburgh, Jr. 2001. Compositional, physical and wet milling properties of accessions used in the germplasm of maize project. *Cereal Chemistry* 78(3):330-335.

Singh, S., L.A. Johnson, L.M. Pollak and C.R. Hurburgh, Jr. 2001. Heterosis in compositional physical and wet milling properties of adapted X exotic corn crosses. *Cereal Chemistry* 78(3):335-341.

Table 1. American Soybean Association 2001 soybean quality survey data.

Region	State	Number of Samples	Protein		Oil	
			Percent Average	Std. dev.	Percent Average	Std. dev.
Western Corn Belt (WCB)	Iowa	176	34.34	1.41	18.51	1.04
	Kansas	30	34.69	1.57	19.15	0.98
	Minnesota	118	33.18	1.73	18.65	1.04
	Missouri	67	35.61	1.49	18.56	0.95
	Nebraska	78	33.73	1.53	19.10	0.99
	North Dakota	22	33.36	1.41	18.73	1.21
	South Dakota	52	33.41	2.04	18.90	1.18
Averages	Western Corn Belt	543	34.05	1.76	18.71	1.06
Ranges	Western Corn Belt		(28.4 - 39.8)		(39.8 - 14.9)	
Eastern Corn Belt (ECB)	Illinois	228	34.94	1.71	19.57	1.02
	Indiana	112	36.05	1.49	19.05	0.93
	Michigan	31	35.88	1.27	19.07	0.89
	Ohio	74	35.77	1.54	19.19	1.02
	Wisconsin	27	34.23	1.64	18.71	0.82
Averages	Eastern Corn Belt	472	35.36	1.69	19.31	1.01
Ranges	Eastern Corn Belt		(29.5 - 39.8)		(16.2 - 22.96)	
Midsouth (MDS)	Arkansas	68	36.40	1.55	18.70	1.08
	Kentucky	14	36.56	1.39	19.15	0.83
	Louisiana	16	37.13	1.53	19.75	0.96
	Mississippi	19	37.15	1.79	19.11	1.03
	Oklahoma	2	36.30	1.98	19.60	1.41
	Tennessee	13	36.41	2.00	18.75	1.01
	Texas	2	32.85	3.32	20.70	0.42
Averages	Midsouth	134	36.56	1.70	18.98	1.09
Ranges	Midsouth		(30.5 - 41.2)		(15.4 - 21.7)	
Southeast (SE)	Alabama	9	37.73	1.82	19.01	1.49
	Florida	1	34.30	-	18.70	-
	Georgia	4	37.50	1.79	18.90	0.71
	North Carolina	28	35.51	1.52	19.10	0.98
	South Carolina	7	36.34	1.36	18.47	0.74
Averages	Southeast	49	36.17	1.80	18.97	1.03
Ranges	Southeast		(32.6 - 40.0)		(17.0 - 21.8)	
East Coast (EC)	Delaware	4	37.38	0.48	18.75	0.67
	Maryland	12	36.34	1.30	19.17	0.59
	New Jersey	6	35.60	2.76	19.60	0.65
	Pennsylvania	11	37.04	1.62	18.57	0.98
	Virginia	12	36.24	1.96	18.82	1.25
Averages	East Coast	45	36.48	1.77	18.95	0.94
Ranges	East Coast		(32.6 - 40.0)		(16.7 - 21.0)	
USA	Averages	1243	34.99	1.95	18.99	1.07
	Ranges		(28.4 - 41.2)		(14.9 - 22.96)	
	US 1986-2001 avg.		35.40		18.56	

Basis 13% moisture

GB\Surveys\soybeans\Data\2001\ASA01_Survey_Table.xls

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural and Biosystems Engineering

By: Hurburgh, C.R. Jr.

NC 213 Objective: A Procedure: 1a

Project Objectives: Provide grain quality data for soybean and corn variety trials.

Results for 2001: Various organizations often sponsor strip-style variety trials, in which 0.3-0.5 acre strips are planted with a check inserted periodically across the plot. Iowa State has been providing quality analyses for these plots.

Table 1 summarizes the plots involved. Weather conditions and planting dates caused abnormally large variations. Certain areas experienced severe drought in 2001.

Plans for 2002: Continue data collection; expand the placement of weather stations; and, correlate weather variables with composition and agronomic performance.

Table 1. Grain quality and yield data for county plots 2001.

County	<i>n</i>	Protein (%) (range)	Oil (%) (range)	Starch (%) (range)	Density (g/cm ³) (range)	Test Weight (lb/bu) (range)	Yield (bu/a) (range)
-----Corn Plots-----							
Adair	37	6.7 (5.8 - 8.4)	3.7 (3.2 - 4.4)	60.0 (56.6 - 61.3)	1.27 (1.24 - 1.30)	56.9 (55.8 - 58.6)	109.5 (87.4 - 129.5)
Benton	74	8.0 (6.5 - 9.3)	3.7 (2.7 - 4.2)	58.9 (57.3 - 60.3)	1.27 (1.24 - 1.32)	57.7 (54.1 - 59.1)	180.5 (106.1-221.4)
Blackhawk	50	7.3 (6.3 - 8.0)	3.7 (3.0 - 4.2)	58.9 (57.7 - 60.2)	1.25 (1.23 - 1.29)	55.8 (53.6 - 59.1)	188.6 (151.6 - 211.9)
Bremer	51	7.5 (6.4 - 8.4)	3.7 (3.3 - 4.0)	59.5 (58.3 - 60.6)	1.26 (1.23 - 1.29)	58.6 (56.3 - 61.3)	187.5 (156.6 - 208.5)
Cass	57	8.5 (6.9 - 10.1)	3.7 (3.1 - 4.1)	58.5 (56.6 - 59.7)	1.28 (1.25 - 1.31)	58.4 (56.6 - 61.0)	167.2 (143.5 - 187.7)
Clay	120	7.7 (6.4 - 9.1)	4.1 (3.1 - 5.9)	58.2 (56.0 - 59.9)	1.25 (1.20 - 1.29)	54.9 (50.8 - 57.8)	130.7 (93.7 - 173.7)
Iowa	36	8.0 (7.0 - 9.1)	3.4 (2.6 - 3.9)	56.9 (55.4 - 58.3)	1.25 (1.23 - 1.27)	55.5 (53.1 - 58.6)	195.0 (175.0 - 208.2)
Jones	2	7.8 (7.3 - 8.3)	3.0 (2.7 - 3.3)	57.7 (57.3 - 58.0)	1.24 (1.22 - 1.25)	55.0 (54.0 - 56.0)	217.2 (216.6 - 217.8)
Lee	9	7.4 (6.9 - 7.8)	3.4 (3.2 - 3.6)	61.1 (60.7 - 61.4)	1.29 (1.27 - 1.30)	59.0 (58.5 - 59.7)	155.4 (145.7 - 169.9)
Linn	88	7.2 (6.1 - 8.6)	3.7 (3.0 - 4.4)	58.9 (57.3 - 60.2)	1.25 (1.22 - 1.28)	56.9 (53.5 - 60.4)	183.6 (160.7 - 204.2)
Palo Alto	44	8.3 (7.2 - 9.1)	3.6 (3.2 - 4.1)	57.7 (56.1 - 59.3)	1.25 (1.22 - 1.28)	54.4 (50.5 - 59.5)	167.5 (138.8 - 192.1)
Wright	55	7.6 (7.0 - 8.5)	3.6 (3.2 - 4.2)	60.6 (59.5 - 61.7)	1.27 (1.25 - 1.29)	56.1 (54.1 - 57.7)	145.6 (131.3 - 165.7)
-----Soybean Plots-----							
				Fiber (%) (range)			
Adair	20	34.5 (33.6 - 35.7)	19.1 (18.5 - 19.8)	5.0 (4.9 - 5.2)			43.9 (39.1 - 49.7)
Adair RR	27	34.1 (32.8 - 35.2)	18.9 (18.2 - 19.6)	5.2 (4.9 - 5.4)			45.0 (37.5 - 51.7)
Blackhawk RR	41	35.3 (33.9 - 37.4)	18.5 (16.8 - 19.3)	5.1 (4.8 - 5.4)			55.0 (50.1 - 59.1)
Bremer	25	36.1 (34.7 - 37.2)	18.1 (17.1 - 19.0)	4.9 (4.7 - 5.2)			52.6 (45.9 - 65.2)
Bremer RR	45	35.4 (34.6 - 36.1)	18.1 (17.3 - 18.8)	5.0 (4.8 - 5.3)			51.3 (43.8 - 59.2)
Butler RR	9	33.0 (31.5 - 35.0)	18.7 (17.7 - 19.3)	5.3 (4.9 - 5.5)			15.1 (13.5 - 17.5)
Cass RR	34	33.4 (31.6 - 35.2)	19.8 (18.3 - 20.7)	5.4 (5.1 - 5.6)			56.6 (52.9 - 63.7)
Clay	30	35.4 (34.2 - 36.9)	17.7 (16.6 - 18.7)	5.5 (5.1 - 5.8)			44.0 (31.7 - 49.1)
Clay RR	70	35.4 (34.2 - 36.9)	17.9 (16.4 - 19.5)	5.5 (5.1 - 6.3)			48.1 (37.5 - 55.4)
Jones	30	35.9 (34.6 - 37.3)	17.0 (16.1 - 17.6)	5.2 (5.1 - 5.3)			26.6 (18.7 - 34.9)
Linn	48	35.6 (34.7 - 36.6)	18.6 (17.5 - 19.4)	5.0 (4.9 - 5.2)			60.1 (53.1 - 68.0)
Linn RR	61	35.2 (33.7 - 36.4)	19.0 (17.5 - 20.0)	5.1 (4.8 - 5.3)			58.1 (49.5 - 64.5)
Palo Alto	32	35.1 (34.1 - 36.3)	18.0 (17.0 - 18.7)	5.2 (4.9 - 5.5)			56.4 (47.3 - 62.3)
Wright RR	44	35.5 (33.6 - 36.8)	17.5 (16.9 - 18.4)	5.1 (4.8 - 5.2)			43.2 (35.1 - 51.2)

Corn data basis 15% moisture; soybean data basis 13% moisture.

NC-213 Progress Report for 2001

From: University of Nebraska-Lincoln
Department of Food Science & Technology

By: Jackson, D.S.

NC-213 Objective: A Procedure: 1a

Project Objectives: Characterize and identify corn hybrids and experimental (exotic) germplasm with superior end-use properties for wet milling, dry milling, and alkaline cooking (for tortillas and corn snacks).

Results for 2001: Five white corn hybrids were processed (nixtamalized) using 10 different processing conditions; tortillas were prepared to establish relationships between corn composition, physical characteristics, and nixtamalization process or product properties. Corn hybrids were characterized by proximate analysis and by measuring Stenvert hardness, Wisconsin breakage, percent floaters, TADD overs, thousand-kernel weight, and test weight. Corn characteristics were correlated with process and product variables (effluent dry matter loss and pH; nixtamal moisture and color; masa moisture, color, and texture; and tortilla moisture, color, and rollability). Process and product variables such as corn solid loss, nixtamal moisture, masa texture, and tortilla color were influenced not only by processing parameters (cook temperature, cook time, and steep time) but also depended on corn characteristics. Significant regression equations were developed for nixtamalization dry matter loss ($P < 0.05$, $r^2 = 0.79$), nixtamal moisture ($P < 0.05$, $r^2 = 0.78$), masa gumminess ($P < 0.05$, $r^2 = 0.78$), tortilla texture ($P < 0.05$, $r^2 = 0.77$), tortilla moisture ($P < 0.05$, $r^2 = 0.80$), tortilla calcium ($P < 0.05$, $r^2 = 0.93$), and tortilla color a value ($P < 0.05$, $r^2 = 0.87$). It can be concluded that, although processing variables primarily affect nixtamalization and product characteristics (overall larger contribution to regression r^2 values), several factors, such as corn composition and hardness characteristics, critically influence nixtamalization. It is important to understand such relationships for proper selection of corn hybrids suitable for specific nixtamalization needs.

Plans for 2002: Additional research efforts will focus on developing small-scale tests, suitable for breeders samples, that allow prediction of alkaline processing characteristics. In addition, sorghum will be incorporated into some of our studies.

Publications:

Sahai, D., J.P.Mua, I. Surjewan, M.O. Buendia, M. Rowe, and D.S. Jackson. 2001. Alkaline processing (Nixtamalization) of white mexican corn hybrids for tortilla production: Significance of corn physico-chemical characteristics and process conditions. Cereal Chem. 78(2):116–120.

Impacts: Issue: Although alkaline cooking (nixtamalization) is one of the major uses of food-grade corn, identification of corn traits that impact processing characteristics continues to be lacking. Although additional study is required, the publication cited in this report outlines several corn traits that result in superior nixtamalization properties. Major corn

purchasers for this industry have already begun to test for these traits when applicable to their process.

What Was Done: Corn with various traits has been alkaline cooked in a near-commercial size processing facility. Key traits that influence processing characteristics have been identified.

NC-213 Progress Report for 2001

From: Purdue University
Agricultural & Biological Engineering

By: Maier, D.E.
Reising, J.D.
Day, K.M.
DeVillez, P.
Christmas, E.

NC-213 Objective: A Procedure: 1a

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

Title: Intrinsic properties and end use value determination for corn and soybeans.

Results for 2001: This project has focused on (1) the quantification of composition (protein, oil and fiber) and end use value of soybean samples collected as part of the Performance of Public and Private Soybeans in Indiana between 1996-99, and soybean samples collected from selected county plots and farmers' fields in 1998-1999 in Southwest Indiana, and (2) the development of premium schedules for soybean protein and oil content based on regional differences of production in Indiana over multiple years. Preferable soybean varieties for farmers and processors that add value due to their combined higher agronomic and processing yield could not be identified primarily because the top selling varieties were significantly under represented in the four year data set of the Performance of Public and Private Soybeans in Indiana. The sum of protein and oil (P+O) was found to be a useful indicator of processing value. The southeast part of the state had consistently the most valuable soybeans (with respect to P+O) compared to the other four regions. Based on data from farmers' fields in Southwest Indiana, an earlier planting date showed a positive correlation on agronomic yield and end use value. Also, yield had 8-35 times greater variability throughout a field compared to composition, thus samples taken from trucks were statistically representative of each field in terms of processing value. A component pricing system for commodity soybeans for five Indiana regions was developed that could be used as a model to pay value added premiums based on composition analysis at the first point of sale. The development of separate protein and oil premium schedules indicated that producers could capture over \$2 million in value-added premiums a year if they received 10% of the theoretical added value in soybeans grown in Indiana. Future premiums would serve as an incentive for farmers to select soybean varieties based on agronomic yield and end use value. The delivery of soybeans with more uniformly higher protein and oil contents would also benefit soybean processors by improving their product yields and processing efficiencies.

Plans for 2002: Expand the analysis of corn and soybean samples from Indiana private, county and statewide variety test plots.

Quantify the Estimated Processed Value (EPV) per bushel for corn and soybean samples.

Confirm observed trends over multiple years and maximize the end-use value through better variety selection and improved site-specific farming practices.

Publications:

Reising, J.C. 2001. Analysis of soybean composition variation and end use value determination in Indiana. Unpublished M.S. Thesis, Purdue University, West Lafayette, IN.

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 Was 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 35,000 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 have 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 five years, and through press releases and extension publications. The economic gain in marketing specific quality traits to Indiana corn and soybean producers is significant. 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 Value Added Grant Program, Consolidated Grain & Barge Company

Contacts:

Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University, Phone: 765-494-1175, Fax: 765-496-1356, e-mail: maier@ecn.purdue.edu

NC-213 Progress Report for 2001

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

By: Pratt, R.C.
Thomison, P.R.
Beuerlein, J.E.

NC-213 Objective: A Procedure: 1a

Project Objectives: 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 2001: One grain sample of each soybean cultivar entered in 1 test in the appropriate maturity region, and 3 samples of each maize hybrid in 1 test within each of three regional tests, were analyzed using the Tecator 1225 whole grain near-infrared transmittance analyzer and Compositional Systems System One calibrations. Two hundred and sixty-nine corn, and 190 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 Southwestern and West Central 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 Roundup Ready beans showing a wider range in both protein and oil concentration. Average oil and protein concentrations were slightly higher in 2001 than in 2000. Normal varieties tended to have a larger seed size (10% fewer seeds per pound) than Roundup Ready varieties.

Plans for 2002: A database documenting regional and seasonal variations in compositional data in Ohio will be generated.

Publications:

2001 Ohio Corn and Soybean Performance Trials. Ohio's Country Journal, November 2001.
Dept. of Horticulture and Crop Science: Soybean Series 212 and Corn Series 215
available at <http://www.ag.ohio-state.edu/~perf>.

Issues: 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 Was 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.

Impacts: 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

Contacts:

Rich Pratt, NC-213 Ohio Representative, Department of Horticulture and Crop Science, OARDC/OSU, T: 330-263-3972, F: 330-263-3887, email: pratt.3@osu.edu.

Thomison, Peter, Corn Performance Test, Department of Horticulture and Crop Science, OARDC/OSU, T: 614-292-2373, F: 614-292-7162, email: thomison.1@osu.edu.

Beuerlein, James, Soybean Performance Trials, Department of Horticulture and Crop Science, OARDC/OSU, T: 614-292-9080, F: 614-292-7162, email: beuerlein.1@osu.edu.

Table 1. Grain Quality of Corn Hybrids in Ohio, 2001.

Region or location	-----Number-----		---- Protein % ---		-----Oil % ----		-----Starch %-----	
	hybrids	locations	mean	range	mean	range	mean	range
Southwestern and West Central	101	3	8.7	7.7 – 9.5	3.7	3.3 – 4.2	61.3	59.8 – 62.8
Northwest	104	3	8.1	7.3 – 9.4	3.7	3.3 – 4.0	61.8	60.3 – 63.4
Northcentral and Northeastern	64	3	8.4	7.6 – 9.3	3.7	3.4 – 4.1	61.6	60.0 – 63.1

Compositional data are expressed at 15.0% moisture basis.

Table 2. Grain Quality of Soybean Cultivars in Ohio, 2001.

Entry Type	No. of entries	----- Protein % -----		----- Oil % -----		----- Seeds/Lb. -----	
		mean	range	mean	range	mean	range
Roundup Ready	154	41.1	37.8 - 45.7	20.9	18.2 - 22.9	3160	2510 - 3730
Normal	36	41.1	38.3 - 42.8	20.7	19.4 - 22.5	2830	1830 - 3500

Compositional data are expressed at 13.0 % moisture basis.

NC-213 Progress Report for 2001

From: Texas A&M University
Soil & Crop Sciences Department

By: Rooney*, L.W.
Betran, J.
Waniska, R.D.

NC-213 Objective: A Procedure: 1a

Project Objectives: 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 2001: Several new sorghum snack foods were developed from identity preserved US white sorghum in Japan. Commercial sales in Japan continue to expand. The hybrids used are derived from Atx631XRTx436 released from TAES several years ago.

New white and red tan plant sorghum hybrids with promising properties were identified in white tan plant hybrid trials grown across the sorghum belt.

Several new earlier maturity food hybrids are nearing commercial reality. Market development in Asia and Mexico was expanded by the Grains Council with assistance from data obtained in this project.

NIR and single kernel hardness instruments were used to evaluate sorghum quality. Calibration equations for NIR data from more than 100 whole kernel sorghum samples were developed for a Pertin 7000DB.

Milling evaluation of food type sorghums include adjustment of the milled product yields to a constant acceptable color. This clearly indicated significant differences among food type sorghums. The Clorox bleach test for tannin sorghums sometimes gives erroneous results for weathered sorghum. Clear-cut standards must be run since weathered kernels bleach into discolored kernel that can be improperly classed as tannin sorghum.

Nutraceuticals from tannin and black sorghum brans are promising. Bread with high antioxidant, soluble and insoluble dietary fiber and omega -3 fatty acid levels was produced by a bread mix

containing sorghum bran, gluten, flax, barley and other ingredients. It gives a dark natural color with great taste and texture comparable to variety breads.

Tortillas were produced using corn tortilla equipment from barley flours. Barley tortillas have excellent flexibility with a significantly different taste that varies depending upon the variety. Low levels of barley flour give some improvement of texture of dry masa table tortillas, which are probably related to beta-glucan properties. Amylose and beta-glucan content affect the tortilla properties of the barley flours.

Corn table tortilla texture was not significantly improved by addition of different levels of emulsifiers and shortenings. Staling of tortillas is quick and a real challenge to control in a cost effective manner. Enzymes in combination with other additives look promising but maybe too costly.

The quality of wheat flour for tortillas is quite different from bread flour quality. A pilot scale lab test using 1kg of flour was used to determine the tortilla baking properties of several wheat flours. Significant differences among flours exist that are related to protein content and quality. Strong gluten flours produce tortillas with reduced diameter and opacity. Leavening affects the opacity and thickness and keeping properties of flour tortillas significantly. Wheat samples were evaluated for milling and bread baking quality with emphasis on early generation testing.

Plans for 2002: Evaluate factors affecting processing quality of corn and sorghum. Compare extrusion properties of sorghum with corn and rice. Develop calibration equations for use of NIR on whole grains of sorghum, maize and their products, e.g., masa, chips, tortillas. Determine factors affecting the staling of flour and corn tortillas. Determine quality of wheat samples emphasizing early generation progeny. Test wheat flours and other ingredients for tortilla quality.

Publications:

Lusas, E. and L.W. Rooney (eds.). 2001. *Snack Foods Processing*.

Dombrink-Kurtzman, M.A. and L.W. Rooney. 2001. Effect of nixtamalization on fumonisin-contaminated corn for production of tortillas. *Effects of Food Processing Bioactive Compounds in Foods* (In press).

Serna-Saldivar, S.O., M.H. Gomez, and L.W. Rooney. 2001. Food uses of regular and specialty corns and their dry-milled fractions, chapter 11 in *Specialty Corns: Second Edition*, Hallauer (ed.).

Rooney, L.W. and E.L. Suhendro. 2001. Food quality of corn, chapter 3 in *Snack Foods Processing Book*, E. Lusas and L.W. Rooney (eds.).

McDonough, C.M., M.H. Gomez, L.W. Rooney and S.O. Serna-Saldivar. 2001. Alkaline-cooked corn products, chapter 4 in *Snack Foods Processing*. E. Lusas and L.W. Rooney, (eds.).

- Huang, D.P. and L.W. Rooney. 2001. Starches for snack foods, chapter 5 in *Snack Foods Processing*. E. Lusas and L.W. Rooney (eds.).
- Betran, J., A.J. Bockholt, A.J., L.W. Rooney. 2001. Blue corn, chapter 10 in: *Specialty Corns: Second Edition*, A. Hallauer (ed.).
- Waniska, R.D. 2001. Evaluation methods and quality control for snacks, chapter 24 in *Snack Foods Processing Book*. E. Lusas and L.W. Rooney (eds.).
- Beta, T., H. Corke, L.W. Rooney and J.R.N. Taylor, J.R.N. 2001. Starch properties as affected by sorghum grain chemistry.
- Beta, T., H. Corke, L.W. Rooney, J.R.N. Taylor. 2001. Effect of steeping treatment on pasting and thermal properties of sorghum starches
- Waniska, R.D., F.P. Bejosano, A. Chandrashekar, J. Jayaraj, J. Jeoung., S. Krishnaveni, G.H.Liang, S. Muthukrishnan, and R.T. Venkatesha, 2001. Antifungal proteins and other mechanisms in the control of sorghum stalk rot and grain mold.
- Beta, T., L.T. Marovatsanga, L.W. Rooney, and J.R.N. Taylor. 2001. Effect of chemical treatments on polyphenols and malt quality in sorghum. (in press).

Thesis and Dissertation:

- Chinnapha, N. August 2001. Effects of amylose and amylopectin on quality of rice noodles. MS Thesis. Texas A&M University, College Station, Texas.
- Gordon, L.A.. December 2001. Utilization of sorghum brans and barley flour in bread. MS Thesis. Texas A&M University, College Station, Texas.
- Mitre-Dieste, M. December 2001. Barley tortillas and barley flours in corn tortillas. MS Thesis. Texas A&M University, College Station, Texas.
- Kelekci, N.N.. August 2001. The effects of flour types and storage temperatures on the staling of wheat flour tortillas. MS Thesis. Texas A&M University, College Station, Texas.
- Zelaya, N. May 2001. Characterization of tortillas and tortilla chips from sorghum varieties high in phenolic compounds. MS Thesis. Texas A&M University, College Station, Texas. 129 pp.

Reports:

- Rooney, L.W. 2001. Food and nutritional quality of sorghum and millet, Project TAM-226. INTSORMIL Annual Report 2001, University of Nebraska, 54 Nebraska Center, Lincoln, NE 68583 (in press).

Abstracts/Presentations:

- Awika, J.M., L.W. Rooney and R.D. Waniska. 2001. Exploring the potential of specialty sorghum bran fractions as a source of antioxidants. AACC 86th Annual Meeting, October 14-17, Charlotte, NC
- Bejosano, F.P., R.R. Klein, L.W. Rooney, L.W., W.L. Rooney and R.D. Waniska. 2001. Antifungal proteins in commercial hybrids and elite sorghums. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- Bueso, F., L.W. Rooney and R.D. Waniska. 2001. Anti-staling properties of fat in corn tortillas. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- Garza-Casso, J.B., L.W. Rooney and R.D. Waniska. 2001. Fumaric acid induced changes in pH of flour tortillas. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- McDonough, C.M., Rooney, L.W., E.L. Suhendro. 2001. Effect of freezing on the generation of artifacts in samples viewed with the environmental scanning electron microscope. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- Mitre-Dieste, C.M., N.P. Ames, N.P., L.W. Rooney, R.D. Waniska. 2001. Barley tortillas: effects of amylose and beta-glucan content. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- Suhendro, E.L., D.G. Gualberto, C.M. McDonough, R.D. Waniska, L.W. Rooney. 2001. The effect of soy products and dry gluten on corn tortilla properties. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- Suhendro, E.L., D.G. Gualberto, C.M. McDonough. 2001. Staling in corn tortillas. AACC 86th Annual Meeting, October 14-17, Charlotte, NC.
- Bueso, F., L.W. Rooney and R.D. Waniska. 2001. Anti-staling properties of vegetable shortening on corn tortillas. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA, section 20.
- McDonough, C.M., L.W. Rooney and E.L. Suhendro. 2001. Effect of added gluten on the structure and staling of corn tortillas. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA, section 20.
- Suhendro, E.L., C.M. McDonough and L.W. Rooney. 2001. The effect of soy products on corn tortilla qualities. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA., section 21.
- Yeggy, H., C.M. McDonough, L.W. Rooney, E.L. Suhendro, N. Zelaya. 2001. Effects of high oil and high amylopectin Content on the Texture of Corn Tortillas. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA.

- Zelaya, N., L.W. Rooney, E.L. Suhendro, H. Yeggy. 2001. Characterization of table tortillas from sorghum high in phenolic compounds. Proceedings of the Tortilla Industry Association Seminar, May 20-23, City of Industry, CA. 22:1-4
- Adams, J.L. and R.D. Waniska. 2001. Effect of hot-press dwell time and pressure on wheat flour tortilla properties. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA, section 23.
- Cepeda, M., F.P. Bejosano, L.W. Rooney, R.D. Waniska. 2001. Effects of leavening acids and dough temperature in wheat flour tortillas. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA, section 24.
- Mitre-Diestre, C.M., N.P. Ames, L.W. Rooney, R.D. Waniska. 2001. Barley tortillas: effects of amylose and beta-glucan content. Tortilla Industry Association Seminar, May 20-23, Los Angeles, CA, section 27.
- Bejosano, F.P., R.R. Klein, L.W. Rooney, W.L. Rooney and R.D. Waniska. 2001. Antifungal proteins in commercial hybrids and elite sorghums. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN, p. 84.
- Mitre-Dieste, C.M., J. Awika, L.A. Gordon, L.W. Rooney and E.L. Suhendro. 2001. Cookies made with sorghum brans high in phenols and catechins. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN, p. 54.
- Rooney, W.L., S.D. Collins, D. Pietsch, L.W. Rooney, 2001. The tan plant hybrid sorghum test - purpose, use and function. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN., p. 35-36.
- Zelaya, N., L.W. Rooney, E.L. Suhendro and H. Yeggy. 2001. Characterization of table tortillas from sorghum high in phenolic compounds. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN, p. 55.
- Proceedings/Presentations:
- Awika, J.M., L.W. Rooney and R.D. Waniska. 2001. Exploring the potential of sorghum phenols as antioxidants. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN, p. 103-107.
- Bueso, F., P. Carrillo, J. Medina, L.W. Rooney and E.L. Suhendro, E. 2001. Quality and shelf stability of alkaline cooked products made with food-type sorghums versus corn. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN, p. 116-120.

Gordon, L.A., J. Awika, L.W. Rooney, and E.L. Suhendro and R.D. Waniska. 2001. Characteristics of breads baked with sorghum brans high in phenolic compounds. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN, p. 98-102.

Rooney, L.W. 2001. Food sorghums-perspectives and marketing. 2001 Sorghum Industry Conference & 22nd Biennial Grain Sorghum Research and Utilization Conference, February 18-20, Nashville, TN.

Rooney, L.W. 2001. Future sorghum food and industrial utilization markets. 4th Australian Sorghum Conference. February 5-8, 2001, p. 40-44.

Rooney, L.W. 2001. White food sorghum technology. US Grains Council, Sorghum Food Product Development Project Seminar, June 19-21, Tokyo, Japan.

Issues: Sorghum quality for food is alleged to be inferior and sorghum is used only as livestock feed in the Western Hemisphere. Sorghum food quality must be improved to capture food and ingredient markets.

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 Was Done: New sorghum hybrids with significantly improved food characteristics were 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.

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.

Impacts: 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 producers to plant food sorghums. Value added products for ethnic and dietary markets are being sold with excellent results. 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. Information and grain samples were supplied to potential Japanese food processors by US Grains Council. L. Rooney provided technical assistance in Japan and Mexico. New markets for food sorghum are possible.

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, dry masa processors, snack producers, and tortilla and snack food companies to secure optimum quality corn for processing.

NC-213 Progress Report for 2001

From: National Center for Agricultural Utilization Research, USDA
Agricultural Research Service
Peoria, IL

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

NC-213 Objective: A Procedure: 1a; 1b

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

Results for 2001: The aflatoxin and fumonisin in grain at harvest is found concentrated at high levels in a relatively few corn kernels and our research seeks to accurately identify and remove these toxin-contaminated kernels from contaminated grain lots. ARS Scientists in Manhattan, KS, in collaboration with an ARS scientist in Peoria, IL, obtained near infrared spectra for corn kernels with symptoms of *Aspergillus flavus* or *Fusarium verticillioides* infection, and also asymptomatic kernels. After spectra acquisition, each kernel was analyzed for aflatoxin or fumonisin. More than 97% of the aflatoxin contaminated kernels were correctly classified as containing either high (> 100 ppb) or low (< 10 ppb) levels of aflatoxin and nearly 100% of the fumonisin contaminated kernels were correctly classified as containing high (> 100 ppm) or low (< 10 ppm) levels of fumonisin.

Plans for 2002: Determine if resistance to seed coat tearing contributes to the demonstrated aflatoxin resistance of several corn varieties, in collaboration with D.G. White, University of Illinois.

Investigate the potential importance of endophytic fungi antagonistic to *A. flavus* in confounding the interpretation of corn varietal trials for aflatoxin resistance, in collaboration with D.G. White, University of Illinois.

Describe novel anti-fungal metabolites produced by corn endophytes, in collaboration with J.B. Gloer, University of Iowa.

Classify corn kernels infected by several common species of kernel rotting fungi that do not produce aflatoxin or fumonisins and acquire near infrared spectra to be used in building computer models for automatic detection and segregation of mycotoxin contaminated grains, in collaboration T. Pearson, ARS, USGMRL, Manhattan, KS.

Publications:

Calvo, A.M., H.W. Gardner, and N.P. Keller. 2001. Genetic connection between fatty acid metabolism and sporulation in *Aspergillus nidulans*. *Journal of Biological Chemistry* 276:25766-25774.

Gardner, H.W. and M. Grove. 2001. Method to produce 9(S)-hydroperoxides of linoleic and linolenic acids by maize lipoxygenase. *Lipids* 36: 529-533.

Wicklow, D.T. and C.P. Kurtzman. 2000. In Memorium - Clifford W. Hesseltine (1917-1999).
Mycotoxins. 50: 1-2.

Issues: 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 (this work was not continued following the retirement of H.G. Gardner in 2001).

What Was Done: Calibrations were developed based on NIR spectra that allow for the accurate detection of individual aflatoxin or fumonisin contaminated kernels within a grain bulk. The data will be used in building spectral and other features of classification into computer models for automatic detection and segregation using high volume commercial optical sorters for grains and oil seeds.

Impacts: The ability to accurately classify individual aflatoxin or fumonisin contaminated kernels, including those with symptomless infections presents opportunities for detection of these grains in a variety of applications including the rapid evaluation of grain samples from corn variety trials for mycotoxin resistance.

NC-213 Progress Report for 2001

From: Kansas State University
Department of Grain Science and Industry

By: Herrman, T.J.
Bramble, T.
Loughin, T.

NC-213 Objective: A Procedure: 1b

Project Objectives: Analyze the protein variability among individual kernels within a head, between plants, locations within a field, fields, and cultivars. These results will enable us to: 1) Assess the best sampling strategy for identifying protein variability during harvest and 2) Establish realistic goals for controlling wheat quality variation through segregation.

Title: Wheat Protein Variance Component Structure in Kansas

Results for 2001: A hierarchical sampling design used to map the variance structure included fields, plots within fields, rows within plots, plants within rows, heads on a single plant, spikelet position on a single head, and kernels within a spikelet. Individual kernels (10,150) were collected from 47 fields of Jagger, 2137, Ike, and TAM 107 and evaluated for protein content using an SKCS 4170 system equipped with single kernel diode array near infrared (NIR) system. Five hundred kernels were selected as the model development set and reference protein content was determined using a Leco combustion nitrogen analyzer. The resulting model had a standard error of cross validation (SECV) of 1.21% and $r^2 = 0.84$. The model was most accurate with Jagger kernels where the SECV was 0.93%, and $r^2 = 0.90$. It was least accurate with TAM 107 kernel where the SECV was 1.52%, $r^2 = 0.85$

The kernel protein variance component analysis revealed that all components except spikelet were statistically significant ($P < 0.05$) for varieties Jagger, 2137, and Ike. For TAM 107, the field and plant components were not significant, however, the remaining components were significant ($P < 0.05$). We found that the field and plot components contributed the greatest amount of variance within the hierarchy for Jagger, 2137, and Ike. For TAM 107, plot contributed the greatest source of variance. The least squares means were calculated for the fixed effect spikelet position on a head and all four varieties possessed a significant protein gradient in which the highest protein content occurred at the base of the head and the lowest protein content at the top.

Another hierarchical sampling procedure was employed in an attempt to measure protein variability, as it exists in a local wheat-producing region. In total, 276 trucks were sampled from 89 fields located primarily in Stanton and Morton Counties. Six varieties - 2137, Ike, Jagger, Quantum, and TAM 107, and TAM 110 - were received in a sufficient number of trucks to warrant inclusion in this study. The analysis of variance for the components Field, Truck, and Sample resulted in significant contributions to the overall variance as measured at the $\alpha = 0.05$ level. Estimates of the protein variance for the six varieties included in this study were

calculated with the greatest variance occurring among fields and decreasing proportionately through the Truck and Sample components.

Plans for 2002: Complete data analysis for 2001 harvest results and develop sampling recommendation.

Publications:

Bramble, T., T.J. Herrman, T. Loughin, and F. Dowell. 2001. Single kernel protein variance structure in commercial fields in western Kansas. Crop Science, accepted.

Bramble, T. 2001. Wheat protein variance components in a commercial production system M.S. Thesis, Dept. of Grain Science and Industry, Kansas State University.

Issues: Controlling variability is an important step in improving wheat quality. This study provides a current assessment of the amount of variation that exists in a commercial wheat production system.

Impacts: The results of this study are being used to develop sampling and marketing plans for identity preserved wheat.

Funding Sources:

Kansas Wheat Commission, Kansas Dept. of Commerce and Housing Ag. Product Development Division, Kansas Agricultural Experiment Station.

Contacts:

Tim Herrman, Department of Grain Science and Industry, phone: (785) 532-4082, tjh@wheat.ksu.edu

NC-213 Progress Report for 2001

From: Kansas State University
Department of Grain Science and Industry

By: Herrman, T.J.
Shroyer, J.P.

NC-213 Objective: A

Procedure: 1b

Project Objectives: Maximize the value of new hard white (HDWH) wheat cultivars developed by the Kansas Agricultural Experiment Station. Recent activities include: 1) Conduct farmer focus groups to assess reasons for deciding whether or not to plant HDWH and 2) Improve hard white wheat yield and quality through identifying the blend of two varieties (Trego and Betty) that optimizes agronomic and processing performance.

Title: Hard White Wheat Commercialization in Kansas

Results for 2001: A partial analysis of variance (ANOVA) are presented are presented in Table 1. The least square means for significant main effects and two-way interactions indicate that a minimum of 30 percent Betty is necessary in a Trego:Betty blend to augment loaf volume and maintain satisfactory yields.

Table 1. ANOVA results for mixture experiment.

Variable	Model Pr>F	R-Square	Loc Pr>F	Blend Pr>F	Loc*Blend Pr>F
Protein Diff	<.001	0.62	0.02	<.001	0.68
Test Wt. Diff	.046	0.48	0.004	0.33	0.11
Yield Diff	<.001	0.62	0.002	0.10	0.002
Flour Diff	0.07	0.46	<.001	0.27	0.58
Volume Diff	0.42	0.37	0.94	0.04	0.77

Plans for 2002: Repeat Field Test: Agronomic performance of Betty and Trego blends will be evaluated for a second year at the same four locations in western Kansas. Single variety checks for Trego and Betty will be included at each site. Total grain yield, test weight, and single kernel characterization measurements will enable us to assess agronomic and economic benefits derived from blending.

Processing Performance Evaluation: Milling, dough testing, and baking performance evaluations for each blend will enable us to assess the effect of field blends on end-use performance. Flour extraction measures involve milling 1000 g wheat on a Quadramat Senior laboratory mill. Flour water absorption and tolerance will be measured on a Brabender Farinograph. Bake tests will be performed using the 100 g straight dough pup-loaf technique.

Publications:

Eberle, B, J. Shroyer, and T. Herrman. 2001. Factors affecting decisions by producers whether or not to plant white wheat in western Kansas. Internal document, Kansas State Univ. Manhattan.

Issues:

The transition of Kansas wheat production from hard red winter (HRW) to the hard white (HDWH) class involves overcoming several economic constraints. The limited number of varieties increases producer risk, particularly, as it relates to disparities in grain yield and quality. The HDWH variety Betty tends to display a higher protein content compared to Trego while Trego displays superior yield potential. Combining these traits into a single field through mixing seed to pre-determined ratios offers the possibility of achieving high yield, good protein content, and good protein quality.

Thus, the purpose of this study involves identifying seed blends of Trego and Betty HDWH wheat cultivars that optimize yield and quality in an attempt to maximize profitability for Kansas wheat farmers, speed adoption of HDWH, and minimize producer risk resulting from limited commercial varieties adapted for western Kansas.

Impacts:

HDWH wheat plantings increased to 150,000 acres for the 2001 harvest. The presence of stripe rust during the growing season reduced grain yield of Trego and total acres sown to HDWH in 2001 increased to only 200,000 acres. Absence of good HDWH cultivars will continue to limit growth in acres planted to this class of wheat. Focus groups helped identify the major issues that prevent farmers from planting HDWH.

Funding Sources:

Kansas Wheat Commission, Kansas Dept. of Commerce and Housing Ag. Product Development Division, Kansas Agricultural Experiment Station.

Contacts:

Tim Herrman, Department of Grain Science and Industry, phone: (785) 532-4082, tjh@wheat.ksu.edu

Jim Shroyer, Department of Agronomy, phone; (785) 532-0397, jshroyer@oznet.ksu.edu

NC-213 Progress Report for 2001

From: Purdue University
Agricultural & Biological Engineering

By: Maier, D.E.
Berruto, R.

NC-213 Objective: A Procedure: 2

Project Objectives: The main goal of this project is to use the system simulation approach to improve the efficiency and economics of the receiving operation at commercial grain elevators.

Title: System modeling of grain handling operations

Results for 2001: Different ways to increase the throughput of the unloading operation for country elevators have been investigated by means of a discrete event system simulation model. The investigation has focused on improvements regarding: pit holding capacity and dimensions, conveyor flow rates, relocation of scale and probing stations, and adoption of electronic data transmission within the elevator. The model has been validated against the performance of a large commercial midwestern grain elevator and has been used to verify the feasibility of different facility improvements. The parameter used to compare the performance of the different elevator configurations is the average service time per customer, expressed as the difference between the moment the truck enters and leaves the system. It includes all unit operation times and waiting times incurred by each truckload delivered to the grain elevator. Preliminary results for one facility indicate that enlarging the pit size in order to dump the two hoppers of a semi truck trailer without moving it back and forth would yield a 50 sec. saving of time for each load. For 327 trucks arriving on a busy day this would result in service times of about 32 min per load for the proposed configuration vs. 59 min per load for the elevator in its present configuration. This 46% improvement will increase the throughput capacity of the elevator significantly, and for farmers it will reduce the cycle time per load, which will increase the crop harvested per day without having to add additional transportation equipment from the field to the elevator.

Plans for 2002: Develop additional facility-specific models and use them in order to study unloading strategies for commodity grains at commercial grain handling facilities.

Perform simulation runs to evaluate the impact of IP and GM grains and oilseeds on unloading operations, and simulate logistics changes to improve system performance.

Publications:

Berruto, R. and D.E. Maier. 2001. Analyzing the receiving operation of different grain types in a single pit country elevator. ASAE Transactions. 44(3):631-638.

Berruto, R. and D.E. Maier. 2001. Using modeling techniques to test the feasibility of segregating non-GM soybeans at commercial elevators. Paper No.01-6062. ASAE, St. Joseph, MI.

Issues: Increased globalization of agricultural markets and the introduction of genetically modified (GM) crops through biotechnology have created a need for further investigation of the U.S. grain handling infrastructure to segregate cereals and oilseeds in order to remain the world's least cost provider of safe and wholesome foods and feeds. This research addresses the study of grain unloading operations at country elevators using system simulation methodology. The differentiation of crops (Genetically Modified crops, Identity Preserved crops, etc.) increases the burden of elevators, which need to handle the same or greater amounts of grain, but with an increased number of crop types to be segregated. This fact poses a significant challenge for operators in terms of unloading, drying, and storage of different grains in facilities that were built to handle few commodities (corn, wheat and soybeans).

What Was Done: The goal of this project is a system simulation study of country elevators to improve the efficiency and the economics of grain handling. The study, rather than addressing the economic value of the operation with respect to IP or non-GM grains, will analyze different simulated scenarios (product arrival, logistic of the system, management strategies, external drivers of change like market forces and regulations) in order to provide strategies to better manage the grain receiving operation.

Impacts: Creation of an object oriented grain handling system software package will enable elevator operators to test the flexibility of their current facility or create their ideal grain handling facility with all its equipment in a simple click and drag type format. A system simulation and economic analysis tool would allow them to define the operating conditions at their elevator (e.g. truck size distribution, type of grain, delivery rate), estimate average delay time and queue length, and quantify the least cost segregation strategy. Additionally, this approach holds the future potential for a grain company (or merging companies) to link multiple individual elevator facility models together and evaluate the optimization of combined system network resources.

Funding Sources:
USDA-NRI

Contacts:
Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University, Phone: 765-494-1175; Fax: 765-496-1356; e-mail: maier@ecn.purdue.edu

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

NC-213 Progress Report for 2001

From: National Center for Agricultural Utilization Research, USDA
Agricultural Research Service
Peoria, IL

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

NC-213 Objective: A Procedure: 2a

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

Results for 2001: An *in vitro* method was developed for evaluating the effects of fungal competition on *A. flavus* growth, sporulation, and aflatoxin. All strain pairings with *A. flavus* resulted in toxin inhibition but the amount depended strongly on the two strains involved and the proportion of spores from each strain. The *in vitro* method can be used to identify superior microbial competitors of *A. flavus* and has proven useful in interpreting mechanisms of intraspecific competition;

Aspergillus oryzae and *Aspergillus sojae*, used in the production of traditional Oriental fermented beverages or foods, are identified in a recent U.S. Patent as safe non-aflatoxin producing 'biocompetitive agents' for controlling aflatoxin in susceptible grains and oil seeds. DNA fingerprinting was performed on 80 cultures of *A. oryzae* and *A. sojae* deposited with the ARS Culture Collection between 1909 and 1988. Identical DNA fingerprints were produced by multiple cultures of *A. sojae* and *A. oryzae* obtained from different food fermentations, locations, and years. Our research has shown that *Aspergillus* isolates producing identical DNA fingerprints are vegetatively compatible and capable of forming a common filamentous network. This information will enable scientists to combine cultures with unique physiological or biochemical adaptations to produce a superior 'biocompetitive' inoculum.

Fungi that parasitize other fungi were shown to be a source of novel anti-fungal chemicals in bioassays using the two most important mycotoxin-producing fungi infecting corn, *A. flavus* and *Fusarium verticillioides*. These ongoing studies are contributing to a growing database that will be useful in interpreting structure function relationships and potential cellular targets in *Aspergillus* and *Fusarium*. Newly discovered bioactive compounds are being further tested by the animal health and pharmaceuticals industry, in collaboration with J.B. Gloer, University of Iowa.

Plans for 2002: Examine the potential role of intraspecific competition in naturally suppressing aflatoxin outbreaks in the central U.S. Corn Belt.

Identify mechanisms of intraspecific fungal competition in interference with aflatoxin and fumonisin.

Isolate and identify mycoparasitic fungi, produce fermentation extracts, and perform bioassays using *Aspergillus flavus* and *Fusarium verticillioides* to guide the isolation of novel anti-fungal metabolites.

Publications:

Ito, Y., S.W. Peterson, D.T. Wicklow, and T. Goto. 2001. *Aspergillus pseudotamarii*, a new aflatoxin producing species in *Aspergillus section Flavi*. *Mycological Research* 105: 233-239.

McAlpin, C.E. 2001. An *Aspergillus flavus* mutant producing stipitate sclerotia and synnemata. *Mycologia*. 93: 552-565.

Soman, A.G., J.B. Gloer, R.F. Angawi, D.T. Wicklow, and P.F. Dowd. 2001. Vertilecanins: new phenopicolinic acid analogs from *Verticillium lecanii*. *Journal of Natural Products*. 64: 189-192.

Issues:

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 cornfields and management practices to prevent a population build-up leading to mycotoxin contamination.

What Was Done:

Demonstrated a mechanism of intraspecific competition whereby hyphal intermingling (“barrage formation”) between vegetatively incompatible strains of *A. flavus* results in the suppression of aflatoxin formation *in vitro*.

Discovered several novel metabolites produced by mycoparasites of *A. flavus* sclerotia.

Impacts:

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.

We continue to distribute fungal extracts and pure compounds for company testing in the area of animal health products.

NC-213 Progress Report for 2001

From: USDA–ARS, Grain Marketing and Production Research Center
Manhattan, Kansas

By: Casada, M.E., Engineering Research Unit
Arthur, F.H., Biological Research Unit

NC-213 Objective: B Procedure: 1a

Project Objectives: Develop and evaluate automatic grain aeration control strategies for maintaining grain quality and controlling insects during storage.

Results for 2001: In a second year of field tests of aeration of wheat in Kansas, a summer aeration cycle (the first of three cycles) was not as effective as it was the first year at reducing temperatures to a level that slows insect development (21 - 24°C). However, temperatures near the top and south wall of the bins re-warmed less than they did the first year because the first cycle fan operation was extended to over 200 h, which removed some of the heat gained from solar irradiation. Temperatures in a non-aerated control bin were unacceptable well into autumn again this year and insect numbers will be a serious problem if the grain re-warms next year.

In both years of tests with aeration at low airflow rates in summer immediately after harvest, there appeared to be sufficient hours with air temperatures below 24°C to cool the grain with a low airflow rate, 0.1 cfm/bu. However, in this second year, high humidities during these nighttime periods of low temperatures resulted in final grain temperatures higher than 24°C due to the heating effect when the high humidity air slightly rewet the grain (Fig. 1). An early fall aeration cycle the same year also resulted in temperatures higher than ambient due to the heating effect from rewetting.

Evaporative heating is a fundamental physical effect that occurs when aerating with rewetting conditions and diminishes the aeration cooling effect. Summer aeration in warm climates often faces limited hours with temperatures cool enough to be effective, and even those acceptable temperatures are borderline; if evaporative heating increases the effective aeration temperature, the amount of acceptable hours for aeration will be reduced further. This evaporative heating made automatic control of aeration with temperature alone inadequate this year for cooling grain to the desired temperature during summer aeration. These results also show the importance of looking at both temperature and humidity together to determine if typical weather conditions are acceptable for adequate cooling during summer aeration.

Plans for 2002: Collect, analyze, and report a third and probably final year of data on performances of selected grain aeration strategies and temperature monitoring systems. Use the collected data to validate the grain storage computer model.

Publications:

Casada, M.E. 2001. Moisture adsorption characteristics of wheat and barley. *Transactions of the ASAE*. (In press.)

Issues: Optimizing the design and management of grain storage systems requires proper analytical tools such as validated computer models of the stored grain environment. Several modeling and temperature accumulation studies indicate that an additional summer cooling cycle for stored wheat, in addition to cooling in early and late autumn, can limit population development of insect pests.

What Was Done: A second year of field validation tests were conducted to evaluate 3 temperature management strategies: 1) no aeration, just natural cooling (a control bin), 2) controlled aeration at (15°C) 60°F in early autumn and 7°C (45°F) in late autumn, the standard 2-cycle cooling regimes currently used for stored wheat, and 3) controlled aeration at 24°C (75°F) after binning in addition to the autumn cooling cycles. Bin temperatures were monitored with 126 thermocouple sensors. The use of a small number of HOBO temperature sensors (12 or less) was also evaluated as a potential simple and economical monitoring system for stored grain.

Impact: The potential to reduce energy consumed for grain cooling is estimated at 25-50 percent. The greatest impact is the assurance of timely grain cooling and prevention of grain quality losses from deterioration and insect infestations. Results from this project may lead to the development of new insect pest management and temperature management strategies for stored wheat.

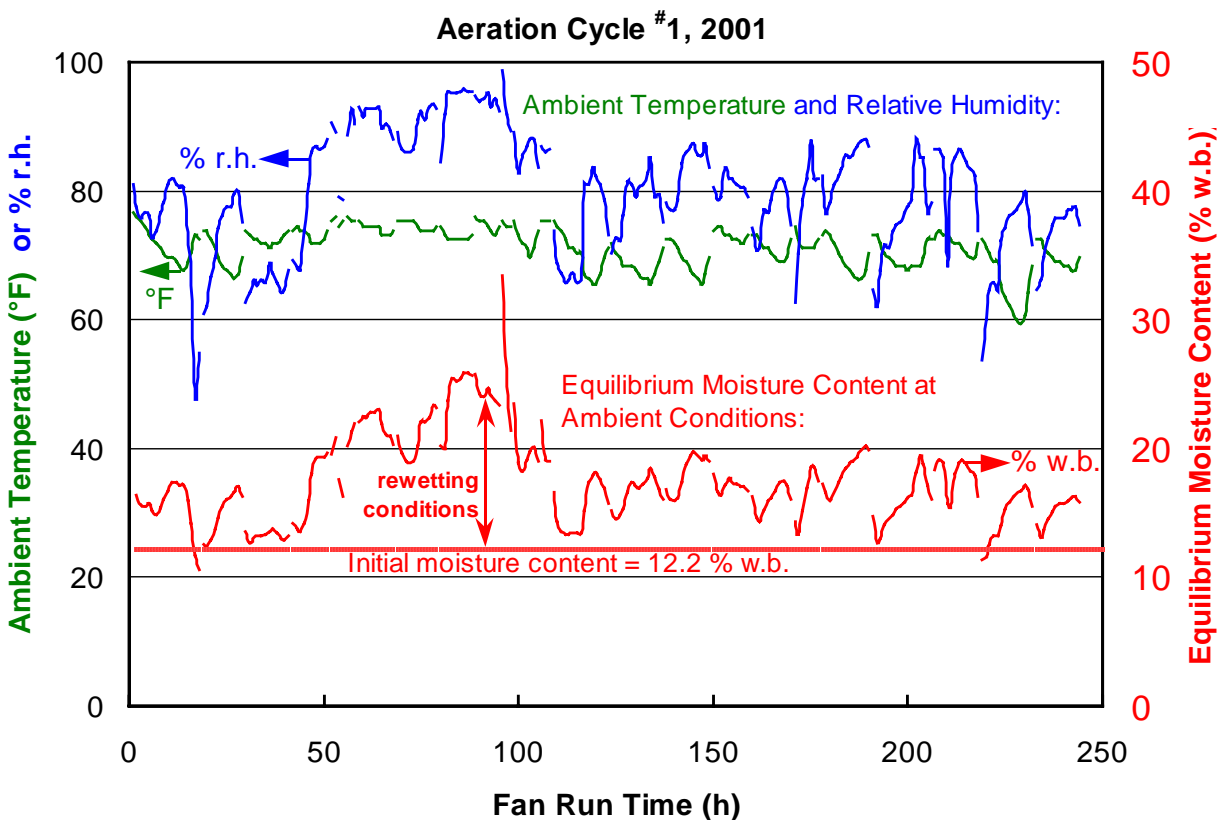


Figure 1. Summer aeration cycle in 2001 almost entirely under rewetting conditions (all fan hours occurred at night; ambient conditions measured *after* air passed through the fan).

NC-213 Progress Report for 2001

From: University of Minnesota
Biosystems and Agricultural Engineering Department

By: Wilcke, W.F.
Ileleji, K.E.
Morey, R.V.
Kaliyan, N.

NC-213 Objective: B Procedure: 1a

Project Objectives: The primary objective of our work in 2001 was to compare the relative allowable storage time of corn hybrids that contain higher than normal amounts of oil to the allowable storage time for parent hybrids that contain normal amounts of oil and to compare the allowable storage time for corn hybrids that contain the Bt gene to the allowable storage time for similar corn hybrids that do not contain the Bt gene.

Results for 2001: Carbon dioxide production by corn samples was used to determine the amount of time to reach 0.5% dry matter loss (DML) for five hybrids each of high-oil, normal-oil, Bt, and non-Bt corn held at 20°C and at 22% and 19% moisture (wet basis). Hybrids were selected in pairs such that each high-oil hybrid was compared to a normal-oil hybrid that had similar parent genetics and each Bt hybrid was compared to a hybrid that was identical except for insertion of the Bt gene complex. We also determined microbial infection levels before and after storability tests and mold damage after storability tests (DKT levels) for all hybrids. In the normal oil/high-oil study, we also measured fat acidity levels before and after storability tests.

The mean adjusted times to 0.5% DML for normal-oil and high-oil corn hybrids were significantly different at 0.05 probability level for all five hybrid pairs at 19% moisture, but time to 0.5% DML was significantly different for only two hybrid pairs at 22% moisture. The deterioration rate for high-oil corn was faster than for normal-oil content corn in most hybrid pairs at both 19 and 22% moisture. Fat acidity values were significantly different at 0.05 probability level for all hybrid pairs at both moisture levels, both before and after storability tests. Fat acidity values for high-oil corn hybrids were much higher than for comparable normal-oil content corn hybrids after the test. There was a strong positive correlation between oil content and fat acidity after storability tests at both moistures. In general, the high-oil corn hybrids had higher levels of damaged kernels (DKT) at the end of the storability tests, at both 19 and 22% moisture. Fat acidity and DKT results indicate that high-oil corn hybrids might not store as well as normal-oil content corn.

For conventional and Bt corn hybrids, the mean adjusted times to 0.5% DML were significantly different at 0.05 probability level for three hybrid pairs at 19% moisture and for four hybrid pairs at 22% moisture. In some cases, time to 0.5% DML was greater for the conventional hybrid and in other cases, time to 0.5% DML was greater for the Bt hybrid. There was little difference in fungal counts and DKT values after storability tests for comparable hybrid pairs of conventional

and Bt corn at both moisture levels. These results do not allow any conclusions to be drawn about the relative storability of Bt corn hybrids compared to conventional hybrids.

Plans for 2002:

In 2002, we plan to submit a paper on our allowable storage time research with high-oil/normal-oil corn and Bt/non-Bt corn for publication in a refereed journal. We have submitted several proposals with a new stored product entomologist at the University of Minnesota and if we can get funding, we hope to start work on use of aeration during cold weather to manage stored product insects. We have a new M.S. graduate student who is interested in storage of damp corn (wet enough for fungal growth but not wet enough for ensiling) in silage bags. His research will probably include laboratory studies and possibly field studies on corn storage in silage bags.

Publications:

Wilcke, W.F., K.E. Ileleji, P. Gupta, R.V. Morey, and R.A. Meronuck. 2001. Comparison of sample storage and conditioning methods for corn storability tests. *Transactions of the ASAE* 44(2): 369-376.

Ileleji, K.E., W.F. Wilcke, and R.V. Morey. 2001. Relative storability of high-oil and Bt corn hybrids compared to conventional hybrids. ASAE Paper No. 016057. Presented at Annual ASAE Meeting, Sacramento CA, July 30 - August 1. St Joseph MI: ASAE.

Issues:

Because crops that contain higher amounts of oil need to be stored at lower moisture contents to minimize quality loss during storage, there is a concern that high-oil corn hybrids might need to be stored at lower moisture contents than are recommended for conventional corn. In fact, there is some anecdotal evidence from commercial storage managers that high-oil corn does not store as well as conventional corn. Allowable storage time data for high-oil corn hybrids are needed so that we can quantify relative storability and adjust drying and storage recommendations for high-oil hybrids (if necessary).

There have been articles in the popular press that have implied that corn hybrids containing the Bt gene store better (i.e. experience slower fungal growth) than hybrids that do not contain the Bt gene. It is possible that Bt corn has a lower level of fungal infection at harvest because Bt corn has less insect damage. (Insects that attack corn before harvest carry fungal spores on their bodies and insect damage to corn ears provides access points for fungal spores.) But it seems unlikely that the Bt toxins contained in Bt corn would have an effect on post-harvest growth of fungi. Allowable storage time data for Bt corn hybrids are needed to determine whether the Bt gene has an effect on fungal growth after corn harvest.

What Was Done:

We measured carbon dioxide production by five high-oil corn hybrids, five comparable hybrids that contain normal levels of oil, five Bt corn hybrids, and five comparable hybrids that do not contain the Bt gene at 20°C and at 19 and 22% moisture (wet basis). Carbon dioxide production was used to calculate corn dry matter loss, which is an indicator of quality loss. Based on rate of dry matter loss for the hybrids we studied, it appears that high-oil hybrids deteriorate slightly faster in storage than do hybrids containing normal amounts of oil. There were no consistent trends in the dry matter loss data in the Bt/non-Bt tests

and we were not able to draw any conclusions about relative storability of Bt corn hybrids compared to non-Bt hybrids.

Subsamples of all twenty hybrids were plated before and after storage tests to determine initial and final levels of fungal infection. As expected, all hybrids showed greater numbers of fungal colonies at the end of storage tests than at the beginning of storage tests. But surprisingly, there were no large differences or patterns to the differences in initial (before storage tests) or final (after storage tests) fungal counts for any of the hybrid pairs in either the high-oil/normal-oil test or the Bt/non-Bt test. Corn subsamples were also submitted for DKT (damaged kernels, total) analysis by licensed grain inspectors after storage tests. There were no differences to the patterns in DKT levels for the Bt and non-Bt hybrids, but in most cases, the high-oil hybrids had higher levels of DKT than did the normal-oil hybrids.

We measured fat acidity levels for the high-oil and normal-oil hybrids before and after the storage tests. Fat acidity levels increased for all hybrids during the storage tests. The high-oil hybrids had slightly higher fat acidity levels than the normal-oil hybrids before the storage tests and the high-oil hybrids had much higher fat acidity levels than the normal-oil hybrids after the storage tests.

Impacts: It appears that high-oil hybrids do not store quite as well as their normal-oil counterparts. This means that it might be necessary to store high-oil hybrids at slightly lower moisture contents, or at lower temperatures, or for shorter periods of time to avoid quality loss.

It does not appear that the relative storability (at least in terms of mold growth) of Bt hybrids is any better or any worse than that of comparable non-Bt hybrids and thus Bt and non-Bt hybrids can be managed the same way in drying and storage systems.

NC-213 Progress Report for 2001

From: Purdue University
Agricultural & Biological Engineering

By: Maier, D.E.
Ileleji, K.
Woloshuk, C.P.
Mason, L.J.

NC-213 Objective: B Procedure: 1a, 2a

Project Objectives: The goal of this project is to evaluate, under field conditions, the use of carbon dioxide detectors to monitor for spoilage of corn prior to the time that spoilage would be detected by traditional methods. Our hypothesis is that CO₂ monitors can efficiently detect grain in the early stages of spoilage. The first objective was to determine the parameters for monitoring changes in CO₂ concentrations within a grain bin. The second objective was to determine the relationship between a fungal biomass growing in a grain bin and the early detection of CO₂.

Title: Monitoring stored grain quality

Results for 2001: The first objective of this research project was completed in 2000, and has been previously reported on. The second objective is in the process of being completed. Conditions conducive for grain spoilage and mycotoxin production are high moisture content and warm temperatures. When these conditions are ideal, CO₂ production will correlate to the size of the colonized grain. The goal of Objective 2 is to gain a better understanding of the relationship between detecting increased CO₂ in a grain bin and the size of the spoiling mass of grain. The results of Objective 1 showed that the sensor installed under the bin roof was able to detect a 0.5 mL/min CO₂ injection rate, which was equivalent to deterioration of 0.04% of the grain bulk by weight. However, we did not have any reference data indicating the possibility of such detection during the deterioration of actual grain. Therefore, we decided to conduct two preliminary laboratory grain deterioration trials using an automatically controlled water drip apparatus and Plexiglas tubing before venturing into the pilot bin test. The grain moisture content in each tube increased and fungi development on kernels was observed after about two weeks. Interestingly, the dripped water did not penetrate the grain as deep as anticipated. Instead, most of the moisture increase occurred in the top 0.150 m (6 in) of the 2 kg sample. Grain moisture contents in layers 1, 2, 3 and 4 increased from 14.7% to 32.5%, 30.1%, 19.5% and 14.8%, respectively. By the end of the experiment the temperature in the center of the 2 kg tube in Layers 1 and 2 increased by 2.5 and 2°C, respectively, despite the relatively large heat exchange between the tubes and the chamber, and frequent aeration in order to remove CO₂. The temperature increase will likely be higher in the grain mass of the pilot bin. The relative humidity in the wheat bulk close to the CO₂ injection point from the Plexiglas tubing did not reach high enough levels to indicate wheat deterioration. Therefore, CO₂ detected by the headspace sensor in the wheat column was produced entirely by the 0.5 kg corn tube. CO₂ reached detectable levels after 6 days of the drip experiment as defined by the 100 ppm CO₂ spike observed during the wheat column aeration.

The presence of CO₂ was detected during wheat column aeration as well as during the non-aeration periods. CO₂ detected showed a cyclic pattern, which correlated to the temperature change (cooling or heating) in our laboratory. As during the CO₂ injection experiment in Objective 1, it will be important to monitor wind velocity, ambient conditions, and possibly air currents inside the pilot bin headspace in order to improve our understanding of the effect of environmental factors on CO₂ accumulation, diffusion and possible detection. During August and September 2001 an experimental system was developed to simulate a hot spot due to deteriorating grain. A pilot bin filled with 350 bu of corn (Bin #12) located at the Post Harvest Education and Research Center (PHERC) facility at the Agronomy Research Center (ARC); Purdue University, IN was used for the deterioration simulation trials. Two replications have been completed and the third one has just been initiated. Data analysis will be completed in early 2002.

Plans for 2002: To determine the impact of fungal feeding insect infestations on detection of CO₂ from spoiling grain.

To implement CO₂ monitoring at grain elevator facilities, and to document the costs and benefits of this new stored grain quality monitoring technology.

Publications:

Zagrebenyev, D., D.E. Maier, and C.P. Woloshuk. 2001. Simulation of grain deterioration using CO₂ injection. Paper No. 01-6028. ASAE, St. Joseph, MI.

Issues:

In the United States more than 15 billion bushels of grain are stored every year. Insects and fungi create numerous quality problems in these stored grains. Total annual storage losses are estimated at more than \$1 billion. It is essential for the grain storage industry to have effective pest management programs to protect against economic loss due to contamination from insects, fungi and mycotoxins. A major contributor to the spoilage of grain is the growth of various fungal species, including several that produce mycotoxins. Although quality of harvested grains can never be improved with storage time, the rate of deterioration can be slowed with an integrated systems approach that combines engineering, biological and economic principles.

What Was Done:

Monitoring the condition of thousands of bushels of grain is a difficult task with only the technology of temperature monitors. Our research has presented evidence that CO₂ monitoring technology can be effectively used in grain management.

Impacts:

The impact of this research will help solve grain storage problems by applying an available technology that can detect spoilage before it gets out-of-hand. If spoilage is detected early by an increase in CO₂ concentrations, the problem can be corrected by simple management practices such as applying aeration to cool and dry the grain mass.

Funding sources:

Anderson Research Grant Program 1999-2001

Contacts:

Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University; Phone: 765-494-1175; Fax: 765-496-1356; e-mail: maier@ecn.purdue.edu

URL:

<http://www.GrainQuality.org>

NC-213 Annual Report for 2001

From: Center for Agricultural, Medical and Veterinary Entomology
ARS, USDA
Gainesville, Florida

By: Arbogast, R.T.
Weaver, D.K.
Kendra, P.E.

NC-213 Objective: B

Procedure: 2

Project Objectives: To determine seasonal trends in grain temperature and capture rates of two stored-product beetles, *Typhaea stercorea* (L.) and *Tribolium castaneum* (Herbst) in farm storage bins, and to examine the association between grain temperature and trap catch, before and after elimination of seasonal trends.

Title: Temperature Variation in Stored Corn and Its Effect on Capture of Beetles in Grain Probe Traps.

Results for 2001: A series of trap samples can be used to estimate relative changes in abundance, provided the proportion of the population trapped remains constant; that is, it is not affected by population density or by changing environmental conditions. However, we know too little about the influence of these factors to evaluate the validity of trap catch as an estimate of relative abundance. In the present study, we used data sets from stored corn to determine seasonal trends in grain temperature and capture rates of two stored-product beetles, *Typhaea stercorea* (L.) and *Tribolium castaneum* (Herbst), and to examine the association between grain temperature and trap catch. Mean weekly temperature and weekly trap catch were fitted to cubic polynomials, which expressed changes over time (from all causes) in temperature and trap catch, and were used to eliminate seasonal trends by calculating residuals (observed values - predicted values). Correlation analysis showed a strong association between trap catch and temperature that disappeared, or was greatly weakened, when residuals, rather than raw data were analyzed to eliminate seasonal trends. This, along with other features of the data, suggested that population density was, in general, more important than the effect of temperature on insect activity in determining trap catch. Thus, temperature variation should not pose a serious problem in estimating relative abundance, as long as mean temperature during the trapping period remains above the activity threshold of the insects. More information on the relationship between temperature and species specific activity levels is needed to refine our interpretation of trap catch.

NC-213 Progress Report for 2001

From: Center for Agricultural, Medical and Veterinary Entomology
ARS, USDA
Gainesville, FL 32608

By: Shuman, D.
Epsky, N.D.

NC-213 Objective: B Procedure: 2

Project Objectives: To promote the technology transfer of the Electronic Grain Probe Insect Counter (EGPIC) System for monitoring infestations in stored-products.

Title: Refinement and Commercialization of the Electronic Grain Probe Insect Counter (EGPIC), a System for Detection and Population Estimation of Stored Product Insects.

Results for 2001: The EGPIC technology (U.S. Patent No.5,646,404 issued 7/97) for direct insect population estimation is being integrated by OPI Systems of Calgary, Canada into StorMax, their stored grain management system to become the world's first commercially available automated stored-product insect monitoring system. The EGPIC system, developed and patented by CMAVE, ARS, uses infrared-beam sensors in a fall tube grain probe to electronically count the numbers of insects distributed throughout stored agricultural products, and then records and displays these counts at a central computer. These data can be used to reduce fumigations, enhance the viability of pesticide alternatives, and provide rapid and safe control efficacy feedback. OPI Systems is a company that develops, manufactures, and distributes state-of-the-art technologies (e.g., digital temperature cables) for maintaining the quality of stored grain.

The Cooperative Research and Development Agreement (CRADA) with OPI Systems was extended to complete the commercialization process with major enhancements to the EGPIC performance. During the past year under the CRADA, a new invention known as Sensor Output Analog Processing or SOAP (patent pending) was included in EGPIC to provide species identification information and other performance enhancements such as immunity to electrical impulse noise and erroneous counts due to insects inadvertently crawling around in the infrared-beam and uniformity of performance independent of environmental factors and component aging. The EGPIC probe body was redesigned to be manufactured by injection molding in order to reduce its projected retail cost.

NC-213 Progress Report for 2001

From: Center for Agricultural, Medical and Veterinary Entomology
ARS, USDA
Gainesville, FL 32608

By: Silhacek, D.L.

NC-213 Objective: B

Procedure: 2

Project Objectives: Indianmeal moth infestations in processed cereal products during storage could be managed with little or no use of conventional pesticides if there was a greater recognition and use of the moth's innate vulnerabilities. Slowing or preventing the growth of infesting larvae is a simple strategy that can decrease the amount of commodity damage and decrease the need for pesticide intervention.

Title: Indianmeal Moth Infestation of Cereal Products: Nutritional Considerations.

Results for 2001: Female Indianmeal moths are attracted to a broad range of cereal products for oviposition with the level of infestation being commodity dependent. The growth rates of newly hatched larvae on different cereal products varies widely indicating product-related differences in nutrient availability for the insects. Nutrient availability depends upon physical characteristics that can restrict the ingestion of nutrients as well as the amounts of nutrients in the cereal being consumed. Our objective is to identify these nutritional and physical characteristics so that one or more of them can be incorporated into processed commodities for management of cereal moth populations.

As a starting point, a chemically defined test commodity was needed that was not encumbered by nutrient or physical impediments to larval growth and development. Wheat germ provides such a commodity. When supplemented with carbohydrate this growth medium achieves the performance of the standard Plodia diet (Silhacek and Miller, 1972). Our upcoming studies will begin to identify nutritional and physical characteristics that could be incorporated into processed cereal products that would make them refractory to insect infestation without impairing their food value for man and animal.

NC-213 Progress Report for 2001

From: Montana State University
Department of Entomology¹ and Plant Sciences

By: Dunkel¹ F.V.
Watts¹ V.
Klaas¹ L.
Talbert² L.
Bruckner² P.
Habernicht² D.
Luck¹ G.G.

NC-Objective: B

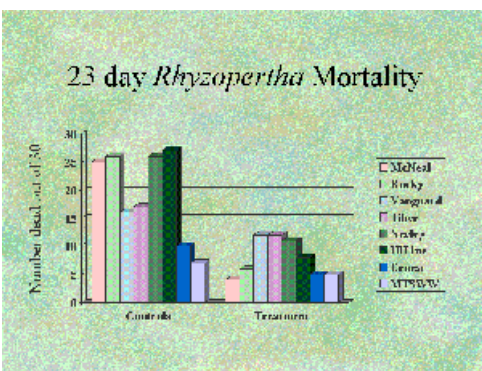
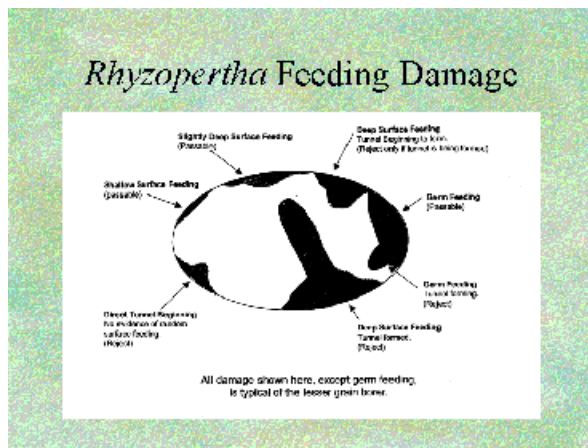
Procedure: 2a

Project Objective: Evaluate resistance of Montana-grown hard red spring, hard red winter, hard white, and soft white wheat varieties to Montana strains of storage insects. (In 2002-3, this project will also address NC 213 Objective A, specifically to determine the effects of genetic traits, climatic factors, agronomic practices on the quality of cereals, that is the ability of hard wheat varieties to resist insect attack during long-term storage.)

Results for 2001: Our study this year tested the hypothesis that the post-harvest insect resistance we previously discovered in hard spring and winter wheat of the Northern Great Plains, was, in some varieties, a factor associated with the pericarp and not the endosperm. We tested our hypothesis with Montana-grown hard spring wheat varieties (Ernest, Mt 9433, Hi-Line, McNeal, Newana, and Amidon) and Montana-grown hard winter wheats (Nuwest, Tiber, Rocky, Redwin, Vanguard, and Neeley). For a sensitive control, we used the soft white wheat, Pennewawa (MTSWW). We observed a statistically significant difference in the ability of hard winter and hard spring varieties to resist attack by the most destructive of the two insect species tested, the lesser grain borer, *Rhyzopertha dominica* (F.). Ernest and Tiber were significantly more vulnerable to feeding by *R. dominica* than Vanguard and McNeal (Table 1). Neeley was significantly more vulnerable to feeding by *R. dominica* than Vanguard (Table 1). This difference, however, was wheat moisture content dependent (Table 1, 2).

We found Hi-Line, Scholar, McNeal and others significantly more resistant to supporting populations of the lesser grain borer (and therefore more resistant) than the susceptible control variety, Pennewawa (Table 1). Ernest and others produced progeny levels not significantly different from the sensitive control (Table 1). In subsequent studies we found that the Indian mealmoth, *Plodia interpunctella* (see insert), was able to attack and reproduce on a diet of only sound kernels of each of the 12 varieties of hard wheat, including Hi-Line, Scholar, and McNeal. In each case, the attack was not, however, of a type that would cause penalties in a grain grading situation. In no kernel was any tunneling made by the *P. interpunctella*, either through the pericarp directly or through the germ end of the kernel, after germ removal by larvae of *P. interpunctella*. Therefore, *P. interpunctella* is not a threat to the monetary value of hard wheat. The larva of this moth, though, could be an effective accomplice to other organisms that attack sound, hard wheat, such as the lesser grain borer and storage fungi. *Plodia interpunctella* cause

the kernel to be rejected in the Federal Grain Inspection System. Each individual kernel of 50g samples in each of 3 replicates from these 12 varieties plus the soft wheat control were examined. *Plodia interpunctella* feeds exclusively on the germ, but it completely slices off the germ (see insert “germ feeding” which is **not** typical of *R. dominica*, but the only feeding pattern of *P. interpunctella* in wheat), fully exposing the endosperm, thereby making the grain vulnerable to attack by other storage insects, possibly the “bran” insects that typically do not feed on sound kernels at all. This feeding behavior of *P. interpunctella* also may make the



kernel more vulnerable to attack by storage fungi such as *Fusarium graminearum* and possible contamination with the mycotoxin, deoxynivalenol (Pitt and Hocking 1999).

Indeed, we found (Dunkel et al. unpublished 2001 data) that when the lesser grain borer is allowed to feed on mealmoth-damaged kernels (labeled as “treatment” on bar graph insert), *R. dominica* has significantly less mortality and does significantly more damage with the “assistance of its insect collaborator” than it does without such “assistance.” The most interesting result

of these “collaborative damage” studies was that degerming by the Indian mealmoth **significantly reversed** the status of the variety McNeal (but not Hi-Line) **from more resistant** to the lesser grain borer **to sensitive** to the borer. It seems, therefore, that in the pericarp of McNeal there is either a physical or chemical trait that confers resistance to attack by the lesser grain borer. This is interesting from a stored grain management perspective, but it needs to be verified in other crop years and at other locations. In crop year 2001, McNeal comprised about 50% of the hard red spring wheat grown in Montana, a 10 fold increase over the previous year. So, this information has the potential for widespread impact for grain handlers that are making long term storage decisions in areas where *R. dominica* and *P. interpunctella* are problems. It is also interesting as a possible trait that could be selected in a breeding program to confer postharvest resistance during longterm storage.

In 2001, we evaluated all of the damage analyses of each kernel used in the study (50g per replicate; 3 replicates per variety). Prior to insect exposure, each kernel was evaluated visually to confirm that it was sound. Nine weeks after introduction of the lesser grain borer, *Rhyzopertha dominica* (F.), each kernel was scored by the same person under the same lighting using the following scale: 1) sound kernel, no visible damage; 2) surface feeding only; 3) feeding tunnels in the endosperm but not extending to the opposite side of the kernel; 4) extensive endosperm feeding (tunneling plus deep surface feeding) extending from one side of kernel to

the other; 5) severely damaged most of endosperm consumed, only a shell of the pericarp remaining. Rejection in most marketing systems would be at levels 3 and above (Table 1,2). During the 9 weeks of the test, the same kernels were fed upon by parent *R. dominica* as well as their F₁ generation and younger larval instars of their F₂ generation. When all of the 13 varieties were compared in a simultaneous comparison, Neeley, Tiber, and Ernest had significantly less sound kernels than Vanguard (Table 1,2). In previous studies (NC-213 Ann. Rep. 1999 p. 55) we reported that kernel hardness from these wheat samples was significantly greater in Vanguard than in Tiber and Ernest, but Neeley did not show this as a significant difference, a difference that may be related to a different mechanism of feeding deterrence by the lesser grain borer, particularly early larval stages, possibly a chemical rather than physical resistance.

We discovered that the Indian mealmoth, *Plodia interpunctella* (Huebner) also causes damage in and can reproduce when given only sound kernels of low moisture hard wheat, specifically, the varieties most frequently chosen for production in Montana. This damage is markedly different than that of *R. dominica*. *Plodia* feeds primarily in the germ (text insert). No evidence of endosperm tunneling was detectable in the 3,900 kernels individually inspected during our damage analysis studies.

Plans for 2002: This project was funded by the Anderson Foundation for 2002 and 2003. As such the objectives will be to:

1. Determine the role of crop production location and agronomic practices on the varietal resistance / sensitivity we observed in pilot studies.
2. Explore interaction of other destructive insect species in the postharvest community of low moisture, Northern Great Plains hard wheat.
3. Determine alpha-amylase inhibitor levels in each of the wheat samples used in the postharvest varietal insect assays as an example of a biochemical postharvest resistance factor that may be possible and appropriate to incorporate into a hard wheat breeding program.
4. Determine (in collaboration with L. Bullerman, University of Nebraska-Lincoln) the effect of damage from *P. interpunctella* and *R. dominica*, separately, on fungal invasion of hard wheat varieties stored at 15% moisture content (typical of high-risk areas within an individual storage structure).

Publications:

Watts, V., and F.V. Dunkel. Post-harvest resistance in hard spring and winter wheat varieties of the Northern Great Plains to the lesser grain borer (Coleoptera: Bostrichidae). Submitted to the Journal of Economic Entomology.

Issues:

Hard wheat is grown mainly in northern temperate areas of the world and is considered easy to store due to its resistance to insect attack. Some alarming recent research results now may negate this statement. Recently, the lesser grain borer, *Rhyzopertha dominica* (F.), a southern temperate/tropical insect that thrives on hard red wheat has been moving north (Fields and Phillips 1995). *Rhyzopertha dominica* is able to survive Montana conditions, probably due to its ability to locate refugia (microhabitats with the right conditions for survival) in or near the grain mass. *R. dominica* was officially unknown in Montana before

1987. In 1996, this insect was uncommon. In 2001, *R. dominica* was ranked second most frequently encountered insect by elevator operators in Montana. Unfortunately, wheat varieties are not developed for their ability to resist postharvest insect attack.

What Was Done: We found that at low moisture contents typical of storage situations in the Northern Great Plains, currently popular hard spring and hard winter wheats are significantly different in their ability to resist attack by *R. dominica*. With the assistance of another storage insect now found in the Northern Great Plains, *P. interpunctella*, we determined that the resistant status of one variety (McNeal) can be significantly reversed.

Impacts: Determining factors responsible for postharvest resistance could be objectives in a breeding program provided these factors do not affect milling, baking, noodle quality and other important end-use properties. If global warming is a reality, these southern insects, *R. dominica* and *P. interpunctella*, that are moving into the Northern Great Plains could become even more of a problem in long-term storage. NC213 scientists could take the lead in developing a hard wheat variety that was good for very long term storage and thereby enhance the opportunities of producers to take advantage of fluctuations in the grain market.

Funding Sources:

Montana Agricultural Experiment Station (Dunkel)

National Institutes of Health: Initiative for Minority Scientific Development (Watts)

Montana Apprenticeship Program (Good Luck)

Contacts:

Florence V. Dunkel, Department of Entomology, Montana State University; Phone: 406-994-5065; Fax: 406-994-6029 and 406-585-5608; e-mail: ueyfd@montana.edu

URL:

<http://scarab.montana.edu./people/flodunk.htm>

Table 1. Resistance of Montana-grown wheat varieties to *Rhizopertha dominica* from 0-72 hr post adult emergence to early instars of the F₂ generation (parents removed after 2 weeks, progeny removed after 7 additional weeks)(15 parents / 50 grams / replicate; 3 replicates per variety)(same experiment as Table 2).

Assay Date / CropYear / Mean % Initial Moisture Content	Variety	Mean ^{1,4} Total Progeny	Mean ¹ Percent Moisture Content		Mean ¹ Dry Weight Loss ² g/cc
			Before Inoculation of Parent Generation (Standard Deviation)	9 Weeks After Inoculation of Parent Generation	
9 July 99/ Crop Year 1998 / 10.64	Pennewawa (Susceptible Control)	370A	10.9 (0.0)	12.9A	0.14A
	Hi-Line	110B	10.9 (0.0)	12.2ABC	0.06AB
	Newana	140B	10.7 (0.0)	12.4ABC	0.07AB
	Amidon	146B	10.6 (0.1)	12.2BC	0.03B
	Scholar	104B	10.1 (0.3)	12.2BC	0.06AB
	Ernest	228AB	10.6 (0.0)	12.6AB	0.08AB
	McNeal	88B	10.2 (0.0)	11.9C	0.06AB
	Redwin	204AB	10.8 (0.0)	12.1BC	0.06AB
	Neeley	232AB	10.8 (0.0)	12.4ABC	0.08AB
	Nuwest	168B	10.6 (0.0)	12.4ABC	0.06AB
	Tiber	249AB	10.5 (0.0)	12.2BC	0.09AB
	Rocky	181B	10.7 (0.0)	12.0BC	0.08AB
	Vanguard	154B	11.0 (0.0)	12.2BC	0.03B
26May00 /Crop Year 1998 / 9.41	Pennewawa (Susceptible Control)	263A	8.4 (0.0)	10.9A	0.17A
	Hi-Line	23B	9.7 (0.0)	9.6BC	0.02B
	Newana	61B	9.2(0.1)	9.7BC	0.04B
	Amidon	84B	9.3 (0.4)	9.8BC	0.05B
	Scholar	103B	9.1 (0.0)	9.7BC	0.05B
	Ernest	57B	9.7 (0.1)	10.0ABC	0.04B
	McNeal	53B	9.3 (0.0)	9.4BC	0.04B
	Redwin	70B	9.8 (0.0)	10.3AB	0.06B
	Neeley	86B	9.6 (0.0)	9.2C	0.03B
	Nuwest	60B	8.8 (0.2)	10.2ABC	0.06B
	Tiber	49B	9.9 (0.0)	9.9BC	0.05B
	Rocky	56B	9.8 (0.4)	10.1ABC	0.06B
	Vanguard	67B	9.6 (0.0)	10.2ABC	0.05B

¹ Means followed by the same letter in a column within an assay date are not significantly different at the 5% level (Student-Newman-Keuls grouping used for comparison of means following ANOVA).

² Results for other damage categories available in Table 4.

³ Hardness studies were not repeated because the wheat varieties, Crop Year, and field samples of each variety were the same as in the 9 July 99 assay for which the hardness values were determined.

⁴ When all progeny data are combined, a 1.2 per cent higher moisture content resulted in significantly higher at the 5% level (Student-Newman-Keuls grouping used for comparison of means following ANOVA) mean total progeny for the following varieties: Tiber and Pennewawa, the soft white susceptible control.

Table 2. Damage caused in 9 weeks by *Rhyzopertha dominica* to Montana spring wheat varieties using a subjective damage index with five categories (15adults/50g wheat/rep, 3 reps/variety).

Assay Date / Crop Year / Mean Initial % Moisture Content ³	Variety	Categories of Damage ² (Mean ^{1,3} Percent in Each Category)		
		1	2 and 3	4 and 5
9 July 99 / 1998 / 10.64	Pennewawa (Susceptible Control)	60.7D	14.0 A	25.0A
	Hi-Line	86.3ABC	7.0 CB	7.0B
	Newana	81.7ABC	9.7 B	8.7B
	Amidon	86.0ABC	8.0 CB	6.0B
	Scholar	89.0AB	6.0 CB	5.5B
	Ernest	75.7C	13.0 A	11.3B
	McNeal	89.0AB	6.6 CB	5.0B
	Redwin	80.5ABC	7.7 CB	11.5B
	Neeley	77.7BC	9.0 B	13.7B
	Nuwest	85.3ABC	6.3 CB	9.0B
	Tiber	75.7C	13.7 A	10.3B
	Rocky	80.7ABC	7.0 CB	11.7B
	Vanguard	90.0A	6.7 C	5.0B
25 May00 / Crop Year 1998 / 9.41	Pennewawa (Susceptible Control)	75.3B	10.1A	11.3 A
	Hi-Line	97.7A	1.5 C	0.7B
	Newana	95.3A	2.8 BC	1.8B
	Amidon	92.7A	4.5 BC	2.8B
	Scholar	91.3A	6.3 B	2.3B
	Ernest	95.7A	4.1 BC	2.6B
	McNeal	94.7A	4.0 BC	1.4B
	Redwin	93.7A	3.0 BC	2.7B
	Neeley	92.0A	3.6 BC	4.3B
	Nuwest	95.3A	1.6 C	2.7B
	Tiber	96.0A	3.2 BC	1.1B
	Rocky	95.3A	2.5 BC	2.0B
		Vanguard	94.3A	2.9 BC

¹ Means followed by the same letter in a column within an assay date are not significantly different at the 5% level (Student-Newman-Keuls grouping used for comparison of means following ANOVA).

² Kernel-damage-due-to-insect-feeding indices: 1= Sound Kernel (no evidence of insect feeding); 2= Some evidence (involving 1 to 25% of the kernel is damaged) of surface feeding, for example, one feeding hole but not all the way through the kernel; 3= Two holes, all the way through kernel (25 to 50% of the kernel is damaged); 4= More than 2 holes and/or severely damaged (kernel is 50 to 75% damaged); 5= Mainly holes (75 to 99% of the kernel is damaged, basically the kernel is a hollowed out shell).

³ When all data within category are combined, a 1.2 per cent higher moisture content resulted in significantly lower at the 5% level (Student-Newman-Keuls grouping used for comparison of means following ANOVA) mean per cent sound kernels for the following varieties: Neeley, Tiber, Ernest, Newana, Rocky, Redwin, and Pennewawa, the soft white susceptible control.

NC-213 Progress Report for 2001

From: University of Nebraska
Department of Food Science and Technology

By: Bullerman, L. B.

NC-213 Objective: B Procedure: 1b

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

Results for 2001: Work on this objective has been expanded to include studies of biological control agents alone and in combination with antifungal chemicals. The objective of this year's work was to study ability of *Bacillus pumilus* NE B1 and *Lactobacillus rhamnosus* VT1 to inhibit growth of *Fusarium* species and mycotoxin production. Both bacterial isolates were obtained from foods and had previously exhibited strong antifungal properties. The specific objective was to investigate the ability of live cells of both bacteria and a fermented skim milk of *L. rhamnosus* VT1 to inhibit mycelial growth and the production of Fumonisin B₁ (FB₁) by *Fusarium proliferatum* M5689 and *F. verticillioides* M1325 in sterile rice and maize substrates. Both *Fusarium* species were grown simultaneously with live cells of each bacterial strain and re-suspended freeze-dried milk fermented by *L. rhamnosus* VT1 in sterile steamed maize and long grain white rice for 14 days. The inhibition of mycelial growth was assessed using visual observations, while the amount of FB₁ produced was determined by high performance liquid chromatography with fluorescence detection. To varying degrees, the antifungal agents tested exhibited inhibition of mycelial growth as well as mycotoxin production. *Bacillus pumilus* NE B1 was found to have the strongest antifungal and antimycotoxigenic activity, followed by live cells of *L. rhamnosus* VT1 and milk fermented by *L. rhamnosus* VT1, respectively. Percentages of inhibition of FB₁ production by *B. pumilus* NE B1 ranged between 82.9% and 100.0%. These results suggest that the bacterial strains tested have potential as biocontrol agents of molds and mycotoxins in cereal grains and food commodities, and warrant further study.

Plans for 2002: Determine inhibition of *Fusarium graminearum* and production of deoxynivalenol and zearalenone by *Bacillus pumilus* NE B1 and *Lactobacillus rhamnosus* VT1 in a sterile rice substrate.

Determine ability of *Bacillus pumilus* NE B1 and *Lactobacillus rhamnosus* VT1 to prevent *Fusarium graminearum* from infecting wheat and causing head blight (scab) in green house trials.

Publications:

Stiles, J., and L.B. Bullerman. 2001. Inhibition of *Fusarium* species and mycotoxin production by *Bacillus pumilus* NE B1 and *Lactobacillus rhamnosus* VT1. Presented at the 13th International Reinhardtsbrunn Symposium on Modern Fungicides and Antifungal Compounds. Friedrichroda, Germany. (Full article in press in the Proceedings.)

Stiles, J., S. Penkar, and L. B. Bullerman. 2001. Inhibition of mold growth and spore production by food-borne bacteria and their metabolites in a liquid medium. Presented at the 2001 Annual IFT Meeting. June 23-27. New Orleans, LA.

Issues: Controlling and preventing mold growth and mycotoxin production in grain both in field and during storage continues to be a challenge. The use of fungicides and antifungal chemicals for the control of mold or fungi is plagued by issues of safety concerns, regulations and costs. Because of this there is interest in finding alternative control methods. Non-toxic and non-pathogenic microorganisms are increasingly being studied as potential biological control agents for preventing mold growth and mycotoxin production. Objective B, procedure 1b investigates the effects of preservatives and fungicides for control of mold. The goal of this research is to expand these investigations to include biological control agents alone and in combination with safe chemicals and preservatives.

What Was Done: Two bacteria isolated from foods, which had previously been shown to have antifungal and antimycotoxigenic activities, were studied for ability to inhibit growth of *Fusarium proliferatum* and production of fumonisins in a solid-state fermentation. *Bacillus pumilus* completely inhibited growth and fumonisin production. Further studies using other *Fusarium* species and other solid substrates will be done to determine the scope of the antifungal activity of both *B. pumilus* and *L. rhamnosus* and how this might be optimized.

Impacts: The results suggest that *B. pumilus* and *L. rhamnosus* have the potential for development and use as biological control agents in grain storage and possibly in the field. This should lead to low cost, non-polluting, non-hazardous fungal control agents suitable for use in the field and during storage.

NC-213 Progress Report for 2001

From: Purdue University
Botany & Plant Pathology

By: Woloshuk, C.P.
Mason, L.J.
Maier, D.E.

NC-213 Objective: B Procedure: 1b

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

Title: Grain ozonation for insect control

Results for 2001: The success of ozone fumigation in a field test to determine efficacy against stored-products pests in 350 bu of corn utilizing 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. This year we completed the analysis of experimental data to determine an optimum fumigation velocity through wheat, which is attainable with current aeration equipment. Subsequent fumigation of pre-ozonated wheat was done at the same velocity and concentrations in the grain mass were established more rapidly due to Phase 2 fumigation characteristics. Additionally, we exposed food corn, wheat (soft and hard), popcorn, rice and soybeans to ozone fumigation concentrations to quantify whether end use processing characteristics were affected. Analysis was completed this year, and confirmed that no negative effects could be determined.

Plans for 2002: To quantify scale-up parameters to develop a commercial ozone generator.

To conduct scale-up experiments to quantify the relationship between ozone half-life and mold inhibition and insect mortality further.

Publications:

Mendez, F. 2001. Characterization of ozone fumigation of wheat and effect of ozone on the quality of end product made from grains. Unpublished M.S. Thesis, 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 Was 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 1998 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. Those experiments were expanded in 2000 to include wheat and other major food grains.

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

Contacts:
Charles Woloshuk, Department of Botany and Plant Pathology, Purdue University; Phone: 765-494-3450; Fax: 765-494-0363; e-mail: woloshuk@btny.purdue.edu

Linda Mason, Department of Entomology, Purdue University, Phone: 765-494-4586; Fax: 765-494-2152; e-mail: lmason@entm.purdue.edu

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

NC-213 Progress Report for 2001

From: Kansas State University
Department of Grain Science and Industry

A joint study with Purdue University funded through the Anderson Team Grant

By: Herrman, T.J.
Maier, D.

NC-213 Objective: B and D Procedure: 1b

Project Objectives: 1) Identify technical, social, economic, and institutional constraints that impede segregation of GM-based VE crops and 2) Create system analysis and management tools to assist in the adoption of VE grain handling and marketing strategies.

Title: Grain Facility System Analysis to Improve Adoption of Value-Enhanced Grain Handling and Marketing in the U.S.

Results for 2001: The western region of the study included 75 country grain elevators in KS, NE, and IA. All conveying equipment was characterized, ticket summary reports for the 2000 harvest were collected, bushels received during every hour of harvest tallied, and individual reports on each facility prepared. Additionally, stop watch time study data were collected at 10 representative facilities.

A country elevator database including bushel storage, probe type, scale length, and railroad access were prepared for these states using grain and feed association data and state-federal warehouse licensing data.

Plans for 2002: Complete data analysis by state and region; perform simulation modeling activities, and economic analysis of country elevator operation.

Issues: The globalization of agricultural markets and proliferation of genetically modified (GM) crops create the need for further investigation of the U.S. grain handling infrastructure to segregate cereals and oilseeds in order to remain the world's least cost provider of safe and wholesome foods and feeds. While market analysts predicted growth for specialty markets, few anticipated that the avoidance of GM crops that possess traits that augment crop management practices (e.g., Bt corn for insect control) would become a major driving force behind marketing specialty grains. Similar to other global businesses, customers expect the U.S. cereal and oilseed industry to implement certifiable quality management systems.

Impacts: This study will provide the most complete characterization of the U.S. grain handling system in the central U.S. corn-soybean belt. We will be able to extend results to country elevators throughout this production region (wide inference space) due to the geographically diverse (KS, NE, IA, IL, IN, OH) and large number (150) of facilities included in the study.

Funding Sources:

OARDC/The Ohio State University - Anderson Endowment fund.

Contacts:

Tim Herrman, Department of Grain Science and Industry, phone: (785) 532-4082,
tjh@wheat.ksu.edu

NC-213 Progress Report for 2001

From: Montana State University
Department of Entomology

Mycotech Corporation (Present address: USDA-ARS Sidney, Montana)
Butte, Montana

By: Dunkel,¹ F.V.
Broughton,¹ M.
Jaronski,² S.

NC-Objective: B Procedure: 2b

Project Objective: Develop new bio-rational residual and fumigative applications for stored grain, oilseeds and other post-harvest commodities from natural materials as novel management strategies for stored product insects.

Results for 2001: 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^R for control by contact of greenhouse whitefly and aphids. Due to lack of funding, this project was put on hold and only the manuscript was worked on this year.

Plans for 2002: Obtain additional funding and upscale the test bin size. Complete peer refereed manuscript reporting 1998-2001 studies. Investigate combination of this compound with other natural fumigants to increase efficacy for more resistant insect species and stages.

Publications:

Dunkel, F.V., S. Jaronski, M.J. Broughton, J.A. Demoney, B.A. Phillips, and K. Fox. Evaluation of cinnamaldehyde as a fumigant against stored product insects. In author review. To be submitted to J. Econ. Entomology.

Issues: EPA removal and restriction of stored grain fumigants has created an urgent need for new fumigants. Fumigant materials/procedures that are effective in an appropriate timeframe (48 hours) and are exempt from registration are ideal. Thus far, our research has shown that cinnamic aldehyde has these characteristics.

What Was Done: We have had good success with demonstrating fumigative properties of this compound for a Montana stored grain strain of the lesser grain borer, *Rhyzopertha dominica* (F.), and field collected (California) populations of the Indian mealmoth, *Plodia interpunctella* (Huebner) and cigarette beetle, *Lasioderma serricorne* (F.). In our scale-up designs, we were not able to achieve 100% mortality in either the 7,821cc sealed minibin or the 240 forced air minicolumn. In the forced air column with wheat, we delivered the cinnamic aldehyde by forcing air through the pure liquid fumigant in a container external to the grain

column. Delivery was a problem. A wire basket design with a cinnamic aldehyde impregnated gauze wick solved the problem. Although we achieved 100% mortality with the new delivery design, control mortality was higher than usual. Based on this basic delivery system, we also designed and built a larger scale wick suspension system for closed loop fumigation of grain bins of 16,000cc and for bins of 176,000cc). We concluded that control mortality needs to be reduced and then the fumigant action of cinnamic aldehyde should be tested in these larger scale containers.

Impacts: The possibility of another new, natural, exempt-from-tolerance fumigant exists.

Funding Sources:
Montana Agricultural Experiment Station (Dunkel)(2001)

Montana Apprenticeship Program (Fox)(1999)

Contacts:
Florence V. Dunkel, Department of Entomology, Montana State University; Phone: 406-994-5065; Fax: 406-994-6029 and 406-585-5608; e-mail: ueyfd@montana.edu

URL:
<http://scarab.montana.edu./people/flodunk.htm>

NC-213 Progress Report for 2001

From: USDA-Agricultural Research Service
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center

By: Bean, S.R.
Chung, O.K.

NC-213 Objective: C Procedure: 1a

Project Objectives: Conduct basic and applied research in the biochemistry and technology of grain sorghum to identify and evaluate the biochemical components that govern processing, digestibility, and susceptibility to mold. The information is used to improve sorghum quality and utilization for increasing domestic and export markets.

Results for 2001: A new Research Chemist (S.R. Bean) was hired October 22, 2001. Results for this year have included purchasing and setting up lab equipment, gathering relevant references, reviewing literature, and initiating grain sorghum research proposal.

Plans for 2002: Investigate roles of kafirins and lipids in the functionality and digestibility of sorghum and study modification of sorghum flour to improve functionality and digestibility. Develop, improve, and evaluate methods that can be used to objectively and rapidly characterize sorghum quality for increasing domestic and export markets.

Publications:

Bean, S.R. 2001. Improving high performance capillary electrophoresis methods for characterizing the proteins of wheat, barley, oats, rice, maize, and sorghum: Ph.D., Diss., Kansas State University. 129 pp.

Vasil, I.K, S.R. Bean, J. Zhao, P. McCluskey, G.L. Lookhart, H. Zhao, F. Altpeter, F., and V. Vasil. 2001. Evaluation of baking properties and gluten protein composition of field grown transgenic wheat lines expressing high molecular weight glutenin gene 1Ax1. J. Plant Physio. 158:521-528.

Hicks, C., S.R. Bean, G.L. Lookhart, J.F. Pedersen, K.D. Kofoed, and M.R. Tuinstra. 2001. Genetic analysis of kafirins and their phenotypic correlations with feed-quality traits, in vitro digestibility, and seed weight in grain sorghum. Cereal Chem. 78:412-416.

Bean, S.R., and G.L. Lookhart. 2001. Optimizing quantitative reproducibility in HPCE separations of cereal proteins. Cereal Chem. 78:530-537.

Bean, S.R., and G.L. Lookhart. 2001. Recent advances in the HPCE of cereal proteins. Electrophoresis 22:1503-1509.

Bean, S.R., and G.L. Lookhart. 2001. Factors influencing the characterization of gluten proteins by SEC-MALLS. *Cereal Chem.* 78:608-618.

Bean, S.R., and G.L. Lookhart. 2001. HPCE of meat, dairy, and cereal proteins. *Electrophoresis.* (In press)

Impacts: Relative to other cereals grains, little research has been carried out with respect to the relationship between the major classes of sorghum biomolecules and end-use quality (both for food and animal feed). In order to produce higher quality sorghum products, and thus increase the utilization of sorghum, more research is needed in this area. A new scientist position was filled on October 22, 2001 at the Grain Quality and Structure Research Unit, GMPRC to initiate basic and applied research in the area of sorghum biochemistry. The research laboratory was set up and research plans and collaborations have been initialized. This position was created and filled in response to efforts by the National Grain Sorghum Producers to enhance sorghum value in food and non-food products. The research will result in: improved grain sorghum quality for human foods and animal feeds; increased utilization; and enhanced domestic and export markets.

Funding Sources:

U.S. Department of Agriculture, Agricultural Research Service

Contacts:

Scott R. Bean, Phone: 785-776-2725, FAX: 785-537-5534, E-mail: scott@gmprc.ksu.edu.

NC-213 Progress Report for 2001

From: USDA-Agricultural Research Service
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center

By: Bechtel, D.B.

NC-213 Objective: C Procedure: 1a

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

Results for 2001: Starch was isolated from wheat grains of different classes and analyzed using digital image analysis coupled to a light microscope to determine starch size distributions. The image analysis data was converted into volume data. Starch granules with diameters greater than 5 μm were treated as oblate spheroids for calculating volume using the formula for an oblate spheroid. The same starch was also analyzed using laser light diffraction instrumentation for determination of size distributions. Comparison of image analysis data, converted to spheroid volume average basis to data obtained from laser light diffraction revealed differences between the two measurement systems. On a volume basis, the diffraction system showed two peaks, one centered at about 4 μm and the other at 22 μm , while image analysis showed the two peaks centered at about 6 μm and 15 μm .

The data suggests that laser diffraction is measuring type A granules somewhere between being true spherical and oblate spheroid in shape. The smaller type B granule population, as measured by laser diffraction, tended to have a smaller diameter (about 2 μm) than those measured by image analysis measured. On a number basis, the most prevalent type starch was the small type C granules. While prominent by number, the type C granules were insignificant on a volume basis.

Plans for 2002: Image analysis is method of choice for accurately measuring starch size distributions, but is too slow for routine sample analysis. Laser light diffraction systems delivers repeatable data on starch analyses, but is inaccurate. We plan on using image analysis data to formulate corrections so that laser light diffraction methods can be used for routine starch size distributions.

Publications:

Shewry, P.R., D.B. Bechtel. 2001. Morphology and chemistry of the rye grain. In W. Bushuk, ed., pp. 69-127. Rye: Production, Chemistry and Technology. Amer. Assoc. Cereal Chem., Inc., St. Paul, MN.

Bechtel, D.B., J.D. Wilson. 2001. Digital image analysis of isolated starch from wheats of different classes and application of correction factors to determine starch size distributions. In: Program Book of the 86th AACC Annual Meeting. Page 134.

Impacts: 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. 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 image analysis and laser light diffraction. These methods will be used to routinely characterize wheat samples for starch size distributions. 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. The methods will allow breeders to be able to select for specific starch size distributions.

Funding Sources:

U.S. Department of Agriculture, Agricultural Research Service

Contacts:

Donald B. Bechtel, Phone: 785-776-2713, FAX: 785-537-5534, e-mail: don@gmprc.ksu.edu.

NC-213 Progress Report for 2001

From: USDA-Agricultural Research Service
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center

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

NC-213 Objective: C

Procedure: 1a

Project Objectives: 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 2001: 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. In addition, we have a leading role in both Wheat Quality Council Sample evaluation for domestic customers and Overseas Varietal Analysis Project for international customers.

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/. Using a simple, user-friendly relational database system, we provided simultaneous assessment of multiple quality traits. It was the fourth year for us to distribute the database to all wheat breeders at the annual Breeders Field Day. For breeders and other industry customers to be able to easily access regional performance nursery data via the internet, we provided a web page for the HWWQL (<http://gqu1.usgmrl.ksu.edu/gqu/HWWQL/HWWQLHome.htm>). The webpage also allows for the HWWQL to more rapidly respond to customer needs.

We have continued to study the interaction of wheat flour protein, starch, and lipids in the presence of water and as they are mixed in order to provide basic chemical information the rheology of flour/water dough systems using FTIR and Raman spectroscopy.

We have continued to study the relationships of breadmaking with wheat and/or flour characteristics, including single kernel parameters, NIR hardness scores, gluten, pasting, and mixograph parameters, and flour particle size and starch granule size distributions.

We have completed method development of: (a) Pressurized Solvent Extraction System for extracting genistein and its beta-glucoside conjugates from soybean flours and soy-based foods; and (b) NIR transmittance estimation of free lipid and its glycolipid contents using wheat flour lipid extracts. In addition, we have expanded the use of Supercritical Fluid Extraction (SFE) system for extracting total fat from breakfast cereals for nutritional labeling. Three professional societies, including the AOAC, International; AACC, and ICC (International Association for Cereal Science and Technology) are in the process of jointly developing SFE method of cereal fat content determination as a possible Official Method.

Plans for 2002: 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. 2001. Welcome address of ICC President. In: Program and Abstract Book of the 1st Baltic Conference on Rye, Kaunas, Lithuania. Page 4.

Chung, O.K., W. Bushuk, and J.B. Ohm. 2001. Rye production and uses worldwide. In: Program and Abstract Book of the 1st Baltic Conference on Rye, Kaunas, Lithuania. Page 21.

Chung, O.K., H. Glattes, and R. Schoenlechner. 2001. Rye in the USA. In: Program and Abstract Book of the 1st Baltic Conference on Rye, Kaunas, Lithuania. Pages 23-24.

Chung, O.K., G.L. Lookhart, S.R. Bean, J.B. Ohm, M. Tilley, D.B. Bechtel, L.M. Seitz, J.D. Wilson, A. Sayaslan, M.S. Ram, B.W. Seabourn, M.S. Caley, J.D. Hubbard, S.H. Park, R.K. Lyne, J.M. Downing, and F.E. Dowell, F.E. 2001. Wheat research in the U.S. Grain Marketing Research Laboratory. Annual Wheat Newsletter 47:256-263.

Chung, O.K., J.B. Ohm, M.S. Caley, and B.W. Seabourn. 2001. Prediction of baking characteristics of hard winter wheat flours using computer-analyzed mixograph parameters. Cereal Chem. 78:493-497.

Chung, O.K., J.B. Ohm, M.S. Caley, and B.W. Seabourn. 2001. Prediction of quality characteristics of hard winter wheat flours using single kernel and mixograph parameters. In: Program Book of the 86th AACC Annual Meeting. Page 171.

Chung, O.K., J.B. Ohm, A.M. Guo, C.W. Deyoe, G.L. Lookhart, and J.G. Ponte, Jr. 2001. Free lipids in air classified high protein fractions of hard winter wheat flours. Cereal Chem. (In press).

- Chung, O.K., J.B. Ohm, G.L. Lookhart, and R.F. Bruns. 2001. Comparison of quality characteristics of hard winter and hard spring wheat cultivars grown in a common environment. *J. Cereal Sci.* (In press)
- Chung, O.K., J.B. Ohm, B.W. Seabourn, and F.E. Dowell. 2001. Total quality-based wheat marketing system. Pages 449-455 In: *Cereals 2000. Proceedings of the 50th Australian Cereal Chemistry Conference and the 11th International Cereal and Bread Conference.* B. Osborne and M. Wootton, eds. Royal Australian Chemical Institute, Cereal Chem. Division, Surfers Paradise, Australia.
- Downing, J.M. 2001. Pressurized solvent extraction of genistein and its beta-glucoside conjugates from soybean flours and soy-based foods. M.S. Thesis, Kansas State University, Manhattan, KS. 54 pp.
- Dupont, F.M., S.B. Altenbach, O.K. Chung, R. Chan, and R. Lopez, R. 2001. Positive effects of growing environment on wheat protein content and breadmaking quality. In: *Program Book of the 86th AACC Annual Meeting.* Page 173.
- Haley, S.D., J.L. Gellner, M.A.C. Langham, Y. Jin, S. Salsbeck, C. Stymiest, J. Rickertsen, R. Little, B.E. Ruden, O.K. Chung, B.W. Seabourn, D.V. McVey, and J.H. Hatchett. 2000. Registration of 'Harding' wheat. *Crop Sci* 40:1500-1501.
- Hubbard, J.D., J.M. Downing, and O.K. Chung. 2001. Supercritical fluid extraction of total fat from breakfast cereals for nutritional labeling. In: *Program Book of the 86th AACC Annual Meeting.* Page 144.
- McCluskey, P.J., O.K. Chung, and T.J. Herrman. 2001. Milling & bread-baking qualities of hard winter wheat varieties: 2001 Kansas update. Kansas State University, Agricultural Experiment Station and Cooperative Extension Service. MF-1077. 4 pages.
- Ohm, J.B. and O.K. Chung. 2000. NIR transmittance estimation of free lipid content and its glycolipid and digalactosyldiglyceride contents using wheat flour lipid extracts. *Cereal Chem* 77:556-559.
- Ohm, J.B. and O.K. Chung. The relationships of free lipids with quality factors in hard winter wheat flours. *Cereal Chem.* (In press).
- Park, S.H. 2001. Bread volume and crumb grain study: effects of wheat and flour characteristics and starch granule size. Ph.D. Dissertation, Kansas State University, Manhattan, KS. 170 pp.
- Park, S.H., O.K. Chung, and P.A. Seib. 2001. Effects of particle size on loaf volume and internal characteristics of experimental pup-loaf breads. In: *Program Book of the 86th AACC Annual Meeting.* Page 158.

Sayaslan, A., O.K. Chung, P.A. Seib, and L.M. Seitz. 2000. Volatile compounds in five starches. *Cereal Chem.* 77:248-253.

Impacts: Securing and improving the quality of grains produced in the U.S. so that they meet the needs of both domestic and overseas customers has always been a monumental task. Grain quality improvement begins with a breeding program and ends with growers. We at the HWWQL evaluated intrinsic quality parameters of hard winter breeding lines (2000 crop) and our data of breeders' nursery samples are of prime importance for the release of breeding lines to become cultivars to be grown by farmers. On average of the last three years, the U.S. wheat production was 66.5 million metric tons (about 2.24 billion bushels): nearly one-half of U.S. wheat production and 41% of U.S. wheat export comes from hard red winter wheat. Over 95% of all hard winter wheats have been evaluated for end-use quality before they were released as cultivars.

Funding Sources:

U.S. Department of Agriculture, Agricultural Research Service

Contacts:

Okky Chung, Phone: 785-776-2703, FAX: 785-537-5534, E-mail: okchung@gmprc.ksu.edu.

NC 213 Progress Report for 2001

From: Iowa State University - Ames Laboratory
Agricultural & Biosystems Engineering
U.S. Department of Energy

By: Cogdill, R.
Hurburgh, C.R. Jr.
Jones, R.

NC 213 Objective: C Procedure: 1a

Project Objectives: Apply spectroscopic imaging to grain quality analysis.

Results for 2001: The objectives of this research were: 1) to develop a technique for creating calibrations to predict the constituent concentration of single maize kernels from near-infrared (NIR) hyperspectral image data; and 2) to evaluate the feasibility of a NIR hyperspectral imaging spectrometer as a tool for the quality analysis of single maize kernels. Single kernels of maize were analyzed by hyperspectral transmittance in the range of 750 – 1090 nm.

The spectral image data were standardized using an opal glass transmission standard and images of the analysis stage with no sample present. Standard normal variate, multiplicative scatter correction, and no preprocessing were compared before calibration was finalized. Spectral data were transformed by both log (1/T) and power transformations before PLS calibration models for the prediction of moisture and oil concentration were created. Variable selection by genetic algorithm was tested as a means of reducing the required amount of spectral image data. Variable selection significantly increased the performance of the oil calibration while decreasing the variable space by 79%; oil calibration standard error of cross validation (SECV) was reduced to 1.20% from 1.59%.

The moisture calibration correlation and ratio of data range to SECV indicate that NIR hyperspectral imaging can be an effective tool for non-destructively determining the quality of single-kernels of maize. The performance and subsequent analysis of the performance of the oil calibration reveal the need for improved methods of destructive analysis for single-kernel calibration reference.

Other previous work on imaging was published.

Plans for 2002: Expand single-seed calibrations and automate the single-seed imaging system.

Publications:

Cogdill, R.P., C.R. Hurburgh, Jr., T.C. Jensen, and R.W. Jones. 2001. Single kernel maize analysis by near infrared hyperspectral imaging. Proc NIR 2001, International Diffuse Reflectance Council, Seoul, Korea (poster, abstract).

Cogdill, R.P., C.R. Hurburgh, Jr., G.R. Rippke, R.W. Jones, T.C. Jensen, and J.F. McClelland. 2001. Single kernel maize analysis by near-infrared hyperspectral imaging. Trans. ASAE (sub).

Steenhoek, L.A., M.K. Misra, C.R. Hurburgh, Jr., and C.J. Bern. 2001. Implementing a computer vision system for corn kernel damage evaluation. Trans. ASAE 17(2):235-240.

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural & Biosystems Engineering

By: Dzubin, R.
Hurburgh, C.R. Jr.

NC 213 Objective: C Procedure: 1a

Project Objectives: Optimize performance of near-infrared analyzers in network situations.

Results for 2001: The ISU Grain Quality Laboratory has been creating calibrations for near-infrared (NIR) analyzers. Through this process, very large databases have been collected, containing information on thousands of samples. Very large data sets and fast computers allow the use of mathematical methods not possible using the internal instrument software. A software solution was designed to:

- Implement a universal Internet-enabled communication and analysis model for NIR instruments.
- Create a model for handling of data through Internet capable storage to provide immediate analytical results for unknown samples and store spectra in a central database.
- Develop a scalable object-based system of implementation for data processing and analysis for NIR instruments. Implement and compare multiple mathematical algorithms in real time.

The software links multivariate instruments (NIR) with high capacity numerical software (MATLAB) for central multivariate processing over the Internet. The software solution is built on a 3-tier architecture, called “server-centric,” enabling the application logic to run on servers instead of on users’ computers.

1st tier: Visual Basic (VB) application, client personal computer (486 and higher) with Internet connection, NIR instrument with serial port to send optical data to client computer. There is a low performance requirement for local hardware because only a part of the solution needs to be installed on the user’s computer.

2nd tier: Consists of several programming routines running as background processes on the server, Information Server (IIS), and Matlab™ software. The central part of the 2nd tier is the MATLAB™ application – computational environment to run calibration models. Matlab provides a large collection of built-in functions for building new algorithms and assures easy “upgrade”, because only Matlab routines need to be replaced.

3rd tier: Database that organizes and provides data for running the applications and for users. In this project, MS SQL-Server 7.0 and SQL-Server 2000 were used to assure scalability and availability of the central database.

The software solution has been implemented and is currently being tested with very favorable results.

Plans for 2002: Publish and copyright software and conduct field test with 3-5 units.

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural & Biosystems Engineering

Cemagref
GIQUAL

By: Hurburgh, C.R. Jr.
Roussel, S.

Hardy, C.L.
Rippke, G.R.

NC 213 Objective: C Procedure: 1a

Project Objectives: Develop near-infrared calibrations for identification of genetically modified grains.

Results for 2001: Identification and segregation of genetically modified (GMO) grains challenges the world grain handling system to find a rapid and inexpensive test to distinguish GMO grain from non-GMO grain in inbound deliveries. Roundup Ready™ soybean (RR) was the first genetically modified grain to be widely adopted by U.S. farmers (0% of soybean acres grown in 1996 to more than 50% in 2000). Currently, only an ELISA and PCR (Polymerase Chain Reaction) method have been validated for commercial testing of Roundup Ready™ soybean; however, those methods are time-consuming and expensive. In comparison, near-infrared spectroscopy offers non-destructive, rapid and cost-effective measurements. Though near-infrared spectrometers are not precise enough to detect compounds at the DNA concentration level (parts per trillion), spectral differences caused by larger structural changes accompanying the modification might be measurable.

The objective of this study was to develop a near-infrared spectroscopy protocol for distinguishing Roundup Ready™ from conventional soybeans. A database containing more than 8000 soybean samples was measured by transmission spectrometers (FOSS/Tecator Infratec).

Three data processing algorithms were compared to determine which model would classify soybean samples with the greatest accuracy: Partial Least Squares - Discriminate Analysis (PLS-DA), Locally Weighted Regression (LWR), and Artificial Neural Networks (ANN). Locally Weighted regression provided the most accurate classification model with 93% accuracy (96% if constituent levels were used to augment neighbor selection), while ANN and PLS methods provided classification accuracy of 90% and 78%, respectively. A new LWR algorithm was designed to reduce computation time when very large databases are used.

Plans for 2002: Increase database size to 20,000 spectra, implement on-line, and test alternative algorithms.

Publications:

Roussel, S.A., C.L. Hardy, C.R. Hurburgh, Jr., and G.R. Rippke. 2001. Detection of genetically modified soybeans by near infrared spectroscopy. European Commission. Environment, Health and Safety: A challenge for measurements. UNESCO, Paris. June 14-15, 2001 (poster).

Roussel, S.A., C.L. Hardy, C.R. Hurburgh, Jr., and G.R. Rippke. 2001. Detection of Roundup Ready™ soybeans by near-infrared spectroscopy. *Applied Spectroscopy* 55(10):1425-1430.

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural & Biosystems Engineering
Agronomy

By: Lacombe, S.
Hurburgh, C.R. Jr.
Westgate, M.

NC 213 Objective: C Procedure: 1a

Project Objectives: Develop procedures for rapid measurement of grain subunits.

Results for 2001: Soybean isoflavones may contribute to the prevention of chronic diseases such as cardiovascular disease or cancer. Acting as phytoestrogens, soybean isoflavones may contribute to the decrease of detrimental effects of menopause such as osteoporosis and hot flashes. Determination of isoflavone levels in soybean seeds is certainly a first step of supporting health claims of soybean isoflavones.

Determination of isoflavone contents has been reported by RP-HPLC, capillary electrophoresis, and gas chromatography (quantification of aglucon forms). Those methods have disadvantages of time and cost per analysis.

A faster and cheaper way of performing isoflavone determination is by using spectroscopy techniques with chemometrics. The purpose of this study is to develop a method for the determination of isoflavones in soybean seeds with UV spectroscopy and multivariate calibration. Preliminary experiments with a reduced number of data points were necessary to prove the feasibility of this technique.

Soybean cultivars were grown at different locations in the U.S., Canada, and France, to provide a range of isoflavone contents (from 1.5 mg.g⁻¹ to 6 mg.g⁻¹) within different genetic lines. Total isoflavones in methanol extracts were quantified both by absorption in the UV range (200 to 400 nm), and by RP-HPLC (with UV detection). The multivariate calibration method Partial Least Squares (PLS) was used to obtain calibration models. Predicted values of test samples obtained with this model were compared with HPLC reference measurements. Preliminary results show that chemometric tools can extract sufficient information from an UV spectrum to quantify isoflavone contents in soybean seeds.

Plans for 2002: Refine and publish method and to determine if time can be reduced.

NC-213 Progress Report for 2001

From: USDA-Agricultural Research Service
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center

By: Lookhart, G.L.

NC-213 Objective: C Procedure: 1a

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

Results for 2001: 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 new method to extract sorghum proteins using SDS was developed and then they were analyzed by free zone capillary electrophoresis. The sorghum proteins (kafirins) were extracted and analyzed by capillary electrophoresis from a wide genetic base of grain sorghums. The results of the genetic analysis of the kafirins and their phenotypic correlations with feed-quality traits, in vitro digestibility, and seed weight were compared and correlated.

Size-exclusion chromatography and multiangle laser light scattering (SEC-MALLS) methods were developed for characterizing gluten proteins and the factors required to get reproducible results were described. Molecular sizes for each of the extractable and separable fractions of wheat proteins were found. Molecular weights were determined to be in the 40,000 region for gliadins and up to the tens of millions for the largest “unextractable” proteins.

The gluten protein composition and baking properties were evaluated of field grown transgenic wheat lines expressing high molecular weight glutenin gene 1Ax1. Those lines with high copy numbers of the transgene (very large amounts of gluten 1Ax1) were found to have poorer baking quality than the control. The transgenic wheat was found to be stable in field-grown environments.

A method to optimize the quantitative reproducibility in high-performance capillary electrophoresis (HPCE) separations of cereal proteins was developed. Important steps found include the presence of hydroxy propyl methyl cellulose (HPMC) in the buffers to stabilize the capillaries and the means of cutting the ends of the capillaries (making the cut square) was also found significant.

A standard method to determine wheat color class was developed using the NaOH test. This test provides a simple and step-by-step procedure that can easily be followed by non-technical people.

Plans for 2002: Faster and more sensitive analytical methods we have developed will be utilized to characterize proteins in wheat and related species. Relate results to their properties. Characterize the formation of various wheat proteins and protein size distributions during grain maturation as a function of glutenin subunits 5 + 10 vs 2 + 12.

Publications:

Bean, S.R., C. Hicks, M. Tuinstra, and G.L. Lookhart, G.L. 2001. The use of SDS for extraction and analysis of sorghum proteins by free zone capillary electrophoresis. *Cereal Chem.*78:84-87.

Vasil, I.K., S. Bean, J. Zhao, P. McCluskey, G.L. Lookhart, H. Zhao, F. Altpeter, and V. Vasil. 2001. Evaluation of baking properties and gluten protein composition of field grown transgenic wheat lines expressing high molecular weight glutenin gene 1Ax1. *J. Plant Physiology* 158:521-528.

Hicks, C., S.R. Bean, G.L. Lookhart, J.F. Pedersen, K.D. Kofoed, and M.R. Tuinstra. 2001. Genetic analysis of kafirins and their phenotypic correlations with feed-quality traits, in vitro digestibility, and seed weight in grain sorghum. *Cereal Chem* 78:412-416.

Bean, S.R. and G.L. Lookhart. 2001. Factors influencing the characterization of gluten proteins by size-exclusion chromatography and multiangle laser light scattering (SEC-MALLS). *Cereal Chem.* 78:608-618.

Bean, S.R. and G.L. Lookhart. 2001. Recent developments in high-performance capillary electrophoresis of cereal proteins. *Electrophoresis* 22:1503-1509.

Bean, S.R. and G.L. Lookhart. 2001. Optimizing quantitative reproducibility in high performance capillary electrophoresis (HPCE) separations of cereal proteins. *Cereal Chem.* 78:530-537.

Lookhart, G.L. and S.R. Bean. 2001. Ultrafast separation of cereal proteins by HPLC. *In: Cereals 2000. Proceedings of the 50th Australian Cereal Chemistry Conference and the 11th International Cereal and Bread Conference.* B. Osborne and M. Wootton, eds. Royal Australian Chemical Institute, Cereal Chem Division, Surfers Paradise, Australia, pp. 362-371.

Siriamornpun, S., M. Wootton, G.L. Lookhart, S. Bean, C.W. Wrigley, and F. Bekes. 2001. Interlaboratory comparative study of capillary electrophoresis of gliadins from Australian and U.S. wheats. *In: Cereals 2000. Proceedings of the 50th Australian Cereal Chemistry Conference and the 11th International Cereal and Bread Conference.* B. Osborne and M. Wootton, eds. Royal Australian Chemical Institute, Cereal Chem. Division, Surfers Paradise, Australia. pp. 372-376.

Bean, S.R. and G.L. Lookhart. 2001. Optimizing quantitative reproducibility in HPCE separations of cereal proteins. *In*: Abstract Book of the 86th AACC Annual Meeting. Page 166.

Ram, M.S., F.E. Dowell, L.M. Seitz, and G.L. Lookhart. Development of standard procedures for a simple, rapid test to determine wheat color class. *Cereal Chem.* (In press).

Lookhart, G.L. and S.R. Bean. Overview of cereal protein separations by HPCE. *J. of Capillary Electrophoresis.* (In press).

Bean, S.R. and G.L. Lookhart. HPCE of meat, dairy, and cereal proteins. *Electrophoresis.* (In press).

Chung, O.K., J.B. Ohm, G.L. Lookhart, and R.F. Bruns. 2001. Comparison of quality characteristics of hard winter and hard spring wheat cultivars grown in a common environment. *J. Cereal Sci.* (In press).

Impacts: 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. We have developed high performance liquid chromatography and high performance capillary electrophoresis methods to quickly (less than 5 min) and accurately identify cereal grain cultivars from ½ grains to bulk flours. We have also developed methods to identify barley, maize and sorghum cultivars. The utilization of these methods allows 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.

Funding Sources:

U.S. Department of Agriculture, Agricultural Research Service

Contacts:

George Lookhart, Phone: 785-776-2736, FAX: 785-537-5534, E-mail: george@gmprc.ksu.edu.

NC-213 Progress Report for 2001

From: Michigan State University
Department of Food Science & Human Nutrition

By: Ng, Perry K.W.

NC-213 Objective: C Procedure: 1a

Project Objectives: Examine milling properties, dough characteristics, protein functionality, and baking properties of soft white wheat.

Results for 2001: We have continued to examine soft wheat varieties for milling and baking qualities. Biochemical studies on flour proteins were conducted. There was a wide range of protein quality among the examined flour samples. In addition, dough properties and baking qualities of these samples have been investigated and correlated. The developed laboratory procedure for cracker making was used for evaluating some of the soft wheat varieties for cracker-making potential, and is continuing to be refined.

Plans for 2002: Continue to evaluate intrinsic quality parameters for soft wheat varieties for milling and baking characteristics; continue to identify possible biochemical markers for these characteristics; and publish available data.

Publications:

Koksel, H., D. Sivri, P.K.W. Ng, and J.F. Steffe. 2001. Effects of transglutaminase enzyme on fundamental rheological properties of sound and bug-damaged wheat flour doughs. *Cereal Chem.* 78:26-30.

Anderson, A.K. and P.K.W. Ng. 2001. Thermal and hydrophobic properties of extruded wheat flour components as measured by differentials scanning calorimetry and fluorescences spectroscopy. *Food Science and Biotechnology* 10:156-160.

Ryu, G.H. and P.K.W. Ng. 2001. Effects of selected process parameters on expansion and mechanical properties of wheat flour and whole cornmeal extrudates. *Starch* 53:147-154.

Lee, L., P.K.W. Ng, J.H. Whallon, and J.F. Steffe. 2001. Relationship between rheological properties and microstructural characteristics of non-developed, partially developed, and developed doughs. *Cereal Chem.* 78:447-452.

Schluentz, E.J., J.F. Steffe, and P.K.W. Ng. 2001. SEM sample preparation techniques for developed and undeveloped wheat doughs. *Food Engineering Progress* 5(2):138-143.

Schmid, K.D., K.D. Dolan, and P.K.W. Ng. 2001. Thiamin retention of wheat flour extruded at lower temperatures using carbon dioxide gas as a puffing agent. *AACC Annual Meeting Program Book.*

- Cha, J.Y., K.D. Dolan, and P.K.W. Ng. 2001. Effect of shear on thiamine destruction in extrusion processing. AACC Annual Meeting Program Book.
- Reiter, E., P.K.W. Ng, and E. Berghofer. 2001. Potential use of spelt wheat wholemeal for cracker production. AACC Annual Meeting Program Book.
- Basman, A., H. Koksel, and P.K.W. Ng. 2001. Examining of polymer formation of wheat, soy and barley proteins with transglutaminase enzyme. AACC Annual Meeting Program Book.
- Sivri, D., A. Ozkan, H. Koksel, and P.K.W. Ng. 2001. Effects of bug (*Aelia rostrata*) damage on rheological properties of six bread wheat cultivars. AACC Annual Meeting Program Book.

NC 213 Progress Report for 2001

From: Iowa State University
USDA

Grain Inspection, Packers & Stockyards Administration

Cemagref
GIQUAL (France)

By: Roussel, S.
Hurburgh, C.R. Jr.
Funk, D.

NC 213 Objective: C Procedure: 1a

Project Objectives: Optimize performance and computational capabilities of near-infrared analyzers.

Results for 2001: NIR calibration models must be accurate and robust to all kinds of perturbations. The model accuracy is usually estimated by the Standard Error of Prediction (SEP). However, defining the model robustness is less clear. The objective of this paper is to quantify and compare the noise robustness of calibration models through a model robustness test.

Different multivariate models were built on 3700 corn calibration spectra (Foss Tecator Infratec 122x series) to predict the moisture content of whole corn kernels: Partial Least Squares (PLS) regression with various pre-processing techniques (Standard Normal Variate (SNV) and Genetic Algorithms (GA) for wavelength selection), Locally Weighted Regression (LWR) and two types of Artificial Neural Networks (pruned and regularized-ANN).

To simulate noise, synthetic noises were generated and introduced in a test dataset of 410 samples: random noise, path length variations (multiplicative effects), gain variations (baseline shift), monochromator wavelength axis variations (wavelength shift and spectral stretch/shrink), stray light, and monochromator bandwidth variations (convolution with modified bandwidths). The robustness of each model was compared, by assessing the robustness criteria $R_N = \partial SEP / \partial N$ ($N=Noise$) and the noise level to double initial SEP.

No model significantly outperformed all the others. However, artificial neural networks appeared to be the most robust. As expected, the local models were the least robust in most cases (except for random noise and monochromator bandwidth).

Data pre-processing played a great role in the model robustness. SNV pre-processing was efficient in improving the model robustness, but with a trade-off in the initial model accuracy. Even though parsimonious (fewer variables included) models are supposed to be more robust to perturbations, the higher amplitude of GA-PLS regression coefficients nullified any advantage gained from the wavelength selection.

This method can be applied to any spectroscopic measurement, to assess the robustness of models and determine their noise thresholds, such as, for example, before standardizing data coming from different instruments or before merging databases.

Other previous work was published.

Plans for 2002: Publish results and develop methods for merging large databases.

Publications:

Roussel, S.A., C.R. Hurburgh, Jr., and D.B. Funk. 2001. Accuracy and robustness comparison of different processing algorithms for grain quality assessment. Chemometrics 2001. Paris, France. December 4-5, 2001 (presentation).

Chang, Ching-Wen, D. Laird, M.J. Mausbach, and C.R. Hurburgh, Jr. 2001. Near-Infrared Reflectance Spectroscopy – Principal Component Regression Analysis of Soil Properties. Soil Sci. Soc. Am. J. 65:480-490.

Siska, J., C.R. Hurburgh, Jr. and P. Siska. 2001. The standardization of near-infrared instruments using master selection and Wiener filter methods. J. Near Infrared Spectrosc. **9**, 97-105.

Siska, J., C.R. Hurburgh, Jr. and P. Siska. 2001. The impact of engineering parameters on the accuracy of calibration transfer. J. Near Infrared Spectrosc. **9**, 107-116.

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural & Biosystems Engineering

Cemagref
GIQUAL (France)

Almaco, Inc.

By: Roussel, S.
Hurburgh, C.R. Jr.

Rippke, G.
Schroeder, T.

Carr, B.

NC 213 Objective: C Procedure: 1a

Project Objectives: Develop near-infrared applications in on-line of mobile situations.

Results for 2001: The objective of this work was to apply an NIR instrument (Zeiss Corona 1.7 InGaAs sensor) that provides a 128-wavelength reflectance spectrum in the 940nm-1710nm range) to field measurement conditions on ALMACO research plot harvesters.

Calibration models were generated with corn samples measured on a laboratory test stand. High frequency spectral measurements allowed up to 20 scans per sample, which was filtered and combined using pre-treatment algorithms. A flow through sample presentation device was designed and patented.

The NIR sensor was calibrated for corn moisture, protein and oil content, using Partial Least Squares (PLS) regression. The model Standard Errors of Prediction, assessed in cross-validation, were satisfactory. 0.35% pts (range 7.0%-24.2%), 0.39% pts (range 5.4%-14.2%), 0.35% (range 2.8%-12.4%), 0.79% (range 48.2%-67.6%), and 0.126 g/cm³ (range 1.19 g/cm³-1.38 g.cm³) for corn moisture, protein, oil, starch and density, respectively.

During the 2001 harvest, updated calibration models with temperature compensation were tested on an ALMACO plot harvester in mid-west cornfields. The field trial gave suitable predictions for on-the-go corn quality assessment.

Plans for 2002: Calibrate for soybeans, update corn calibrations, operate over full harvest season, and evaluate other optics alternatives.

NC-213 Progress Report for 2001

From: USDA-Agricultural Research Service
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center

By: Tilley, M.
Lookhart, G.L.

NC-213 Objective: C Procedure: 1a

Project Objectives: Examine high molecular weight glutenin subunits (HMW-GS) from the D-genome progenitor of bread wheat *Aegilops (Triticum) tauschii*.

Results for 2001: A cDNA library was constructed from developing kernels of screened to isolate cDNAs encoding HMW-GS Dx43 and Dy44. Analysis of the DNA sequences and predicted amino acid sequences revealed Dx43 to have 97.1% and 96% identity to HMW-GS Dx2 and Dx5, respectively, and HMW-GS Dy 44 to have 90.8% similarity to Dy10 of bread wheat (*T. aestivum*).

Plans for 2002: The cDNA clones will be inserted into appropriate expression vectors and transformed into elite cultivars of *T. aestivum* by collaborators (G. Liang and S. Muthukrishnan, KSU Depts of Agronomy and Biochemistry). The vectors contain site specific promoters for targeted expression in the endosperm.

Publications:

Tilley, M., S.R. Bean, P.A. Seib, R.G. Sears, and G.L. Lookhart. 2001. PCR amplification and DNA sequencing of high molecular weight glutenin subunits 43 and 44 from *Triticum tauschii* accession TA2450, pp. 105-108. In: Wheat Gluten, Shewry, P.R., Tatham, A.S., editors. Royal Society of Chemistry, Cambridge, UK.

Chung, O.K., G.L. Lookhart, S.R. Bean, J.B. Ohm, M. Tilley, D.B. Bechtel, L.M. Seitz, J.D. Wilson, A. Sayaslan, M.S. Ram, B.W. Seabourn, M.S. Caley, J.D. Hubbard, S.H. Park, R.K. Lyne, J.M. Downing, and F.E. Dowell. 2001. Wheat research in the U.S. Grain Marketing and Production Research Center. Annual Wheat Newsletter 47:256-253.

Impacts: Because the common HRW wheat cultivars grown in the U.S. are the result of limited germplasm, the effects of novel gluten proteins from distant wheat ancestors needs to be examined to study the impact of the D genome HMW-GS. *T. tauschii* has been used in crosses with established cultivars to develop plants bearing disease and insect resistance, and containing new combinations of HMW-GS. We have isolated and characterized novel HMW-GS from *Aegilops (Triticum) tauschii* at the protein and DNA level. Research thus far shows that gluten proteins of *T. tauschii* are similar in both structure and behavior to those of *T. aestivum*. Results indicate that introducing the specific genes for those gluten proteins into bread wheats is a viable method for improving bread quality.

Funding Sources:

U.S. Department of Agriculture, Agricultural Research Service and Kansas Wheat Commission

Contacts:

Michael Tilley, Phone: 785-776-2759, Fax: 785-537-5534, E-mail: mtilley@gmprc.ksu.edu.

NC-213 Progress Report for 2001

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

By: Dowell, F.E.
Pearson, T.C.

NC-213 Objective: C

Procedure: 1b

Project Objectives: Develop sensors, instrumentation, and procedures for objective grading, on-line measurement, and end-use property assessment of single kernels or bulk samples.

Results and

Impacts for 2001: Karnal bunt has resulted in thousands of acres and millions of bushels being quarantined in the US in 2001, is a threat to all US wheat production, and could devastate our export wheat markets and US agriculture economy. We showed in 1997 that we could detect bunted kernels using optical sensors, thus, at APHIS request, we cooperated with APHIS, several state labs, and Satake USA to apply high-speed sorting technology to rapidly screen samples for the presence of bunted kernels. We showed that this technology could remove 100% of bunted kernels from samples, which will reduce inspector error and significantly reduce sample-processing time. These results have changed the procedure for inspecting samples for bunted kernels, and the reduction in errors and time will greatly improve our ability to detect and control additional outbreaks, and help insure the quality of our grain and preserve our export markets.

We investigated visible and near-infrared reflectance and transmittance spectroscopy to detect fumonisin in single corn kernels. Kernels with greater than 100 ppm and less than 10 ppm were classed accurately as fumonisin positive or negative, respectively. The color and chemical constituents of the infected kernel contributed in the classification process. These results show that this technology can be used to rapidly and nondestructively screen single corn kernels for the presence of fumonisin, and may be adaptable to on-line detection and sorting. Real-time detection would allow identification and segregation of fumonisin-contaminated lots destined for food or feed consumption. This is cooperative research with Dr. Don Wicklow, ARS, Peoria, IL.

We investigated visible and NIR spectroscopy to detect aflatoxin in single corn kernels. More than 95% of the kernels were correctly classified as containing either high (>100 ppb) or low (<10 ppb) levels of aflatoxin. Instrumentation that utilizes single-feature reflectance spectra can be practically implemented for automated high-speed detection and sorting. This technology will be valuable to the corn industry for rapidly detecting and sorting aflatoxin in corn. This is cooperative research with Dr. Don Wicklow, ARS, Peoria, IL.

We developed and commercialized a laboratory single kernel quality measurement instrument in 1998, but the industry requested a lower cost unit that could potentially be used at field locations. Thus, we developed a low-cost single kernel quality measurement device in cooperation with

KSU Biological and Agricultural Engineering Department. Perten Instruments, Springfield, IL, has agreed to commercialize the new system through a CRADA. This system will allow measurement of quality factors such as bunted kernels, protein, moisture, scab damage, and color class at farmer marketing, thus allowing segregation at the first point of sale.

At industry request, we developed protein and insect detection calibrations for a single kernel quality measurement instrument (SKCS 4170) developed through a CRADA with Perten Instruments in 1998. The calibrations included multiple classes and completed the CRADA work plan. These calibrations are being used by industry laboratories that have purchased the single kernel instrument. The wheat industry uses this information to purchase wheat for mills to optimize flour quality, and to segregate insect infested wheat to minimize insect fragments in flour.

At the request of FGIS, we are developing calibrations to detect vitreousness of wheat using a GC310 machine vision system manufactured by Foss. We have developed calibrations using samples that represent all vitreous defect classes. We transferred these calibrations to FGIS and they are currently collecting field samples to evaluate the system using 2001 crop year wheat. This system will reduce inspector error and labor in detecting vitreousness, allow quality and price to be more accurately accessed, and allow more precise segregation of wheat in order to improve end-use quality.

Plans for 2002: Complete development of a low-cost NIR system for detecting single kernel attributes and sorting based on these attributes.

Continue investigating other single kernel quality measurements such as protein and starch quality, and detection of transgenic attributes.

Continue image acquisition, calibration and testing of the GC 310 to determine performance and potential as an aid to grain inspectors. Develop the "best" GC 310 calibration, which will separate dark hard vitreous (DHV) kernels from non-DHV wheat kernels. Develop the "best" GC 310 calibration, which will separate hard vitreous and amber colored (HVAC) kernels from non-HVAC wheat kernels.

Continue cooperating with industry and other researchers to investigate single kernel NIRS to measure insect characteristics and quality of other commodities.

Publications:

Dowell, F.E., A.B. Broce, F. Xie, J.E. Throne, and J.E. Baker. 2000. Detection of parasitized fly puparia by using near-infrared spectroscopy. *J. Near Infrared Spectroscopy*. 8:259-265.

Dowell, F.E., T.C. Pearson, E.B. Maghirang, F. Xie, and D.T. Wicklow. 2001. Reflectance and transmittance spectroscopy applied to detecting fumonisin in single corn kernels. *Cereal Chem.* Accepted June 2001.

Hicks C, M.R. Tuinstra, J.F. Pedersen, F.E. Dowell, and K.D. Kofoed. 2001. Genetic analysis of feed quality and seed size in sorghum inbred lines and hybrids using analytical methods and NIRS. *Euphytica*. Accepted.

Pearson, T.C., D.T. Wicklow, E.B. Maghirang, F. Xie, and F.E. Dowell. 2001. Detecting aflatoxin in single corn kernels by using transmittance and reflectance spectroscopy. *Trans. ASAE*. Accepted May.

Ram, M.S., F.E. Dowell, L. Seitz, and G. Lookhart. 2002. Development of standard procedures for a simple, rapid test to determine wheat color class. *Cereal Chem.* (In Press).

Wang, D, F.E. Dowell, and D.S. Chung. 2001. Assessment of heat-damaged wheat kernels using near-infrared spectroscopy. *Cereal Chem.* Accepted June.

Issues: The production and marketing of grain are major components of the U.S. agricultural economy. Improved utilization and market efficiencies with objective quality, functionality and grain grade assessments will increase food wholesomeness, safety, and market competitiveness. For example, accurate, rapid detection of attributes could assist in: marketing or segregating genetically modified grain; detecting food safety concerns such as aflatoxin or fumonisin in corn; or detecting attributes that can lead to quarantine of commodities such as karnal bunt in wheat. This information is particularly useful in evaluating grain prior to purchase or trade in market channels. Single kernel assessments are needed to detect defects that may be present in only a small percentage of kernels or to detect mixtures of contrasting quality characteristics. New technology developed through this research will provide FGIS with several options for providing additional objective quality assessments of grain along with official grade services and thereby improve their services and operating efficiencies. The objective assessments of grain quality are useful to producers, breeders, growers, grain handlers, marketers, millers, bakers, and government agencies such as the Extension Service, FGIS, FSIS, APHIS and OSHA.

What Was Done: We investigated high-speed sorting technology for removing Karnal bunt from samples, and for removing red from white wheat stock. We also investigated NIR spectroscopy for detecting internal insects and protein in wheat and aflatoxin and fumonisin in corn, and machine vision technology for determining wheat vitreousness.

NC-213 Progress Report for 2001

From: University of Illinois - Illinois Agricultural Experiment Station
Agricultural Engineering Department

By: Paulsen, M.R.
Bajaj, M.

NC-213 Objective: C

Procedure: 1b

Project Objectives: 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 2001: In 2001, research continued on using near-infrared spectroscopy to measure extractable starch and for determining amylose content in corn. Over the 1997 to 2000 crop years, over 1705 samples of corn were scanned on the Foss Infratec 1229 near-infrared transmittance (NIT) unit. Plans are underway to use the extractable starch calibration at several FGIS field locations in 2002.

We completed research initiated by Dr. Steven Mbuvi at the Identity Preserved Seed Laboratory, Champaign, IL for developing calibrations for amylose content using near-infrared spectroscopy for corn. Amylose percentages in corn were predicted using Foss NIRSystems 6500 and 5000 instruments on whole and ground samples, respectively. The third derivative, 3,5,5,1 math treatment predicted calibration data better than the standard 1,4,4,1 math treatment, Figure 1. For the validation data set, the 3,5,5,1 treatment predicted better than the 1,4,4,1 treatment for the Model 6500; but with the Model 5000, a higher R^2 was obtained using the 1,4,4,1 treatment. The NIRSystems 6500 calibration using the 3,5,5,1 math treatment with unground samples predicted its validation set with an R^2 of 0.83, SEP of 7.6% and an RPD of 2.24. With the 1,4,4,1 math treatment, the R^2 was 0.82, SEP was 7.8% and the RPD was 2.17.

The NIRSystems 5000 calibration using the 3,5,5,1 math treatment with ground samples predicted its validation set with an R^2 of 0.73, SEP of 2.98% and a RPD of 1.92. The 1,4,4,1 math treatment predicted its validation set with an R^2 of 0.78, but a higher SEP of 3.05% and a lower RPD of 1.89. In comparing the two instruments, the Model 5000 with the 3,5,5,1 treatment with the ground samples had a lower SEP, higher R^2 , and higher RPD than the whole kernel samples in the Model 6500 for the calibration data set. For the validation data set, the Model 6500 with whole kernel samples covered a wider range and had an improved R^2 , but a much higher SEP and a slightly higher RPD compared to the Model 5000.

Plans for 2002: Plans for 2002 are to continue testing high-temperature dried samples and other types of corn with wide ranges of extractable starch and to work with FGIS field locations and wet millers for validation of results.

Publications:

Xie, W. and M.R. Paulsen. 2001. Machine vision detection of tetrazolium staining in corn. Transactions of ASAE. 44(2): 421-428.

Mbuvi, S.W., M.R. Paulsen, M. Bajaj, and S.K. Harrison. 2001. Application of near-infrared spectroscopy to predict amylose content in corn. ASAE Paper No. 01-6007. ASAE. St. Joseph, MI.

Paulsen, M.R., M. Bajaj and S.W. Mbuvi. 2001. NIRS: A rapid means to estimate wet milling yield of corn. Abstract. International Starch Technology Conference. University of Illinois. Urbana, IL. Jun 3-6, 2001.

Bajaj, M., M.R. Paulsen, S.J. Schmidt, and K.D. Baker. 2001. Effect of corn drying temperature of extractable starch characteristics. Abstract No. 45. American Assoc. Cereal Chemists' 86th Annual Meeting. AACC Charlotte, NC.

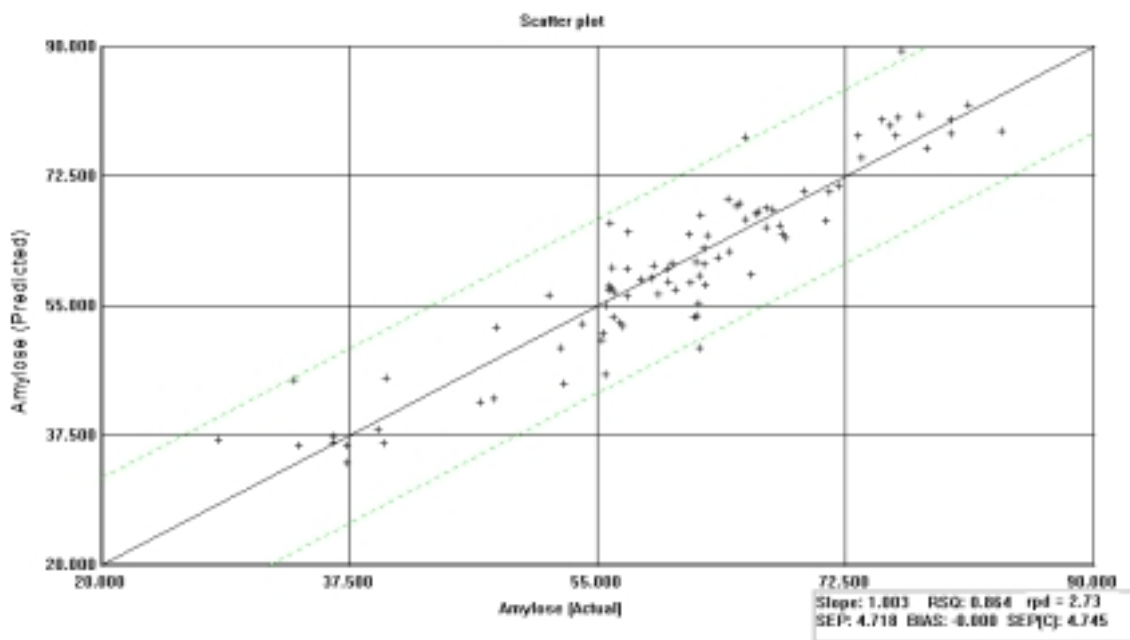


Figure 1. NIRSystems Model 6500 predicted amylose content for ca88c.cal calibration data set using ca883.eqa, modified PLS equation developed using a 3,5,5,1 math treatment.

Issues: Ability to quickly measure extractable starch and amylose percentages in corn.

What Was Done: Starch yield is influenced by corn variety, environmental conditions, and 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.

Impacts: For corn used for wet milling and dry grind ethanol production, 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 estimated increase in value of 4-6 cents per bushel per percentage point of extractable starch.

Funding Sources:

Dupont Specialty Grains, GIPSA-FGIS, Illinois Council on Food and Agricultural Research; and the 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: mpaulsen@uiuc.edu

NC-213 Progress Report for 2001

From: University of Nebraska-Lincoln
Department of Food Science & Technology

By: Jackson, D.S.

NC-213 Objective: C

Procedure: 2a

Project Objective: Determine and identify specific chemical and physical factors in corn and changes in processing conditions which influence corn wet milling, dry milling or alkaline processing yields.

Results for 2001: A successful enzymatic nixtamalization process suitable for processing whole kernel corn to produce instant masa flours (a.k.a. nixtamalized corn flour) has been developed. The product can be used to produce masa foods and snack products such as corn tortillas, tortilla chips, corn chips, taco shells, and burrito wraps. The enzymatic nixtamalization process eliminates the need to cook corn in a lime solution and substantially reduces alkaline waste and wastewater generation. Enzymatically produced masa dough has characteristics similar to traditional masas. Enzymatic nixtamalization thus offers an alternative to traditional nixtamalization as it reduces waste generation at its source, minimizing investment in expensive waste treatment systems.

Instant masa flour finds extensive use in the food industry for making tortillas, taco shells, tamales, corn chips, and tortilla chips, and as an ingredient in extruded snacks. Due to lack of standard techniques for measuring masa functionality, processors and end-users use masa flour particle size distribution and rheological characteristics in an attempt to predict its end use. In this study, a commercial masa flour sample was characterized by fractionating on the basis of particle size. Physicochemical and functional properties of masa flour fractions were investigated to establish structure-composition and functionality relationships. Nixtamalized masa flour is a mixture of particles that exhibit different functionality. To produce masa flour suitable for a specific food application, masa flour is usually separated based on particle size and blended to obtain the desired size distribution. Relationships between RVA pasting properties and textural attributes of rehydrated masa dough indicate that RVA can be used as a tool to evaluate masa flour. We conclude that when masa flour manufacturers alter masa size distributions through regrinding and blending they change masa flour functionality. This functional change, however, probably relates to differences in the intrinsic starch polymer characteristics of these fractions rather than absolute particle size. Further research on interactions between corn constituents during nixtamalization and an understanding of how to control starch characteristics to achieve desired masa quality and functionality would help to optimize nixtamalization processes and improve or standardize products made from instant masa flours.

Plans for 2002: Uses for “enzymatic nixtamalized” corn and sorghum will continued to be explored; techniques to improve flour will be assessed.

Publications:

Sahai, D. and D.S. Jackson. 2001. A novel enzymatic nixtamalization process for producing corn masa flour. *Cereal Foods World*: 46:240-246.

Sahai, D., M.O. Buendia, and D.S. Jackson. 2001. Analytical Techniques For Understanding Nixtamalized Corn Flour: Particle Size and Functionality Relationships in a Masa Flour Sample. *Cereal Chem.* 78(1):14–18.

Impacts: Issue: Alkaline cooking / Nixtamalization of corn products is an understudied processing technique; further information needs to be developed regarding how to best process corn and sorghum for this process. Use of the data collected could help processors reduce waste generation and optimize the yield and quality of alkaline cooked products.

What Was Done: A novel enzymatic nixtamalization process was developed that substantially reduces process times and waste generation. In addition, analytical tools for determining instant masa flour characteristics were developed.

NC-213 Progress Report for 2001

From: Kansas State University
Department of Grain Science and Industry

By: Herrman, T.J.
Gwartz, J.

NC-213 Objective: C Procedure: 3a

Project Objectives: 1) Identify technical, social, economic, and institutional constraints that impede segregation of GM-based VE crops and 2) Create system analysis and management tools to assist in the adoption of VE grain handling and marketing strategies.

Title: Impact of Storage on Wheat Milling Performance.

Results for 2001: Study I: The following response variables; flour extraction, reduction flour ash content, average particle size and particle size standard deviation, exhibited a significant moisture content x time interactions (Figures 1-4).

The wheat moisture content x temper time interaction for flour extraction was driven by the one-hour temper time response, where percent extraction increased significantly for each one percent increase in wheat moisture content. The 8 and 16 hour temper treatment showed a non-significant increase in flour extraction for each percent increase in wheat moisture. In all three-temper time treatments, the lowest percent flour extraction occurred for wheat with a 10 percent moisture content prior to tempering.

The wheat moisture content x temper time interaction for flour ash content (Figure 2) resulted from a different trend direction between the one-hour temper time and the longer temper times (8 and 16 hours) across wheat moisture content. In the one-hour temper treatment, the percent ash in the reduction flour decreased from 0.49 percent to 0.457 percent as wheat moisture increased from 10 percent to 12 percent. The ash content remained similar ($P>0.05$) for the one-hour temper for wheat moistures 12 through 15 percent. The difference in the flour ash content from 10 percent moisture wheat for 8 and 16-hour temper times (0.437 and 0.425, respectively) are significantly less ($P<0.05$) than the 15 percent moisture content wheat (0.447 and 0.453) for the 8 and 16 hour temper times, respectively.

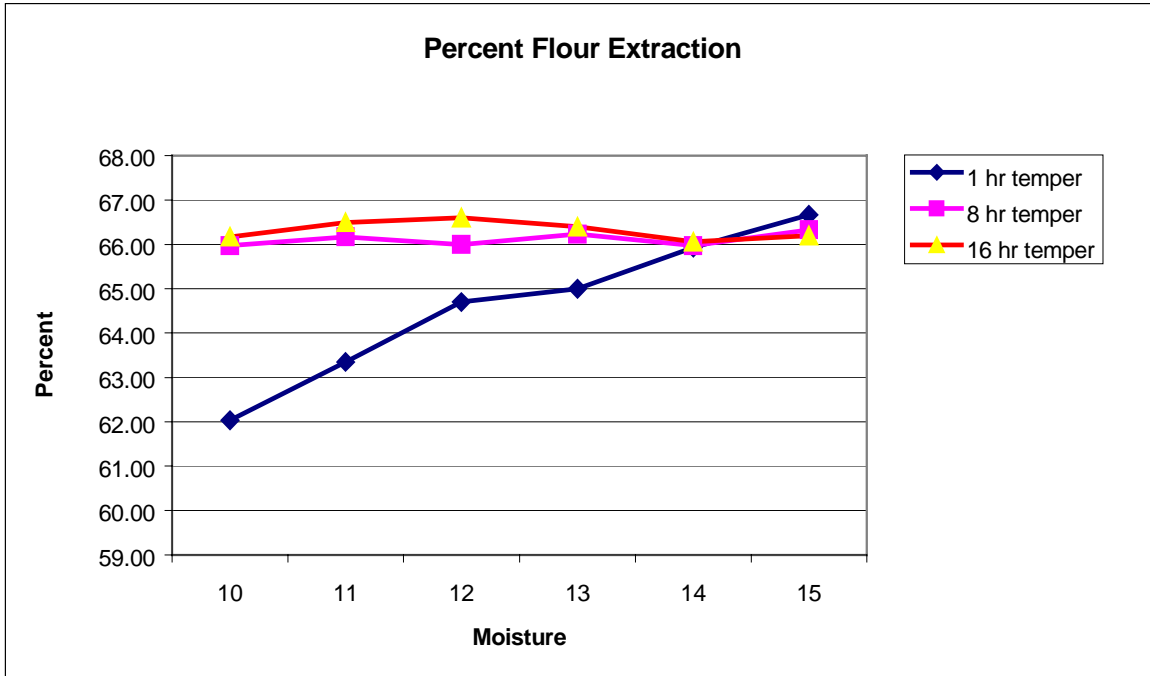


Figure 1. Percent flour extraction for wheat possessing 6 moisture levels and three temper time treatments.

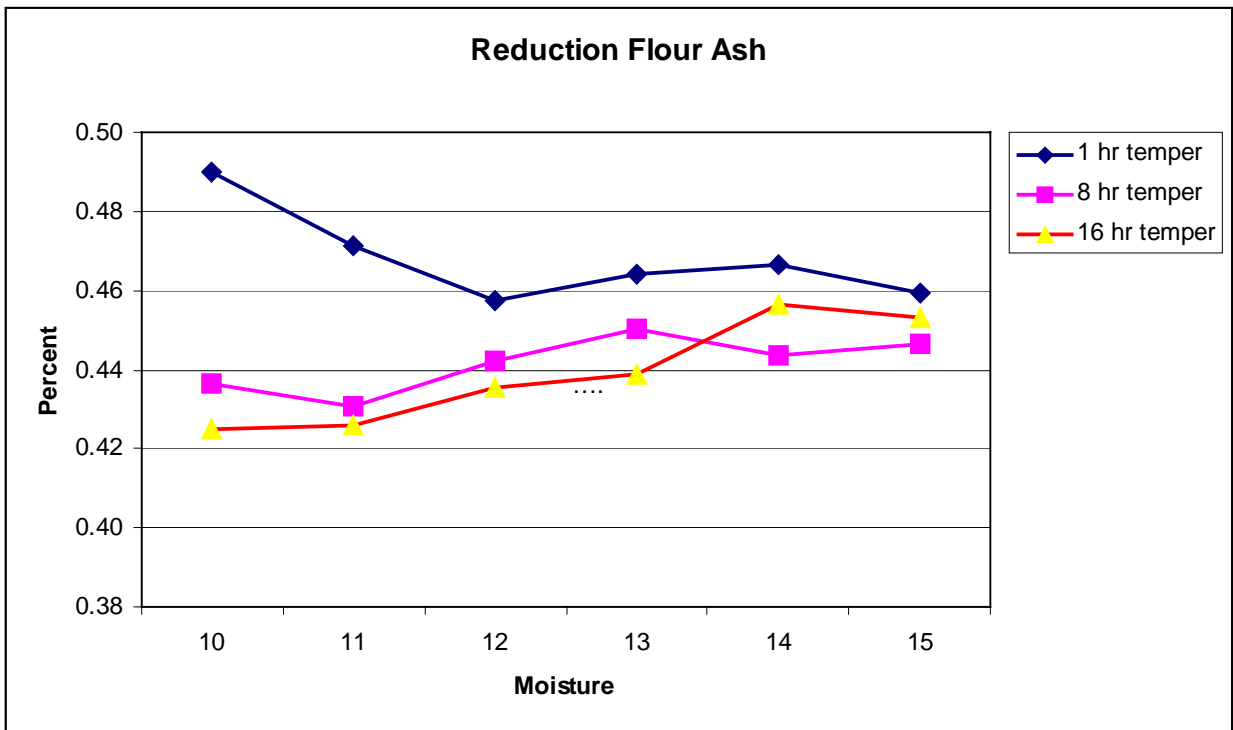


Figure 2. Percent ash (reduction flour) in response wheat moisture and three temper time treatments.

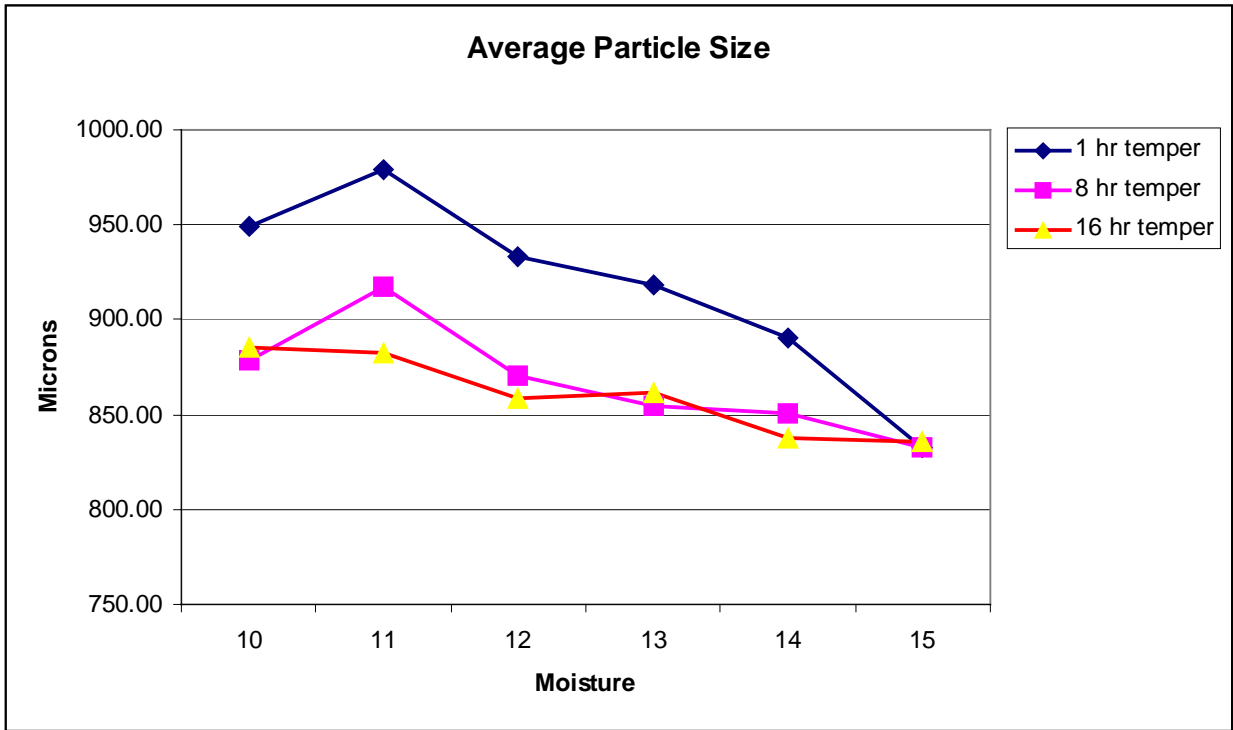


Figure 3. Wheat midds particle size (microns) in response to wheat moisture and temper time treatments.

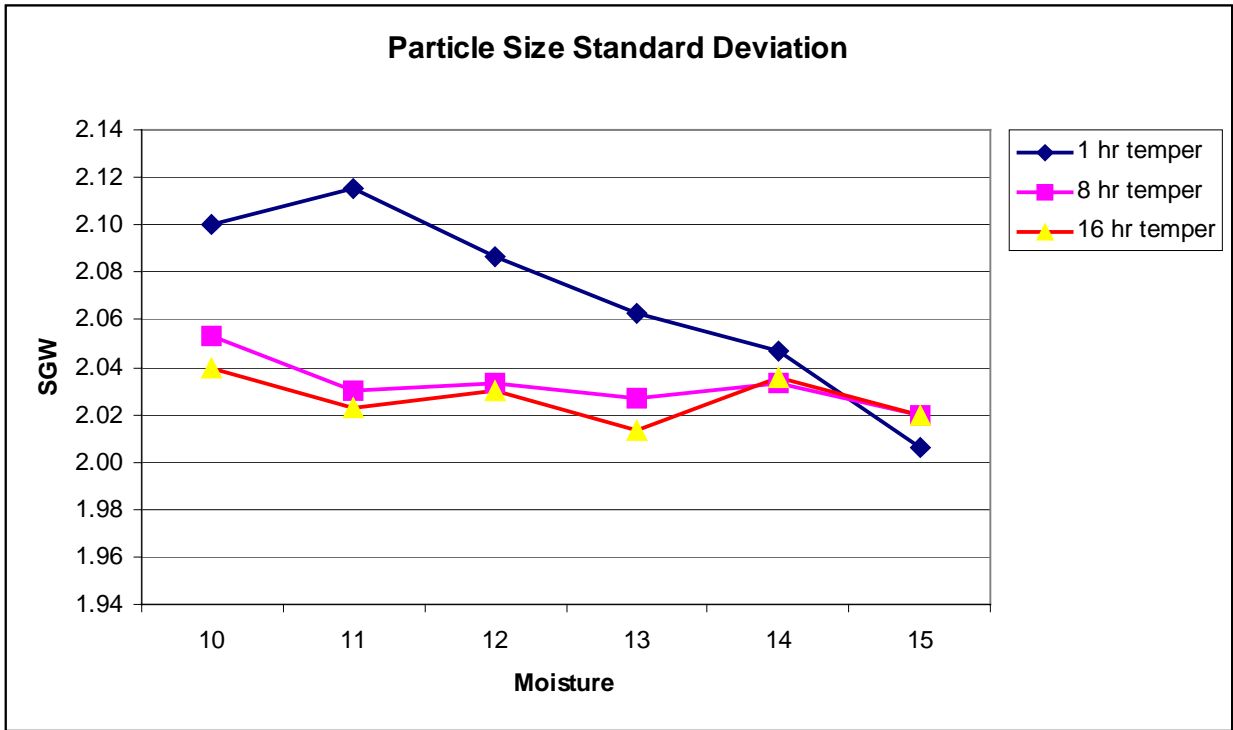


Figure 4. Wheat midds particle size standard deviation (Sgw) in response to wheat moisture and temper time treatments.

The wheat moisture content x temper time interaction for **average particle size** resulted from a significant increase in particle size from 10 percent to 11 percent moisture content wheat for 1 and 8 hour temper times and a subsequent decline ($P<0.05$) in particle size for wheat midds produced from 12 percent moisture wheat. This change in direction and the higher average particle size for 1-hour temper treatments for 10 through 14 percent moisture wheat compared to the 8 and 16-hour temper treatments, resulted in the two-way interaction. The significant two-way interaction for wheat midds particle size standard deviation followed a similar pattern, as did the average particle size.

Significant ($P<0.05$) main effects for moisture content were observed for flour extraction, average particle size and particle size distribution response variables (Table 1). Significant main effects for temper time were observed for flour extraction, break flour ash content, reduction flour ash content, average particle size, and particle size standard deviation (Table 1).

Table 1. Main effects for wheat moisture content and temper time for percent flour extraction, percent break flour ash, percent reduction flour ash, wheat midds average particle size (microns) and wheat midds particle size standard deviation (Sgw).

Variable	Treatment level	Flour extraction	Break flour ash (%)	Reduction flour ash (%)	Average particle size	Particle size std. dev.
Moisture	10	64.72	NS	NS	904.5	2.064
	11	65.59	NS	NS	919.6	2.049
	12	65.76	NS	NS	887.4	2.050
	13	65.87	NS	NS	878.2	2.034
	14	65.98	NS	NS	859.7	2.039
	15	66.40	NS	NS	833.6	2.016
Time	1	64.69	0.413	0.468	913.5	2.067
	8	66.11	0.394	0.442	867.4	2.032
	16	66.32	0.401	0.439	860.3	2.027

The percent flour extraction derived from a 15 percent initial wheat moisture content was significantly ($P<0.05$) greater than the response to other treatment levels. The 15 percent initial wheat moisture content also resulted in a smaller average particle size ($P<0.05$) and standard deviation (Sgw) for wheat midds compared to lower (<15 percent) wheat moisture content.

Temper time increase resulted in a corresponding increase in flour extraction and a lower break and reduction flour ash content. The 16-hour temper time also resulted in a smaller average particle size and standard deviation (Sgw) for wheat midds.

Study II: The response variables break flour extraction and reduction flour extraction was significantly ($P<0.05$) by storage temperature (Table 2). The 35°C storage temperature resulted in a significantly greater break flour extraction and a significantly lower ($P<0.05$) reduction flour extraction percentage.

Break flour extraction, reduction flour extraction, and flour extraction percentage responded significantly to the storage time (Table 2). The one week and 16 week storage times were not significantly different for all extraction measures. The week 4 storage time resulted in a significantly lower extraction response compared to weeks 1 and 16.

Table 2. Storage temperature and time effect on flour extraction.

Variable	Treatment Level	Break flour extraction (%)	Reduction flour extraction (%)	Flour extraction (%)
Storage Temperature (°C)	15	24.02	43.53	NS
	25	24.08	43.39	NS
	35	24.53	43.28	NS
Storage Length (weeks)	1	24.30	43.39	67.67
	4	24.17	43.06	67.24
	8	23.90	43.51	67.40
	16	24.53	43.50	68.04

Issues: Identifying the optimum storage moisture content, storage temperature, and storage time that maximizes flour extraction should result in better management of the storage cost center, lead to further innovation of environmental control within the storage bin, and improve flour extraction and profitability.

Impacts: This study has been performed with a laboratory mill and further work exploring a large scale milling operation is necessary before significant impacts on the flour milling industry will occur.

Funding Sources:
OARDC/The Ohio State University - Anderson Endowment fund.

Contacts:
Tim Herrman, Department of Grain Science and Industry, phone: (785) 532-4082, tjh@wheat.ksu.edu

NC-213 Progress Report for 2001

From: USDA-Agricultural Research Service
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center

By: Seitz, L.M.

NC-213 Objective: C Procedure: 3a

Project Objectives: 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 2001: From analyses previously completed, data was available on relative concentrations of volatile compounds in 745 samples of corn, sorghum, soybeans, and wheat. Sensory data was also available for each sample from at least two panels. Previous processing of the data chemical and sensory data by multivariate methods such as principal component analysis and partial least squares helped to determine what volatiles could be used to classify odors. In this study, artificial neural network methods were used to classify odors in the samples. A back-propagation feed-forward type of network was developed consisting of 25 input variables (concentrations of odor indicating compounds), one hidden layer of 16 processing elements, and five output elements (representing five odor types: okay, insect, sour, musty, and smoke). The network was developed with a selected set of 163 samples. With each sample in the learning set, panelists generally agreed that a definite single odor was present. As expected with the learning set, odor classification by the network was in generally good agreement with classification by the panelists. Most of the samples that were classified incorrectly (disagreed with panelists) had musty and smoke odors. The network was used to classify odors in a test set that contained single-odor samples and mixed-odor samples. With single-odor samples, network classification into insect and sour categories agreed well with results from panelists, but it was less effective in classifying musty and smoke odors. Among samples that panelists had classified as okay, the network tended to assign insect or sour odor when it failed to correctly classify those samples. With mixed-odor samples, the network was effective in identifying samples containing both musty and sour odors. Classification accuracy was generally lower with samples in other mixed odor categories that included smoke-musty, smoke-sour, and musty-insect.

Plans for 2002: Evaluation of sensory and chemical data collected from large groups of grain samples will be continued. There appears to be potential for improvement in classification because many parameters, such as input weighting, can be modified when networks are developed. Other types of networks are also available and classification into fewer categories, such as okay and off, will be investigated.

Publications:

Seitz, L.M. and M.S. Ram. 2000. Volatile methoxybenzene compounds in grains with off-

odors. *J. Agric. Food Chem.* 48:4279-4289.

Sayaslan, A., O.K. Chung, P.A. Seib, and L.M. Seitz. 2000. Volatile compounds in five starches. *Cereal Chem.* 77:248-253.

Seitz, L.M. and M.S. Ram. 2000. Classification of grain odors by multivariate analyses of chemical & sensory data. *In: Abstract Book of the 85th AACC Annual Meeting.* Pages 202-203.

Seitz, L.M. and M.S. Ram. 2001. Volatile insect pheromones in commercial wheat samples. *In: Abstract Book of the International Wheat Quality Conference - II, Manhattan, KS, May 20-24.* Page 70.

Seitz, L.M. and M.S. Ram. 2001. Analysis of chemical and sensory data for grain odor classification. *In: Abstract Book of the 86th AACC Annual Meeting.* Pages 142.

Impacts: A safe, objective method for classifying odors is needed for routine use by grain inspectors. Rapid methods are needed for determining grain quality. An artificial neural network was used to classify grain odors using chemical data based on relative amounts of volatile compounds purged from each sample. Proper choice of samples and use of optimized variables (compounds indicating off-odors) was important in developing an effective network. Classification into specific odors such as musty, sour, smoke, or insect was possible as well as classification into mixed-odor categories such as musty-sour, musty-insect, or smoke-sour. The information could be used to set up an objective reference method for odor determinations. Detection of specific volatiles could indicate deterioration of grain by molds, insects, and heating during storage or transport.

Funding Sources:

U.S. Department of Agriculture, Agricultural Research Service

Contacts:

Larry Seitz, Phone: 785-776-2735, FAX: 785-537-5534, E-mail: larry@gmprc.ksu.edu.

NC 213 Progress Report for 2001

From: Indiana Agricultural Experiments Station (Purdue University)
Department of Agricultural and Biological Engineering

By: Stroshine, R.L.
Seitz, L.M. (Cooperator from USGMRL)

NC-213 Objective: C

Procedure: 3a

Project Objectives: The objective of this project is to evaluate the use of the Solvita[®] test kit for measuring the susceptibility of shelled corn to invasion by storage mold. The test kit was developed by Woods End[®] Research Laboratory for the measurement of compost maturity and soil biological respiration. It includes a plastic “paddle” that can be inserted into the sample being tested (see sketch in Figure 1 below). A portion of the paddle is covered with an indicator gel that changes color in response to increases in the percentage of carbon dioxide (CO₂) in the container. In these tests, the paddle was inserted into a sealed container at the appropriate time (Figure 1, right). Fungi growing on the shelled corn in the jar produce CO₂ and as the CO₂ level in the jar increases, the gel indicator changes color. There are five different colors and therefore five levels of CO₂ can be measured.

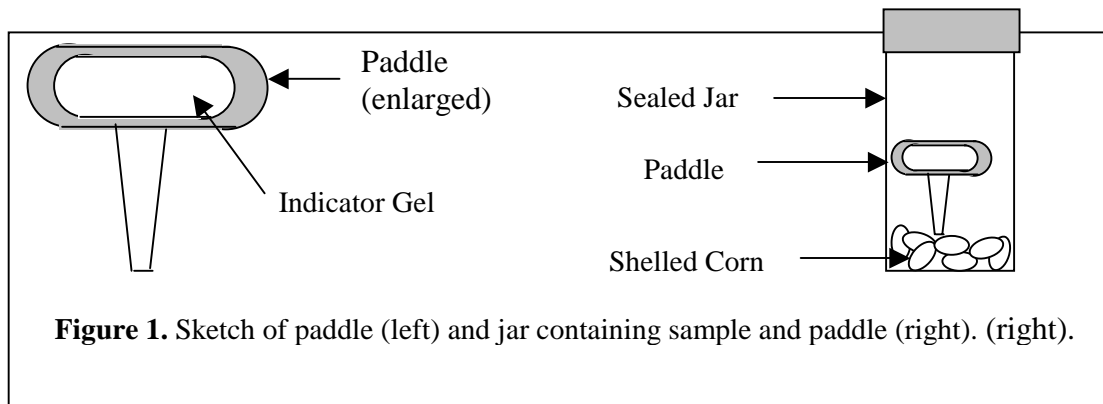


Figure 1. Sketch of paddle (left) and jar containing sample and paddle (right). (right).

Results for 2001: Tests were conducted in a laboratory with relatively good temperature control (23°C ± 2°C). Several samples of shelled corn were rewetted to 22% moisture by the addition of tap water and equilibrated in a sealed plastic bag for 24 hours. Then, 100 g sub-samples were removed from each bag and placed in separate jars that were sealed with a metal lid having a rubber insert. After 67.5 hours, the lids were removed so that the CO₂ content of the air in the jar could equilibrate with the atmosphere. At 68 hours after re-wetting, paddles were placed in the jars and the jars were sealed. The color of the paddle was read hourly until a total of 76 hours had elapsed after re-wetting. Upon completion of the tests, the moisture content of the corn in each jar was determined and a sub-sample was removed and dried gently (40°C) in a forced convection oven. These sub-samples were sent to the U.S. Grain Marketing Research Laboratory in Manhattan Kansas where Dr. Larry Seitz performed ergosterol

determinations. The percentage of CO₂ in the jars was estimated using data on color versus percent CO₂ that were obtained from Woods End Research[®].

Results of the tests are summarized in Table 1. Higher color numbers correspond to greater CO₂ evolution rates. The samples were chosen so they would have different susceptibilities to storage fungi. For example, B73XMo17 was collected in 1993, stored in a freezer for several years, and then stored at 4°C for several more years. Although there was no visible mold in the sample, it was in very poor condition. KGC98, KGC99 and KOKC97 were collected from commercial storage facilities. AFCD was a sample from corn dried using combination drying and FLLT was from corn dried using ambient air. As indicated by the results in Table 1, the Solvita[®] test kit was capable of revealing differences in susceptibility to mold invasion among the samples. The table also includes results of ergosterol tests conducted before and after the incubation. Ergosterol did not increase in the samples that produced the least CO₂ (low color number). For these samples, both initial and final values were low and the presence of a single moldy kernel in the initial sample could have influenced results. CO₂ kit results were consistent when a given sample was included in several different tests (note the results for B73xMo17).

Preliminary tests have shown the test kit to be capable of distinguishing differences in fungal growth among samples of shelled corn. They have also revealed some of the factors that must be controlled in order to ensure the reliability of the method. For example, it was discovered that during the first 36 hours after rewetting, CO₂ is produced by seed respiration and the CO₂ measurements are unreliable indicators of fungal growth.

Table 1. Results of preliminary tests with Carbon Dioxide Test Kits. Readings were taken five hours after insertion of color indicator strip and 73 hours after rewetting

Sample	Date	Ergosterol (ppm)		Color Number	Approximate CO ₂ level, %
		Initial	Final		
B73xMo17	8/10/00	0.44	4.83	5.0	3.0%
FLLT	8/10/00	0.54	0.51	3.5	1.1%
AFCD	8/10/00	0.61	0.14	3.5	1.1%
ASHT	8/10/00	0.11	1.08	5.0	3.0%
B73xMo17	8/17/00	0.44	4.36	5.0	3.0%
KGC98	8/17/00	0.55	0.30	3.0	0.8%
KGC99	8/17/00	0.26	0.27	5.0	3.0%
KOKC97	8/17/00	0.51	0.87	4.0	1.5%

Plans for 2002: Additional tests will be conducted on shelled corn and tests with re-wetted wheat will be conducted. Funding for additional research with the test kit and research on other measures of storability are being sought. If money becomes available, a large number of samples will be collected from grain inspection facilities and tested with the test kit. Other potential measures of susceptibility to fungal invasion will also be evaluated, such as ergosterol content, physical damage, percent germination, percent kernel infection and electrolyte leakage. Using results of the ergosterol and percent kernel infection tests as the standard, the effectiveness of the various methods of measuring susceptibility to fungal invasion will be compared.

Issues: The majority of shelled corn bought and sold in the United States is co-mingled. Therefore, when shelled corn arrives at an elevator or processing plant, the manager usually has very little information on how long the grain has already been in storage or under what conditions it was previously stored. These factors can greatly influence the susceptibility of the grain to invasion by storage fungi. If the manager decides to store the grain, he or she has no good method of measuring or predicting the likelihood of spoilage. They must rely on experience and the moisture content when assessing risk. A test that could quantify the likelihood of fungal deterioration of shelled corn would allow appropriate action to be taken to maintain the corn's quality until the it is processed. If the corn were to be shipped overseas to tropical or subtropical locations, such a test could indicate the risk of subsequent spoilage.

What Was Done: A test kit has been evaluated as a possible means of measuring susceptibility to fungal invasion. Results were promising and indicated that the test kit results were sensitive to differences among the samples tested. Although the test would require re-wetting of the samples and a three-day incubation period, there are many situations in which it would be useful. For example, elevator managers that are attempting to decide whether to hold over shelled corn from one season to the next could use the test to determine which grain lots would be least susceptible to storage mold during the additional storage period.

Impacts: Further development of the test kit would give managers of storage facilities or grain merchandisers a tool that would reduce the likelihood that the shelled corn they have in storage or intend to ship overseas has a high potential for spoilage as a result of fungal growth.

NC-213 Progress Report for 2001

From: University of Nebraska
Department of Food Science and Technology

By: Bullerman, L.B.

NC-213 Objective: C

Procedure: 3b

Project Objectives: 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 high performance liquid chromatographic (HPLC) and enzyme-linked immuno-sorbant assay (ELISA) methods for detection and quantification of moniliformin in cereal grains.

Results for 2001: Work on this objective was done and reported in previous years. No additional work was done in 2001.

Plans for 2002: No additional work is planned for this objective during 2002.

Publications:

Saxena J., C. Munimbazi, and L. B. Bullerman. 2001. Relationship of mould count, ergosterol and ochratoxin A production. Int'l J. Food Microbiol. 71:29-34.

NC-213 Progress Report for 2001

From: University of Nebraska
Department of Food Science and Technology

By: Bullerman, L.B.

NC-213 Objective: C

Procedure: 3c

Project Objectives: Study incidences and levels of contamination of *Fusarium* spp., fumonisins, moniliformin, deoxynivalenol and zearalenone in corn and wheat intended for processing into human foods. Determine effects of processing on *Fusarium* spp., fumonisins, moniliformin, deoxynivalenol and zearalenone by monitoring the survival of the organism and the toxins.

Results for 2001: The effects of moisture content (26%, 30% and 34%) and incubation time (12 hrs, 24 hrs, 36 hrs and 48 hrs) on deoxynivalenol (DON) production by *Fusarium graminearum* in corn flaking grits were determined to develop a method of producing corn grits contaminated with DON for use in processing studies. The relationship between 26% moisture content and deoxynivalenol production at all the four incubation times appeared to be linear. However, with moisture contents of 30% and 34%, DON concentration appeared to be quadratic at all the time intervals. Maximum amount of DON production was observed at 34% moisture content. The difference in DON production at 30% and 34% moisture content was not very prominent when compared to 26% at the respective time intervals. Therefore it was calculated that a 26% moisture content could be used to produce grits contaminated with 5-10 ppm DON in 36 to 48 hours. The heat stability of DON was determined using a pressurized heat reactor to study the effect of time, temperature and pH on DON concentration. Deoxynivalenol was dissolved in Teorell and Stenhagen's citrate-phosphate-borate buffer at 5 ppm and heated to temperatures of 100°C, 150°C, 165°C, 180°C and 230°C at pHs of 4.0, 6.1, 7.0, 7.9 and 10.0 respectively using a central composite design. All the treatments were conducted over a time interval of one hour with samples collected at 10-minute intervals. Regression analysis showed significant reduction in DON as temperature and time of heating increased. After 30 minutes of processing time, less than 8% of the toxin remained with $\text{pH} \geq 7$ and temperature $\geq 165^\circ \text{C}$. For DON concentrations at 60 minutes, a second order response surface was fit with $R^2 = 0.84$. Using this surface, a pH of 8.6 and temperature of $173^\circ \text{C} \pm 1^\circ \text{C}$ reduced remaining DON to less than 8%. However at $\text{pH} \geq 7.0$ and temperature $\geq 165^\circ \text{C}$ remaining concentrations of DON were also quite low, indicating that a broad range of pH and temperature conditions (above pH 7.0 and 165°C) would yield major reductions in the concentrations of DON. While this work showed conditions that may destroy DON, other studies have shown DON to be stable in heated and baked foods. Therefore, the effect of extrusion cooking on DON was determined at different temperatures (160°C, 180°C, 200°C and 220°C) and screw speeds (50 rpm, 80 rpm, 110 rpm, 140 rpm). Regression analysis showed significant reduction of DON as temperature and screw speed increased ($R^2 = 0.94$). Significant effects were observed for different temperature and screw speeds ($p < 0.01$) and there was an interaction between these two variables ($p < 0.01$). Extrusion cooking resulted in reductions of up to a maximum of 40% at 220°C and 140 rpm.

Plans for 2002: Additional studies on the effects of the extrusion processing on DON, zearalenone, fumonisins and moniliformin will be done using the parameters determined in previous studies that will give the greatest destruction of these toxins. Extruded materials will be evaluated for loss of toxicity by various chemical, biochemical and biological tests.

Publications:

Castelo, M.M., L.S. Jackson, M.A Hanna, B.H. Reynolds and L.B. Bullerman. 2001. Loss of fumonisin B₁ in extruded and baked corn-based foods with sugars. J. Food Sci. 66: 416-421.

Ryu, D., N. Doddapaneni, K.M. Eskridge and L.B. Bullerman. 2001. Heat stability of deoxynivalenol in an aqueous buffered model system. Presented at the 115th Annual Meeting of AOAC International. September 9-13. Kansas City, MO.

Doddapaneni, N. 2001. Effect of heat and extrusion processing on deoxynivalenol. M.S. Thesis University of Nebraska, Lincoln, NE.

Issues: *Fusarium* mycotoxins are heat stable compounds that can survive thermal food processing methods and remain as residues contaminating processed grain-based food products. Extrusion processing is a thermal process that uses very high temperatures, pressure and shear forces to rapidly cook and bring about molecular transformations in cereal grains while processing them into breakfast cereals, snack foods and pet foods. By employing the proper parameters, extrusion processing offers hope as a means of reducing the concentrations of *Fusarium* mycotoxins in finished, processed foods.

What Was Done: Thermal stability of deoxynivalenol was first determined in a buffered solution free of grain matrix effects. Based upon these studies an extrusion experiment was designed using the parameters that were believed to cause the greatest reduction of DON. Maximum reduction observed was 40%.

Impacts: The results show that DON is very heat stable and that other combinations of temperature, time and moisture content will need to be found to get complete reduction of DON. This may be aided by adding certain chemicals to the extrusion mix. Identifying the conditions that cause the greatest reductions of the *Fusarium* toxins will allow industry to adjust processes to ensure safer processed foods.

NC-213 Progress Report for 2001

From: North Dakota State University
Department of Cereal and Food Sciences

By: Wolf-Hall, C.E.

NC-213 Objective: C Procedure: 3c

Project Objectives: To evaluate methods to treat *Fusarium* head blight (FHB) infected barley in order to prevent *Fusarium* growth and mycotoxin production during malting.

Results for 2001: Hot water treatments included four temperatures (45, 50, 55, and 60°C) for 0, 1, 5, 10, and 15 minutes; UV-C radiation included 0, 5, 10, and 15 minutes of exposure; and electron-beam radiation included dosages of 0-11.4 kGy. For hot water treatments, at 45°C, reductions in *Fusarium* infection rate (FIR) averaged 97% after 10 and upto 15 minutes, with no significant reductions in germinative energy rate (GER). Significant reduction (25%) in GER occurred at 50°C after 5 minutes. For temperatures 55 and 60°C, significant reductions (48% and 95% respectively) in GER were seen at 1 minute. UV-C irradiation caused no significant reductions in FIR and GER. For electron-beam radiation, significant reduction in the FIR started between 2.3-4.7 kGy. Higher doses (9.2 kGy, and 11.4 kGy) achieved complete reduction (100%) of FIR. GER decreased with increase in the electron-beam dosage. Significant decrease (7%) in GER started at 4.7 kGy. 11.4 kGY caused a larger (32%) reduction in GER.

Plans for 2002: Continue screening treatment methods, including physical and biological methods for effects on FIR and GER. Effective treatments will be further studied for effects on malting quality and mycotoxigenesis of surviving *Fusarium*.

Issues: Barley with mild *Fusarium* head blight (FHB) may lead to the production of mycotoxins during malting. Maltsters have strict limits for malt quality, which ultimately have severely affected barley production in the USA. Treatment of FHB infected barley may prevent mold growth and further mycotoxin production during malting allowing utilization of otherwise good quality barley.

What Was Done: Several physical methods for treating FHB infected barley were screened for effectiveness in reducing FIR while leaving GER as unchanged as possible. Microwaves and steam exposure were eliminated as too damaging to GER. Hot water, UV-C and electron-beam treatments were further studied and the results indicated above.

Impacts: The results suggest that hot water treatments and electron-beam radiation may be effective physical treatments to pasteurize mildly FHB infected barley, allowing the utilization of otherwise good quality barley without safety and quality concerns due to mold growth during malting.

NC-213 Progress Report for 2001

From: Kansas State University
Department of Grain Science and Industry

By: Herrman, T.J.
Arizmendi, B.
Eustace, D.
Loughin, T.

NC-213 Objective: D Procedure: 1a

Project Objectives: Perform a commercial scale (50,000 bu) evaluation of a quality based marketing system of hard red winter (HRW) wheat with one Mexican flour milling company by performing the following tasks:

- Task 1* - conduct pre-delivery market development and data collection,
- Task 2* - secure high quality wheat,
- Task 3* - coordinate a grain delivery system,
- Task 4* - monitor milling and baking performance with Mexican partners,
- Task 5* - assess the economic value of superior quality wheat, and
- Task 6* - expand market development activities.

Title: Identity Preserved Marketing of Kansas Hard Red Winter Wheat in Mexico

Results for 2001: Research exploring the performance of identity preserved wheat (IP) wheat was conducted to evaluate its impact on the uniformity and quality of the flour produced by the Mexican flour milling industry and commercial baking industry.

Three kinds of IP wheat from different locations (Harper-Kingman, Sublette, and Charleston, Kansas), were shipped to Mexico and tested in the mill using four different wheat blends, as follows, 40% commodity Hard red winter (HRW), 40% Mexican Northwester (NW), and 20% IP wheat, 40% IP, 40% Mexican NW and 20% Canadian wheat, 60% IP, and 40% NW., 60% HRW and 40% IP wheat. These blend were compared to the performance of the regular grist used at the mill (40% HRW, 40% NW and 20% Canadian wheat). IP wheat blends were tested in two different mills (Central Harinera and Harinera Nacional) and replicated twice. The control grist was milled every day during the second and third shift while the IP treatment was milled during the first shift. Flour was characterized for the alveograph W value, loaf volume, and flour extracting and sent to a commercial bakery to evaluate baking performance.

Canadian wheat possessed a higher W value, a larger standard deviation within cargoes, and was more consistent between cargoes compared to HRW> Blending wheat, using a theoretical W value, reduced finished flour variability by approximately 50 percent.

Extraction rate from IP wheat blends were consistently lower than the regular grist. While not statistically significant, the IP wheat did display a consistently lower break release on the primary breaks. W values were significantly ($P < 0.05$) affected by the blend main effect at Nacional and loaf volumes were significantly ($P < 0.05$) affected by the blend main effect in Central. Additionally, the IP blends for Kingman and Charleston wheat displayed more uniform loaf volume compared to the control.

Improved loaf volumes were obtained at one commercial bakery for flour containing Charleston IP wheat. Improved loaf volume was also observed for blend 1 in which IP wheat was substituted for Canadian wheat in the mill grist.

Statistically significant main effects, interactions, and trends observed in this study indicate the IP wheat, when substituted for Canadian wheat in the commercial wheat grist, improves loaf volume and product uniformity. Additional work is needed to identify optimum mill settings, temper time, and temper moisture to obtain equal flour extraction with IP wheat.

Plans for 2002: Extend results and work with producer groups engaging in IP wheat marketing to Mexico. Complete economic analysis and pursue funding for additional research to explore tempering research.

Publications:

Arizmendi, B. 2001. Wheat quality and uniformity needs in the Mexican milling and baking industry. M.S. Thesis, Dept. of Grain Science and Industry, Kansas State University.

Arizmendi, B. and T. Herrman. 2001. Wheat quality and uniformity needs in the Mexican milling and baking industry. Second International Wheat Quality Conference, May 20-24, Manhattan, KS.

Issues: The U.S. wheat industry enjoyed a 90% market share for Mexico's imported wheat while CONASUPO (Mexican wheat buying agency) was in existence. Since the government discontinued grain trading, due in part to the North American Free Trade Agreement (NAFTA) and other globalization pressures on their economy, new growth in the wheat market has been captured by Canada. Today, Canadian wheat comprised 30% of the Mexican wheat imports. This study addresses a growing need within Mexico to improve the quality of the wheat grist in Mexican mills to address flour quality and uniformity needs within the Mexican baking industry.

Impacts: The results of this study are being used to develop sampling and marketing plan for identity preserved wheat.

Funding Sources:

Kansas Wheat Commission, Kansas Dept. of Commerce and Housing Ag. Product Development Division.

NC 213 Progress Report for 2001

From: Iowa State University
Agricultural & Biosystems Engineering

By: Hurburgh, C.R. Jr.

NC 213 Objective: D Procedure: 4a

Project Objectives: Assist in the development of quality system certification processes for the grain market.

Results for 2001: A large farmer-owned grain handling company, Farmers Cooperative Company (FCC), Farhamville, IA began the process of certification for quality management. FC has 35 facilities; the Odebolt, IA facility was selected as the initial facility to be certified. We decided to use first the American Institute of Baking (AIB) QSE certification program, then to move to internationally recognized ISO 9000-2000 registration. The AIB system was well organized and understandable by grain handlers; it contained approximately 75% of the items required for documentation in the ISO system.

In weekly on-site meetings, a quality manual, job descriptions, process controls, traceability and statistical controls have been developed. We were attempting to change the culture and attitude of all employees, not just obtain a certification.

The primary benefit will be in internal operating efficiencies; immediate market premiums are not expected.

Figure 1 is an example of the flow chart work instructions being put on the corporate website. Figure 2 shows an example control chart for the outbound grain grading operation. The entire quality management system will eventually be web-based, administered by the corporate MIS group.

From a traceability standpoint, the overall objective is to be able to identify for any rail grain shipment (car lot) which producers and scale tickets are included. The corporate inventory operations are being modified to achieve this. A traceability simulation model is also being created.

AIB certification is expected in August 2002.

Plans for 2002: Complete the AIB process; publish the traceability and statistical components; and, begin ISO registration.

Figure 1.

Elevator Receiving Flow Chart

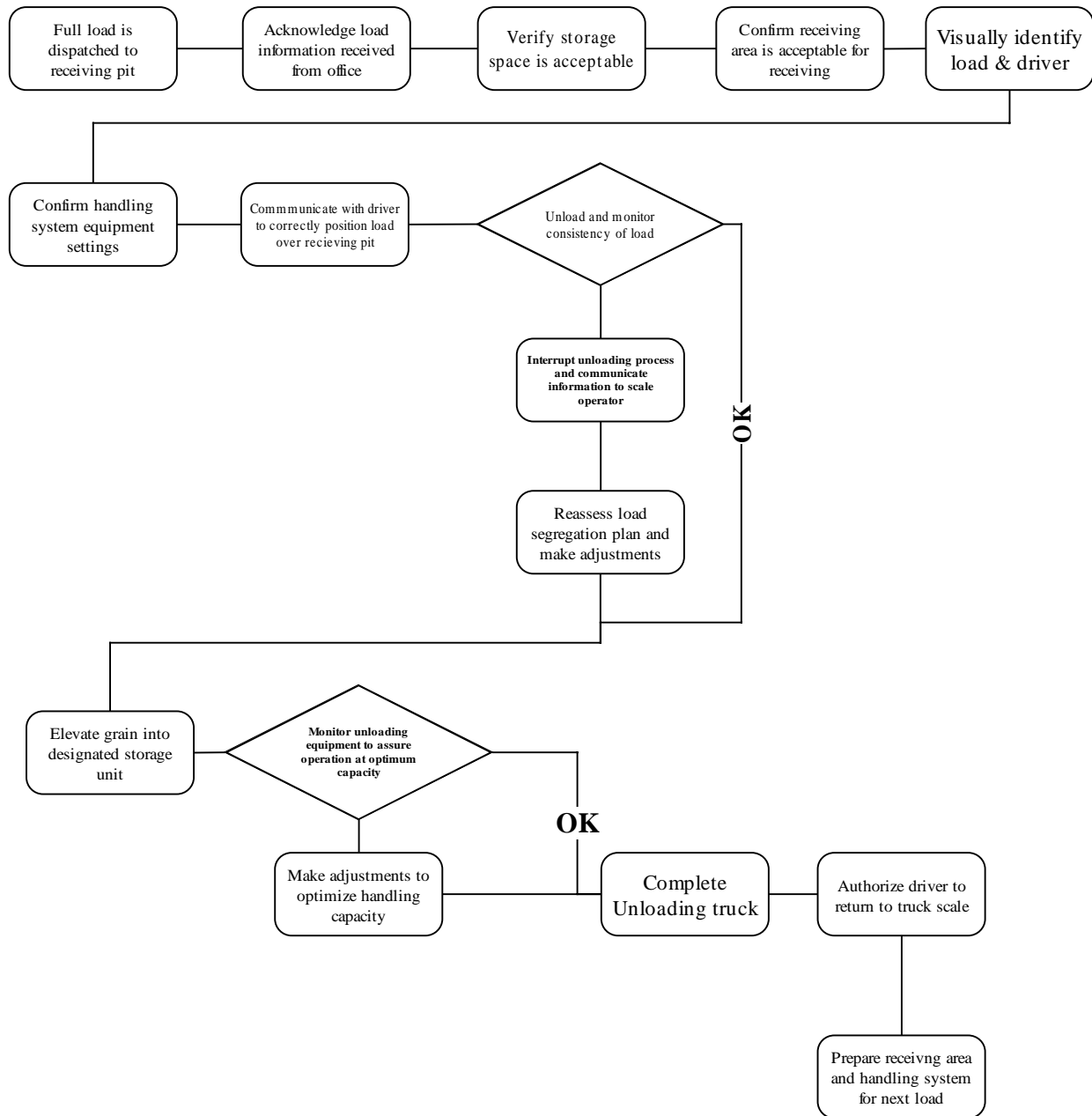
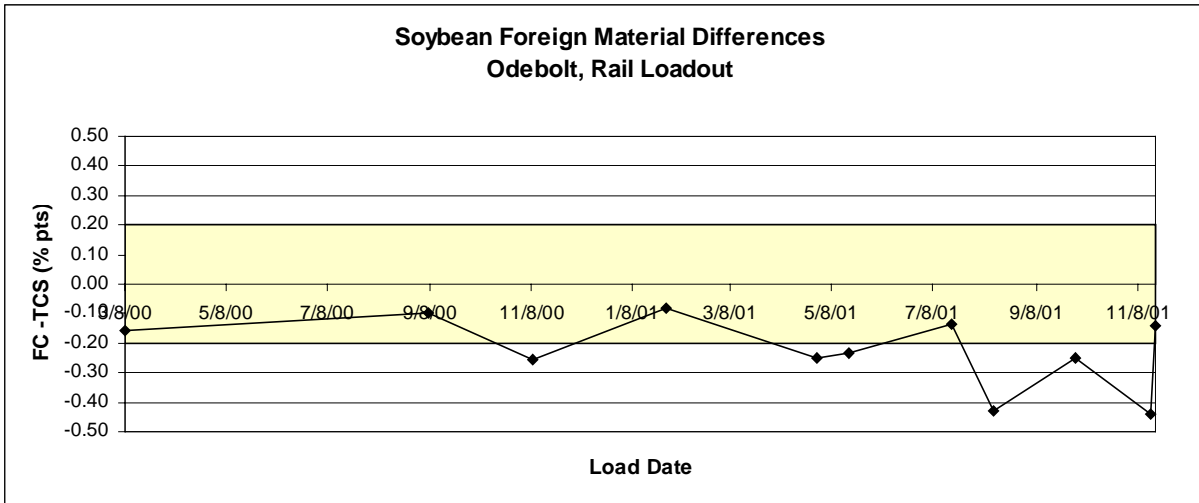
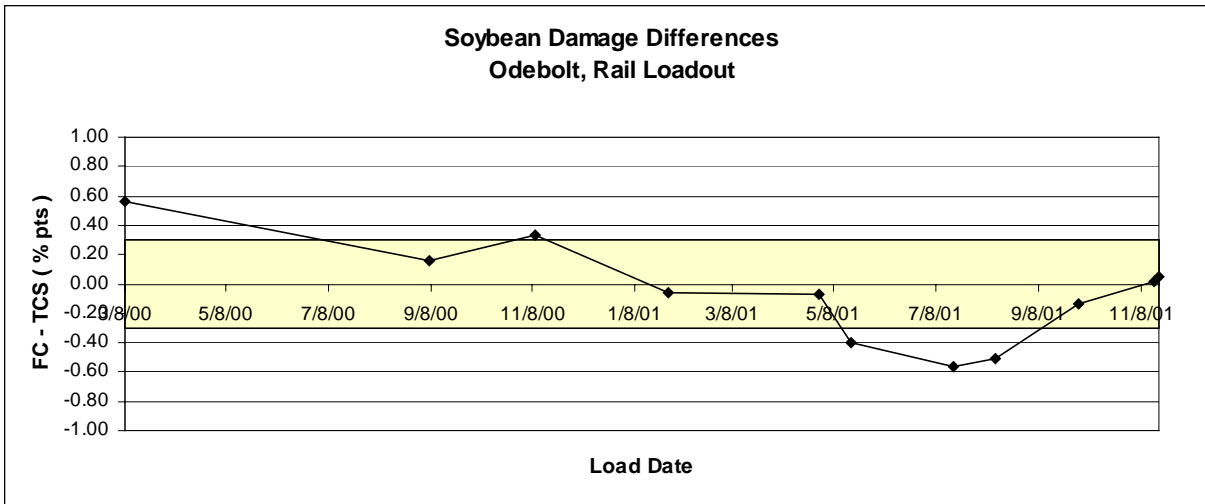
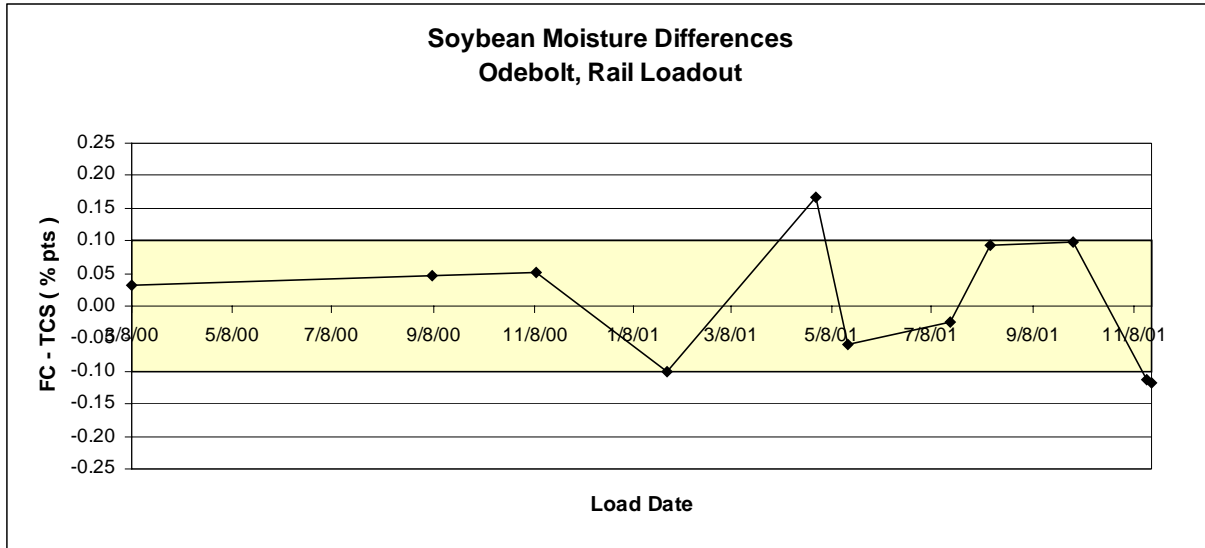


Figure 2. Control Charts for Rail Soybean Loadout, by Facility



NC-213 Progress Report for 2001

From: Michigan State University
Department of Sociology

By: Busch, L.
Ng, Perry P.K.

NC-213 Objective: D Procedure: 4a, 4b

Project Objectives: Examine the institutional issues raised by the Starlink incident and develop recommendations for developing effective institutional mechanisms for promoting transparency in grading of genetically modified crops.

Results for 2001: Much of the time spent on this project during 2001 involved gathering information on the inadvertent release of Starlink corn into the human food chain. This was accomplished by collection of news articles in the popular press, examination of various technical documents, and attendance at several key meetings at which the plans for a response were discussed and implemented.

Plans for 2002: During 2002 I plan to examine carefully the issues raised at the recent EPA hearings on Starlink. In addition, I plan to interview key actors in the development of tests for the presence of genetic modifications so as to gain greater understanding of the social, economic, and political implications of the tests under development.

Issues: The inadvertent introduction of Starlink corn into the US food supply has raised a number of important issues with respect to standards for genetically modified crops. Of particular importance is that, for each genetic modification at each step in the food supply chain, tests will need to be developed that are rapid, precise, accurate, and economically feasible. Moreover, such tests will need (1) to be transparent to all actors in the food supply chain, and (2) to encourage honest reporting of test results, if trust between the parties is to be maintained. In addition, for non-GM crops, a definition of zero-GM will need to be developed that is acceptable to all parties. This new addition to NC-213 will examine the interface between the technical issues involved in the development of satisfactory tests and the organizational arrangements necessary to inspire confidence in those tests.

What Was Done: Data was collected on the Starlink incident and initial analysis began.

Impacts: This project will result in specific recommendations for developing institutional and organizational structures that are transparent to all stakeholders concerned with genetically modified crops.

NC 213 Progress Report for 2001

From: Iowa State University
Iowa Grain Quality Initiative
Agricultural & Biosystems Engineering Dept.
Economics Dept.

By: Hurburgh, C.R. Jr.
Ginder, R.G.
Jarboe, D.

NC 213 Objective: D Procedure: 4b

Project Objectives: Development of producer education programs for biotechnology grains.

One specific objective of the Iowa Grain Quality Initiative (IGQI) is the provision of education programs in response to short-term grain quality issues caused by weather conditions, biotechnology, or other external forces.

StarLink™ corn, a hybrid not approved for human consumption, was found in the U.S. grain system, with 40% of the product located in Iowa. IGQI responded by developing programs, publications, and electronic information about StarLink corn and made it available through multiple media outlets. Ginder, Dr. Neil Harl, Hurburgh, and Jarboe helped the Iowa congressional delegation, federal agencies, and the media understand the issue, proposed solutions, and assisted with implementation of the solutions. A total of 21,438 StarLink™ corn publications were downloaded from the IGQI web site. The articles provided were: The StarLink™ Situation (16,886), Genetically Modified Crops (905), Action Checklist for StarLink™ (880), StarLink™ News main page (817), GMO Testing Directory (766), Potential Liquidity Problems (630), Testing for GM Grains (372), and Grain Channeling (182). Hurburgh served on the Environmental Protection Agency Scientific Advisory Panel for Starlink™.

Producers, grain handlers, and processors were able to cope with StarLink™ corn in the grain system and maintain their financial standing. A \$20,000 USDA emergency assistance grant was awarded for FY02 based on IGQI's success with the StarLink™ situation. Producers became more aware of the restrictions on biotechnology products, reducing the likelihood of future problem situations.

Outreach programs were developed for biotechnology grain production and management. Extension field staff members were provided slides that listed biotechnology products not approved in Europe and the producer risks associated with the products. Faculty and staff gave grain quality presentations at the international (8 meetings, 81 participants), national (3 meetings, 30 participants), state (17 meetings, 1,139 participants), and area (9 meetings, 100 participants) levels. The IGQI web site had over 750,000 hits, most of which related to biotech grains.

IGQI co-developed a grain-channeling program with Extension, the Iowa Department of Agriculture and Land Stewardship, and Monsanto to channel Roundup Ready corn to the appropriate collection sites. Two different posters were created and distributed to all grain warehouse license holders in Iowa. Over 2,000 posters were sent to the 547 license holders.

Plans for 2002: Continue to develop education programs in response to short-term grain quality issues caused by weather conditions, biotechnology, or other external forces.

Publications:

Ginder, R.G. 2000. Potential Liquidity Problems in the Elevator Sector Arising from Commingled StarLink Grain and Policies to Address Them. Iowa Grain Quality Initiative Web Site. October 26.

Ginder, R.G., D. Jarboe, L. Sternweis, D. Pavlik, and D. Schemmer. 2001. Roundup Ready Corn Channeling Poster (18" x 24"). SP-161. September 15.

Ginder, R.G., D. Jarboe, L. Sternweis, D. Pavlik, and D. Schemmer. 2001. Roundup Ready Corn Channeling Poster (8.5" x 11"). SP-162. September 15.

Harl, N.E. 2000. Genetically Modified Crops: Guidelines for Producers. Iowa Grain Quality Initiative Web Site. October 30.

Harl, N.E., R.G. Ginder, C.R. Hurburgh, Jr., and S. Moline. 2000. The StarLink™ Situation. Iowa Grain Quality Initiative Web Site. October 23.

Hurburgh, C.R. 2000. Action Checklist for Starlink Corn Producers and Elevators. Iowa Grain Quality Initiative Web Site. November 3.

Hurburgh, C.R. and D. Jarboe. 2000. GMO Grain Testing Directory. Iowa Grain Quality Initiative Web Site. October 3.

Hurburgh, C.R., D. Jarboe, and G. Cummins. 2000. Testing for Genetically Modified Grains. Iowa Grain Quality Initiative Web Site. September 5.

NC-213 Progress Report for 2001

From: Kansas State University
Information Support Services for Agriculture (ISSA)

By: Schenck-Hamlin, D.C.

NC-213 Objective: A-D Inclusive

Project Objectives: Development of producer education programs for biotechnology grains.

Results for 2001: 1. **Additions:** 1024 new records of publications were added to the ISSA Voyager database, under the categories “Grain and Oilseed Quality”; “Stored Product Protection”; and “Grain Economics.” To search the database, users begin from <http://www2.lib.ksu.edu/cgi-bin/Pwebrecon.cgi?PAGE=dbPage>

2. **System Maintenance:** The *Voyager* integrated library system purchased by Kansas State University from Endeavor systems (www.endinfosys.com) continued as the platform for the database, despite some flaws in its user interface. Optional sorting of search results (title-sorting is the working default) continues to be a problem for KSU *Voyager* clients. Date and author sorting was registered as a problem early in 2001, but Endeavor has failed to resolve it to date.

ENCompass is the digital library platform selected for the KSU Digital Library. It offers an alternative to *Voyager* by including a wider variety of resource formats (such as data sets, cited below, #4) and distributed collections in its searching. As a first step in preparing NC213 data for the KSU Digital Library, ISSN (International Standard Serial Number) identifiers of 3,841 periodicals in which NC213 publications appear were looked up and added to the database. This step will facilitate future linkage from an article title to its holdings in KSU or other libraries’ collections.

3. **Reporting:** ISSA began monthly notification of new titles to researchers in March 2001, directing them to the Voyager system for detailed subject searches. At the NC213 Summer workshop it was requested that statistics on use of the database be captured. Since the Voyager system did not permit record-level or session-level recording of public searches, ISSA introduced its own web page front-end with a visitor counter <http://www.ksu.edu/issa/nc213/> . Since the December 11 introduction of that page, 38 visitors have been recorded.

4. **Data sets** are labor-intensive information resources that direct the conclusions and future direction of research projects. However, their “life after publication” tends to decline as investigators move on to new agendas or job locations. Only recently have there been attempts to systematically catalog and preserve research data sets for Internet retrieval. Pioneering this effort are groups such as the Long-Term-Ecological Research Network (<http://lternet.edu/>), who have developed entire information architecture around data collected at 24 cooperating research sites. We proposed a prototype catalog of NC213 shared research data, which will be presented with sample data offered by Tim Herrman at the February 2002 meeting. A web form was

developed for on-line registration and requesting of data, along with the essential metadata elements to make for good searching.

Plans for 2002:

1. **Additions:** Continue updating the database with newly emerging publications from refereed scholarly journals, while increasing the quantity of selected dissertations, extension materials, and trade publications. Do not exclude foreign-language titles, if English summaries can be obtained. Maintain regular communication with NC213 scientists to adjust focus of acquisitions on specific topics as necessary.
2. **System Maintenance:** Complete the loading of NC213 to the KSU Digital Library and modify front-end web site to explain searching methods.
3. **Reporting:** Continue reporting new title additions to NC213 members.
4. **Data sets:** Pending approval from NC213, survey all participating institutions for data sets deemed accessible to the public or exclusive to specific groups of researchers. Register the cataloged data sets and provide means for direct off-loading from the Internet at distributed sites or mediated distribution from ISSA's central site.

Impacts:

It is difficult to gauge the impact that libraries, databases, and other collections of information have on research itself, although lack of access to these resources would be a setback for most institutions. This service offers those involved in the research side of the grain industry a central site for locating refereed publications. The entire archive of NC213 publications was combined in 2000 with the Food and Feed Grains Institute's post harvest literature database to make up the current collection. Following the monthly updates and searching the retrospective archive are a means of identifying important knowledge resources in the discipline.