

# NC-213

## 2003 ANNUAL PROGRESS REPORTS

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### MANAGEMENT OF GRAIN QUALITY AND SECURITY IN WORLD MARKETS

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**NC-213 Objective A**

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

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Develop a method for quantification of sphingolipids in soybeans without alteration of their chemical structure and to provide preliminary evidence reflecting the effects of composition (variety), maturity, and environmental conditions on sphingolipid contents of soybeans..... 1  
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**Objective A**

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

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## **NC-213 Objective A**

### **Project Objectives**

Develop a method for quantification of sphingolipids in soybeans without alteration of their chemical structure and to provide preliminary evidence reflecting the effects of composition (variety), maturity, and environmental conditions on sphingolipid contents of soybeans.

### **From**

Iowa State University  
Department of Food Science & Human Nutrition  
Department of Agronomy

Georgia Institute of Technology  
School of Chemistry and Biochemistry and School of Biology

### **By**

Wang, T. (Toni)  
Sullards, M. C.  
Fehr, W. R.

### **Results for 2003**

Soybean is believed to be a relatively rich source of sphingolipids, which are a class of polar lipids with desirable biological activities. However, analytical methods for sphingolipids vary, and quantitative data is scarce. The objectives of this study were to develop a method for quantification of sphingolipids in soybeans without alteration of their chemical structure and to provide preliminary evidence reflecting the effects of composition (variety), maturity, and environmental conditions on sphingolipid contents of soybeans. Separation of neutral lipids and interfering polar lipids from sphingolipids by saponification, transesterification, and solvent partition was studied. Solvent partition and TLC purification was identified to be the most accurate sample preparation method for HPLC quantification. This study showed that cerobroside concentrations among soybeans with different compositions (variety), maturities and growing conditions ranged from 142 to 493 nmol/g seed dry-weight-basis, and the Edmame seeds contained about twice as much cerobroside as in the mature seeds. However, the composition of molecular species of cerobroside was relatively unchanged.

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## **NC-213 Objective A**

### **Project Objectives**

To determine the effect of porosity on the permeability and airflow resistance of grains.

#### **From**

University of Kentucky  
Biosystems and Agricultural Engineering Department

Purdue University  
Agricultural and Biological Engineering Department

#### **By**

Montross, M.D.  
McNeill, S.G.

Maier, D.E.

### **Results for 2003**

Permeability is an important material property in determining the magnitude of natural convection currents during periods of non-aerated storage. The permeability of corn, soybeans, soft white wheat and soft red wheat was measured as a function of bulk density and moisture content. Air was passed through a column of grain and the flow rate and pressure drop measured. Bulk density and kernel density were also measured to determine the porosity of the grain in the test column. A dense filling method increased the bulk density by approximately 50 kg/m<sup>3</sup>, a maximum increase of 7%. This resulted in a reduction in the porosity of approximately 4 percentage points. However, the permeability decreased by a maximum of 45%. Wheat had the lowest permeability (between 1.15x10<sup>-8</sup> and 7.29x10<sup>-9</sup> m<sup>2</sup> depending on bulk density and moisture content) and corn and soybeans were similar and varied between 1.30x10<sup>-8</sup> and 3.03x10<sup>-8</sup> m<sup>2</sup>. Experiments were conducted up to a velocity of 0.0052 m/s that resulted in a Reynolds number of 2.5, which is above the maximum expected during non-aerated grain storage. Nevertheless, Darcy's law is appropriate to predict natural convection currents during non-aerated storage.

Airflow resistance of corn, red wheat, white wheat, and soybeans was determined using Ergun's equation. Previous work had indicated that Ergun's equation would not be applicable to grain aeration due to packing effects within the bin. However, research has indicated that packing can be estimated using granular mechanics models and changes in porosity of grain bulks could be estimated. The overall error using Ergun's equation was less than 10 Pa/m, when the pressure drop was less than 250 Pa/m. If all data was included up to a pressure drop of 1,000 Pa/m the standard error averaged 40 Pa/m. The effect of grain orientation that would be typical in storage bins was negligible. With grain orientations that varied between perpendicular and 20° greater than the angle of repose, the change in pressure drop was negligible.

### **Plans for (2004**

Duct work will be placed in model bins and a finite element model of non-uniform airflow distribution validated. Non-uniform airflow distribution will be integrated into a model of heat and mass transfer within stored grain. Based on these results the system will be investigated at some farms and elevators.

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## **Publications**

Molenda, M., M.D. Montross, S.G. McNeill, and J. Horabik. Airflow resistance of seeds at different bulk densities. Paper No. 03-6009. ASAE International Meeting. Las Vegas, NV. July 27-30, 2003.

## **Issues**

Current models of airflow resistance do not adequately predict the pressure drop in deep bins. This is primarily due to the overburden pressure of the grain in the bin and the decrease in the porosity of the grain bulk.

## **What Was Done**

The airflow resistance and permeability of corn, soybeans, white wheat, and red wheat were tested at three moisture content levels and two packing levels.

## **Impacts**

Traditionally airflow resistance has been predicted using Shedd's equations. However, the equations do not accurately predict airflow resistance in deep bins. Combining models of packing and airflow resistance would allow for the determination of airflow resistance in deep bins.

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## NC-213 Objective A

### Project Objectives

Examine milling properties, dough characteristics, protein functionality, and baking properties of soft white wheat varieties.

### From

Michigan State University  
Department of Food Science & Human Nutrition

### By

Ng, Perry K.W.

### Results for 2003

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. The use of transglutaminase (TG) to improve dough strength of weak gluten protein flour samples was investigated. The incorporation of TG allowed soft wheat flour to make satisfactory pan bread. Results revealed that TG has more beneficial effects on weaker protein flour than strong protein flour samples. Furthermore, when TG was incorporated in frozen dough samples, the freezing effects on dough samples were reduced. The biochemistry of the cross-links formed among flour proteins via TG is being examined.

### Plans for 2004

Our plans are to continue evaluating intrinsic quality parameters for soft wheat varieties for milling and baking characteristics, to continue identifying possible biochemical markers for these characteristics, and to publish available data. In addition, biochemistry of TG in dough will be further examined.

### Publications

Ng, P.K.W., Ward, R., Tanhehco, E. MSU Wheat Quality Testing Program: Report on Milling and Baking Test Results for Selected Michigan-Grown Soft Wheats Harvested in 2001. January 2003. 37 pp.

Mujoo, R. and Ng, P.K.W. 2003. Physicochemical Properties of Bread Baked from Flour Blended with Immature Wheat Meal Rich in Fructooligosaccharides. *J. of Food Sci.* 68:2448-2452.

Basman, A., Koksel, H., and Ng, P.K.W. 2003. Utilization of Transglutaminase to Increase the Level of Barley and Soy Flour Incorporation in Wheat Flour Breads. *J. of Food Sci.* 68:2453-2460.

Mujoo, R. and Ng, P.K.W. 2003. Identification of wheat protein components involved in polymer formation upon incubation with transglutaminase. *Cereal Chem.* 80:703-706.

Khan, K., Nygard, G., Pogna, N.E., Redaelli, R., Ng, P.K.W., Fido, R.J., and Shewry, P.R. 2003. Electrophoresis of Wheat Gluten Proteins. Pages 31-59. In *Wheat Gluten Protein Analysis*. Ed. by P.R. Shewry and G.L. Lookhart. AACC, St. Paul, MN.

Basman, A., Koksel, H., and Ng, P.K.W. 2003. Utilization of rapid visco analyzer for assessing the effect of different levels of transglutaminase on gluten quality. In Proceedings of Gluten 2003, Universita degli Studi della Tuscia, Viterbo, Italy.

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Otani, M., Rujoo, R., and Ng, P.K.W. 2003. Effect of wheat-koji on baking quality of bread. AACC Annual Meeting Program Book.

Gazza, L., Niglio, A., Pogna, N., and Ng, P.K.W. 2003. Allele composition at the *Pina-D1* locus coding for puroindoline an in bread wheat. AACC Annual Meeting Program Book.

Otain, M., Mujoo, and Ng, P.K.W. 2003. Modification of wheat proteins by transglutaminase in bread doughs during frozen storage. AACC Annual Meeting Program Book.

### **What Was Done**

Samples were obtained from the Michigan State University Wheat Quality Testing Program, from various breeding programs in the country, and from some commercial wheat flour samples. Experimental analyses were carried out either according to AACC official methods or following published procedures. Partial results were presented at the Michigan State Miller's Association Annual Meeting and the AACC Annual Meeting, and published in refereed journals.

### **Impacts**

This project will result in a better understanding of wheat flour quality in relation to end-use products. In addition, the use of TG will potentially allow (1) bakers to use weaker flour to produce satisfactory baked products, and (2) millers to provide more consistent flour quality to bakers in spite of environmental growing factors.

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## **NC-213 Objective A – Procedure 1a**

### **Project Objectives**

Maintain national database of corn/soybean yield-quality results.

### **From**

Iowa State University  
Department of Agricultural Engineering

### **By**

Brumm, T.J.  
Hurburgh, C.R., Jr.

### **Results for 2003**

U.S. soybean producers, representing 30 soybean production states, in response to a mailed request, provided 1204 samples of 2003 crop soybeans for analysis. Samples were analyzed for protein and oil contents using an Infratec near-infrared instrument (Foss North America, Eden Prairie, Minn.). A geographically distributed subset was sent to the University of Missouri for amino acid analysis. From other sources, data on the yield and physical quality (U.S. Grade factors) of U.S. soybeans have been collected. Data were organized by state and region (groups of states). Weather data for the 2003 growing season were collected to demonstrate the impact of unusual environment (drought in Midwest) on soybean composition. From other sources with measured crop yield, approximately 2500 soybean plot samples were also analyzed.

Composition data are given in Table 1. Average U.S. protein and oil contents for 2003 were 35.65% and 18.66% respectively (on a 13% moisture basis). These are slightly above the long-term U.S. averages of 35.42 % protein and 18.60 % oil. The soybeans from the 2003 crop will produce, on average, 43.8 lbs of 48% protein meal and 10.9 lbs of oil per bushel at 13% moisture. If the soybeans were at 11% moisture, they would yield an average of 44.8 lbs of 48% protein meal and 11.2 lbs of oil per bushel.

The variability (standard deviation) within states, regions, and the U.S. was substantially higher than in 2002. This means that regional or other forms of geographic buying for higher protein and oil will yield more uncertain results. The higher variability was particularly pronounced in the oil, with a standard deviation of 1.02 percentage points as compared to an 18-year average of 0.89 percentage points.

The north to south protein pattern (lower north, higher south) was present, but was not consistent. For example, Minnesota soybeans were very close to the national averages in protein and higher in oil. This is very unusual; it has happened only one other time (1991). Likewise, Midsouth soybeans were lower in protein than those in the Eastern Corn Belt. Harvest temperatures were at or above average throughout harvest, so there should be little frost damaged soybeans which cause oil refining problems. Expect moistures under 12% this year, below the historical average. Soybeans will be small, which may require resetting of cracking rolls and other equipment to prevent abnormal oil loss into meal. This was the 19<sup>th</sup> year of the survey. Figure 1 demonstrates that there has been virtually no change in soybean quality over that period despite steady yield increases.

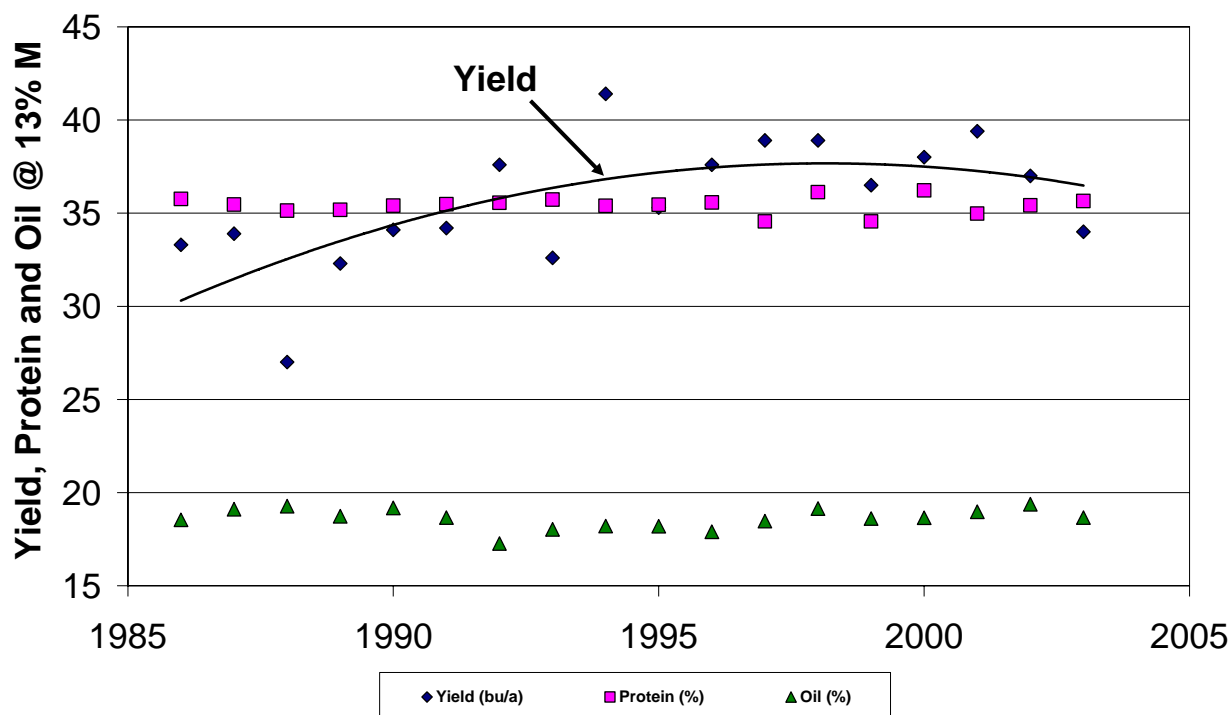
Table 1. United Soybean Board/American Soybean Association 2003 Soybean Quality Survey Data.

Region	State	Number of Samples	Protein		Oil	
			Percent Average	Std. dev.	Percent Average	Std. dev.
Western Corn Belt (WCB)	Iowa	268	35.82	1.41	18.69	0.85
	Kansas	30	35.48	2.10	18.76	1.29
	Minnesota	104	35.66	1.60	19.04	0.85
	Missouri	67	34.75	2.17	19.09	1.09
	Nebraska	105	34.31	1.10	19.24	0.82
	North Dakota	30	35.13	1.98	18.81	0.94
	South Dakota	58	34.88	1.62	18.49	0.93
Averages	Western Corn Belt	662	35.32	1.67	18.86	0.93
Ranges	Western Corn Belt		(26.2 - 41.8)		(15.1 - 21.6)	
Eastern Corn Belt (ECB)	Illinois	234	35.55	1.60	18.75	1.00
	Indiana	110	36.12	1.42	18.29	0.86
	Michigan	38	36.57	1.33	17.83	0.86
	Ohio	84	36.76	1.38	17.73	0.84
	Wisconsin	38	36.21	1.62	18.25	1.02
Averages	Eastern Corn Belt	504	36.00	1.57	18.37	1.02
Ranges	Eastern Corn Belt		(31.2 - 42.0)		(15.2 - 21.0)	
Midsouth (MDS)	Arkansas	46	36.15	1.39	18.76	1.01
	Kentucky	12	34.94	1.67	19.05	1.05
	Louisiana	6	36.28	1.57	19.40	0.52
	Mississippi	24	35.64	1.81	19.36	1.41
	Oklahoma	1	36.90	—	16.80	—
	Tennessee	10	35.87	1.15	19.12	1.07
	Texas	4	34.05	0.61	19.85	1.20
Averages	Midsouth	103	35.80	1.56	19.03	1.15
Ranges	Midsouth		(30.9 - 40.1)		(16.8 - 22.5)	
Southeast (SE)	Alabama	3	36.70	2.37	17.90	1.17
	Florida	0	—	—	—	—
	Georgia	1	36.30	—	19.00	—
	North Carolina	8	36.16	1.45	18.59	0.96
	South Carolina	2	36.05	0.49	18.85	0.92
Averages	Southeast	14	36.26	1.44	18.50	0.95
Ranges	Southeast		(34.5 - 39.2)		(16.6 - 20.7)	
East Coast (EC)	Delaware	2	36.80	1.41	18.20	0.42
	Maryland	6	36.18	1.57	18.12	0.99
	New Jersey	4	36.53	1.11	18.33	0.73
	New York	7	36.96	1.86	17.31	1.02
	Pennsylvania	4	36.50	1.35	17.38	0.87
	Virginia	2	37.05	0.92	17.90	0.42
Averages	East Coast	25	36.62	1.41	17.80	0.91
Ranges	East Coast		(33.3 - 40.5)		(15.6 - 19.9)	
USA	Averages	1308	35.65	1.65	18.66	1.02
	Ranges		(26.2 - 42.0)		(15.1 - 22.5)	
	US 1986-2003 avg.		35.41		18.60	

Basis 13% moisture

Data as of November 7, 2003

**Figure 2. Historical Summary of Yield and Quality Data for U.S. Soybeans**



The yield-quality plot data demonstrated no correlation between grain yield and quality of commonly planted soybean varieties at a plot location. As part of a United Soybean Board project, this data is presently being analyzed for patterns that could be exploited in pricing and marketing programs.

### Plans for 2004

Continue the survey. Use the long-term database for strategic planning of incentive and breeding programs. This work will now be reported in Objective 1 of the 2003-2008 NC 213 project. Only the database development will be reported as an NC213 contribution from Iowa State.

### Publications

Brumm, T.J. and C. R. Hurburgh, Jr. 2003. Quality of the 2003 US Soybean Crop. American Soybean Association Asia Quality Seminar Tour. November 15-22, 2003. Tokyo, Seoul, Taipei, Beijing, Shanghai, Dalian.

### Issues

International buyers request protein and oil content of new crop soybeans.

### What Was Done

US soybean producers provided samples for analysis. Data was presented at six seminars in Asia.

### Impacts

Customers were generally satisfied with US soybean quality, although there will be some reduction in oil content from 2002, an abnormally high oil year. Individual countries asked for quite different emphasis in quality improvement (one asked for higher protein, one for higher total of protein and oil, and one for higher oil with control of protein loss).

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## NC-213 Objective A – Procedure 1a

### Project Objectives

Evaluate physical, chemical and processing properties of sorghum and corn and develop improved food quality cultivars.

Improve aflatoxin tolerance and improve nutritional and processing quality of corn through breeding.

Define the attributes of wheat flours with excellent quality for flour tortillas.

### From

Texas A & M University  
Soil and Crop Sciences Department

### By

Rooney, L.W.  
Betran, J.  
Waniska, R.D.  
Jones, E.

### Results for 2003

Sorghum Nutraceuticals. The procyanidins or tannins of special sorghums have high levels of antioxidants as measured by several in vitro methods including the Oxygen Radical Absorbance Capacity (ORAC), DPPH, and ABTS methods. The antioxidants are concentrated in the pericarp and pigmented testa which can be removed by abrasive milling. The bran has a dark brown color with high insoluble dietary fiber and ORAC levels much higher than blueberries.

HPLC was used to analyze the oligomers of tannins in sorghum and processed sorghums. The levels of monomers and dimmers were increased by extrusion of sorghum bran while the high molecular weight polymers decreased indicating that the higher molecular weight polymers were altered. Baking, moist cooking and other methods did not cause similar changes. This may indicate that high friction extrusion can improve the availability of these higher molecular weight polymers. The extrudates could be used in healthy snacks and other products.

A blend containing high antioxidant levels and insoluble fiber from sorghum bran, soluble dietary fiber from barley and omega-3 fatty acids from flax seed produced bread with a natural brown crumb color and excellent taste and texture. A bread mix containing these ingredients plus vital wheat gluten produces excellent bread.

Food Sorghum. New white and red tan plant hybrids with promising properties were identified in sorghum hybrid trials grown across the sorghum belt. Several new earlier maturity food hybrids are nearing commercial reality. Late and intermediate maturity food type hybrids are competitive in grain yields with feed grain hybrids. A few producers are marketing identify preserved sorghums for food and interest continues.

Whole sorghum snacks were produced by low cost short barrel friction extrusion. They have excellent properties and can be flavored with mild to strong seasonings. The hybrids used are derived from ATx631XRTx436 released from TAES several years ago. Market development in Asia and Mexico by the US Grains Council with assistance from this project continues.

Sorghum Mold Prevention. Sorghums that retain higher levels of antifungal proteins (chitinase and sormatin) in their caryopses from physiological maturity to combine harvest have improved grain mold resistance. It is clear that antifungal proteins prevent mold damage in some cultivars but they are ineffective in other cultivars. Thus, a

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combination of factors affect mold resistance in sorghum including kernel hardness, presence of unknown inhibitors to molds in some grains, plant characteristics and other factors.

Corn Tortillas. Staling of corn tortillas made with dry masa flour was reduced the most by use of specific maltogenic amylases in combination with CMC and guar. Experiments with fresh masa tortillas indicated that significantly lower levels of enzymes were required. The fresh masa was more susceptible to enzymes since it has not been dried and rehydrated. Tortillas with significantly improved texture can be made by proper combinations of enzymes and hydrocolloids.

Corn Quality. Progress has been made to develop corn lines with improved resistance to aflatoxin. Inbred lines and their hybrids were evaluated under inoculation in three locations in South and Central Texas. The most promising inbreds for reducing the risk of aflatoxins under Texas growing conditions are CML269, CML176, CML78, and Tx807 for white grains and TxX69's, CML323, Tx772, and CML288 for yellow grain. Most of these inbreds have subtropical or tropical origin with hard grain.

Quality protein maize (QPM) inbreds released by the corn improvement program has good food processing properties and higher lysine and tryptophan content. The alkaline cooking properties of several QPM hybrids were excellent and comparable to the best quality food corns. There are differences in cooking times and pericarp removal among the different QPM hybrids.

Flour Tortillas. In collaboration with the US Grain Marketing Lab in Manhattan, KS, a small-scale baking procedure to evaluate wheat cultivars for tortilla quality was devised and correlated with a pilot-scale hot-press tortilla procedure. The small scale test is being applied to wheat cultivar evaluation.

Flours with good bread baking properties usually do not produce good tortillas. Some combination of protein quality and content characterizes the properties of wheat flours that produce excellent tortillas.

The utilization of selected protein isolates significantly improved the performance of flours that produce tortillas with short shelf stabilities and large diameters. The combination of protein isolates gives these weaker flours the ability to produce tortillas with optimum attributes.

## **Plans for 2003**

### Objective 2

Evaluate factors affecting processing quality of corn and sorghum. Evaluate the levels of proanthocyanidins and other antioxidants in special sorghum cultivars with different genetics. Determine what happens to proanthocyanidins during friction type extrusion.

Continue efforts to develop aflatoxin resistant corn hybrids. Determine factors affecting the staling of flour and corn tortillas. Evaluate wheat flours and other ingredients for tortilla quality.

## **Publications**

### Chapters

Rooney, L.W. and Serna-Saldivar, S.O. 2003. Food use of whole corn and dry-milled fractions. In: Corn Chemistry and Technology. White, P.J. and Johnson, Lawrence A. (eds.), American Association of Cereal Chemists, St. Paul, MN, pp. 495-535.

Rooney, L.W. and Serna-Saldivar, S.O. 2003. Sorghum. In: Encyclopedia of Food Sciences and Nutrition, 2nd ed. (B. Caballero, LC Trugo, PM Finglas, eds.) Volume 8, pp 5370-5375. London: Academic Press.

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Serna Saldivar, S.O., and Rooney, L.W. 2003. Tortillas. In: Encyclopedia of Food Sciences and Nutrition. Second Edition. B. Caballero, L. Trugo and P. Finglas (eds.) Academic Press, London, UK. ISBN 0-12-227055-X pp. 5808-5813.

#### Refereed Journal Articles

Earp, C.F., McDonough, C.M., Awika, Joseph M. and Rooney, L.W. 2004. Microscopic changes during development of sorghums with and without pigmented testa. *J. Cereal Sci.* (in press)

Earp, C.F., McDonough, C.M., Rooney, L.W., 2004. Microscopy of pericarp development in the caryopsis of *Sorghum bicolor* (L.) Moench. *J. Cereal Sci.* (in press)

Awika, J.M., Dykes, L., Gu, L., Rooney, L.W., and Prior, R.L. 2003. Processing of sorghum (*Sorghum bicolor*) and sorghum products alters procyanidin oligomer and polymer distribution and content. *J. Agric. Food Chem.* 51:5516-5521.

Awika, J.M., Rooney, L.W., Wu, X., Prior, R.L., Cisneros-Zevallos, L. 2003. Screening methods to measure antioxidant activity of sorghum and sorghum products. *J. Agric. Food Chem.* 51:6657-6662.

Bejosano, F.P., Rooney, W.L., Klein, R.R., Rooney, L.W. and Waniska, R.D. 2003. Antifungal proteins in commercial hybrids and elite sorghums. *J. Ag. and Food Chem.* 51:5911-5915.

Betran, F.J., D. Beck, M. Bänziger, G. Edmeades. 2003. Genetic analysis of inbred and hybrid grain yield under stress and non-stress environments in tropical maize. *Crop Sci* 43:807-817.

Betrán, F.J., D. Beck, G. Edmeades, M. Bänziger. 2003. Secondary Traits in Parental Inbreds and Hybrids under Stress and Non-stress Environments in Tropical Maize. *Field Crops Research* 83: 51-65.

Betrán, F.J., A. Bockholt, F. Fojt III, G. Odvody. 2003. Registration of Tx807 Maize Parental Line. *Crop Sci.* 43: 1892-1893.

Betrán, F.J., A. Bockholt, F. Fojt III, L. Rooney. 2003. Registration of Tx811 Maize Parental Line. *Crop Sci.* 43: 1893-1894.

Betrán, F.J., A. Bockholt, F. Fojt III, R. Waniska. 2003. Registration of Tx802 Maize Parental Line. *Crop Sci.* 43: 1891-1892.

Betrán, F.J., J.M. Ribaut, D. Beck, and D. Gonzalez de Leon. 2003. Genetic diversity, specific combining ability and heterosis in tropical maize under stress and non-stress environments. *Crop Sci.* 43:797-806.

Bhatnagar, S., F.J. Betrán, and D. Transue. 2003. Agronomic performance, aflatoxin accumulation and protein quality of subtropical and tropical QPM hybrids in southern USA. *Maydica* 48: 113-124.

Hugo, Leda F., Lloyd W. Rooney, and John R. N. Taylor. 2003. Fermented sorghum as a functional ingredient in composite breads. *Cereal Chem.* 80(5):495-499.

Rooney, W.L., Miller, F.R., Rooney, L.W. 2003. Registration of RTx437 Sorghum Parental Line. *Crop Science* 43:445-446.

#### Thesis

Acosta, David. December 2003. White food-type sorghum in direct-expansion extrusion applications. MS Thesis. Texas A&M University, College Station, TX. 120 pp.

Leal Diaz, Ana. 2003. December 2003. Food quality and properties of quality protein maize. MS Thesis. Texas A & M University, College Station, TX. 150 pp.

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Silva, Laura. August 2003. Effects of barley flour and beta-glucans in corn tortillas. MS Thesis. Texas A&M University, College Station, TX. 98 pp.

Awika, Joseph. May 2003. Antioxidant properties of sorghum. PhD Dissertation. Texas A&M University, College Station, Texas. 118 pp.

Bueso, Javier. May 2003. Staling of corn tortillas. PhD Dissertation. Texas A&M University, College Station, Texas. 104 pp.

Maranphal, Nitit. May 2003. Direct expanded snacks from sorghum. MS Thesis. Texas A&M University, College Station, Texas. 65 pp.

Rudiger, Crystal. May 2003. The formulation of a nutraceutical bread mix using sorghum, barley, and flaxseed. MS Thesis. Texas A&M University, College Station, Texas. 97 pp.

#### Conference or Symposium Proceedings

Acosta, D., Riaz, M., Waniska, R.D. and Rooney, L.W. 2003. Decortication level and particle size effects on extrudates made from a food-type white sorghum. In J. A. Dahlberg et al. (eds.) Proc. 23rd Biennial Grain Sorghum Res. and Util. Conf., Feb. 16-18, 2003, Albuquerque, New Mexico. pp. 119-127.

Betrán, F.J., Tom Isakeit, Gary Odvody, Kerry Mayfield. 2003. Identification, development and characterization of corn germplasm to reduce aflatoxin contamination. Aflatoxin/Fumonisin Workshop 2003, October 13-15, 2003, Savannah, GE.

Kerry Mayfield, Bryan Jones, Leslie Lutz, Adam Blackwelder, T. Isakeit, Gary Odvody, and Javier Betrán. 2003. Aflatoxin accumulation in maize inbreds and hybrids. Aflatoxin & Fumonisin Workshop 2003, October 13-15, 2003, Savannah, GE.

#### **Issues**

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

Corn quality for alkaline cooking and tortilla staling. Fresh corn tortillas have excellent taste and texture but many 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. Marketing of food sorghums is currently expanding.

Special sorghums contain high levels of antioxidants equivalent to or better than blueberries. The bran contains 3-5 times more antioxidants.

New methods to measure texture and other changes during staling of tortillas were devised. These methods were applied to determine factors affecting staling of corn and flour tortillas.

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## **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 limited irrigation combined with slightly higher grain prices have encouraged producers to plant food sorghums. A source of good quality sorghum is available for use in food and feed products. Information and grain samples were supplied to potential Japanese food processors by US Grains Council. L. Rooney provided technical assistance in Japan and Mexico. Increased 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. A combination of maltogenic amylases and hydrocolloids give tortillas longer shelf life in terms of rollability.

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## NC-213 Objective A - Procedure 1a

### Project Objectives

Improve corn resistance to *Aspergillus flavus* and aflatoxin.

### From

National Center for Agricultural Utilization Research  
USDA, Agricultural Research Service  
Peoria, Illinois

### By

Wicklowsky, D.T.  
Kendra, D.  
Muhitch, M.

### Results for 2003

The aflatoxin and fumonisin in grain at harvest is found concentrated at high levels in relatively few corn kernels and our research seeks to accurately identify and remove these toxin-contaminated kernels from contaminated grain lots. An ARS Scientist in Manhattan, KS, in collaboration with an ARS scientist in Peoria, IL, obtained near infrared spectra for corn kernels infected by the mycotoxin producers *A. flavus* and *F. verticillioides*, making it possible to correctly classify infected kernels contaminated with mycotoxins. These spectra were applied successfully in programming a high volume commercial optical grain sorter to reject aflatoxin- and fumonisin-contaminated kernels in combine harvested 2002 corn grown in Eastern Kansas and Central Illinois to produce an 'accepted grain lot' conforming to FDA guidelines for use in human food.

### Plans for 2004

Evaluate the spectral properties of symptomatic and asymptomatic grains from commercially grown and harvested white corn grown in Illinois, Kentucky and Texas in order to optimize sorting of mycotoxin contaminated white corn. Classify symptomatic and asymptomatic grains from wound-inoculated ears of corn varieties with demonstrated resistance or susceptibility to *A. flavus* kernel rot and/or aflatoxin in 2002 variety trials performed by a corn seed producing company. We seek to determine if the near infrared spectra used in detecting aflatoxin and fumonisin contaminated grains of FS 7111 and Pioneer 3394 will prove equally effective in evaluating grains over a diverse genetic background. Determine if spectra can be applied to classify 'resistant' vs 'susceptible' asymptomatic grains across genotypes. This collaborative research involves corn pathologists at a seed producing company and T. Pearson, GMPPRC, ARS, Manhattan, KS. Isolate and characterize antifungal proteins produced by fungi shown to interfere with *A. flavus* and *F. verticillioides* infection of individual kernels and therefore are adapted to function effectively in maturing corn kernels.

### 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. This project investigates corn resistance factors that impact kernel susceptibility to *A. flavus* infection and aflatoxin, examines the role of corn endophytes *F. verticillioides* and *A. zeae* as confounding variables in corn variety trials for aflatoxin resistance, assesses differential expression of genes for their role in fungal / fungal and fungal / host plant interactions; discovers novel metabolites and proteins with antifungal activity against *Aspergillus* and *Fusarium*, and attempts transgene integration and expression of antifungal genes within the grain pedicel (rachilla), the primary route of *A. flavus* and *F. verticillioides* infection.

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The co-occurrence of fumonisin with aflatoxin in the diet significantly increased the incidence of liver cancer in rainbow trout (Carlson et al., 2001. *Toxicol. Appl.Pharmacol.* 172: 29-36). Therefore, we also seek to simultaneously eliminate both aflatoxin- and fumonisin-contaminated grains in a single pass through a commercial optical sorter. Procedure 1a evaluates corn genotypes for resistance to kernel infection and aflatoxin.

### **What Was Done**

A high speed bi-chromatic sorter was tested for removing corn contaminated in the field with aflatoxin and fumonisin. Single kernel reflectance spectra were analyzed to select the optimal pair of optical filters to detect mycotoxin contaminated corn during high speed sorting. These spectra were applied successfully in programming a high volume commercial optical grain sorter to reject aflatoxin- and fumonisin- contaminated kernels in commercially harvested grain from Kansas and Illinois.

### **Impacts**

Over 90% of corn samples having an initial aflatoxin level between 20 and 100 ppb, and fumonisin between 4 and 100 ppm, were reduced to levels below the FDA's recommendation for these mycotoxins by removing approximately 5% of the incoming grain.

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## 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.

### From

National Center for Agricultural Utilization Research  
USDA, Agricultural Research Service  
Peoria, Illinois

### By

Wicklow, D.T.  
McAlpin, C.E.  
Poling, S.

### Results for 2003

The common corn endophyte *Acremonium zeae* has been shown to interfere with *A. flavus* and *Fusarium verticillioides* growth *in vitro* and limit *A. flavus* infection of preharvest corn kernels, but no one has determined if *A. zeae* produces antifungal metabolites that interfere with more destructive fungal pathogens of maize? A University scientist in Iowa City, IA in collaboration with an ARS scientist in Peoria, IL, have shown that culture extracts of *Acremonium* display significant antifungal activity in assays against *A. flavus* and *F. verticillioides* and have isolated and identified recently reported pyrrocidine antibiotics (He et al. 2002. Tetrahedron Letters 43: 1633-1636) that account for this activity. Corn ears were wound-inoculated with cultures of *A. zeae* shown to produce the antibiotics *in vitro* and pyrrocidines were detected in the grain at harvest. These compounds represent the first natural products recorded from *A. zeae* and are being further investigated as factors contributing to the biocontrol potential of this fungus.

Using mycotoxin-producing fungi *A. flavus* and *F. verticillioides* as targets, a University scientist in Iowa City, IA, in collaboration with an ARS scientist in Peoria, IL, have isolated and identified numerous antifungal metabolites present in culture extracts of fungi that attack and kill other fungi (mycoparasites). These ongoing studies are contributing to a growing data base that will be useful in interpreting structure function relationships and potential cellular targets in *Aspergillus* and *Fusarium*. All novel bioactive compounds discovered in this research, in addition to our reference collection of primary fermentation extracts, are being evaluated in numerous antifungal, antiviral, and anticancer assays performed through the "NIH Inter-Institute Program for the Development of AIDS-Related Therapeutics" (National Cancer Institute & National Institute for Allergy and Infectious Diseases, Frederick, Maryland).

### Plans for 2004

Determine the conditions promoting germination, growth, sporulation and production of pyrrocidine antibiotics for the corn endophyte *A. zeae*. Develop analytical methods for measuring the concentration of pyrrocidines produced in liquid and solid media, and throughout the developing corn plant. Evaluate the activities of pyrrocidines against both fungal and bacterial pathogens of corn. Isolate and identify mycoparasitic fungi, produce fermentation extracts, and perform bioassays using *A. flavus* and *F. verticillioides* to guide the isolation of novel antifungal metabolites.

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## Publications

Wicklow, D.T., Bobell, J., and Palmquist, D. Evaluation of intraspecific competition (*Aspergillus flavus* Link) and aflatoxin formation in suspended disc culture. *Mycological Research*. 2003. v. 107. p. 617-623.

Goto, T., Wicklow, D.T., McAlpin, C.E., Peterson, S.W. *Aspergillus bombycis* genotypes (RFLP) from silkworm cultivation. *Mycoscience*. 2003. v. 44. p. 209-215.

Zhang, Y., Li, C., Swenson, D.C., Gloer, J.B., Wicklow, D.T., Dowd, P.F. Novel antiinsectan oxalicine alkaloids from two undescribed fungicolous *Penicillium* spp. *Organic Letters*. 2003. v. 5. p. 773-776.

Joshi, B. K., Gloer, J.B., Wicklow, D.T. Antifungal natural products from a sclerotium-colonizing isolate of *Humicola fuscoatra*. *Journal of Natural Products*. 2002. v. 65. p.1734-1737.

## 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 corn fields and management practices to prevent a population build-up leading to mycotoxin contamination. The research investigates the role of pyrrocidines in the ecology and pathology of *A. zeae*, a common endophyte of corn that has been shown to interfere with *F. verticillioides* and *A. flavus* infection of corn. There is also an urgent need for new sources of antifungal agents and fungi that parasitize and kill other fungi offer a potential source of novel antifungal agents useful to agriculture and medicine.

## What Was Done

Chemical studies of an organic extract from corn kernel fermentations with *A. zeae* isolates from corn that displayed significant antifungal activity against *A. flavus* and *F. verticillioides*, revealed that the metabolites accounting for this activity were two newly reported antibiotics pyrrocidines A and B.

## Impacts

Microbial endophytes can restrict the spread of *A. flavus* and other mycotoxin producing fungi in preharvest corn and there is a common interest in understanding the mechanism(s) by which competing strains of *Aspergillus* species inhibit aflatoxin production. *Acremonium zeae* is one of the two most common fungal endophytes of corn and pyrrocidine antibiotics have a central role in effecting the outcome of competitive encounters with other microbial endophytes of corn.

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## **NC-213 Objective A – Procedure 3a**

### **Project Objectives**

To determine the effect of preharvest production practices on enduse quality of wheat.

### **From**

North Dakota State University  
Department of Plant Sciences

### **By**

Manthey, F.A.  
Wolf-Hall, C.E.

### **Results for 2003**

Belzer, Ben, and Rugby durum wheat were sown near Fargo and Langdon, ND. Wheat was cut and windrowed or treated with glyphosate when the kernel moisture content was 50 and 30%. Standing wheat was harvested as a control. Kernel weight, kernel size, and vitreous kernel content were greatest for grain that was harvested from standing wheat, intermediate from standing wheat that had been treated with glyphosate, and least from windrowed wheat. Protein content was not affected by harvest treatment.

Microbial loads were greater at Fargo than Langdon. Preharvest treatment did not affect microbial load on grain harvested at Langdon. At Fargo, aerobic plate counts were greatest with grain from wheat cut and windrowed when the kernel moisture was 50%, intermediate with grain harvested from wheat cut and windrowed when kernel moisture was 30% or from standing wheat and least from grain harvested from standing wheat that was treated with glyphosate at 30% kernel moisture. Aerobic plate counts were lower for Belzer than for Ben or Rugby. Yeast and mold counts were similar for all three durum cultivars.

### **Plans for 2004**

To determine the relative susceptibility of current durum cultivars to kernel bleaching which can occur in windrowed wheat.

### **Issues**

Traditionally, durum wheat grown in the northern Great Plains has been cut and windrowed to promote the desiccation of green vegetation and reduction of kernel moisture prior to harvest. Untimely rainfall and/or prolonged damp conditions can result in kernel bleaching, preharvest sprouting, and subsequent mold growth in spikes and grain in the windrows. Standing grain allows air circulation around the wheat spikes, which results in faster drying after rainfall.

### **What Was Done**

Belzer, Ben, and Rugby durum wheat were sown near Fargo and Langdon, ND. Wheat was cut and windrowed or treated with glyphosate when the kernel moisture content was 50 and 30%. Standing wheat was harvested as a control. Grain quality and microbial load were evaluated.

### **Impacts**

Results indicate that grain quality was best when wheat was harvested from standing plants.

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**Objective B**

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

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## NC-213 Objective B

### 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.

Examine the historical trends of seed saving practices by farmers and implications for production, marketing and delivery of quality cereals and oilseeds.

### From

Michigan State University  
Department of Sociology

### By

Busch, L.  
Ng, PK

### Results for 2003

The Starlink corn case provides a window on the complexities of standards in the making. Starlink corn is genetically modified to express the insecticidal *Bacillus thuringiensis*-derived protein, Cry9c. At once a crop, food, and pesticide, Starlink is regulated simultaneously by USDA, FDA, and EPA. In 1998, due to concern that Cry9c may potentially be a human allergen, EPA granted Starlink a split registration, approving it for animal feed and industrial use but not for human food use or for export. Nevertheless, in September 2000, an environmental organization discovered Starlink contamination in human food products, resulting in massive and expensive recalls. In the midst of the subsequent crisis of public faith in the biotechnology regulatory process, EPA called two Scientific Advisory Panel meetings to address the question of the allergenic potential of Starlink. During this process, the competing assumptions about scientific and technical standards sustaining knowledge claims became highly contested and therefore visible. The high degree of scientific uncertainty and indeterminacy in this case further heightened the visibility of the ethical and political character of these techno-scientific disputes. The novelty of Starlink required the generation of new standards, policies, regulatory processes, agricultural practices, markets, economics, science, and ethical decisions, all at once. As the challenges of biotechnology become increasingly complex, understanding the indivisibility of techno-scientific and ethical/political problems in the Starlink case helps us to appreciate what is at stake.

Data on seed saving has been collected for wheat and soybeans over approximately the last 50 years. In general, data suggest that farmers with larger farms are more likely to save seed than those with smaller farms. Preliminary examination of these data suggest that the advent of genetically modified soybeans drastically reduced seed saving of that crop. In contrast, more than half of the wheat in the United States is planted with saved seed.

### Plans for 2004

During 2004 we intend to analyze the extant data on seed saving in the United States for major crops for which data is available. We will examine the distribution by farm size as well as regional differences over approximately the last fifty years. Implications for grain quality will be explored.

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## **Publications**

Jacquelyn Miller, Maite Salazar, Michael Mascarenhas and Lawrence Busch (In press). “Starlink™: Standards in the Making”. In Agriculture, Food and Standards. Jim Bingen and Lawrence Busch (eds.) NY: Kluwer.

## **Issues**

Although the US seed industry is more than 100 years old and has contributed significantly to the improvement of American agriculture, seed saving for major cereals and oilseeds (excluding corn) is still fairly commonplace. Moreover, it is the larger and presumably better educated and capitalized farmers who are most likely to save seed. This is the case despite some evidence that farmer saved seed is of lesser quality than purchased seed. Given this, it is unclear why farmers continue to save seed.

## **What Was Done**

Data was collected on seed saving using archival data from USDA and purchased data from Doane’s Agricultural Services. Initial analyses have been presented at several professional meetings including that of the Rural Sociological Society.

## **Impacts**

This project will result in a better understanding of the nature, extent, and importance of farmer saved seed in the United States as well as implications for grain quality.

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## **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.

### **From**

USDA, ARS, Grain Marketing and Production Research Center  
Manhattan, Kansas

Engineering Research Unit

Biological Research Unit

### **By**

Casada, M.R.

Arthur, F.H.

### **Results for 2003**

Data from three years of field tests of controlled aeration of wheat in Kansas were analyzed and a journal manuscript prepared. Results from this study showed that there were benefits from summer aeration of stored wheat. Automatic control of aeration based on ambient temperature alone is not always adequate for summer aeration in such warm, humid climates because conditions are commonly encountered where temperatures normally desirable for summer aeration (below 21 to 24°C) occur with humidity high enough that no cooling takes place. In some cases it would have been better to not run the fan when the temperature was marginal and the humidity was high.

Forty-six years of historical weather data were studied to evaluate the effect of year-to-year weather variation on summer aeration management in Kansas. Data were evaluated for controlled aeration with the fan operating when the ambient temperature was below 24°C (75°F) and the relative humidity was below 95%; i.e., aerating during cool nights only. Results, in Table 1, showed that in an average year it takes about 20 days to accumulate enough fan run time to move a typical aeration front through a bin using a low aeration rate (0.1 cfm/bu). In the warmest years it takes 40 to 50 days to complete the cycle at the low airflow rate. These warm years required 34 days and 23 days to complete the summer cycle for medium (0.2 cfm/bu) and high (0.3 cfm/bu) airflow rates, respectively.

### **Plans for 2004**

Begin collecting field data to evaluate the effect of the following management techniques on controlled summer aeration: (1) airflow direction: upward or downward, (2) airflow rate: 0.1 to 0.3 cfm/bu, (3) use or absence of regular maintenance cooling cycles during the summer (short cycles to cool local areas that reheated due to solar heating).

### **Publications**

Billate, R.D., R.G. Maghirang, and M. E. Casada. 2003. Measurement of particulate emissions from corn receiving operations with simulated hopper bottom trucks. ASAE Paper No. MC03-406.

Casada, M.E., M.S. Ram, and P.W. Flinn. 2003. Thermal design of shipping containers for beneficial insects. ASAE Paper No. 03-6158.

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Casada, M.E., and K. O'Brien. 2003. Accuracy and repeatability of protein content measurements for wheat during storage. *Applied Engineering in Agriculture*. 19(2): 203-209.

Ingles, M.E., M.E. Casada, and R.G. Maghirang. 2003. Handling effects on commingling and residual grain in an elevator. *Transactions of the ASAE*. 46(6): 1625-1631.

## **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**

Three years of field validation tests were conducted comparing two temperature management strategies: 1) 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 2) controlled aeration at 24°C (75°F) after binning in addition to the autumn cooling cycles. Historical weather data were evaluated to see the effect of temperature variations on summer aeration control strategies.

## **Impacts**

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.

**Table 1.** Historical available aeration time in July and August and length of aeration cycle for Topeka, Kansas (46 years of weather data).

Frequency of availability out of 46 years <sup>2</sup>	Mean available fan run time per week, h	Days, at specified airflow rate, required to complete aeration cycle <sup>1</sup> started on July 1		
		0.1 cfm/bu	0.2 cfm/bu	0.3 cfm.bu
100%	23.9	51	34	23
<b>98%</b>	<b>35.0</b>	<b>40</b>	<b>28</b>	<b>16</b>
95%	35.6	27	22	16
<b>90%</b>	<b>37.2</b>	<b>34</b>	<b>23</b>	<b>12</b>
Average	51.6	23	15	7
<b>TMY<sup>3</sup></b>	<b>56.6</b>	<b>20</b>	<b>15</b>	<b>11</b>

**Notes:**<sup>1</sup> Assumptions: 150 hours of fan operation required for cooling with humid, cool air at night; fan runs when temperature is below 24°C (75°C) and relative humidity is below 95%.

<sup>2</sup> Years ranked by total available aeration hours during the eight-week period starting July 1, not ranked by hours available for initial cooling cycle.

<sup>3</sup> Typical Meteorological Year; from TMY2 data, NREL, Golden, Colorado

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## 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 bio-activity in stored corn prior to the time that spoilage would be detected by traditional methods. Our hypothesis is that CO<sub>2</sub> monitors can efficiently detect grain in the early stages of spoilage. The specific project objectives are:

- (1) To determine the parameters for monitoring changes in CO<sub>2</sub> concentrations within a grain bin.
- (2) To determine the relationship between a fungal biomass growing in a grain bin and the early detection of CO<sub>2</sub>.
- (3) To determine the impact of fungal feeding insect infestations on detection of CO<sub>2</sub> from spoiling grain.
- (4) To determine scale-up parameters through modeling in order to implement the CO<sub>2</sub> monitoring technology in commercial-sized storage structures.

### From

Purdue University  
Agricultural and Biological Engineering  
Botany and Plant Pathology  
Entomology

### By

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

### Results for 2003

The first objective of this research project was completed in 2000, and has been previously reported on. The in-lab experiments of the second objective were completed in 2001, and were previously reported on. The pilot bin trials of the second objective were completed in 2002, and were previously reported on. The impact of fungal feeding insect infestations on detection of CO<sub>2</sub> was monitored as part of on-going stored grain insect pilot bin studies during the summer of 2003. Two CO<sub>2</sub> sensors were used to intermittently monitor stored grain conditions in two pilot bins between June and August 2003. The two bins had different aeration strategies. One of the bins was aerated with ambient air using an automatically controlled fan, while the other bin was not aerated. CO<sub>2</sub> concentrations as high as 3500 PPM were observed in the non-aerated bin, which correlated well with high levels of stored grain insect infestation. Cyclic variations in CO<sub>2</sub> concentrations were observed in both bins. High peak readings were observed during the night, while lower concentrations were observed during the day. The feasibility of CO<sub>2</sub> detection was further explored by intermittently monitoring the exhaust air of several 500,000 bushel steel tanks at one commercial elevator between January and June 2003. We developed a methodology for quantifying the total amount of CO<sub>2</sub> retained in the storage structure using a portable CO<sub>2</sub> that confirms the feasibility of early detection of the onset of grain spoilage. One storage tank containing semi-wet corn the on-set of grain spoilage was detected almost two weeks before it was detected with temperature cables. We also developed a preliminary mathematical model for the generation and movement of low CO<sub>2</sub> levels due to biological activity (fungi, insects) in a stored grain mass using a Computational Fluid Dynamics package called Fluent.

### Plans for 2004

The fourth objective of this research project will be completed in 2004. We will focus on the completion of the CO<sub>2</sub> movement model. It will be validated using data collected from the in-lab and pilot bin experiments of CO<sub>2</sub> detection undertaken for objectives 2 and 3 of the project.

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## **Publications**

Bhat, C.G., D.E. Maier, and K.E. Ileleji. 2003. Exploratory Use of a Portable CO<sub>2</sub> Sensor for Early Detection of Spoilage in a Large Corn Storage Tank. Paper No. 036149. St. Joseph. Mich: ASAE.

## **Issues**

In the United States close to 20 billion bushels of grain are stored every year. Insects and fungi create numerous quality problems in these stored grains that cause millions of dollars in losses. 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 sensors. Our research has presented evidence that CO<sub>2</sub> monitoring technology can be effectively used in stored 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 CO<sub>2</sub> concentration, the problem can be corrected by simple management practices such as applying aeration to cool and dry the grain mass.

## **Funding Sources**

The Andersons Research Grant Program 1999-2001; 2002-2003

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## NC-213 Objective B – Procedure 1b

### Project Objectives

To screen food grade lactic acid bacteria for antifungal activity and to determine the effects on mold growth and mycotoxin production.

### From

University of Nebraska-Lincoln  
Department of Food Science & Technology

### By

Bullerman, L.B.

### Results for 2003

Several strains of lactic acid bacteria (LAB) isolated from sourdough bread cultures were previously found to significantly inhibit the growth of a number of common spoilage and mycotoxigenic molds. So the antifungal activity of 4 intact sourdough bread cultures and 8 strains of lactic acid bacteria isolated from 2 of the sourdough bread cultures were examined. *Aspergillus flavus* NRRL 1290 and *Aspergillus parasiticus* NRRL 2999 were used as mold test strains because of their importance as potential aflatoxin producers. To determine the inhibitory effect of the sourdough cultures and the LAB, a dual agar plate assay in petri plates was used. The sourdough cultures were grown in wheat flour hydrolysate (WFH), commercial de Man-Rogosa-Sharpe (MRS) agar and modified MRS (mMRS) agars. Each sourdough culture and strain of LAB (1% of active sourdough culture and grown LAB culture in WFH, MRS and mMRS, 37C, 18 hr) was inoculated into 15 mL of WFH, MRS or mMRS agar. After solidification, plates were overlaid with soft (0.75% agar) yeast extract sucrose agar (YES) or potato dextrose agar (PDA). Mold spores were spotted onto the agar surfaces in the center of the plates. Colony diameters and degree of sporulation of the growing mold cultures were measured every day. Mold growth and sporulation were completely inhibited by almost all sourdough cultures and strains of LAB grown on the WFH and MRS agars. Sourdough culture isolates 02 and 011 from an old original home grown sourdough bread culture and grown on MRS agar delayed mycelial growth and spore production by 7 and 6 days, respectively. The antifungal activity was less when cultures were grown on mMRS.

### Plans for 2004

Additional surveys of lactic acid bacteria from natural sources such as additional sourdough bread cultures, dairy starter cultures, silage inoculants, fermented foods, other natural sources and pure cultures will be conducted to search for isolates with antifungal activity. The most inhibitory isolates will be studied for their ability to inhibit growth of spoilage and mycotoxigenic molds common to cereal grains. Those isolates which have antifungal activity will also be studied for effects on mycotoxin production and ability to degrade or remove mycotoxins from solutions. This work will address elements common to both objectives 1 and 2 of the new NC-213 project.

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## Publications

Giesova, M., V. Martinez and L. B. Bullerman. 2003. Inhibition of *Aspergillus flavus* by sourdough lactic acid bacteria. Presented at the 90<sup>th</sup> Annual Meeting of the International Association for Food Protection. August 10-13, 2003. New Orleans, LA.

Bullerman, L. B., D. Deibert, Y. Hassan, M. Giesova and D. Ryu. 2003. Inhibition of mycotoxigenic fungi by sourdough bread cultures and lactic acid bacteria. Presented at the 2<sup>nd</sup> International Symposium on Sourdough. Sponsored by AACC European Section. October 8-11, 2003. Brussels, Belgium.

Bullerman, L. B., Y. Hassan, D. Deibert and D. Ryu. 2003. Antifungal activity of sourdough bread cultures. Presented at the 5<sup>th</sup> International Workshop on Food Mycology. Sponsored by the International Commission on Food Mycology. October 15-19, 2003. Ballen, Samsø, Denmark.

## Issues

Fungi cause spoilage and losses of cereal grains in the field and during storage, and pose food and feed safety concerns by potential production of mycotoxins. Interest in novel antifungal preservation methods and inhibition of mycotoxin production without using chemicals has increased in recent years, supported by research that antagonistic microorganism or their metabolites may have antifungal properties. Research is needed to screen food grade bacteria from various sources for antifungal and antimycotoxigenic activity and to define the ability of active cultures to inhibit mold growth and mycotoxin production.

## What Was Done

Lactic acid bacteria from sourdough bread cultures were screened for antifungal activity, and, preliminarily five cultures were found to possess antifungal activity. In addition, intact sourdough bread cultures were also shown to be inhibitory to aflatoxigenic molds, and lactic acid bacteria isolated from these cultures were likewise inhibitory.

## Impacts

These results indicate that sourdough bread cultures and certain lactic acid bacteria may have sufficient antifungal and antimycotoxigenic activity to offer promise for possible development of safe natural antimycotic biological agents to prevent fungal invasion and mycotoxin contamination of cereal grains.

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## **NC-213 Objective B – Procedure 2**

### **Project Objectives**

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

### **From**

Purdue University  
Agricultural & Biological Engineering

Kansas State University  
Grain Science and Industry

### **By**

Maier, D.E.  
Herrman, T.H.

### **Results for 2003**

Kansas State University and Purdue University developed a common survey tool in order to gather data from 150 country elevators throughout seven U.S. Corn Belt states. Information gathered from state grain and feed association directories allowed a random sample of elevators to be drawn based on overall licensed warehouse storage capacity. The purpose of this study was to investigate how well country elevators were equipped to handle the segregation of incoming multiple grain types.

The Western Corn Belt region of the study was conducted by staff of Kansas State University and included 75 country grain elevators in Kansas, Nebraska, and Iowa. 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.

The Eastern Corn Belt region of the study was conducted by staff of Purdue University and included 75 country elevators in Illinois, Indiana, Michigan and Ohio. The receiving equipment and capacities, and storage type and capacities were characterized. Additionally, ticket summary reports for the 2002 harvest were collected; bushels received during every hour of harvest on selected days tallied, and stop watch time study data were collected at 5 representative facilities. The data revealed that about 90% of the elevators surveyed have more than one receiving pit and bucket elevator. The survey also indicated that the majority (65%) of elevators have more than 10 smaller storage bins of less than 50,000 bushels and relatively fewer large storage bins greater than 100,000 bushels. Given that most facilities have more than one receiving pit and multiple smaller storage structures, Eastern Corn Belt country elevators should be able to segregate multiple streams of grains successfully. The inability to successfully segregate multiple streams of incoming grains could generally be related to poor logistical management of incoming trucks during the harvest peak period, lack of trained personnel, and poor allocation of available resources, labor, equipment, and time. Additionally, site-specific system simulation models were developed for the receiving operation of three elevator facilities. The models were validated with the collected data, and used to explore “what if” grain segregation scenarios. For one facility, improvement plans made by one operations manager were modeled to quantify the envisioned changes.

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## **Plans for 2004**

Kansas State University and Purdue University are currently collaborating to complete the data analysis by state and region, perform simulation modeling activities of representative facilities, and analyze the economics of country elevator operations for the segregated handling of value-enhanced grains and oilseeds.

## **Publications**

Herrman, T. J., M. Boland, K. Agrawala, and S. Baker. 2002. Use of a simulation model to evaluate wheat segregation strategies for country elevators. *Applied Engineering in Agriculture*. 18(1):105-112.

McGill, J.M. and Maier, D.E. 2003. Capability of Eastern Cornbelt country elevators to segregate crops during harvest. Paper No. 03-6001. ASAE, St. Joseph, MI. Presented at the 2003 ASAE Annual International Meeting, Las Vegas, Nevada, USA, 27-30 July 2003.

## **Issues**

Increased globalization of agricultural markets and the introduction of transgenic (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 (Transgenic 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**

The Andersons Team Research Grant Program 2000-2002.

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## NC-213 Objective B – Procedure 2

### Project Objectives

To develop trapping and contour analysis of trap catch as a method for monitoring stored product insect pests in warehouses, processing plants, and retail stores, and locating foci of infestation. Our specific objective during 2003 was to determine the functional relationship between trap catch and distance from a product infested by stored-product moths.

### From

Center for Medical, Agricultural and Veterinary Entomology  
Agricultural Research Service, USDA  
Gainesville, Florida

### By

Arbogast, R.T.\*  
Chini, S.R.

### Results for 2003

The Indian meal moth, *Plodia interpunctella* (Hübner), was selected as a representative stored-product moth to test the validity of contour mapping of trap catch for pest monitoring in warehouses and retail stores. Three experiments, each replicated 5 times, were conducted in a 3.2 x 9.0-m aluminum shed. Each experiment involved placing pupae at a single release point and recording the numbers of emerging adult males captured after 24, 48, and 72 h in each of 4 pheromone-baited sticky traps attached to the walls of the shed, about 1.2 m above the floor. The experiments differed only with respect to the point of release. Consecutive contour maps of trap catch tracked the dispersal of emerging males from each point. As the moths dispersed and total trap catch increased, cumulative trap catch remained highest near the release points. The rate of capture increased during the first 24 h as moths began to emerge from the pupae, and then became nearly constant. The cumulative numbers captured by any trap after 24, 48, and 72 h decreased linearly with distance from the point of release. The observed spatial patterns of trap catch relative to sources of infestation and the inverse relationship of trap catch to distance from a source support the validity of contour mapping as a means of monitoring stored-product moths and locating foci of infestation.

### Plans for 2004

The physical/biological meanings of the parameters in the functions relating trap catch of stored-product beetles and moths to distance from an infested product will be investigated by further experimentation.

### Publications

Arbogast, R. T. 2003. Humidity response of adult male *Oryzaephilus surinamensis* (Coleoptera: Cucujidae) with special reference to the effect of carbon dioxide. *Environ. Entomol.* 32: 264-269.

Arbogast, R.T., S.R Chini, P.E. Kendra, and D.K. Weaver. 2003. Temperature variation in stored maize and its effect on trap capture of beetles in grain probe traps. *J. Stored Prod. Res.* 40: 135-150.

Arbogast, R.T., S.R. Chini, and P.E. Kendra. 2003. *Lasioderma serricornis* (Coleoptera: Anobiidae): Spatial relationship between trap catch and distance from an infested product. *Florida Entomol.* 86: 437-444.

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## **Issues**

Regular monitoring of insect pests is an essential component of integrated pest management, and trapping combined with spatial analysis of trap catch by contour mapping has shown considerable promise as a reliable and practical method. The value of the method lies in its ability to locate as well as detect infestation, and in the utility of contour maps for documentation and communication. The maps provide graphic, easily understood evidence of insect infestation and can also be used to show the effectiveness of control intervention. They are thus of considerable value in communicating insect problems to managers and to maintenance, sanitation, and pest control personnel. Information relating trap catch to severity and location of infestation is needed to optimize the value this monitoring method.

## **What Was Done**

Experiments with a representative stored-product moth, the Indian meal moth (*Plodia interpunctella*), showed that the number of males captured in pheromone-baited sticky traps was inversely related to distance from a source of emerging adult moths, and that the relationship was adequately described by a straight line.

## **Impacts**

The inverse relationship between trap catch and distance from an infested product supports the validity of trapping and spatial analysis for locating foci of infestation. Knowing the form of the relationship and will be useful in pinpointing trouble spots.

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## NC-213 Objective B – Procedures 2b and 2c

### Project Objectives

The primary objectives of our work in 2003 were to study the effects of low temperatures on mortality of Indian meal moth (*Plodia interpunctella*), to model temperatures inside grain bins under various management schemes, and to use this information to develop stored grain management recommendations that will reduce problems with Indian meal moth (IMM).

### From

University of Minnesota  
Biosystems and Agricultural Engineering Department  
Entomology Department

### By

Wilcke, W.F., University of Minnesota - Biosystems and Agricultural Engineering Department  
Morey, R.V., University of Minnesota - Biosystems and Agricultural Engineering Department  
Kaliyan, N., University of Minnesota - Biosystems and Agricultural Engineering Department  
Cannon, C.A., University of Minnesota - Entomology Department  
Carrillo, M., University of Minnesota - Entomology Department

### Results for 2003

Accomplishments and results for 2003 include:

- Collected data for percent mortality (lower lethal temperature) of third-, fourth-, and fifth-instar larvae, pupae, and adults of *P. interpunctella* at different temperatures (from -30 to 0°C) using minimum exposure (1 min).
- Collected data on mortality for laboratory cultures of fifth-instar *P. interpunctella* exposed to -10°C for different periods of time.
- Initiated a field experiment during fall 2003 to determine the mortality of cold acclimated fifth-instar *P. interpunctella* under field conditions (in grain bins). Data from field tests will be compared to that obtained in the laboratory and to that predicted by computer models. The experiment is still in progress.
- Completed and submitted a manuscript describing the methodology for obtaining desired cooling rates for supercooling point (SCP) determination to *CryoLetters*. The manuscript is currently in press.
- Developed a computer model to simulate temperatures of the grain bin headspace and grain within one meter of the top surface during mechanical ventilation of the headspace.
- Used simulation studies to develop practical weather-based management for controlling cold-acclimated, diapausing *P. interpunctella* larvae. Simulations included use of winter ambient air for eight locations in the Midwest: Minneapolis-St. Paul, MN; Des Moines, IA; Grand Island, NE; Kansas City, MO; St. Louis, MO; Indianapolis, IN; Columbus OH; and Lexington, KY. Results indicated that continuous mechanical ventilation of the grain bin headspace from December through February would reduce the temperatures of the headspace and the top grain layers to a depth of 0.4-m far below critical temperatures for more than enough hours to cause 100% mortality of over wintering *P. interpunctella*. It is expected that manipulation of grain bin headspace temperature during winter will result in nearly complete control of over wintering Indian meal moth stages in grain bins in several locations in the Midwest without a need for chemicals. Winter cooling will also reduce chances of insect infestation during the following spring and summer.

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## Plans for 2004

In 2004, we plan to analyze data from field experiments and then repeat the experiments in fall 2004. We will also continue development of computer models and attempt to use field and laboratory data to validate the computer predictions.

## Publications

Carrillo, M.A., Kaliyan, N., Cannon, C.A., Morey, R.V., and Wilcke, W.F. 2003. A simple method to adjust cooling rates for supercooling point determination. *CryoLetters*. In press.

Ileleji, K.E., W.F. Wilcke, and R.V. Morey. 2003. Relative storability of high-oil and Bt corn compared to conventional hybrids. *Transactions of the ASAE* 46(2): 407-414.

Morey, R.V., W.F. Wilcke, and D.J. Hansen. 2003. Aeration strategies for reconditioning dry soybeans. *Applied Engineering in Agriculture* 19(4) 433-446.

## Issues

Alternatives to chemical insecticides are needed for managing stored grain insects. Insects have become resistant to some traditional stored grain chemical insecticides and there is growing concern about the impact of insecticides on the environment and on human health. It is well known that insect activity slows as temperature decreases. Most insects become dormant below certain critical temperatures and many insects die if held at a low enough temperature for a long enough time. In the northern parts of the U.S. grain growing areas, it should be possible to manage stored grain insect populations by using aeration with outdoor air to control temperatures inside bins of stored grain at levels that limit insect activity and possibly even kill insects. More information is needed on the specific time-temperature relationships needed to kill insects and on the typical number of hours available at various outdoor temperatures in order to develop recommendations that can be used to limit stored grain insect populations and reduce the need for chemical insecticides.

## What Was Done

We collected data for percent mortality (lower lethal temperature) of third-, fourth-, and fifth-instar larvae, pupae, and adults of *P. interpunctella* at different temperatures (from -30 to 0°C) using minimum exposure (1 min). We also collected data on mortality for laboratory cultures of fifth-instar *P. interpunctella* exposed to -10°C for different periods of time.

We developed a computer model to simulate the temperature of headspace and grain in the upper 1.0-m depth. This model can be used for any geographical location. The model requires readily available inputs such as bin and grain properties, and local weather information such as air temperature, solar radiation, and wind speed. The model outputs the temperatures of headspace and grain layers to a depth of 1.0-m from the top surface for mechanically ventilated and unventilated headspace conditions. Simulated temperatures were analyzed to determine the accumulated number of hours of temperatures below critical values (such as -10°C for 8 h, and -20°C for 1 h) that cause 100% mortality of over wintering *P. interpunctella* larvae. The critical temperatures were obtained from the supercooling point and lower-lethal-temperature-and-time studies.

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We initiated a field experiment during fall 2003 to determine the mortality of cold acclimated fifth-instar *P. interpunctella* under field conditions (in grain bins). Data from field tests will be compared to that obtained in the laboratory and to that predicted by computer models. The experiment is still in progress.

### **Impacts**

It is expected that this research will lead to recommendations for storage bin equipment and for stored grain management that can be used to limit insect populations without the use of chemical insecticides. Reduced use of chemical insecticides should reduce grain storage costs and reduce potential harmful environmental and human health impacts from chemical insecticides.

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**Objective C**

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

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## **NC-213 Objective C**

### **Project Objectives**

To developed a non-enzymatic preparative-scale synthetic method for dityrosine and 3-bromotyrosine, to conduct a study to evaluate the effects of handling equipment on commingling during grain transfer operations in the research elevator at the USDA-ARS Grain Marketing and Production Research Center in Manhattan, Kansas, and to develop an economic decision aid that performs a gross margin analysis comparison between planting hard red winter (HRW) and hard white (HDWH) wheat that would enable KS wheat producers to make more informed planting decisions.

### **From**

Kansas State University

### **By**

Herrman, T.J.  
Tilley, K.  
Maghirang, R.

### **Results for 2003**

Dr. Tilley's project has developed a non-enzymatic preparative-scale synthetic method for dityrosine and 3-bromotyrosine. These standard compounds make detection of these structures much easier in the many biological systems in which they occur. They have prepared a patent that describes a native peroxidase in the endosperm of wheat that causes formation of tyrosine crosslinks during the breadmaking process. The protein and gene structure of the peroxidase are illustrated in detail. This patent also illustrates the manipulation of the breadmaking process using free radical scavengers to affect the activity of this native enzyme.

Dr. Maghirang's project conducted a study to evaluate the effects of handling equipment on commingling during grain transfer operations in the research elevator at the USDA-ARS Grain Marketing and Production Research Center in Manhattan, Kansas. White corn was moved first through selected pieces of cleaned elevator equipment followed by yellow corn through the same equipment without any special clean-out between the two operations. Grain flow rates ranged from 43 to 50 t/h. Commingling was calculated as the percentage of white kernels mixed in the yellow corn samples collected at selected time intervals during the second operation. Commingling started at levels above 1% during the first 38 sec or less and declined to levels below 0.5% after the first metric ton of grain transfer. The grain cleaner had the highest cumulative commingling at 0.24%, followed by the weighing scale at 0.22%, the pit and boot at 0.18%, and the grain scalper at 0.01%. For grain transfer in this elevator with the pit and boot, scale, and cleaner in the grain path, total possible commingling was 0.64%.

Dr. Herrman's project developed an economic decision aid that performs a gross margin analysis comparison between planting hard red winter (HRW) and hard white (HDWH) wheat that enabled KS wheat producers to make more informed planting decisions. Completion of a HDWH wheat mixture experiment will assist growers adopt risk management decisions when transitioning to this class of wheat where a limited number of commercial cultivars and marketing options exist. Development of 5 simulation models provides an 80% coverage of infrastructure variation among U.S. grain handling facilities. Physical and biochemical characterization of corn hardness components enables KSU scientists to assist corn growers identify hybrids that maximize end-use quality that possess superior yield potential.

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## Impacts

Kansas hard white (HDWH) wheat harvested acres increased to 490,000 in 2003, compared to approximately 100,000 harvested acres in 2001. About 27 million mt of feed produced in China using SPC exhibited lower absolute protein variance, worth approximately \$30 million savings each year. The K-State Food-Grade Corn Program evaluates dry milling quality of approximately 100 hybrids each year. In 2003, the adoption of one new hybrid (from zero acres in 2002 to 10,000 acres in 2003) boosted producer revenue by \$0.5 million.

## Publications

Herrman, T.J. and T.M. Loughin. 2003. Processing and shelf-life performance of feed manufactured from high moisture corn. *Transactions ASAE* 46(3):697-703.

Ingles, M.E., M.E. Casada, and R.G. Maghirang. 2003. Handling effects on commingling and residual grain in an elevator. *Transactions ASAE* 46(6).

Michael Tilley, Rachel E. Benjamin and Katherine A. Tilley. Non-enzymatic preparative-scale synthesis of dityrosine and 3-bromotyrosine. *Analytical Biochem.*

K. A. Tilley. U. S. Patent Application S/N 09/491,259. Preparation and Use of Polymers Crosslinked with Tyrosine-Containing Peptides.

Yan, J., T.J. Herrman, T.M. Loughin, A. Featherstone, and F.D. Yaun. 2003. Nutritional and economic implications of protein variance structure and the application of statistical process control in the Chinese feed industry. *Cereal Chem.* 80(5):623-626.

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## NC-213 Objective C

### Project Objectives

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

### From

University of Nebraska-Lincoln  
Department of Food Science & Technology

### By

Jackson, D.S.

### Results for 2003

Fourteen (14) flour blends of two natural wild type wheat (*Triticum aestivum* L.) flours, 'Nuplains' and 'Centura,' blended with one waxy flour sample were characterized and processed to Asian salted noodles. The flour amylose content ranged from <1% to 29%. Damaged starch contents were 10.4%, 7.0%, and 6.6% for the waxy wheat, Nuplains, and Centura, respectively. The waxy flour Farinograph water absorption was as high as 79.5%, >20% higher than the wild type flours. Because two types of starch granules (wild type and waxy type) existed in the flour blends, two peaks at 82 C (waxy) and 95 C (wild type) were found in the RVA pasting curves. Reduced amylose content caused high flour swelling volume/power and low falling number. Significant effects of flour amylose content on noodle processing and textural (eating) qualities were found in the study. Noodle qualities, as reflected in covariate analysis, were not significantly impacted by the flour blend's protein content, SDS-sedimentation volume, Mixograph dough development time, or Mixograph tolerance score. The absence of covariate (protein quantity and quality) effects for the food system (flour) used in this study is a very desirable design for the functional studies of starch components. The optimal flour amylose content range for Asian salted noodle products was 21%-24%. Fourteen flour blends with amylose content ranges between <1% and 29% were also used to study tortilla production and quality parameters. Reduced amylose contents decreased dough stickiness and pliability; low amylose doughs were also very smooth in appearance. Very low flour amylose content was associated with earlier tortilla puffing and poor machinability during baking, darker color, low opacity, larger diameters, and reduced flexibility after storage. Tortilla texture analysis indicated that lowering amylose content gave fresh tortillas higher extensibility; after three or more days storage, however, low amylose flours required more force to break the tortillas and the rupture distances became shorter. These results, as reflected in covariate analysis, were not significantly impacted by the flour blend's protein content, swelling volume/power, SDS-sedimentation volume, Mixograph dough development time, or Mixograph tolerance score. Based on our observation of an initial increase in extensibility with reduced-amylose tortillas, adding 10-20% waxy flour into wild type flours should be ideal for restaurant (on-site) tortilla production and/or circumstances where tortillas are consumed shortly (within a day) after production. The optimal flour amylose content for hot-press wheat tortilla products is 24-26%.

### Plans for 2004

There a significant need to identify a small-scale processing method that mimics corn alkaline cooking. Data from studies (already conducted) will be analyzed to determine the extent that a small-scale cooking process mimics large pilot-plant nixtamalization. In addition, corn and sorghum samples will be analyzed for physical grain quality assessments will be associated with pilot scale end-use processing performance in alkaline cooking and wet milling. A standardized set of criteria will be developed to assess the suitability of sorghum and maize for particular end-uses. In cooperation with researchers from USDA-Manhattan and Kansas State University, grain will be classified into "best for... wet milling, dry milling, or alkaline processing" categories that rely upon biochemical, structural, and physical grain measurements.

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## **Publications**

Guo, G., Jackson, D.S., Graybosch, R.A., and Parkhurst, A.M. 2003. Asian salted noodle quality: Impact of amylose content adjustments using waxy wheat flour. *Cereal Chem.* 80(4):437-445.

Guo, G., Jackson, D.S., Graybosch, R.A., and Parkhurst, A.M. 2003. Wheat flour tortilla quality: Impact of amylose content adjustments using waxy wheat flour. *Cereal Chem.* 80(4):427-436.

Specific niche grain markets might prove valuable targets for US producers. Among these include wheats with varying amylose contents and/or mixtures of waxy and non-waxy (regular) wheats.

## **What Was Done**

This research documents the ideal wheat amylose content suitable for wheat varieties targeted towards Asian Noodles and specialty tortilla markets.

## **Impacts**

This study documents the usefulness of waxy wheat flours in two food products. This information will aid breeders and food processors in developing better food products, and help improve the export potential of specialty wheat. More competitive high quality US wheats will help increase exports to Asian countries and domestic/regional consumption in tortilla products.

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## NC-213 Objective C

### Project Objectives

Define the effects of amylose content on starch properties for developing wheat varieties suitable for making instant fried noodles, eventually benefitting wheat growers by expanding wheat export and recapturing noodle wheat markets in Japan and Korea

### From

Washington State University  
Food Science & Human Nutrition

### By

Baik, B.

### Results for 2003

We investigated the relationship between the protein content and quality of wheat flours and characteristics of noodle dough and instant noodles. Protein content of wheat flours exhibited negative relationships with the optimum water absorption of noodle dough and lightness ( $L^*$ ) of the instant noodle dough sheet. Protein quality, as determined by SDS sedimentation volume and proportion of alcohol and salt soluble protein of flour, also influenced optimum water absorption and yellow-blueness ( $b^*$ ) of the noodle dough sheet. Wheat flours with high protein content ( $>13.6\%$ ) produced instant noodles with lower fat absorption, higher  $L^*$ , lower  $b^*$ , and firmer and more elastic texture than wheat flours with low protein content ( $<12.2\%$ ).  $L^*$  of instant noodles positively correlated with SDS sedimentation volume and negatively correlated with proportion of alcohol and salt soluble protein of flour. SDS sedimentation volume and proportion of salt soluble protein of flours also exhibited a significant relationship with free lipid content of instant noodles ( $P < 0.01$  and  $P < 0.001$ , respectively). Protein quality parameters of wheat flour, as well as protein content, showed significant relationship with texture properties of cooked instant noodles.

The effect of amylose content of starch on processing and textural properties of instant noodles was determined using waxy, partial waxy and regular wheat flours and reconstituted flours with starches of various amylose content (3.06.5). Optimum water absorption of instant noodle dough increased with the decrease of amylose content. Instant noodles prepared from waxy and reconstituted wheat flours with 2.4% amylose content exhibited thicker strands and higher free lipids content than wheat flours with 7.1% amylose content. Instant noodles of 2.4% amylose content of starch exhibited numerous bubbles on the surface and stuck together during frying. Lightness of instant noodles increased from 77.3 to 81.4 with the increase of amylose content of starch in reconstituted flours. Cooking time of instant noodles was 4.0 0 min in wheat flours and 6.0 2.0 min in reconstituted flours, and constantly increased with the increase in amylose content of starch. Hardness of cooked instant noodles positively correlated with amylose content of starch. Reconstituted flours with 2.4% amylose content of starch were higher in cohesiveness than those of wheat flours of wild type and partial waxy starches and reconstituted flours with 7.1% amylose content. Instant fried noodles prepared from double null partial waxy wheat flour exhibited shorter cooking time, softer texture and higher fat absorption by 1.2%, but similar color and appearance, compared to noodles prepared from wheat flour of wild type starch.

### Overall Results

Well-documented results on the effects of protein content and quality of wheat on processing characteristics and quality parameters of instant fried noodles will be greatly helpful for developing wheat varieties with appropriate protein content and quality for making noodles and eventually benefit wheat growers by expanding overseas wheat export in noodle wheat markets. The immediate payback will come from our ability to select and segregate high quality wheat for making noodles. The long-term benefits will be the ability to assist breeders in screening wheat lines with suitable protein quality for making noodles.

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Defining the effects of amylose content on starch properties is important for developing wheat varieties suitable for making instant fried noodles, and will eventually benefit wheat growers by expanding wheat export and recapturing noodle wheat markets in Japan and Korea. The proposed study will also allow us to determine the suitability of using waxy and partial-waxy wheat for production of high quality instant noodles.

## **Publications**

Baik, B.-K., and Lee, M.-R. 2003. Effects of starch amylose content of wheat on textural properties of white salted noodles. *Cereal Chem.* 80:304-309.

Baik, B.-K., Park, C. S., Paszczynska, B., and Konzak, C. F. 2003. Characteristics of noodles and bread prepared from double null partial waxy wheat. *Cereal Chem.* 80:627-633.

Park, C. S., and Baik, B.-K. 2003. Relationship between protein characteristics and instant noodle making quality of wheat flours. *Cereal Chem.* In Press.

Park, C. S., and Baik, B.-K. 2003. Cooking Time of White Salted Noodles and Its Relationship with Protein and Amylose Contents of Wheat. *Cereal Chem.* In Press.

Park, C. S., Hong, B. H., and Baik, B.-K. 2003. Protein quality of wheat required for making white salted noodles and its influences on processing and texture of noodles. *Cereal Chem.* 80:297-303.

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## NC-213 Objective C – Procedure 1a

### Project Objectives

Improve accuracy and functionality of near infrared instrumentation.

### From

Iowa State University  
Department of Agricultural Engineering

### By

Hurburgh, C.R., Jr.  
Roussel, S.A.  
Dzupin, R.

### Results for 2003

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

- (1) implement a universal Internet-enabled communication and analysis model for NIR instruments of any brand.
- (2) 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.
- (3) develop a scalable object-based system of implementation for data processing and analysis.
- (4) implement and compare multiple calibration algorithms in real time.

The software links multivariate instruments with high capacity numerical software (MATLAB™) for central multivariate processing over the Internet. The combination enhances measurement capabilities and automates data management.

NIRGrainNet was tested in the fall of 2001, using corn and soybean samples on which moisture and protein was being measured with 3 Foss Infratec 1225/1229 analyzers. Spectral data and predictions on three models (partial least squares, locally weighted regression and artificial neural network) were captured, reported in real time and compared. As expected, the nonlinear models were more accurate than the PLS models, but the best accuracy (25% improvement over any model individually) was obtained by either selecting the best model for each sample/constituent situation or by averaging the results of the three models.

The neural network models are presently being used in the Grain Lab for Infratecs in stand alone situations where the NIRNet cannot yet be enabled. The neural network model created a 25-30% reduction in standard error of prediction compared to any PLS model, for all corn and soybean factors. The standard deviations across like units were generally reduced by the neural network models. However, as reported previously in European networks, a few units produced large errors with the neural network calibrations, while the majority of units were more accurate with them.

The large datasets have been gathered through the years include different types of grain samples with regards to varieties, crop years, environmental/weather conditions, etc. The need for merging datasets has arisen. Before combining data from different instruments into a single larger set, the optical differences between spectra must be assessed and corrected if required. Those inter-instrument measurement variations can be considered as noise in the spectra. There is a need to quantify the noise robustness of different calibration models and determine noise stability areas where optical standardization is not required before merging spectral datasets.

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Multivariate models were built on 3700 Infratec calibration spectra to predict the moisture content of whole corn kernels: Partial Least Squares regression, Locally Weighted Regression, and two types of Artificial Neural Networks. Seven types of noise were defined in cooperation with GIPSA – USDA - random noise, path length, gain, wavelength axis, bandwidth variations, and stray light. These were simulated and introduced in a test set.

Two experimental designs were applied to assess and compare the model robustness. First, full factorial designs were carried out to identify the noises that have a significant influence on model accuracy. Three significant noises were detected: baseline shift, wavelength shift, and multiplicative noise. Second, surface response designs were performed with those three noises, to define the noise stability areas for each calibration model as well as assess the behavior of the model performance in every point of the noisy domain.

The overall robustness of each model was compared by assessing the dimension (as measured by lines of constant standard error of prediction) of the stability area. Data pre-processing (SNV, genetic algorithms) played a large role in the model robustness. Artificial neural networks appeared were the most robust, whereas the local models were the least robust in most cases.

## **Plans for 2004**

Publish the NIRNet and neural network calibration data. Develop completed corn and soybean proximate analysis calibrations for the 13 brands of NIRS now in the Grain Lab. Compare filter, monochromator, diode array and interferometer technologies for measuring soybean amino acids and fatty acids. Apply NIRS to varietal identification of soybeans. Publish the noise-robustness study and develop a standard algorithm for application to future datasets.

This work will now be reported in Objective 1 of the new NC213 project outline.

## **Publications**

- Cogdill, R., P. Dardenne and C.R. Hurburgh, Jr. 2003. Support vector machines for NIRS calibration. Proc. NIR2003, International Conference on NIR Spectroscopy, Cordoba, Spain, April 8-12, 2003.
- Dzupin, R, C. R. Hurburgh, Jr. and S. A. Roussel. 2003. Improvement of prediction speed and accuracy with internet enabled networking software. Proc. NIR2003, 11<sup>th</sup> International Conference on Near Infrared Spectroscopy, Cordoba, Spain. April 6-11, 2003.
- Roussel, S. A., and C. R. Hurburgh, Jr. 2003. Noise robustness comparison for merging large datasets. Proc. NIR2003, 11<sup>th</sup> International Conference on Near Infrared Spectroscopy, Cordoba, Spain. April 6-11, 2003.
- Cogdill, R.P., C.R. Hurburgh, Jr., G.R. Rippke, R.W. Jones, T.C. Jensen, and J.R. McClelland. 2003. Single kernel maize analysis by near-infrared hyperspectral imaging. Trans. ASAE 47(1): 150
- Cogdill, R. P. and C. R. Hurburgh, Jr. 2003. Photometric standardization of a near-infrared hyperspectral imaging spectrometer. J. N.I.R.
- Hurburgh, C. R., Jr. 2003. Measurement of soybean fatty acid content with near-infrared spectroscopy. 2003 Annual Meeting, American Oil Chemists Society, Kansas City, MO May 5-9, 2003. (abstr)
- Stevermer, S.W., B.L. Steward, R.P. Cogdill and C.R. Hurburgh, Jr. 2003. Automated Sorting and Single Kernel Analysis by Near-Infrared Hyperspectral Imaging. ASAE Paper 036159. Am. Soc. Agr. Engr., St. Joseph, MI.

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## **Issues**

New NIRS technologies, and the creation of very large databases, create the need for calibration and standardization procedures that will create uniform readings.

## **What Was Done**

Software was created to manage large databases in real time. The potential for calibration model selection on a sample by sample basis was discovered. A method for assessing robustness (insensitivity to noise) was designed.

## **Impacts**

As these procedures develop, data from multiple sources can be combined in one calibration. Networks with multiple models of NIRS should get results as consistent as those from networks with only one model.

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## 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, functionality, and susceptibility to mold. The information is used to improve sorghum quality and utilization for increasing domestic and export markets.

### From

USDA-Agricultural Research Service  
Grain Quality and Structure Research Unit  
U.S. Grain Marketing Research Laboratory  
Grain Marketing and Production Research Center  
Manhattan, Kansas

### By

Bean, S.R.

### Results for 2003

Wheat free bread was produced from nine food grade sorghum hybrids. Starch and protein content and composition was measured in these lines and related to bread quality. In addition, sorghum lines grown in two locations were used to produce lactic acid and ethanol. Yields of both products were related to grain attributes such as hardness and to starch and protein levels. In addition, improved methods for extracting and analyzing sorghum proteins were developed, and the single kernel characterization system (SKCS) was evaluated for characterizing grain attributes in sorghum. New slope and bias calibrations for predicting kernel size, weight, hardness, and moisture were developed. New slope and bias adjustments for kernel rejection criteria were also developed, improving the use of the SKCS for sorghum grain.

### Plans for 2004

Investigate the relationships between sorghum grain hardness and protein composition and content in both mature grains and in grains collected during kernel development. Determine the role of protein and starch content and composition in governing fermentation yields in sorghum. Investigate methods for making visco-elastic dough from sorghum flours and improving the quality of sorghum products produced from batter type systems. Investigate the relationships between sorghum protein composition, physical grain attributes, and processing quality.

### Publications

- Bean, S. R.** 2003. Evaluation of novel pre-cast gradient gels for the separation of sorghum proteins. *Cereal Chem.* 80:500-504.
- Bean, S. R.** and Tilley, M. 2003. Separation of water soluble proteins from cereals by free zone capillary electrophoresis (FZCE). *Cereal Chem.* 80: 505-515.
- Lookhart, G. L., **Bean, S.**, and Bietz, J. A. 2003. Reversed-phase high-performance liquid chromatography in grain applications. *Cereal Foods World.* 48:9-16.
- Zhan, X., Wang, D., Tuinstra, M., **Bean, S.**, Seib, P. A., and Sun, X. S. 2003. Ethanol and lactic acid production as affected by sorghum genotype and location. *Industrial Crops and Production.* 18:245-255.

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Pedersen, J. F., **Bean, S. R.**, Funnell, D. L., and Graybosch, R. A. 2003. Rapid iodine staining techniques for identifying the waxy phenotype in sorghum grain and waxy genotype in sorghum pollen. In Press.

Park, S. H., and **Bean, S. R.** 2003. Investigation and optimization of the factors influencing sorghum protein extraction. *J. Ag. Food Chem.* 51: 7050-7054.

Rossell, C. M., Aja, S., **Bean, S.**, and Lookhart, G. L. 2003. Wheat flour proteins as affected by transglutaminase and glucose oxidase. *Cereal Chem.* 80:52-55.

## **Issues**

Sorghum is a drought resistant, low input crop currently used as animal feed in the U. S. However, there is great potential for human food uses and bio-industrial uses for sorghum (such as ethanol). To fully utilize sorghum as a renewable resource, basic research into the functionality of sorghum proteins and other biomolecules is needed.

## **What Was Done**

New methods to extract and analyze sorghum proteins were developed. In addition, the single kernel characterization system (SKCS) was evaluated for characterizing sorghum grain attributes. New protein methods and the SKCS were used to relate physical grain attributes and biochemical properties of sorghum hybrids to food functionality and quality, as well as yields of ethanol and lactic acid produced from sorghum.

## **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. White food grade sorghum hybrids were evaluated for bread making quality and the biochemical components of the sorghum hybrids were characterized and related to bread making quality. In addition, the impact on GxE interactions in the yields of ethanol and lactic acid produced from sorghum were investigated. These projects will help to enhance the use of sorghum for human foods and bio-industrial products.

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## NC-213 Objective C – Procedure 1a

### Project Objectives

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

### From

USDA-Agricultural Research Service  
Grain Quality and Structure Research Unit  
U.S. Grain Marketing Research Laboratory  
Grain Marketing and Production Research Center  
Manhattan, Kansas

### By

Bechtel, D.B.

### Results for 2003

Field-grown hard red winter wheat Karl and soft red winter wheat Clark were harvested at 21 days after flowering (DAF) and air-dried in the spike at 20 C for 2, 4, 8, 12, 24, 48, 96 h and until completely air-dried (one week). Fresh samples of Karl and Clark were also harvested and prepared immediately for microscopy. Both wheat varieties underwent similar changes during drying. Few changes were observed during the first 8 h of drying. By 12 h after the start of drying, the rough endoplasmic reticulum (RER) was distended and circularized. Protein bodies were irregular in shape and small autophagic vacuoles found in the cytoplasm. An amorphous material was first observed in areas of the cytoplasm after 24 h of drying. Rough ER was typically associated with those regions. Endosperm tissue looked nearly mature after 48 h of drying. Artificially induced senescence caused by harvesting wheat spikes prematurely caused the endosperm tissue to undergo a number of changes that resulted in the tissue looking normal when compared to wheat that was not prematurely harvested. That suggests the wheat plant has great capacity to develop normally when subjected to environmental stresses. The methods used in this study can be used to investigate endosperm structural changes caused by adverse environmental stress.

### Plans for 2004

Apply laser light scattering technology to measure starch and flour particle size distributions and determine how particle size affects end-use properties. Develop methods for the purification of large amounts of specific size classes of starch granules and use them to help predict baking performance.

### Publications

Hurkman, W. J., McCue, K. F., Altenbach, S. B., Korn, A., Tanaka, C.K., Kothari, K. M., Johnson, E. L., Bechtel, D. B., Wilson, J. D., Anderson, O. D. and DuPont, F. M. 2003. Effect of temperature on expression of genes encoding enzymes for starch biosynthesis in developing wheat endosperm. *Plant Sci.* 164:873-881.

Champagne, E. T., Wood, D. F., Juliano, B. O., and Bechtel, D. B. 2003. The rice grain and its gross. In: E. T. Champagne ed. *Rice: Chemistry and Technology*, 3rd Ed.

Wood, D. F., Champagne, E. T., Juliano, B. O., Bechtel, D. B., Ogawa, Y., Inglesby, M., and Gray, G. M. 2003. Anatomy and histochemistry of the rice grain. In: *Proc. United States-Japan Food & Agr. Panel Meeting*. Pg 200-206.

Bechtel, D. B. and Wilson, J. D. 2003. Amyloplast formation and starch granule development in hard red winter wheat. *Cereal Chem.* 80:175-183.

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Kim, Y. S., R. A. Flores, O.K. Chung, and D.B. Bechtel. 2003. Physical and chemical characterization of wheat flour milling co-products. *Journal of Food Process Engineering* 26(5): 469-488.

Bechtel, D. B. and Wilson, J. D. 2003. Endosperm structural changes in wheat during drying of maturing caryopses. Abstracts AACC Meeting Program pp. 111.

Wilson, J. D., Bechtel, D. B. and Seib, P. A. 2003. Spelt quality and starch chemistry. Abstracts AACC Meeting Program pp.110.

## **Issues**

The sequential stages in which starchy endosperm cells undergo senescence during grain maturation have not been investigated. An understanding of how cellular components degrade and interact during endosperm senescence may provide insight into how it is related to various quality traits important in the marketing of wheat.

## **What Was Done**

Wheat spikes were harvested at 21 days after flowering (14 days pre-ripe) and dried in the laboratory for up to one week. Light and transmission electron microscopy was used to follow the induced senescence in wheat endosperm tissue.

## **Impacts**

The results suggest that the wheat plant has great capacity to develop normally when subjected to environmental stresses. The methods used in this study can be used to investigate endosperm structural changes caused by adverse environmental stress.

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## **NC-213 Objective C – Procedure 1a**

### **Project Objectives**

Evaluate kernel characteristics, milling properties, and dough and bread-, tortilla- and Asian alkaline noodle-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.

### **From**

USDA-Agricultural Research Service  
Grain Quality and Structure Research Unit  
U.S. Grain Marketing Research Laboratory  
Grain Marketing and Production Research Center  
Manhattan, Kansas

### **By**

Chung, O.K.  
Seabourn, B.W.  
Caley, M.S.  
Park, S.H.  
Singh, H.

### **Results for 2003**

The Hard Winter Wheat Quality Laboratory (HWWQL) continues to evaluate end-use intrinsic quality parameters of several thousand hard winter wheat lines from 14 federal, state, and private nurseries. Data were sent to breeders electronically, followed by a written report, upon special request. For the Southern and Northern Regional Performance Nursery (SRPN and NRPN) samples, several intra-zone production area composites were also tested for quality to study the environmental adaptability of each line. In addition, we have led both Wheat Quality Council (WQC) Sample evaluation for domestic customers and the U.S. Wheat Associates' Overseas Varietal Analysis Project for international customers.

Quality data of the SRPN and NRPN 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/](http://greengenes.cit.cornell.edu/). Using a simple, user-friendly relational database system, we provided simultaneous assessment of multiple quality traits. It was the 6th 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 created a web page which allows for the HWWQL to more rapidly respond to customer needs (<http://gqu1.usgmrll.ksu.edu/gqu/HWWQL/HWWQLHome.htm>).

For the first time, we have determined polyphenol oxidase (PPO) contents in wheat meals and the color (Minolta) values of Asian alkaline noodles at 0 and 24 hr for the 2002 crop NRPN and SRPN samples and also the 2002 Wheat Quality Council (WQC) samples. We have provided our customers with information containing these new quality test parameters. We have conducted research on the development of small-scale experimental tortilla-making in collaboration with Texas A&M University.

We were invited to review the status of U.S. bread wheat quality improvement at the 32<sup>nd</sup> Annual Meeting of the U.S. and Japan Natural Resources: Food and Agriculture Panel, Tsukuba, Japan in November 2003. In addition, we were invited to present the direction of U.S. wheat quality at the Pacific Rim Conference of the AACCC, Honolulu, Hawaii in March 2003.

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## Plans for 2004

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; study the suitability of hard winter wheats in Asian noodle-making by testing the PPO levels in breeding lines and also determining noodle-dough color stability; developing a small-scale tortilla-making procedure and textural analysis of tortillas as the quality determinant; conduct studies on prediction of end-use quality using physical and chemical characteristics of wheat and milled flour, including SKCS data, spectral scans by an NIRSystems 6500, and computerized mixograph data; study free lipid composition of commercial hard winter and spring wheat flours; and study dynamic rheological changes and multiple interactions during dough mixing by FTIR and Raman spectroscopy.

## Publications

- Chung, O. K., Ohm, J. B., Lookhart, G. L., and Bruns, R. F. 2003. Quality characteristics of hard winter and hard spring wheats grown under an over-wintering condition. *J. Cereal Sci.* 37:91-99.
- Chung, O. K., Park, S. H., Tilley, M., and Lookhart, G. L. 2003. Improving wheat quality. Chapter 26. Pp. 536-561 in: S. P. Cauvain (ed.), *Bread making: Improving Quality*. Woodhead Pub. Co.: London.
- Chung, O. K., and Steele, J. L. 2003. Editors, *Proceedings of the 2<sup>nd</sup> International Wheat Quality Conference*. Grain Industry Alliance: Manhattan, KS. 509 pp.
- Chung, O. K., and Steele, J. L. 2003. Preface. Pp. iii-iv in: O.K. Chung and J.L. Steele (eds.), *Proceedings of the 2<sup>nd</sup> International Wheat Quality Conference*. Grain Industry Alliance: Manhattan, KS.
- Chung, O. K. 2003. Welcome Reception Statement. Pp. 17-18 in: O.K. Chung and J. L. Steele (eds.), *Proceedings of the 2<sup>nd</sup> International Wheat Quality Conference*. Grain Industry Alliance: Manhattan, KS.
- Graybosch, R. A., Souza, E., Berzonsky, W., Baenziger, P. S., and Chung, O. K. 2003. Functional properties of waxy flours: genotypic and environmental effects. *J. Cereal Sci.* 38:69-76.
- Chung, O. K., Park, S. H., Kim, Y. S., Tilley, M., Seabourn, B. W., and Lookhart, G. L. 2003. Improvement of U.S. Bread Wheat Quality. Pp. 153-160 in: *Proceedings of the 32<sup>nd</sup> Annual Meeting of the U.S. – Japan Cooperative Program in Natural Resources (UJNR): Food and Agriculture Panel*. November 9-15, 2003, Tsukuba, Ibaraki, Japan. National Food Research Institute Pub.: Tsukuba, Ibaraki.
- Kim, Y. S., Flores, R. A., Chung, O. K., and Bechtel, D. B. 2003. Physical and chemical characterization of wheat flour milling co-products. *J. Food Process Engineering* 26:469-488.
- Chung, O.K., Bushuk, W., and Ohm, J.B. Rye production and uses worldwide. 2003. Pages 1-6 in: G. Juodeikiene (ed.), *Proceedings of the 1st Baltic Conference on Rye in the EU*. University of Kaunas Press: Kaunas, Lithuania.
- Chung, O.K., Bean, S.R., Tilley, M., Lookhart, G.L., Dowell, F.E., Ram, M.S., Seitz, L. M., Casada, M.E., Ohm, J.B., Park, S.H., Seabourn, B.W., Caley, M.S., Maghirang, E. B., Wilson, J.D., Bechtel, D. B., Pearson, T. C., Arthur, F. H., Lyne, R. K., Brabec, D. B., Throne, J. E., Baker, J.E., Hubbard, J.D., and Downing, J. M. 2003. Wheat research in the U.S. Grain Marketing Research Laboratory, Grain Marketing and Production Research Center. *Annual Wheat Newsletter* 49:185-198.
- Chung, O.K., Ohm, J.B., Glattes, H., and Schoenlechner, R. Rye in the USA. Pages 36-41. in: G. Juodeikiene (ed.), *Proceedings of the 1st Baltic Conference on Rye in the EU*. University of Kaunas Press: Kaunas, Lithuania.

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- Ram, M.S., Dowell, F.E. and Seitz, L.M. 2003. FT-Raman spectra of unsoaked and NaOH soaked wheat kernels, bran and ferulic acid. *Cereal Chem.* 80:188-192.
- Park, S. H., and Bean, S. R. 2003. Investigation and optimization of the factors influencing sorghum protein extraction. *J. Agric. Food Chem.* 51:7050-7054.
- Cole, T.J., Ram, M.S., Dowell, F.E., Omwega, C.O., Overholt, W.A., and S. B. Ramaswamy, S.B. Near-infrared spectroscopic methods to identify *Cotesia flavipes* and *C. sesamiae* (Hymenoptera: Braconidae). *Ann. Entomol. Soc. Am.* (in press)
- Ram, M.S., Seitz, L.M., Dowell, F.E. Natural fluorescence of red and white wheat. *Cereal Chem.* (in press)
- Wang, D., Dowell, F.E., Ram, M.S. and Schapuagh, W.T. 2003. Classification of fungal-damaged soybean seeds using near-infrared spectroscopy. *Intl. J. Food Properties.* (in press)
- Haley, S. D., Quick, J. S., Johnson, J. J., Peairs, F. B., Stromberger, J. A., Clayshulte, S. R., Clifford, B. L., Rudolph, J. B., Chung, O. K., and Seabourn, B. W. 2003. Registration of 'Anchor' wheat. *Crop Sci.* (In press)
- Graybosch, R. A., Peterson, C. J., and Chung, O. K. 2003. Release of N95111881 and 9519521 strong gluten 1BL.1RS wheat. *Crop Sci.* (in press)
- Graybosch, R. A., Peterson, C. J., Porter, D. R., and Chung, O.K. 2003. Registration of N96L9970 Greenbug resistant wheat (*Triticum Aestivum* L.). *Crop Sci.* (in press)
- Graybosch, R. A., Souza, A. E., Berzonsky, W., Baenziger, P. S., McVey, D. V., and Chung, O. K. 2003. Registration of nineteen waxy spring wheat. *Crop Sci.* (in press)
- Ibrahim, A.M.H., Haley, S. D., Jin, Y., Langham, M.A.C., Stymiest, C., Rickertsen, J., Kalsbeck, S., Little, R., Chung, O.K., Seabourn, B. W., and McVey, D. V. 2003. Registration of Expedition Wheat. *Crop Sci.* (in press)
- Bean, S. R., Park, S. H., Ioerger, B. P., and Dixon, C. E. 2003. Sorghum research at the Grain Quality & Structure Research Unit. Page 42 in: *Proceedings of the 23<sup>rd</sup> Biennial Grain Sorghum Research and Utilization Conference, 2003 Sorghum Industry Conference, Feb. 16-18, 2003, Albuquerque, New Mexico. National Grain Sorghum Producer.*
- Chung, O.K., Tilley, M., Park, S.H., Caley, M.S., and Seabourn, B.W. 2003. Directions in United States wheat quality. Page 14 in: *Program and Abstract Book 2003, AACC Pacific Rim Meeting: Wheat Quality Measurement and Processing into the 21st Century, March 17-19, 2003, Honolulu, HI.*
- Lookhart, G.L., Bean, S.R., Lyne, R., Chung, O.K., Chandra, S., Ohm, J.B., Stearn, M., and Piland, S. 2003. Relationship of relative amounts of insoluble polymeric proteins to dough consistency for flours from commercial mills and individual cultivars. Page 17 in: *Program and Abstract Book 2003, AACC Pacific Rim Meeting: Wheat Quality Measurement and Processing into the 21st Century, March 17-19, 2003, Honolulu, HI.*
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- Bean, S.R., and Chung, O.K. 2003. Tailoring the single kernel characterization system for sorghum. Abstract No. 265. Page 123 in: Program Book of the 88<sup>th</sup> Annual Meeting of the American Association of Cereal Chemists.
- Caley, M.S., Chung, O.K., Park S.H., and Haden, Z.L. 2003. Comparison of pup straight dough method with pound sponge and dough method and pup sponge and dough method. Abstract No. 292. Page 129-130 in: Program Book of the 88<sup>th</sup> Annual Meeting of the American Association of Cereal Chemists.
- Chung, O.K., Park, S.H., and Seib, P.A. 2003. Polyphenol oxidase activity in wheat grain kernels, meals, and flours in relation to noodle color. Abstract No. 232. Page 116 in: Program Book of the 88<sup>th</sup> Annual Meeting of the American Association of Cereal Chemists.
- Park S.H., and Bean, S.R. 2003. Optimization of sorghum protein extraction for possible industrial uses. Abstract No. 262. Page 123 in: Program Book of the 88<sup>th</sup> Annual Meeting of the American Association of Cereal Chemists.
- Singh, H., Lyne, R.K., Chung, O.K., Seib, P.A., and Lookhart, G.L. 2003. Comparison of different strip length for evaluating rheological properties of tortillas. Abstract No. 369a. Page 147 in: Program Book of the 88<sup>th</sup> Annual Meeting of the American Association of Cereal Chemists.
- Singh, H., Lyne, R.K., Chung, O.K., Seib, P.A., and Lookhart, G.L. 2003. The staling of wheat flour tortillas studied by a texture analyzer and SE-HPLC. Abstract No. 369b. Page 147-148 in: Program Book of the 88<sup>th</sup> Annual Meeting of the American Association of Cereal Chemists.

## **Issues**

The U.S. has lost a significant amount (40% from 1987 to 1997) of the world wheat export market, especially for the far-eastern Asian market. It is extremely important to improve U.S. wheat quality desired by our customers in both domestic and international markets.

## **What Was Done**

Intrinsic end-use (milling and bread-baking) quality of about 2,500 hard winter wheat breeding lines were evaluated at the ARS Regional HWWQL so that breeders can select their lines based on intrinsic quality in addition to agronomical quality. We have made progress in developing small-scale methods to evaluate non-bread products (tortillas and Asian alkaline noodles).

## **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 is a very important, but difficult, task. Grain quality improvement begins with a breeding program and ends with growers. In 2003, the HWWQL evaluated intrinsic quality parameters of hard winter breeding lines (2002 crop) and our data of breeders' nursery samples are of prime importance for the release of breeding lines, some of which become released cultivars grown by farmers. Over the last three years, the average 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. Therefore, our efforts greatly impact the overall U.S. wheat industry.

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## NC-212 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.

### From

USDA-Agricultural Research Service  
Grain Quality and Structure Research Unit  
U.S. Grain Marketing Research Laboratory  
Grain Marketing and Production Research Center  
Manhattan, Kansas

### By

Lookhart, G.L.

### Results for 2003

A collaborative project between this researcher and Dr. Christopher Culbertson, a Professor in the Chemistry Department at Kansas State University, was initiated to develop microfluidic devices for quickly identifying wheat varieties and possibly marker proteins for wheat quality. Faster and smaller microfluidic systems (lab-on-a-chip) are producing ever-faster separations. Microfluidic devices (a.k.a. microchips or Lab-on-a-chip devices) have the ability to integrate sample handling and sample processing operations with analyte detection onto a small, monolithic substrate. They appear to offer the rare combination of better-faster-cheaper simultaneously. Preliminary results indicate extraction and separation of wheat cultivars in less than one minute.

The evaluation and comparison of quality parameters from some of the more commonly grown hard winter and hard spring wheats grown under the same conditions studied to determine whether genetics or environment plays the major role in winter and spring wheat classes. This project showed that the selected Spring wheats had slightly higher genetic potential for high protein contents than the selected Winter wheats as they were all grown in a common environment.

We have continued to develop and utilize electrophoretic and chromatographic methods to identify cereal grains. Three book chapters (or reviews) have been published and one book on gluten proteins was co-edited.

The chromatographic and electrophoretic methods developed over the past few years have been applied to detect the effect of oxidative enzymes (Transglutaminase and glucose oxidase) in wheat proteins.

### Plans for 2004

This is a final report.

### Publications

Chung, Okkyung K., Ohm, Jae Bom, **Lookhart, George L.**, and Bruns, R.F. "Quality Characteristics of Hard Winter and Spring Wheats Grown Under an Over-Wintering Condition" *J. Cereal Sci.* 37:91-99. 2003.

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- Chung, O.K., Park, S.H., Tilley, M., and **Lookhart, G.L.** Improvement of U.S. Bread Wheats. pp. 536-561. In S. P. Cauvain (ed.), *Breadmaking: Improving Quality*, Woodhead Publishing Co., London, UK, Chapter 26, 2003.
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- Lookhart, George L.** and Bean, Scott. 2002. Methods for Analyzing Polymeric Proteins of Wheat and Their Impact on Wheat Quality. AACC Pacific Rim Meeting, March 17-19, 2003, Honolulu, Hawaii.
- Lookhart, George L.**, Bean, Scott, Lyne, Rhonda Kay, Chung, Okkyung Kim, Chandra, S., Ohm, J-B, Stearns, M., and Piland, S. 2002. Relationship of Relative Amounts of Insoluble Polymeric Proteins to Dough Consistency for Flours from Commercial Mills and Individual Cultivars. AACC Pacific Rim Meeting, March 17-19, 2003, Honolulu, Hawaii.

## Issues

There is a need to quickly and accurately characterize gluten proteins to identify cultivars and to identify marker proteins. There is also a need to identify end-use qualities early in the development of a cultivar, as that will allow faster development of high quality lines and better product quality. There is a need to identify the effect of oxidative enzymes on wheat flours and proteins and therefore on the quality of products.

## What Was Done

Methods were developed to characterize protein components at various enzyme levels and to quickly identify wheat cultivars.

## 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 2 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.

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## NC-213 Objective C – Procedure 1a

### Project Objectives

Investigate the role of the albumin and globulin proteins (water and salt soluble), phenolics and non-starch carbohydrates of wheat flour on quality and functionality.

### From

USDA-Agricultural Research Service  
Grain Quality and Structure Research Unit  
U.S. Grain Marketing Research Laboratory  
Grain Marketing and Production Research Center  
Manhattan, Kansas

### By

Tilley, M.

### Results for 2003

Data demonstrate that dough properties (as demonstrated by mixograph parameters) can be manipulated by the addition of free radical scavengers such as mannitol.

### Plans for 2004

Examine effects of exogenous enzyme and free radical scavenger addition to dough at molecular level including changes in molecular weight of glutenin polymer.

### Publications

Bean, S. R. and **Tilley, M.** 2003. Separation of water soluble proteins from cereals by high performance capillary electrophoresis (HPCE). *Cereal Chemistry* 80:505-510.

**Tilley, M.** 2003. PCR Amplification of Wheat Sequences from DNA Extracted During Milling And Baking. *Cereal Chemistry* (in press).

Tilley, K., and **Tilley, M.** Modifying tyrosine crosslink formation in wheat dough by controlling innate enzymatic activity. Symposium on Control of endogenous enzymes in food. Institute of Food Technologists Annual Meeting. July 12-16, 2003 Chicago IL.

**Tilley, M.**, and Bean, S.R. Separation of water-soluble proteins from cereals by high performance capillary electrophoresis. Presented at the 88<sup>th</sup> annual meeting of the American Association of Cereal Chemists, September 28-October 2, 2003 Portland, OR, Abstract p.103.

**Tilley, M.**, and Tilley, K.A. Tyrosine crosslink formation in dough: Innate enzymatic activity. Presented at the 87<sup>th</sup> annual meeting of the American Association of Cereal Chemists, September 28-October 2, 2003 Portland, OR, Abstract p.121.

Tilley, K.A., and **Tilley, M.** US patent application S/N 10/464,795 filed June 17, 2003.

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## **Issues**

Chemical oxidants are routinely added to flour to improve breadmaking performance. One of the major chemical oxidants, potassium bromate, is banned in Europe and is being phased out in the United States. With the elimination of potassium bromate and possibly other chemical oxidant additives, alternative oxidation methods must be found. Substitution of chemical oxidants with enzymes is a desirable approach since enzymatic reactions are very specific, with little or no reactivity outside of the substrate. The knowledge of how controlled protein oxidation will support the efforts in developing new baking additives.

## **What Was Done**

Addition of enzymes and free radical scavengers safe for human consumption to a dough system was performed and found to have an effect upon mixing behavior.

## **Impacts**

Enzymes are an attractive approach to replace chemical oxidants, however, understanding how endogenous and exogenous enzymes affect biochemical interactions that underlie changes in quality parameters is essential.

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## **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.

### **From**

Illinois Agricultural Experiment Station  
Agricultural and Biological Engineering Department

### **By**

Paulsen, M.R.  
Nimaiyar, S.

### **Results for 2003**

In 2003, research continued on using near-infrared spectroscopy to measure extractable starch in corn. During the 1997 to 2002 crop years, over 2600 samples of corn were scanned on the Foss Infratec 1229 near-infrared transmittance (NIT) unit. Extractable starch was predicted using the Infratec 1229 NIT spectrophotometer with a standard error of prediction (SEP) of 1.34,  $R^2$  of 0.80 and a RPD of 2.2. The extractable starch calibration has been licensed to Foss North America.

A study was conducted to compare moisture meter readings to the 103°C 72-hr air oven reference method for naturally wet corn during the fall of 2002. A total of 178 samples were collected from 12 counties in Illinois. The oven moistures of the samples ranged from 12.6 to 39.6% wet basis. Each sample was tested by the Illinois Department of Agriculture in triplicate in air ovens and in the Dickey-john GAC 2100, GAC 2000, and GAC II; Motomco 919, 919E, and 919ES; Steinlite SL 95, SB 900, SS 250, RC, RCT; and Burrows 700 moisture meters. Compared to the oven, most of the meters performed within the acceptable limits up to approximately 25% moisture content on combine and hand-shelled corn. Above 25% moisture, most of the meters read lower than the air oven on hand-shelled corn. Based on only one crop year with predominately hand-shelled samples no recommendations for changes in moisture meter calibrations could be made.

Soybeans were obtained from four crop years 1999 through 2002 from the USDA/ARS National Germplasm Lab at the University of Illinois, Urbana-Champaign. Samples were scanned on a Perkin Elmer Spectrum One FT-NIR spectrophotometer. The instrument measured absorbance between 4000 per cm to 12000 per cm, with 8 per cm resolution. A total of 16 scans were averaged for each sample. Prior to building the calibration models using TQ Analyst v6 software, one-third of the samples were removed and placed in a validation set. Partial least squares were used to develop calibration and validation models. The FT-NIR isoflavone calibration equations had a relatively low root mean square error of prediction (RMSEP) and root mean square error of cross-validation (RMSECV) for all three types of isoflavones. FT-NIR calibrations had an RMSEP of 295, 269 and 82 for the total of three forms of daidzin, genistin, and glycitin, respectively. The validation data set correlation coefficients ( $r$ ) ranged from 0.85 to 0.88 for the total of the three forms of daidzin and genistin. Results indicate that the FT-NIR technique with ground samples can be useful in screening for isoflavones levels in soybeans.

### **Plans for 2004**

Plans for 2004 are to add more diverse genotypes, more drying treatments, and to originate quantities of check samples for the extractable starch calibration. Work is started for measuring soybean fatty acid and amino acid composition using FT-NIR spectroscopy.

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## Publications

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## Issues

Ability to quickly measure extractable starch in corn and isoflavones in soybeans.

## What Was Done

Starch yield was measured using NIT spectroscopy. Soybean isoflavones were measured using FT-NIR spectroscopy. Moisture meter accuracy compared to the air oven was measured for shelled corn.

## Impacts

For corn used for wet milling and dry grind ethanol production, extractable starch is a highly important indicator of value. By selecting corn varieties with high extractable starch combined with low to moderate heat 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

State of Illinois through the Illinois Council on Food and Agricultural Research (C-FAR), Dupont/Pioneer, Monsanto, Cargill, Illinois Corn Marketing Board, and the Illinois Agricultural Experiment Station.

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## **NC-213 Objective C – Procedure 1b**

### **Project Objectives**

To develop sensors, instrumentation, and procedures for objective grading, on-line measurement, and end-use property assessment of single kernels or bulk samples.

### **From**

USDA, ARS, Grain Marketing and Production Research Center  
Manhattan, Kansas  
Engineering Research Unit

### **By**

Pearson, T.C.  
Dowell, F.E.  
Armstrong, P.R.

### **Results for 2003**

Internal insect infestation of wheat kernels degrades quality, costs the wheat industry millions of dollars in lost domestic and export markets, and is one of the most difficult defects to detect. We found that the data generated by the Perten SKCS 4100, an instrument developed by our Engineering Research Unit and used by many grain millers and handlers, can be processed for detecting live and dead internal insects in whole wheat kernels. This technology provides the wheat milling and handling industries, as well as FGIS, a rapid and automated method for detecting internal insects in wheat kernels. The software has been transferred to a commercial miller for field testing. Other grain processors throughout the country have expressed interest in this technology.

Wheat hardness is a primary quality trait that relates wheat to its milling properties and end-use quality. The current standard measurement techniques for wheat hardness are destructive, i.e., they require grinding or crushing of wheat samples. There is a need for a measurement technique, such as in breeding programs, that is non-destructive, rapid, accurate, and accommodates small sample sizes. We developed a technique using a single kernel near-infrared instrument developed within the Engineering Research Unit that can measure hardness and sort single kernels automatically at a rate of 1 kernel per second. Wheat breeding programs are expected to benefit from this technique considering its non-destructive feature, small sample size requirement, accuracy, and rapidity.

Wheat breeders currently do not have a non-destructive method to rapidly screen single wheat kernels for protein content. High protein content is preferred in wheat products such as pasta while low protein content is desirable for cakes and cookies. Wheat with higher protein commands higher price in export markets. Our Engineering Research Unit conducted cooperative research with Satake using their high-volume color/NIR sorter for sorting single kernels based on protein content. The sorter is now used by breeders to shift early generation wheat populations toward a target protein level, thus reducing the time required to develop varieties with specific quality traits.

A high-speed color sorter has the potential to help wheat breeders purify their white wheat breeding lines and to help white wheat exporters meet purity requirements of end users. The Engineering Research Unit evaluated a Satake color sorter in cooperation with the Kansas Wheat Commission for removing red wheat from white wheat. The sorter was able to remove red wheat from white at a potential speed of 300 bu/hr. We currently use this technology to purify white wheat samples for breeders in several states as the US develops white wheat varieties to take advantage of significant export markets. The system significantly reduces the time required to develop new white wheat varieties, and improves the quality of new varieties as they are released.

Red and white wheat need to be kept segregated because mixtures of these wheats are discounted, and some have different end uses. Identification of wheat color class is not straightforward, and currently, there is interest in characterizing red and white wheat using spectroscopy and chemical tests. The Engineering Research Unit observed

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that all varieties of red and white wheat exhibited natural fluorescence under ultra-violet light. From a study of 90 cultivars we found that fluorescence emission spectra of red wheat kernels are different from those of white wheat. This information may aid development of a simple, rapid wheat color class identification process easily without the use of chemicals.

Bread staling is a complex process that occurs during bread storage, and the cause of staling is not understood. Understanding the staling phenomena will help us develop methods to reduce staling. Starch, protein, and temperature effects on bread staling were investigated by the Engineering Research Unit in cooperation with KSU using visible and near-infrared spectroscopy and differential scanning calorimetry. Results show that starch, protein, and moisture all contributed to the bread staling process. However, bread staling was mainly due to amylopectin retrogradation. Protein retarded bread staling, but not as much as temperature..

## **Plans for 2004**

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

Investigate other single kernel quality measurements such as protein and starch quality, and detection of transgenic attributes will be continued.

Continue our investigation of physical and spectral properties of corn contaminated with aflatoxin and develop rapid methods of sorting contaminated corn.

Work with researchers at the University of Florida to develop NIRS methods to rapidly and non-destructively identify mutant kernels.

At the request of GIPSA, we will continue image acquisition, calibration and testing of the a high speed image inspection system to determine performance and potential as an aid to grain inspectors which will discriminate dark hard vitreous (DHV) kernels from non DHV wheat kernels. We will also develop the calibrations for the discrimination of hard vitreous and amber colored (HVAC) kernels from non HVAC wheat kernels.

Cooperation with industry and other researchers to investigate the potential of the Perten single kernel NIRS and SKCS 4100 to measure insect characteristics and the quality of other commodities will be continued. We plan to integrate a machine vision system into the single kernel system.

## **Publications**

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Delwiche, S.R., Dowell, F.E. Single kernel wheat NIR analysis. *Proceedings of the 2<sup>nd</sup> International Wheat Conference, Manhattan, KS*. 2001. p. 155-166.

Dowell, F.E., Maghirang, E.B. Accuracy and feasibility of measuring characteristics of single kernels using near-infrared spectroscopy. *Proceedings of the ICC Conference 2002 "Novel Raw Materials, Technologies, and Products – New Challenge for Quality Control," Budapest, Hungary*. 2002. p. 313-320.

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## **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.

## **Impacts**

The results of this study could lead to solutions to reduce bread staling that will bring economic benefit to bakers and consumers

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## NC-213 Objective C – Procedure 2a

### Project Objectives

Relate soybean composition to processing value.

#### From

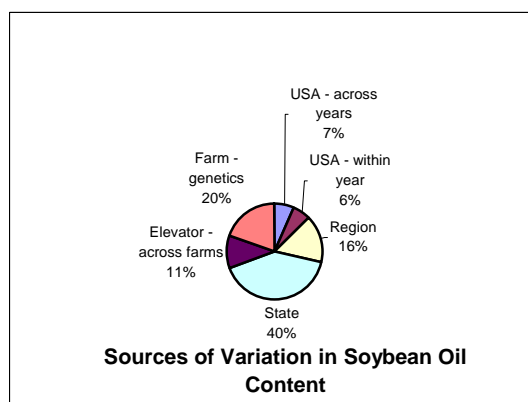
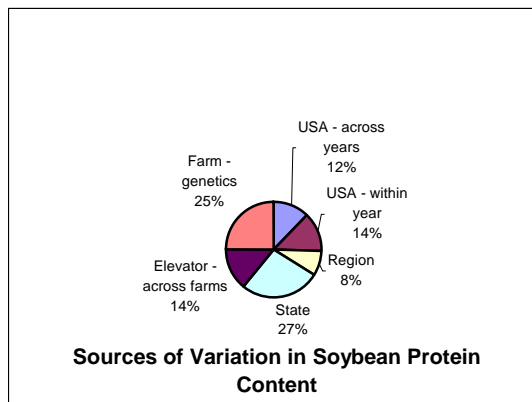
Iowa State University

#### By

Hurburgh, C.R., Jr.  
Brumm, T.J.

### Results for 2003

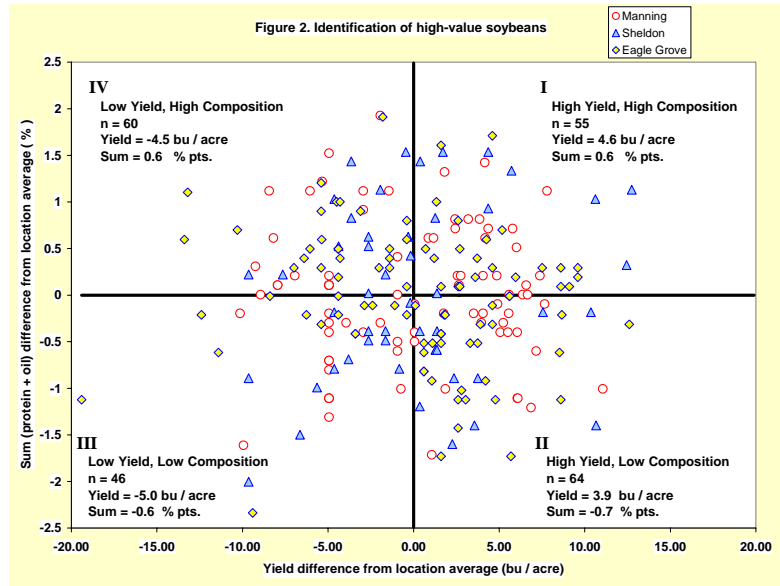
A 20-year history of soybean composition research was assembled. It is possible to calculate accurately the amount and quality of end products from soybeans of given composition (moisture, protein, oil, fiber). The SPROC model, which calculates outputs and estimates a total value of processed products per bushel (EPV), has become a standard tool of breeders and others studying soybean markets. Annual national surveys coupled with the SPROC model have demonstrated consistent regional patterns with accompanying embedded value differences. The amount and relative direction of these differences, northern states versus central versus southern states, have changed very little over time. Forecasting composition on smaller geographic areas (such as county) is much less predictable, which is probably why processors try very hard to minimize basis premiums to areas they think may have better beans. The inherent variability of producer deliveries (from different fields and varieties in a local area) has been very stable through numerous sampling studies from 1983 – present, as has been the variability among varieties grown at a given location. The following charts show a summary of the variance components of protein and oil.



Grain buyers and handlers can test for composition, and can isolate relatively higher valued soybeans for less than 5 cents per bushel on average. Certain elevator designs are more conducive to physical segregation than others, but with general component price scales, which would eliminate the need to sort, all elevators could participate in component pricing at modest cost.

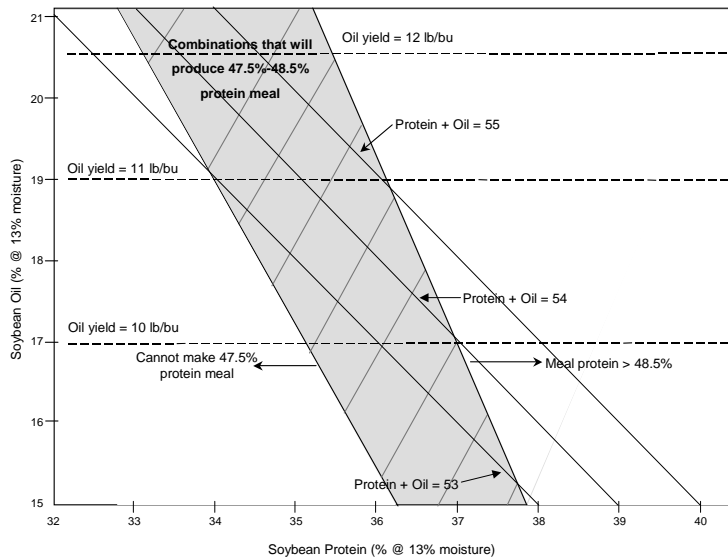
Oil and protein are inversely correlated, but with varying magnitudes and statistical significance among years and regions. The tradeoff between protein and oil has ranged from 4:1 to 1:1. The usual estimate is 2:1 but planning on averages would create substantial risk. There is no consistent relationship between composition and yield within already existing varieties. About 20-25% of samples in any situation will be above average in yield and above average in total components (protein plus oil). One strategy is to normalize yield and quality data by subtracting

location averages so that comparisons can be made as shown in the example below. Normalized EPVA (product of yield and quality) would expand the desirable pool (I) slightly.

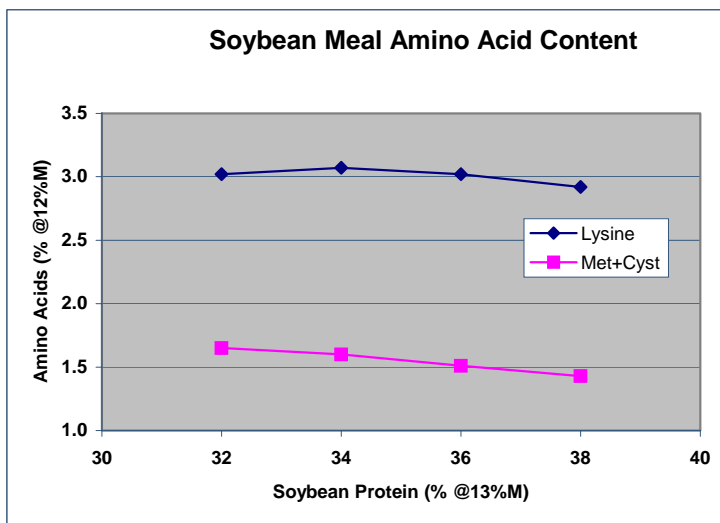


The EPV model (with standard price and processing assumptions) represented the most accurate method for processors to determine possible component premiums/discounts. Fixed premium or discount scales create large risks and send poor signals to plant breeders and others interested in changing composition. Other strategies could be studied. A spreadsheet model is available to estimate the relative distribution (among processors, handlers, producers and seedsmen) of benefits from improved composition strategies (such as the above average in yield and sum strategy).

It is not necessary for the meal market have protein premiums to support component pricing of whole soybeans, especially in the central and western corn belt. Processors in average or deficient protein areas will experience greater meal quantities from improved protein levels; areas with very high protein are forced to give away protein in excess of the 48% specification. It is actually easier for processors in average or deficient protein areas with excess protein. The following chart depicts the relationships among soybean protein, oil, and crush process outputs.



Numerous studies have described the importance of amino acids, rather than crude protein, in animal nutrition. Low protein soybeans appear to be more concentrated in sulfur containing amino acids (relevant to poultry) than higher protein soybeans which means that lower protein meal from northern areas may have higher value if marketed selectively to the poultry industry.



Large databases of yield/composition/variety/location information have been collected over many years. Compilation of this data into a standard format would be very valuable in further assessment of market impacts and benefits for component improvement strategies. A review of US literature on soybean composition supported the Iowa State observations relative to yield, environment, composition and amino acid profiles.

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Because modern high performance nutrition focuses on sub-unit nutrients in soybean meal, like amino acids, isoflavones and carbohydrates. An extension of the previous SPROC soybean processing model was created to estimate amino acid, isoflavone and carbohydrate amounts in soybean meal, and fatty acid levels in soybean oil. Amino acid levels, as percentages of protein, from typical soybeans are more concentrated in meal from lower protein soybeans. In terms of lysine (limiting amino acid in swine rations), meals from 31.6% protein soybeans and 34.6% protein soybeans are equivalent. In sulfur containing amino acids (limiting in poultry rations), meals from the 31.6% soybeans are equivalent to 38.0% soybeans. A pricing system was developed to use the outputs of the new SPROC model in feed formulation. The new system, a linkage of SPROC and a common least-cost feed formulation program, captured feed value more effectively than other pricing systems based on proximate composition alone.

## **Plans for 2004**

The yield-quality database from variety trials, surveys and other sources will be converted to SQL-Server format. At least six and up to ten pricing strategies based on quality will be evaluated. World markets clearly value individual quality components differently, which opens the possibility of market targeting. The impact of data accuracy on yield-quality evaluations will be determined. Publications will be issued.

This work will be reported under Objective 1 of the 2003-2008 work plan. Only the database creation effort was included in the 2003-2008 NC-213 work plan.

## **Publications**

Kundra, A. 2003. A new model to calculate Estimated Processed Value of Soybeans. MS. Thesis. Iowa State University. December 2003.

Hurburgh, C. R., Jr. 2003. A history of soybean yield and quality research. Report to United Soybean Board, St. Louis, MO.

## **Issues**

Subunits, such as amino acids and fatty acids, represent soybean value more accurately than proximate analysis factors.

## **What Was Done**

The widely accepted soybean simulation model SPROC was modified to track subunits and link with feed formulation software. Yield and quality data was reviewed in preparation to evaluate soybean market pricing strategies based on quality. An SQL-server database format was created to organize yield and quality data.

## **Impacts**

US plant breeders and marketers can adopt business strategies that will better target varying customer needs for quality, as opposed to attempts at competing for low cost, generic commodity sales.

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## NC-213 Objective C – Procedure 3a

### Project Objectives

The overall objective of this project is to identify methods of measuring the storability of shelled corn. Storability is related to the amount of fungal growth when the corn is subjected to conditions conducive to fungal growth. Slower fungal growth means greater storability. The specific objectives of this project are: (1) to evaluate storability measurement by means of the CO<sub>2</sub> Test Kit (Woods End Research, Mt. Vernon, Maine), which measures the CO<sub>2</sub> produced in a rewetted sample of corn (2) to evaluate several rapid tests that, when used together, could provide a less precise but more rapid (< 15 min) indication of storability; and (3) to examine the correlations among the various tests used as indicators of susceptibility to invasion by storage mold.

### From

Purdue University  
Agricultural and Biological Engineering  
Indiana Agricultural Experiment Station

### By

Stroshine, R.L.  
Moog, D.J.P.  
Woloshuk, C.P.

Seitz, L.M. - GMPRC, Manhattan, Kansas

Paulsen, M.R. - University of Illinois

### Results for 2003

Samples of shelled corn were evaluated using tests that measure factors affecting the susceptibility of samples to invasion by storage fungi. The tests included the following: percent kernel infection by plating, ergosterol content, percent weight of fines (4.76 mm sieve), mechanical damage by CFC fast green dye, electrolyte leakage, percent germination, NIR reflectance, and CO<sub>2</sub> test kit reading.

Following are additional details about each of the tests. Percent kernel infection was determined in the laboratory of Dr. Woloshuk by plating kernels on malt-salt agar after surface sterilization of the kernels in bleach solution. Ergosterol content in parts per million was determined in the laboratory of Dr. Larry Seitz at the Grain Marketing and Production Research Center in Manhattan, Kansas using chromatographic techniques. In the fast green dye test, kernels were stained with CFC dye and the kernels that retained the stain were visually sorted into categories of minor, major, or severe damage. The “damage index,” which characterizes the severity of kernel mechanical damage was calculated using a formula specified in the literature. The percent weights of kernels with severe, major, and minor damage, the percent weight of fine material determined by sieving and the percent weight of undamaged kernels were multiplied by specified weighting factors. A larger index indicates more damage. Electrolyte leakage was determined by soaking kernels in 400 ml of de-ionized water and periodically stirring the samples while the conductivity of the water was measured at five-minute intervals using a conductance meter. The values reported are the conductivity of the solution after 15 minutes (units of micromhos) and the slope of the conductivity readings between 0 and 15 minutes (micromhos/min). Germination was determined as the percentage of 100 kernels that germinated 7 days after being placed in Petri dishes lined with wetted paper towels. NIR reflectance spectra of the samples are being determined by Dr. Marvin Paulsen at the University of Illinois.

In the CO<sub>2</sub> test kit procedure, a sample was rewetted to 21% (w.b.) moisture content and placed in a sealed container where it was periodically stirred. After 24 hours, 100 g of shelled corn was placed in each of 3 one-pint glass jars. After an additional 24 hours of incubation in the glass jars, the jars were opened for 30 minutes to allow air to reach ambient levels. Next, a paddle (a strip of plastic with a gel containing a color indicator affixed to the

strip) was inserted and the lids were replaced. The indicator in the gel changes color in response to increases in CO<sub>2</sub> concentration. Fungal growth produces CO<sub>2</sub> and therefore the color change indicates the amount of fungal growth. After all of the CO<sub>2</sub> paddles had reached their maximum color change, the lids and paddles were removed and the jars were allowed to equilibrate with the outside atmosphere. The jars were closed until 72 hours after rewetting, at which time the lids were removed for 30 minutes and new paddles were inserted. Once again, the color of the indicator was determined each hour until the maximum change had occurred. The results were reported as the slope of the plot of color number versus time for 48 to 52 hours after rewetting.

The tests described above are being used to evaluate 22 samples of shelled corn having a wide range of storability. Prior to testing, mold growth was visible on several samples that had been in storage for approximately 10 years. Other samples were from recent harvests and appeared to be in excellent condition. Ranges in the quality factor measurements for the samples are given in Table 1. Only 20 of the samples were evaluated using the fast green dye test because two of the samples were small and there was not enough corn available. At the present time only 16 samples have been tested using the CO<sub>2</sub> test kit and the electrolyte leakage test has been completed on 17 samples. The relatively large coefficients of variation shown in Table 1 indicate there was a wide range in the quality factors of these samples.

Regression analysis was used to investigate relationships among several tests. Test results were compared to percent kernel infection (KI), which was assumed to be a fundamental indicator of storability. The correlation coefficient, *r*, for ergosterol (EG) versus percent KI was 0.59. Electrolyte leakage at 15 minutes and the 0-15 minute slope were negatively correlated with EG (*r* = -0.65 and -0.52, respectively) and slightly correlated with percent KI (*r* = -0.12 and -0.20, respectively). The slope of color number 48-53 hours after re-wetting versus time was correlated with percent germination (*r*=-0.72), and EG (*r* = 0.65) and slightly correlated with percent KI (*r* = 0.35).

**Table 1. Summary of results of quality tests conducted on samples of shelled corn.**

Quality Factor	No. Samples	Average	Range	Std. Dev.	Coeff. Of Variation
Ergosterol, ppm	22	2.94	0.042-10.74	2.89	98.5%
Kernel Infection, %	22	39.5	1.0-99.5	31.3	79.1%
Percent Fines	20	1.20	0.0 – 5.90	1.57	131%
FG Dye Severe, % wt.	20	7.9	0.0 – 74.7	15.9	200%
FG Dye Major, % wt.	20	12.8	1.47-32.3	8.3	64.8%
FG Dye Minor, % wt.	20	55.2	3.7 – 83.0	20.4	36.9%
FG Dye Damage Index	20	30.1	12.0–90.7	15.9	52.7%
Germination, %	22	51.5	0 – 99.0	34.6	67.2%
Electrolyte Lkg. 15 min	17	69.6	39.3-103.5	18.6	26.7%
Electrolyte Lkg., slope	17	3.5	1.82 – 5.98	1.18	33.5%
CO <sub>2</sub> Kit, Slope 48-52 h	16	0.85	0.71 -1.01	0.090	10.6%

### Plans for 2004

A second set of 22 samples has been collected and it will also be evaluated using the quality measurement tests. These samples will be augmented by additional samples collected from farms and grain inspection services. Regression analysis will be used to determine correlations among the various measurements. Results of NIR tests being conducted at the University of Illinois will be compared to ergosterol and kernel plating results to determine whether NIR can be used to identify samples that have been invaded by fungi. Results will be interpreted to determine which tests can be used as indicators of storability.

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## **Issues**

When shelled corn arrives at an elevator or processing facility, the manager usually has very little information on duration and conditions of previous storage. These factors can greatly influence the susceptibility of the grain to invasion by storage fungi. If managers decide to store grain, they have no method for determining the likelihood of spoilage and they must rely on experience and the moisture content when assessing risk. A test that could quantify the likelihood of fungal deterioration would assist managers in deciding whether and how long to store their corn.

## **What Was Done**

Twenty-two samples of shelled corn having a wide range in storability were evaluated using a series of quality tests that measure factors affecting the susceptibility of grain to invasion by storage fungi. An initial analysis of the results indicates that electrolyte leakage and CO<sub>2</sub> test kit readings are useful indicators. Additional samples are being tested. Results from these tests are being incorporated into the data base and the expanded data base will be analyzed.

## **Impacts**

Development of procedures for measuring the storability of shelled corn would give the grain industry a means of determining whether and how long shelled corn can be safely stored. There are many situations in which the CO<sub>2</sub> kit, which requires re-wetting and a three-day incubation period, could be used. Elevator managers could use the test to determine whether shelled corn can remain in storage with minimal risk of deterioration. They could also use it to identify lots of shelled corn suitable for shipment to tropical climates where there is a higher risk of fungal induced spoilage. In situations where there is insufficient time available for conducting the 3-day test, several rapid tests, which could be completed in 15 minutes or less, could be used to identify grain lots that appear to be susceptible to invasion by fungi. The more accurate 3-day CO<sub>2</sub> kit test could subsequently be used to confirm and quantify the storability of these samples.

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## NC-213 Objective C – Procedure 3c

### Project Objectives

To determine the effects of food processing on fumonisins, moniliformin, deoxynivalenol and zearalenone.

### From

University of Nebraska-Lincoln  
Department of Food Science & Technology

### By

Bullerman, L.B.

### Results for 2003

During the term of this project the occurrence of fumonisins and moniliformin in corn and corn-based foods was studied along with the stability of the Fusarium mycotoxins fumonisins (FB<sub>1</sub>), moniliformin (MON), deoxynivalenol (DON) and zearalenone (ZEN) in thermal processes, especially extrusion. Food grade corn and corn-based foods were found to be contaminated with fumonisins and/or moniliformin. Seventy-one percent of corn samples contained FB<sub>1</sub> (43 to 1,642 µg/kg) and 50% contained MON (26 to 774 µg/kg.). Some samples were contaminated with both FB<sub>1</sub> and MON. Corn-based foods also contained FB<sub>1</sub> (65%) and MON (68%). Fusarium mycotoxins were found to be quite stable in thermally processed foods, but some reductions were observed with extrusion processing. In general, very high temperatures (above 150C) were required to cause any significant reductions in the concentrations of FB<sub>1</sub>, MON, DON and ZEN. Extrusion temperatures above 150C caused varying degrees of reduction of the four different mycotoxins, with DON seeming to be the most resistant to thermal reduction. Alkaline pH's (10 or above) tended to increase reductions of the mycotoxins, especially DON, by high temperatures. Adding glucose to the corn matrix prior to extrusion greatly increased reduction of FB<sub>1</sub> in the extruded product. Zearalenone seemed to be the least resistant to reduction by high temperatures.

The studies have indicated that the level of fumonisin B<sub>1</sub> in corn-based foods was reduced significantly by extrusion processing as determined by chemical (HPLC) and biochemical (ELISA) assay methods. However, it is still unproven whether the toxicity or biological activity of FB<sub>1</sub> is likewise destroyed. Therefore, there is still a need to determine the reduction of toxicity of FB<sub>1</sub> in extruded corn based food products using *in vitro* and *in vivo* bioassay methods that include cell culture bioassays and feeding of extruded FB<sub>1</sub> contaminated corn grits to rats in controlled feeding studies.

### Plans for 2004

In 2004 work will be initiated under an Anderson Research Grant to assess the reduction of the toxicity of FB<sub>1</sub> during extrusion cooking of contaminated corn grits using *in vivo* bioassay methods. During the two year duration of this project we plan to extrude corn grits contaminated with FB<sub>1</sub> at selected conditions previously determined to give maximum destruction of FB<sub>1</sub> and measure that reduction by HPLC and ELISA, determine the identity of any degradation products by LC-MS and determine residual toxicity of FB<sub>1</sub> in the extruded products by *in vivo* rat bioassay. This work will address elements common to both objectives 1 and 2 of the new NC-213 project.

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## **Publications**

Pineda-Valdes, G., D. Ryu, M. A. Hanna and L. B. Bullerman. 2003. Reduction of moniliformin in corn by heat processing. *J. Food Sci.* 68:1031-1035.

Ryu, D., M. A. Hanna, K. Eskridge and L. B. Bullerman. 2003. Heat stability of zearalenone in an aqueous buffered model system. *J. Ag. & Food Chem.* 51:1746-1748.

## **Issues**

Extrusion processing of cereal grains employs high temperatures, high screw speeds and severe shear forces that cook grain rapidly and cause molecular transformations of molecules such as toxins. We have shown reductions of *Fusarium* mycotoxins by extrusion processing using chemical and biochemical methods of analyses. However, the issue remains as to whether or not the biological toxicity is also destroyed. Work in 2004 will address that issue.

## **What Was Done**

High temperature processing of cereal grains, especially extrusion processing was shown to reduce the concentrations of *Fusarium* mycotoxins in extruded corn products, showing some potential for detoxifying corn during processing.

## **Impacts**

High temperature processing of cereal grains in the manufacture of human foods and pet foods may improve the safety of these products by lowering the concentrations of *Fusarium* mycotoxins. This information is of value to regulators, such as FDA, and the food industry to help arrive at and set reasonable advisory/action levels for these mycotoxins in grains and grain based foods. The determination of the thermal stability of *Fusarium* mycotoxins in grain based foods is likewise of value in establishing the degree of hazard associated with mycotoxins in these processed foods.

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## 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.

### From

North Dakota State University  
Department of Veterinary and Microbiological Sciences

### By

Wolf-Hall, C.E.

### Results for 2003

We expanded our irradiation study to include different levels of *Fusarium* infection and malt quality analyses. Irradiation was done at a Surebeam Corporation plant in Chicago, with dosages of 0, 2, 4, 6, 8 and 10 kGy. Treatments were repeated three times on different days. Treated samples were malted in a pilot-scale malting unit at North Dakota State University. The barley samples were analyzed for *Fusarium* infection (FI), germinative energy (GE), aerobic plate counts (APC), and mold and yeast counts (MYC) and deoxynivalenol (DON). Malted barley samples were analyzed for FI, APC, MYC, and DON. FI decreased with increase in radiation dosage in both the barley and malted samples. In barley samples exposed to 10 kGy, FI was reduced by 50-98%. APC significantly decreased (1-5 logs) in barley with increase in irradiation dosage. A 5-log reduction in APC was observed at 10 kGy for all barley samples. MYC significantly decreased in barley with increase in irradiation dosage. A 1-2.5 log reduction in MYC was observed for all barley samples exposed to 10 kGy. DON was eliminated in malts from barley treated with 2 kGy and higher. Pre-harvest formed DON was likely washed out during steeping. APC and MYC in malts from 8-10 kGy treated barleys were slightly higher than in other malts indicating that radiation resistant microflora were able to thrive during malting due to decreased competition. GE in barley samples was significantly decreased (3-15%) at dosages of 8-10 kGy. The results suggest that dosages between 4-8 kGy may be effective in reducing DON in malt while maintaining the GE in barley. Dosages over 8 kGy reduce GE and appear to lead to higher microbial loads in malt. Additional malt quality analysis is still in progress.

We also evaluated the effect of hydrogen peroxide on FI and GE in naturally FHB infected barley. Treatments included 0, 5, 10 and 15% hydrogen peroxide exposure for 0, 5, 10, 15, 20 and 30 minutes. All treatments were done at room temperature and were repeated three times on different days. For each treatment, 150 seeds were soaked in 50 ml of solution in a 100 ml conical flask. The seeds were agitated during exposure in a shaker at 200 rpm, and then rinsed with sterile distilled water prior to analysis. In the 0% control, FI was decreased by 30% after 30 minutes. With 5% hydrogen peroxide there was a 79-95% decrease in FI between 5-30 minutes of exposure. GE was only negatively affected with treatments of 10 and 15% hydrogen peroxide exposed for 20 minutes.

### Plans for 2004

Continue screening treatment methods, including physical, chemical and biological methods for effects on FI and GE. Effective treatments will be further studied for effects on malting quality and mycotoxigenesis of surviving *Fusarium*. Effects will also be determined for these treatments on overall microbial loads in malt. The most effective treatments will be evaluated for economic feasibility.

A new study will also begin which will look at overall microbial loads and mycotoxin contents from the durum and hard-red-spring wheat crop survey samples and compare these to quality attributes.

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## Publications

Kottapalli, B., **C.E. Wolf-Hall**, P. Schwarz, J. Schwarz and J. Gillespie. 2003. Evaluation of hot water and electron-beam irradiation for reducing *Fusarium* infection in malting barley. *J. Food Protect.* 66:1241-1246.

Manthey, F.A., **C.E. Wolf-Hall**, S. Yalla, C. Vijayakumar, D. Carlson. 2003. Microbial Loads, Mycotoxins and Quality of Durum Wheat from the 2001 Harvest of the Northern Plains Region, USA. *J. Food Protect.*

## Issues

Barley with mild FHB may lead to the production of mycotoxins during malting. Maltsters have strict limits for malt quality that 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. Another issue for food-grade malt producers is high microbial loads in finished malt. The treatments we find effective for control of *Fusarium* during malting may also be effective in reducing levels of other undesirable microbial flora.

## What Was Done

Electron-beam irradiation and hydrogen peroxide were evaluated for treating FHB infected malting barley.

## Impacts

The results suggest that electron-beam radiation may be an effective physical treatment to “pasteurize” mildly FHB infected barley, allowing the utilization of otherwise good quality barley without safety and quality concerns due to *Fusarium* growth during malting. An added benefit may be a reduction in overall microbial loads in food-grade malt. This research could ultimately lead to processing practices that allow increased utilization of US barley for malting.

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**Objective D**

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

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## NC-213 Objective D – Procedure 4a

### Project Objectives

Develop producer training and awareness materials that encourage the development of higher value grain markets in Iowa.

### From

Iowa State University  
Iowa Grain Quality Initiative

### By

Jarboe, D.H.  
Hurburgh, C.R. Jr.  
Ginder, R.G.  
Hanna, H.M.

### Results for 2003

The Iowa Grain Quality Initiative (IGQI) has developed producer training and awareness materials that encourage the development of higher value grain markets in Iowa.

In 2003 the corn stewardship poster project was expanded to include nine Midwestern states. Thirty-seven partners from university extension programs, corn producer organizations, grain handler associations, and three seed companies cooperated on the project that promoted the delivery of Market Choices<sup>SM</sup> corn to grain collection sites willing to accept it. Market Choices<sup>SM</sup> corn is corn that is not authorized but may be scientifically accepted in the European Union.

Two posters were developed, 18"x24" (publication SP 161) and 8.5"x11" (publication SP 162), promoting the delivery of Market Choices<sup>SM</sup> grain to facilities that accept it. The posters used the National Corn Growers Association's *Know Where to Go*<sup>SM</sup> service mark as the main theme. This phrase is recognized by over 85% of producers.

The posters were distributed to 4,346 grain collection sites in the partner states. The 806 Extension offices in cooperating states also received the posters. Pioneer distributed the small poster to 19,000 producers that purchased Market Choices<sup>SM</sup> hybrids. Dow AgroSciences purchased an additional 10,000 small posters for distribution to producers through their seed sales and distribution network. The seed technology companies provided their sales and agronomy staff with project information. The American Seed Trade Association's (ASTA) Market Choices<sup>SM</sup> committee developed a sticker that elevators could use for producer correspondence to indicate their Market Choices<sup>SM</sup> grain receiving policy. The sticker was included in the poster mailing.

A comprehensive web site, [www.marketchoices.info](http://www.marketchoices.info), was created to disseminate information related to Market Choices<sup>SM</sup> grain and receive feedback. The site offered a direct link to the ASTA Grain Handler's Database, National Corn Growers Association hybrid approval list, Market Choices<sup>SM</sup> program information, resources for successful grain stewardship, and tools for grain handlers. The site also contains a media bureau with radio sound bites for use by the media. An overview of the poster project aired on *Today's Ag* on RFD-TV in October. Interviews were given to the *Brownfield Network* and *Farm News* about the program.

In the process of executing the project, working relationships have been developed with a network of cooperating corn entities. These established relationships are a valuable asset for future programs allowing the dissemination of information quickly across the nine state region. Future corn issues that require quick action by value chain participants will be more easily coordinated.

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IGQI provided information about the StarLink™ corn settlement. Producers and Extension offices downloaded the StarLink™ settlement information (2,278 downloads) and the StarLink™ Situation publication (4,666 downloads) from the IGQI web site. The settlement documents enabled producers to file for a share of the \$110,000,000 (plus accrued interest) class action suit settlement for producers of non-StarLink™ corn from 1998 to 2002. The period for producer claims concluded July 31, 2003

The Leopold Center funded a combine sanitation proposal submitted by Mark Hanna, Graeme Quick, and Darren Jarboe. Data was collected for the John Deere conventional and STS combines in the initial year of the two-year project. Next fall one to two additional machines will be examined.

## **Plans for 2004**

Complete the combine sanitation research project initiated in 2003. Extend the Market Choices<sup>SM</sup> project as needed.

## **Publications**

Ginder, R.G., D. Jarboe, J. McGuire, J. Maiers, D. Pavlik, and M. Nelson. 2003. Know Where to Go Poster. SP-161. September 15.

Ginder, R.G., D. Jarboe, J. McGuire, J. Maiers, D. Pavlik, and M. Nelson. 2003. Know Where to Go Poster. SP-162. September 15.

Jarboe, D., C.R. Hurburgh, Jr., and R.G. Ginder. 2003. Education Programs for Biotechnology Grain Producers. Food Science and Human Nutrition Department Open House, Iowa State University. Ames, Iowa. October 3.

Jarboe, D., R.G. Ginder, C.R. Hurburgh, Jr., J. McGuire, and D. Pavlik. 2003. Biotechnology Corn: Fostering Communication Between Producers and Grain Handlers. American Society of Agronomy Annual Meeting. Denver, Colorado. November 5.

### **Computer Software:**

Ginder, R.G., D. Jarboe, M.H. Fung, and R. Dzupin. Corn Contract Explorer 2003. (Iowa State University Research Foundation # 03029, Copyright 2003).

Ginder, R.G., D. Jarboe, A. Naik, M.H. Fung, and R. Dzupin. Soy Contract Explorer 2003. (Iowa State University Research Foundation # 03060, Copyright 2003).

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## **NC-213 Objective D – Procedure 4a**

### **Project Objectives**

Development of quality system certification for the grain market.

### **From**

Iowa State University  
Department of Agricultural and Biosystems Engineering

### **By**

Hurburgh, C.R., Jr.

### **Results for 2003**

An Iowa grain company and Iowa State University have created a guideline procedure for upgrading entry level quality management systems to ISO 9000-2000. An internal study in 2002 showed that \$2 was returned for every \$1 invested in the quality management system. The ISO system expanded the initial AIB system to include management supervision and feedback, in addition to the operationally based requirements of the AIB outline. It was clear that additional benefit is gained from ISO registration but that successful use of ISO to increase efficiency requires first a more operational assessment/system. Three other FC facilities began the AIB process.

Spreadsheet inventory management and traceability tools were developed. The goal is total traceability from inbound receipt to outbound shipment. To date this has been achieved in units of 15,000 – 20,000 bushels, but not to individual railcars or trucks.

An electronic quality manual template was developed. After audit, scheduled for January 13-14, 2004, this template and its development will be made available in the public domain.

### **Plans for 2004**

Publish the ISO guideline for grain handlers, and traceability system for the grain market. Complete the ISO registration process at Farnhamville Coop. Complete the AIB process at Heartland Coop. Begin a test of quality management systems to facilitate large scale IP grain shipments, using 1% linolenic soybeans as the case study.

### **Publications**

Hurburgh, C. R. Jr. and John D. Lawrence. 2003. Quality management systems in agriculture: need and opportunity. Resource. April 2003. American Society of Agricultural Engineers, St. Joseph, MI.

Hurburgh, C. R., Jr. 2003. Certification and source verification in the grain handling industry. 2003 Annual Meeting, Institute of Food Technologists, Chicago, IL. July 15, 2003 (abstr)

Hurburgh, C. R., Jr. 2003. Biotechnology, world trade, and the bioeconomy. 2003 Annual Meeting, American Association of Cereal Chemists, Portland OR. September 1-4, 2003 (abstr.)

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## **Issues**

An industrial style quality management system will be needed to capture marketing opportunities in high value grains, and to improve efficiency of commodity market operations.

## **What Was Done**

A two-stage quality management system process was developed for use by grain handling firms.

## **Impacts**

The USDA-CCC is incorporating these guidelines into a less labor-intensive procedure for inspecting grain warehouses of companies that are willing to adopt quality management systems. FC is planning to use the ISO system for specialty production and marketing of 1% linolenic soybeans, estimated to be 10 million bushels in 2005.