

PROJECT NO: BJKV33

TITLE: Assurance and Improvement of the Milling, Baking, and Nutritional Quality of Idaho Wheat

PERSONNEL: Katherine O'Brien, Manager, U of I Wheat Quality Lab, Aberdeen
Lyona Anderson, Lab Technician
Bonnie Grover, Technical Aide
Ericka Ziebarth, Lab Technician

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JUSTIFICATION: Characterizing end-use quality traits of varieties and advanced breeding lines is valuable to wheat breeding programs, researchers evaluating environmental effects and production practices on wheat, wheat growers and end-use industries. The mission of the University of Idaho wheat quality lab is to provide end-use quality information for wheat developed in the University breeding programs to ensure there are satisfactory characteristics for both producers and end-users. High flour yield, favorable protein content and functionality as well as good bakery performance are attributes of wheat cultivars with good end-use quality. Screening experimental lines for various quality traits gives breeders the information needed to select wheat that has value for both growers and end-users. Early screening allows wheat breeders to cull out lines that have marginal use for end-users. Resources are not wasted advancing poor quality lines, and the lines retained have a higher potential for release. End-use quality of wheat may be affected by both production practices and environmental factors. Wheat researchers in both University breeding and extension programs benefit from receiving end-use quality data obtained from multiple locations for evaluating environmental affects and diverse production practices on both released varieties and experimental lines.

The quality lab compiles data on samples submitted and provides it to interested parties, including University and other wheat researchers, industry personnel, and growers. This data may be used to select those varieties that provide the best yield and end-use quality for particular growing environments. Acceptable or high end-use quality wheat may give Idaho producers market advantages that may improve the profitability of their operations.

HYPOTHESIS & OBJECTIVES: Genetics, environmental conditions, and management practices all influence the end-use functionality of wheat. With this in mind the mission of the University of Idaho wheat quality lab is to pursue the following objectives.

1. Support the U of I wheat breeding programs by providing accurate quality analyses of potential, new, and established varieties in a timely manner.
2. Support extension personnel by evaluating the quality of advanced lines and established varieties grown in diverse environments and with variable management inputs. Provide quality analyses for other wheat researchers to help ensure that all wheats available to Idaho growers are of marketable quality.
3. Evaluate, develop, and implement new procedures for measuring wheat quality.

4. Promote the importance of high and specific quality characteristics desired by the flour industry to increase the market share and volume of Idaho wheats.

PROCEDURES: University of Idaho wheat breeders and cereal extension agronomists submit wheat samples grown in multiple locations across the grain producing areas throughout Idaho. Private wheat breeding companies may also submit samples for analysis as time and resources allow. Lab services are offered to private breeding programs and special projects on a fee basis.

Experimental lines in early generations may have limited amounts of seed available for analysis, yet early screening and characterization of market class enables researchers to more efficiently allocate resources. When quantity is limited, small samples (20-50 grams) may be submitted for testing for protein content and grain hardness, and if desired, SDS/sedimentation (a measure of protein quality and gluten strength). For this test, grain is ground using a Udy cyclone mill and the whole meal is analyzed for protein content and grain hardness by NIR technology using a Perten 8611 analyzer. The Perten is calibrated for protein with an Elementar N-Cube combustion nitrogen analyzer. NIR hardness is calibrated with wheat samples from the Institute of Standards. Large samples of at least 300 grams for soft wheat and 400 grams for hard wheat may be provided for milling into flour on a Brabender Quadramat Senior mill. Total flour yield and break flour yield is measured. Flour protein, flour moisture, and flour ash are measured using NIR technology. The NIR analyzers are calibrated with oven moisture and oven ash using American Association of Cereal Chemists International (AACCI) protocols. To expedite throughput for planting decisions, some samples may be tempered in an environmental tempering cabinet before milling on the Brabender Quadramat Junior Mill. The Junior mill can produce flour from a smaller grain sample than is required for the Senior mill (50-100 grams). Junior milled flours have higher bran content than Senior milled flours. Milling yields may be estimated with the Jr. mill, and flours obtained from a Jr. mill may be used for mixograph tests. Hard wheat flours are tested with a mixograph to determine dough rheology including mix time, dough strength, and water absorption. They are then baked into 100 gram white pan bread loaves for further evaluation. Loaf volume is measured by a seed displacement method and loaves are scored for external and internal appearance. Soft wheat flours are also tested with the mixograph for dough characteristics and are evaluated after baking using the AACC sugar snap method. Cookie diameters are measured and the cookie top grain is scored. Larger diameters are preferred as are higher top grain scores. Selected advanced soft wheat lines may be evaluated using the wire-cut cookie method. Wire-cut cookies are evaluated for stack height and cookie diameter. Texture measurement of wire-cut cookies may be obtained using the TA-XT2 texture analyzer. Solvent Retention Capacity (SRC) testing is done on most advanced and some preliminary soft wheat lines. SRC testing may be performed on other wheat market classes. SRC tests yield specific information on water absorption of flours, starch damage, and gluten strength to supplement baking data. Initial noodle dough color and 24-hour dough color change is measured and evaluated from flours that are mixed into alkaline or white salted noodle dough and sheeted with a hand crank pasta roller. Noodle dough is made using a modified USDA Western Wheat Quality lab protocol. Color is determined using a Minolta CR310 colorimeter. Dough color is measured at time of sheeting and again after 24 hours to evaluate polyphenol oxidase enzyme (PPO) activity in the dough. Soft white wheat and some hard white wheat are evaluated for starch pasting qualities using the Newport Scientific Rapid Visco Analyzer (RVA). The RVA is also used to help characterize starch types of soft flours. Soundness of grain may be evaluated using the Stirring Number protocol on the Rapid Visco Analyzer. Grain hardness and

size may also be evaluated using the single kernel characterization hardness tester. Whole grain protein may be determined on some samples with the Perten 9100 whole grain analyzer. A minimum of 180 grams is needed for this test.

All procedures except the SDS/sedimentation and flour color tests are approved methods of the American Association of Cereal Chemists International (10th edition, March 2000).

DURATION: One year of a continuing project.

COOPERATION:

Brad Brown, U of I Extension Crop Management Specialist, Parma
Juliet Marshall, U of I Extension Crop Management Specialist, Aberdeen
Jianli Chen, U of I Wheat Breeder, Aberdeen
Doug Finkelburg, Support Scientist, Moscow

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:

With end-use functionality information, University of Idaho wheat research programs are better able to select improved quality cultivars, identify optimal production practices, and determine how environmental conditions may affect a cultivar's acceptability to end-users. Idaho wheat producers may use this information to select those wheat varieties that have the best agronomic characteristics for their growing environment and provide a quality product to meet the needs of our diverse wheat grain and flour consumers.

Wheat end-use quality information will be communicated via journal articles, UI publications, presentations, and cereal schools.

LITERATURE REVIEW: Wheat is a complex biochemical entity that varies in composition and properties from year to year, location to location and from one cultivar to another (Hoseney 1994). "Good quality wheat" depends on the desired end-use. Hard wheat products such as bread require higher protein and water absorption levels than soft wheat typically used for pastry products. Wheat cultivars have been developed for Idaho with diverse end-use properties for distinct markets (Souza et al., 2004). End-use quality can be determined through milling and baking tests as well as more definitive tests such as the solvent retention capacity test (Guttieri et al., 2001). End-use quality testing of wheat cultivars enables growers in Idaho to choose wheat cultivars suitable for their environment that are marketable for end-users in the flour industry.

Literature Cited:

Guttieri, M.J., D. Bowen, D. Gannon, K. O'Brien, and E. Souza. 2001a. Solvent retention capacities of irrigated soft white spring wheat flours. *Crop Sci.* 41:1054–1061.

Hoseney, C.R. 1994. *Cereal Science and Technology*. 2nd. Ed. American Association of Cereal Chemists, Inc: St. Paul, Minnesota.

Souza, E.J., Martin, J.M., Guttieri, M.J., O'Brien, K.M., Habernicht, D.K., Lanning, S.P., McLean, R., Carlson, G.R., & Talbert, L.E. 2004. Influence of genotype, environment, and nitrogen management on spring wheat quality. *Crop Sci.* 44:425-432.

**COMMODITY COMMISSION BUDGET FORM
BJKV33**

Allocated by Idaho Wheat Commission during FY 2011 \$ 104,984

Allocated by Idaho Wheat Commission during FY 2012 \$ 103,484

REQUESTED FY 2013 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	CO	Grad Fees	TOTALS
Idaho Wheat Commission	\$ 56,960	\$ 600	\$ 35,424	\$ 2,500	\$ 9,000	\$ -	\$ -	\$ 104,484

OTHER RESOURCES (not considered cost sharing or match):

a) Industry	\$ -
b) UI (salaries, operating)	\$ 104,570
c) Other (local, state)	\$ -
d)	\$ -
e)	\$ -
TOTAL OTHER RESOURCES	\$ 104,570

TOTAL PROJECT ESTIMATE FOR FY 2013:	\$ 104,484	\$ 104,570	\$ 209,054
	<i>(Requested)</i>	<i>(Other)</i>	<i>(Total)</i>

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	(PI name)	(PI name)	(PI name)	(PI name)
Salary	\$ -	\$ -	\$ -	\$ -
Temporary Help	\$ -	\$ -	\$ -	\$ -
Fringe Benefits	\$ -	\$ -	\$ -	\$ -
Travel	\$ -	\$ -	\$ -	\$ -
Operating Expenses	\$ -	\$ -	\$ -	\$ -
Capital Outlay	\$ -	\$ -	\$ -	\$ -
Graduate Student Fees	\$ -	\$ -	\$ -	\$ -
TOTALS	\$ -	\$ -	\$ -	\$ -

Total Sub-budgets \$ -

CURRENT AND PENDING SUPPORT Form:

Name: Katherine O'Brien

NAME (List PI/PD #1 First)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL \$ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITT- ED	TITLE OF PROJECT
O'Brien et al.	Current: Idaho Wheat Commission	\$103,484	7/11-6/12	100%	Assurance and Improvement of the Milling, Baking, and Nutritional Quality of Idaho Wheat.
O'Brien et al.	Pending: Idaho Wheat Commission	\$104,484	7/12-6/13	100%	Assurance and Improvement of the Milling, Baking, and Nutritional Quality of Idaho Wheat.

INTERNAL PEER REVIEW/PRINCIPAL INVESTIGATOR VERIFICATION FORM

INTERNAL PEER REVIEW VERIFICATION

Commodity commissions/organizations require internal peer review by colleagues familiar with the subject matter. This proposal has been peer reviewed by the following individuals:

Reviewer 1: JONATHAN G. HARTWORTH [Signature] 12/22/11
(Type/Print name) (Signature) (Date)

Reviewer 2: Juliet M Marshall [Signature] 1/4/12
(Type/Print name) (Signature) (Date)

Dept. Head/ James B. Johnson [Signature] 9 Jan. 2012
Unit Administrator (Type/Print name) (Signature) (Date)

PROGRESS REPORT

PROJECT NO: BJKV33

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PERSONNEL: Project Leader:
Katherine O'Brien, Manager, Idaho Wheat Quality Lab

Staff:
Lyona Anderson, Lab Technician
Bonnie Grover, Technical Aide
Ericka Ziebarth, Lab Technician

Cooperators:
Dr. Brad Brown, U of I Extension Crop Management Specialist, Parma
Dr. Juliet Marshall, U of I Extension Crop Management Specialist, Aberdeen
Dr. Jianli Chen, U of I Wheat Breeder, Aberdeen
Dr. Robert Zemetra, U of I Wheat Breeder, Moscow

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ACCOMPLISHMENTS: Using American Association of Cereal Chemistry International (AACCI) methods, the University of Idaho wheat quality lab provides wheat end-use quality evaluations to wheat researchers and other wheat industry entities. This information assists wheat breeders in making decisions regarding their experimental lines and released varieties. University extension personnel use end-use quality data to identify best practice management methods. The goal is to enhance and preserve the end-use functionality of wheats developed and produced in Idaho.

Objectives:

1. Support the University of Idaho wheat breeding programs by providing accurate quality analyses of potential, new, and established varieties in a timely manner.

We have processed almost 7,000 experimental lines on new crop samples. Work completed to date includes early generation submissions for protein and hardness evaluation and small samples from University extension programs for protein analysis. SDS sedimentation testing has also been done on selected early generation material. Milling and baking analysis has been completed for all submitted Idaho Yield Trial nurseries and earlier generation nurseries from the breeding program in north Idaho. Also, some regional nursery locations have been milled and baked. North Idaho Extension nurseries under extension support scientist Doug Finkelburg's supervision have been evaluated for protein and hardness. Winter wheat nurseries submitted by Dr. Chen's program in southern Idaho have also been milled and baked. Current emphasis is

on Dr. Chen's spring wheat evaluations. Entries in extension trials grown by Dr. Brad Brown have been evaluated for protein and hardness values. Nurseries from Dr. Juliet Marshall have also been evaluated. We have fewer entries in the lab this year due to the heavy infections of stripe rust eliminating many experimental lines from the breeding programs.

Researcher	No. of samples analyzed to date
Jianli Chen	3342
North Idaho	2417
Extension	763

Soft white wheat lines were milled on the Brabender Quadromat Sr. mill using AACCI method 26-21 and evaluated using the AACCI 10-52 Sugar Snap cookie method. Protein, flour ash, and hardness data were also recorded for these wheats using a Perten 8611 NIR analyzer. The 8611 is calibrated with an Elementar N-Cube combustion nitrogen analyzer for protein. Hardness is calibrated with reference samples from the National Institute of Standards. Flour ash is calibrated in a Thermolyne muffle furnace using the AACCI method 08-01. Rapid Visco Analyzer testing of soft white wheats has been completed on many samples to help characterize starch characteristics of the flour and differentiate wild type and partial waxy type wheats. Some hard wheats have been analyzed for mixing characteristics and gluten strength using the mixograph and SDS/sedimentation tests. A modified method AACCI 10-10B was used to make white pan bread from advanced generation hard wheats. Using the alkaline noodle method, many lines were evaluated for dough color with a Minolta colormeter. Some stirring number evaluations were made on the RVA to compare with Falling Number data. Flour end-use quality data is made available to breeders and is used by them in making breeding line selections, variety release selections, and recommendations for variety selection by growers. Data is presented in technical publications, cereal schools, grower meetings, and other venues.

2. Support extension personnel by evaluating the quality of advanced lines and established varieties grown in diverse environments and with variable management inputs.

Wheat end-use quality data is used by extension personnel to help evaluate best practice management strategies for producing wheats in Idaho. Information on milling and baking characteristics of cultivars grown across the state is useful to producers and end users in making decisions on marketable wheats. Data for protein and hardness has been provided for north Idaho and western Idaho extension nurseries. We have done some special projects with Dr. Marshall on fungicide effects on Stirring Numbers and Falling Number. Data is given to extension researchers and is included in extension publications, cereal school presentations, and the Cereal Sentinel.

3. Evaluate and develop new procedures for measuring wheat quality.

Collaboration on new and revised AACCI methods improves efficiencies and assures that methods used are relevant, accurate, and efficient. Through collaboration with other

quality labs, the U of I lab refines techniques to improve productivity and repeatability of protocols.

4. Promote the importance of high and specific wheat end-use quality characteristics desired by the flour industry to increase the market share and volume of Idaho wheats.

The lab participates in the PNW wheat quality council as a collaborator. The council is made up of PNW wheat researchers, millers, bakers, and other stakeholders in the PNW wheat industry. The lines submitted by U of I wheat researchers to the 2011 wheat quality council were very favorably received.

PROJECTIONS: The University of Idaho wheat quality lab will continue to complement wheat breeding programs by providing accurate timely end-use quality analyses. Wheat end-use quality data will be communicated at cereal schools, field days, and cereal quality forums, as well as University publications, Idaho Grain Producers Magazine, and the popular press.

PUBLICATIONS:

Chen, J., E.J. Souza, D. Hole, M.J. Guttieri, K. O'Brien, J. Wheeler, L. Sorensen, J. Clayton, R. Zemetra, J.M. Windes, and X. Chen. 2012. Registration of 'UI SRG' Wheat. J. Plant Registration 6 (1): 66-70.

Marshall, J., Shelman, T., Jackson, C., & O'Brien, K. (2011). Southeastern Idaho Cereals Web Page. University of Idaho, College of Agriculture and Life Sciences, Cooperative Extension System. Internet site. (updated periodically). Available at <http://www.ag.uidaho.edu/scseidaho>