

PROJECT NO: BJKW33

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: Characterization of 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 U of I 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 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. In later generations, when more grain is available, milling and baking tests are used to evaluate end-user desirability. Protocols used are American Association of Cereal Chemists approved methods or modifications of those methods. Flour yield is an important component of wheat quality, higher yields increase profit margins of millers and higher break flour yields usually indicate higher quality flour. A new flour sifting method has been implemented this fiscal year. The new method has increased milling efficiency with higher flour yields, cleaner flour separation from the bran and improved productivity. A request for funds to purchase two Great Western sifters is being made. These sifters will enable us to align our flour milling protocol more closely with those used by the USDA wheat quality labs and also regional private breeding company wheat quality labs. The Newport Scientific Rapid Visco Analyzer (RVA) is used to help characterize starch types of flours. This instrument is aging and data obtained from it is not of high priority to the breeding program. Therefore, it may be aged out of the lab as repairs become expensive compared to the value of data. A new RVA costs approximately \$45,000 which would not be cost effective for replacement. The wheat breeding program is currently using the Falling Number machine so the RVA may not be used for stirring number soundness either. 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.

Generation	End-use quality test	Amount of seed needed
F ₄	Whole meal protein, hardness, SDS Sedimentation	>40 grams
F ₅	Whole meal protein, hardness, SDS Sedimentation, Jr. mill or Sr. Mill(bake test-cookies for soft wheats, bread for hard wheats)	>40 grams for ground meal testing >80 grams for Jr. Milling 450 grams for Sr. Milling
F ₆	Hardness, Sr. Mill for flour yield, noodle color, sugar snap cookie or white pan bread bake analysis, Solvent Retention Capacity test (SRC)	450 grams
F ₇ and up	Hardness, Sr. Mill for flour yield, noodle color, sugar snap cookie or white pan bread bake analysis, SRC	450 grams

F ₁₁ and up	Hardness, Sr. Mill for flour yield, noodle color, sugar snap cookie or white pan bread bake analysis, SRC. Submit to PNW wheat quality council	450 grams PNW wheat quality council samples are milled on USDA Miag mill in Pullman and distributed to collaborators
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To accomplish goal three to evaluate, develop, and implement new procedures for measuring wheat quality, the quality lab participates in regional methods collaboratives, AACCI methods collaboratives and the PNW wheat quality council.

DURATION: One year of a continuing project.

COOPERATION:

Jianli Chen, U of I Wheat Breeder, Aberdeen
 Juliet Marshall, U of I Extension Crop Management Specialist, Aberdeen
 Doug Finkelnburg, Support Scientist, Moscow
 Jean-Bruno Beaufume, Wheat Breeder-Limagrain Cereal Seeds LLC, Waitsburg, WA

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. 2001. 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

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

Allocated by Idaho Wheat Commission during FY 2013 \$ 104,484

REQUESTED FY 2014 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	CO	Grad Fees	TOTALS
Idaho Wheat Commission	\$ 59,238	\$ 600	\$ 39,689	\$ 2,500	\$ 9,500	\$ 7,921	\$ -	\$ 119,448

OTHER RESOURCES (not considered cost sharing or match):

a) Industry	\$ -
b) UI (salaries, operating)	\$ 109,618
c) Other (local, state)	\$ -
d)	\$ -
e)	\$ -
TOTAL OTHER RESOURCES	\$ 109,618

TOTAL PROJECT ESTIMATE FOR FY 2014:	\$ 119,448	\$ 109,618	\$ 229,066
	<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	\$104,484	7/12-6/13	100%	Assurance and Improvement of the Milling, Baking, and Nutritional Quality of Idaho Wheat
O'Brien et al.	Pending: Idaho Wheat Commission	\$119,448	7/13-6/14	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 Witkowski [Signature] 1/2/13
(Type/Print name) (Signature) (Date)

Reviewer 2: Stephen Love [Signature] 2 Jan 13
(Type/Print name) (Signature) (Date)

Dept. Head/ James B Johnson [Signature] 9 Jan 2013
Unit Administrator (Type/Print name) (Signature) (Date)

PROGRESS REPORT

PROJECT NO: BJKW33

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

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. Jean-Bruno Beaufume, Wheat Breeder, Limagrain
Doug Finkelnburg, North Idaho extension

ADDRESS: Katherine O'Brien, Manager, Idaho Wheat Quality Lab, Aberdeen R & E Center, 1693 S 2700 W, Aberdeen, Idaho 83210. 208-397-4181
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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 management practices. 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 about 4,000 experimental lines of new crop samples as of December 2012. Work completed to date includes early generation submissions for protein and hardness evaluations 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 and Walla Walla, Washington in collaboration with Limagrain.. Also, some regional nursery locations have been milled and baked. Many winter wheat nurseries submitted by Dr. Chen's program in southern Idaho have also been milled and baked to facilitate fall planting selections. Current emphasis is on Dr. Chen's spring wheat evaluations. A

growth chamber experiment was conducted by Dr. Robert Zemetra to simulate potential Late Maturity Amylase production. Seed from this experiment was evaluated for end-use quality and data given to Dr. Zemetra for analysis and reporting.

Researcher	No. of samples analyzed to date
Jianli Chen	1995
North Idaho/Limagrain	1183
U of I Extension	824

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 to formulate recommendations for variety selection by growers. Data is presented by Dr. Chen in technical publications, cereal schools, grower meetings, and other venues. Dr. Jianli Chen indicates the value of our work to her program, saying "Quality data provided by the quality lab plays an important role in decision making for my breeding program: Early generation selection and classification: SDS sedimentation, whole meal protein, and hardness. Line advancement and late generation selection: flour protein, flour yield, baking (cookies and bread), and SRC data. The Quality lab also provided valuable data for the research projects: QTL mapping of bread baking quality; effect of water and nitrogen stresses on end-use quality in adapted and un-adapted wheat lines." UIStone was released in 2012 with improved milling yields and cookie diameters over the varieties Treasure, UIPetitt, and Alturas.

Regular maintenance on equipment is important to obtain accurate results. We replaced the weighing balance in the milling room, refined our modified milling procedure, and performed routine maintenance on equipment. The RVA machine was sent to Perten for maintenance. It is in need of some expensive repair. A new one would cost \$45,000. Dr. Jianli Chen indicates the data obtained may not be useful enough for her to warrant the purchase of a new RVA. We are working with Perten to keep the machine running as long as possible. The Perten 8611 protein/moisture analyzer was sent for routine maintenance and lamp replacement. In July, the mixographs were taken to Lincoln, Nebraska for maintenance and recalibration by personnel at National Manufacturing. We have developed an equipment purchase priority list and forwarded it to IAES.

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 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. All nurseries from Dr. Brad Brown's program were evaluated by September this year to enable him to include the data in his reports before he retired in September. Some nurseries from Dr. Juliet Marshall have also been evaluated. North Idaho Extension nurseries under extension support scientist Doug Finklenburg's supervision have been evaluated for protein and hardness. We provide valuable support to our wheat researchers as varieties must not only be agronomically sound, have disease, and insect resistance but must also have good end-use quality to be of value to end-users. Doug Finklenburg writes "Wheat quality data produced by this (Katherine's) lab continues to be integral for making cultivar selections in advanced generations of soft white wheat due to the comprehensive quality evaluation and timely data production." Dr. Juliet Marshall as the lead wheat extension researcher indicates the value of the wheat quality services "As part of the cereals extension program, I am responsible for dissemination of variety information to our growers. Part of the responsibility of my program is maintaining the high standard of quality associated with PNW wheat for our domestic and export markets. The only way I can do this is through the end-use quality testing performed in the Cereal Quality Lab. Katherine tests the varieties that are grown in the extension variety trials, which represents the environmental conditions under which southern and eastern producers grow varieties. As varieties will respond differently to varying environmental conditions, it is critical that the producer knows how the currently marketed varieties respond to their environmental conditions, for both agronomic and end-use quality characteristics. This can only be done through the cooperation and work of the Wheat Quality Lab." A special project on fungicide effects on end-use quality is underway with Dr. Marshall. The extension nurseries in Aberdeen were evaluated for milling and baking quality and also for stirring number, falling number and src to determine if there could be a potential effect of fungicide application on falling number or end-use quality. Follow-up investigation will be conducted to report results on data collected over multiple years. We also have done some initial end-use quality evaluations for DowAgriScience in Pullman, Washington.

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. This year, the milling procedure used in the lab was modified to accommodate a modification to the Quadromat Senior Mill. The mill has an attached sifter box. The USDA wheat quality labs in Pullman and Wooster have modified the system to use Great Western Shakers with applicable sieves and bypass the attached sifter boxes of the Quad Sr. mill. Many quality labs have adopted this method. It is more efficient, has better cleanout and eliminates contamination between samples in the sieves. The system also is

quicker and eliminates stooping and bending by the mill operator. We found shakers in surplus storage to try the new system. We have improved milling performance using the new system. However, the shakers we are using do not have an orbital motion which is an industry standard in both flour mills and wheat quality labs. A request to purchase Great Western shakers is being made to allow us to standardize our protocol to align with other wheat quality labs.

In keeping with the goal of collaborating with and learning from regional labs, Lyona Anderson and Katherine O'Brien spent two days in May at the Syngenta wheat quality lab in Berthoud, Colorado. Doug Engle from the USDA lab in Pullman also was present. We had a mini collaborative on the Sugar Snap Cookie method and also modified programs and equipment for collecting noodle color data.

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. Advanced experimental lines nearing release are submitted by regional wheat breeders. These lines are milled at the USDA wheat quality lab in Pullman and distributed to participating wheat quality labs, millers, and bakers. They are then evaluated by those parties for standard end-use quality parameters, and usefulness in their specific applications. The council meets annually in January with a roundtable discussion of their results. The lines submitted by U of I wheat researchers to the 2012 wheat quality council were 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.

Chen, J., J. Wheeler, J. Clayton, W. Zhao, K. O'Brien, C. Jackson, J. M. Marshall, B.D. Brown, K. Campbell, X.M. Chen, R. Zemetra, and E.J. Souza. 2012. Registration of 'UI Stone' Wheat. J. Plant Registration (in review).

Marshall, J., Shelman, T., Jackson, C., & O'Brien, K. (2012). 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>