

**Progress Report for the Agricultural Research Foundation  
Oregon Wheat Commission**

Title: **Oregon Wheat Quality Program**  
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**ABSTRACT:**

Selected hard-wheat samples from the 2007 harvest were analyzed for quality traits prior to fall planting. This testing provided the first opportunity to observe “whole-wheat” mixographs, which showed a strong possibility of success. We have also acquired a new grinder that can grind samples with no moisture loss to help increase whole-wheat dough testing throughput. Nine 2007 harvest soft wheat samples were assessed for quality traits at the WWQL labs. This departure from previous protocols accrued because of the loss of both research assistants in mid-2007. More than 1650 winter and spring early generation samples were put through primary quality screening on the single kernel tester with a further 490 tested for enzyme activity. Over 200 triticale lines were tested for potential genetic variants for starch, a small number of candidates were identified. 471 samples from the extension program were tested for grain protein content and this material is to be used for new work on dough strength by a graduate student. Commissioning of the lab-on-a-chip system continued. A number of technical issues were resolved and the system has been used for varietal purity analyses as well as work supporting the cereal genetics program. We also trained graduate students in the use of the single kernel tester and supervised the collection of single kernel data from nearly 2000 samples. New work has commenced on the implications of wheat blending on dough strength and mixing properties and on product development work for both waxy barley and wheat in breadmaking applications in the revamped test-bakery.

**OBJECTIVES (2007-08)**

1. *Provide quality data on Oregon elite breeding lines* including “fast-track” assessments of key milling, dough, and end-product attributes on lines requiring confirmatory data before seed increase or release.
2. *Provide “fast-track” quality-based selection recommendations for F4 and F5 generation material.*
3. *Provide quality data on extension trials.* This proposal emphasizes hard wheat crop management.
4. *Provide quality lab support for cereal genetics program* in the mapping of extra-soft kernel trait and other projects.
5. *Provide quality based selection recommendations* to the breeder for F6 to F10 material tested at WWQL.

6. Monitor the effects of genotype, growth environment, growing season, and crop management strategies on the composition, functionality, and end-use performance of selected elite wheat breeding lines (from Objectives 1 and 3).

7. *Provide preferred variety list data* for Oregon wheats, based on the suitability of varieties for existing market classes.

8. *Identify potential economically valuable novel quality traits* that could be incorporated into Oregon wheats or other winter cereals.

#### **PROCEDURES:**

The project conducts cereal quality testing in support of its companion research programs: wheat breeding, cereals extension, cereal genetics, and barley breeding, as well as specific research within the cereal quality program aimed at improving current test protocols or creating or adapting new techniques. Standard procedures of AACC-International, the professional society for cereal scientists, established methods from the scientific literature, or in-house standard procedures are used for quality analyses of cereal grain and flour components and other quality related attributes.

#### **ACCOMPLISHMENTS TO DEC 31 2007:**

**Objective 1.** *Provide quality data on Oregon elite breeding lines* (includes objective 6)

12 hard-wheat samples (6 lines x 2 locations) from the 2007 harvest were milled and analyzed for kernel texture, milling performance, and mixograph dough properties in the period prior to replanting. This testing also provided us with our first opportunity to observe the potential of “whole-wheat” mixographs using in this instance an 80% extraction flour milled on our new stone-mill. Preliminary results suggest a strong possibility of success. Additionally, we have since acquired a new CleanMill impact mill to replace the obsolete and unreliable Udy impact mills. There are 3 advantages of the CleanMill system with respect helping us increase dough testing throughput; automatic sub-sampling, self-cleaning, and the grinding of samples with *no moisture loss*. With respect to the latter, other mills lose sufficient moisture during grinding to require additional time-consuming oven moisture determinations on the ground meal. The retention of grain moisture in material milled on the CleanMill will allow us to use the grain moisture content value that was previously determined using NIRS or the single kernel tester for further analyses, all of which rely on accurate knowledge of the initial moisture content of the flour or meal for accurate performance and reporting. This testing confirmed the superior dough mixing and mixing tolerance attributes of the new HRW variety Norwest 553 (ORN00B553). Norwest 553 also ranked higher than both check varieties in grain protein content at all three tested locations.

In a departure from previous protocols, 9 soft wheat samples from the 2007 harvest from Pendleton were assessed for full kernel, milling, and cookie and baking attributes at the WWQL labs. This departure from previous protocols accrued from 2 circumstances; the first was that this was the first time in my incumbency that elite soft wheats had been fast-tracked. The second was that testing was done this year only at the WWQL because of the lack of experienced personnel at OSU after the loss of both the OWC and the State of Oregon funded research assistants in mid-2007. Thankfully an experienced research assistant, Caryn Ong, who is familiar with our labs and testing protocols was appointed December 1 2007. The data confirmed the quality attributes of ORI2042037 and OR2050910. ORI2042037 showed acceptable or better quality

with improvements over the check variety in kernel texture, wheat and flour protein contents, cookie diameter and cake volume. Water and other solvent absorption characteristics were acceptable. OR2050910 again showed kernel texture slightly softer than ORSS1757, with seed weight and size equal to or better than Stephens. Like ORSS1757 wheat protein was in the order of 2% lower than Stephens at this location. Cookies and cakes were far superior to Stephens and again similar to those from ORSS1757. These data were taken into account in the decisions by the breeder to move ORI2042037 and OR2050910 to seed increase in the fall 2007 plantings. However, it needs to be noted that full confirmation of these quality attributes requires the support of the full multi-location data set and data from additional years, some of which is already in hand..

A further task was to support the release candidacy of Tubbs-06. WWQL data from Tubbs and Tubbs-06 from 6 sites harvested in 2006 were re-assessed to determine the relative quality of the Tubbs-06 reselection. No significant differences between the two lines were detected across 18 quality attributes that included aspects of grain quality, milling performance, starch characteristics, and cookie diameter.

**Objective 2.** *Provide “fast-track” quality-based selection recommendations for F4 and F5 generation material.*

As in previous years a large number (> 1450) early generation winter wheat samples were put through primary quality screening on the single kernel tester with a further 250 tested for the enzyme associated with undesirable dough darkening. Data collection for kernel characteristics from nearly 300 additional spring wheat samples, and for PPO from another 240 samples were supervised by the quality program. Dr Peterson has reported on the beneficial impact of this early generation testing in his 2007 report.

**Objective 3.** *Provide quality data on extension trials.* (includes objective 6)

471 samples from the extension program were tested for grain protein content to support the hard wheat nitrogen trials. This material is the target of further characterization by a graduate student, Mr Teepakorn Kongraksawech, to see if grain N increases are related to increases in functional protein that contributes positively to dough characteristics. The outcomes of the N trials have been reported by Dr Flowers.

**Objective 4.** *Provide quality lab support for cereal genetics program*

Work has continued on the commissioning of the OSU funded lab-on-a-chip system for protein characterization. At the time of writing a number of technical issues have been resolved. Subsequently, a graduate student has begun to collaborate with the cereal genetics program on optimizing gliadin analyses for their gliadin synthesis project. The potential long-term benefits of this work are justified in the cereal genetics program’s overall aims and I will not amplify them here. We also supported work on the cereal genetics program’s Stephens x OR9900553 – supersoft kernel characteristic population developed by Dr Oscar Riera-Lizarazu; training Dr Riera-Lizarazu’s graduate student in the use of the single kernel tester and supervising the collection of single kernel data from over 1200 samples. Full crush profiles were also collected and data analysis is ongoing. Further single kernel analyses has been supported on over 400 samples from the Coda x Brundage population developed by Bob Zemetra, U of I and being researched by Dr Peterson’s PhD student Martin Quincke.

**Objective 5. *Provide quality based selection recommendations***

As in the past all incoming WWQL data on the intermediate (PYT, RPN, ADV) and Elite trials was prescreened and ranked to make the quality-related retain/discard decisions as streamlined as possible for the breeder.

**Objective 7. *Provide preferred variety list data***

After the loss of Dr Jae Ohm in mid-2007 we decided to ask Doug Engle of the WWQL to crunch the data from the elite multi-location trials for incorporation into the scores that go to create the preferred variety lists. In a departure from previous years' procedures, the data was passed to the staff of the OWC who then oversaw any required updating of the preferred list brochures.

**Objective 8. *Identify potential economically valuable novel quality traits***

An additional accomplishment was the detection of potential genetic variants for starch amongst approximately 200 triticale lines. The identification of starch variants in this high yielding crop may provide advantages for winter cereal growers into the future. This work will be followed up in 2008-09 after a hiatus related to the late 2007 triticale harvest, which at this point appears to be rain-affected.

Work has continued in collaboration with Steve Norberg at Malheur County Experiment Station, Brad Brown of the University of Idaho, Juan Rey and Patrick Hayes of OSU, and the Oregon Grains Commission on the potential for food barley as an alternative winter cereal crop for Oregon. Varieties of hulled and hull-less barleys some with waxy starch were assessed for protein and beta-glucans (the soluble fiber component which has the newly approved "heart healthy" claim in barley). For the Eastern region trials this included over 100 samples, for the OSU barely breeding work this entailed the graduate student, under the supervision of the cereal quality program, assessing another 280 samples for the same components. Work is proceeding in collaboration with the barley breeding program and Dr Flowers on product development work for rustic-style breads made with stone-ground hull-less waxy barley. This material provides a moist dense crumb of unique flavor and may allow bakers to use the heart-healthy claim if the fiber content can be held at a minimum of 0.75 g per serving. Parallel work is proceeding with hard grained waxy wheats (in collaboration with the University of Nebraska and Dr Peterson), mostly for the improvements that can be gained in crumb texture. The aim is to maximize the possibility that either or both waxy barley or wheat could become a viable high-value winter cereal crop for the region in the future.

**Other work.**

A new NIRS whole-grain moisture and protein analyzer was ordered and will be on-line for the 2008 harvest. The new NIRS uses the same artificial neural network calibrations used by the FGIS to ensure compatibility of our results. This capability will streamline greatly the funneling of grain from yield trials into the lab for testing, overcoming a number of current procedural bottlenecks. As noted work has continued to optimize the lab-on-a-chip system for protein characterization. So far we have been able to use the system to rapidly confirm the identity and purity of field reps in the breeding program and we are currently comparing the glutenin patterns to other measures or predictors of dough characteristics in a trial with wheat samples from

collaborators in Uruguay. The capabilities of the test bakery have been significantly upgraded with the incorporation of the equipment and new skills training needed to make “artisanal” or rustic style breads with the goal of having research capabilities relevant to emerging markets for wheat in the PNW region. A small pilot study is being conducted on the implications of blending on the dough characteristics of PNW hard wheats. The work is being conducted largely through the efforts of Food Science and Technology undergraduate student Kayla Johnson of Athena Oregon.

## **IMPACTS**

The major impact of the program is to support the release of new cereal varieties of appropriate quality for market acceptance. To do this the program works closely with the companion programs in breeding, genetics, and extension and contributes to the impacts of those programs. The cereal quality program helps to identify varieties with enhanced end-use quality, such as ORSS-1757, which are expected to increase market demand for Oregon wheat and provide a basis for identity preserved marketing. The cereal quality program helps to ensure that any investments in wheat breeding continue to contribute to the state agricultural economy through improved end-use quality for marketing and through the identification, development, and exploitation of novel quality traits for market development.

## **RELATION TO OTHER RESEARCH**

The project is wholly integrated with the OSU Wheat Breeding Program, and is associated with projects related to quality traits in the cereal genetics program, and the crop management research of the cereals extension program. The work meets the requirements of the breeding program for data that is specific to end-use quality. The research is also integrated with work and breeding on other winter cereals (barley, triticale) that may provide benefit to Oregonian wheat growers. This OWC funded work has also contributed to the book chapter “Passing the test on wheat quality” in a new book “Wheat science and trade” edited by Dr Brett Carver, the wheat breeder at Oklahoma State University.

## ***Related publications and presentations***

### *Publications*

- Ross A.S., Bettge A.D. 2008. Passing the test on wheat end-use quality. Chapter 21 In “Wheat: science and trade”. B Carver Ed. In press. Blackwell Publishing.
- Ohm J. B., Ross A. S., Peterson C. J., and Ong Y- L.. 2008. Wheat flour proteins and color characteristics of noodle doughs. *Cereal Chem.* 85: 123-131.
- Saint Pierre C., Peterson C.J, Ross A.S., Ohm J.B., Verhoeven M.C., Larson M., Hoefler B. 2008. White Wheat Grain Quality Changes with Genotype, Nitrogen Fertilization, and Water Stress. *Agron J* 100:414-420.
- Saint Pierre C., Peterson C.J, Ross A.S., Ohm J.B., Verhoeven M.C., Larson M., Hoefler B. 2008. Winter wheat cultivars under different levels of nitrogen and water stress: Changes in grain protein composition. Accepted. *J Cereal Sci.*
- Petrie S., P. Hayes, A. Ross, J. Rey, K. Rhinhart, and A. Corey. 2007. Agronomic Performance Of Food Barley At Pendleton And Moro. 2007 Dryland Agriculture Research Report. Oregon State University. Agricultural Experiment Station. Special Report 1074. <http://hdl.handle.net/1957/8263> , or, [http://ir.library.oregonstate.edu/dspace/bitstream/1957/8263/1/SR\\_no.1074\\_ocr.pdf](http://ir.library.oregonstate.edu/dspace/bitstream/1957/8263/1/SR_no.1074_ocr.pdf)
- Norberg O.S., C. Shock, L. Saunders, E. Eldredge, A. Ross, P. Hayes, and J. Rey. 2007. Variety Trial of Four Winter Barleys (*Hordum Vulgare* ssp. *Vulgare*) And Two Spring Waxy Varieties Fall Planted. Oregon State University. Agricultural Experiment Station and Extension Service. Malheur Experiment Station 2007 Annual Report. <http://www.cropinfo.net/AnnualReports/2007/TableofContents2007.html>
- Ross A.S. 2007. Selecting for Quality IV: New frontiers. *Oregon Wheat* 59 (4): 12-13.

- Crosbie G.B. Ross A.S. eds. 2007. The RVA Handbook. AACC-International Press.
- Rogers R, Ross A.S. 2007. "Starch refining and modification applications", pp 63-74. In "The RVA Handbook". Crosbie G.B., Ross A.S. eds. AACC-International Press.
- Bennett L., Pollard A. Ross A.S. 2007. "Protein-rich foods and ingredients", pp 95-104. In "The RVA Handbook". Crosbie G.B., Ross A.S. eds. AACC-International Press.
- Verbyla R., Appels A., Saint-Pierre C., Ross A.S. 2007. Fourier modelling, analysis and interpretation of high-resolution Mixograph data. J Cereal Sci. 46: 11-21.

*Publications submitted/ in preparation*

- Ong Y.L., Ross A.S. 2008. Effect of alkali and processing on the characteristics of glutenin macropolymer extracted from low-water doughs. In preparation. J Cereal Sci.
- Rey J.I., P.M. Hayes, S. Petrie, A. Corey, M. Flowers, C. Ong, K. Rhinhart, A. Ross, J Ohm. 2008. Potential for Production of Dryland Barley for Human Food: Quality and Agronomic Performance of Spring Habit Germplasm in Oregon. Submitted, Crop Science.
- Filichkin, T., Budde, A., Corey, A., Duke, S., Gallagher, L., Hayes, P., Helgesson, J., Henson, C., Kling, J., Obert, D., Ohm, J., Petrie, S., Pillman, K., Ross, A., Szucs, P., Vinje, M. 2008. Limited allelic variation and abundant phenotypic variation in diastatic power,  $\beta$ -amylase 1 enzyme thermostability and enzyme activity in experimental barley germplasm. In preparation. Crop Science.
- Ohm J. B. , A. S. Ross, C. J. Peterson, and C. F. Morris. Relationships of Quality Characteristics with Size Exclusion HPLC Chromatogram of Protein Extract in Soft White Winter Wheats. in preparation Cereal Chem.

*Presentations*

- Ross A.S. 2008. Amylose, amylopectin, & amylase: Wheat in the RVA. 55th Annual Soft Wheat Quality Laboratory Research Review and AACC Cincinnati Section Meeting, USDA-ARS Soft Wheat Quality Laboratory Wooster OH, March 12 2008.
- Ross A.S. Selecting for Quality. Presented to Idaho Wheat Farmers Tour, Idaho Wheat Commission, Portland, Oregon January 2008.
- Ross A.S. 2007. Bread: a history of baking. For FST 260 "Food Science and Technology in Western Culture". October 2007.
- Ross A.S. 2007. Wheat: An Australian perspective. For CSS499 "Exploring World Agriculture". October 2007. Corvallis OR.
- Ross A.S. 2007. Large deformation physical testing of wheat flour doughs" OSU Materials Science Seminar Series. June 2007.
- Saint Pierre C., Peterson C.J, Ross A.S., Ohm J.B., Verhoeven M.C., Larson M., Hoefler B. Grain Protein Contents and Composition of Winter Wheat Cultivars Under Different Levels of N and Water Stress. 2007 Western Nutrient Management Conference Salt Lake City, UT. March 2007.
- Ross A.S. Selecting for Quality. Presented to Idaho Wheat Farmers Tour, Idaho Wheat Commission, Portland, Oregon January 2007.