

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

PROJECT: The Oregon Wheat Quality Evaluation Program

PRINCIPLE INVESTIGATOR:

-Dr Andrew S. Ross: Crop & Soil Science, Oregon State University (OSU)

COOPERATORS:

-Dr C. James Peterson, Dr Jae -B. Ohm, Dr Oscar Riera-Lizarazu. Crop & Soil Science Department, OSU.

-Dr Craig F. Morris, USDA ARS Western Wheat Quality Laboratory, Pullman WA.

-Brady P. Carter, Washington State University, Cereal Quality Specialist.

FUNDING HISTORY:	2002-03 OWC Funds	\$5,100
	2003-04 OWC Funds	\$27,715
	Requested 2004-05	\$39,500

ABSTRACT:

The overall goal of the OSU Wheat Quality Evaluation Program (OWQEP) is to provide high quality fundamental and applied research and service with respect to wheat quality. OWQEP activities underpin the quality improvement efforts of the OSU wheat breeding program, and the Oregon wheat industry. To date the OWQEP has provided a number of high impact outcomes.

1 - OWQEP applied early generation selection pressure as part of an overall strategy to increase the genetic quality base of all market classes in the breeding program. OWQEP staff supervised the acquisition of quality data by the breeding program. The data was then analyzed by OWQEP staff. Through this effort between 16% (SWW) and 50% (Hybritech) of the 1460 F4-F5 lines tested were eliminated on the basis of quality alone.

2- Provision of the first SW winter and SW spring preferred variety lists for Oregon. The lists were generated with the unreserved cooperation of the Oregon and Washington Wheat Commissions, the Oregon Wheat Growers League, the USDA ARS Western Wheat Quality Laboratory (WWQL), the OSU breeding program, and wheat quality specialists from Washington State University and the Wheat Marketing Center.

3 - The setting in place of a strategy to capitalize on the use of the WWQL to generate core data on multilocation trials. The strategy is twofold. Firstly, the generation of the core milling, rheology and end-use data, using the WWQL as a central reference lab, allows Oregon specific data to be seamlessly integrated into region-wide quality improvement efforts. Secondly, the generation of the core data at WWQL frees up resources at OSU to test out new, or complementary, methods to enhance our overall ability to identify the best (or worst) genotypes, and to create a more complete understanding of the end-use quality potential of the most advanced lines.

OBJECTIVES:

1. Systematically assess the effects of growth environments, and growing seasons, on the functionality and end-use performance of wheat grown in Oregon.

2. Provide preferred varieties lists for Oregon wheats, based on the suitability of varieties for existing market classes.
3. Disseminate multi-year, multi-location, end-use data on near-release and released varieties through vigorous outreach activities and appropriate media, in collaboration with OSU wheat breeding program, OWC and OWGL.
4. Provide data to the breeding program on the stability of kernel traits across locations and years in Oregon. Identify breeding lines with enhanced stability of functional attributes across environments.
5. Generate enhanced predictive value of end-use attributes from the collected data by employing multivariate analyses as a potential selection tool.
6. Use the multilocation data to validate innovative selection techniques, leading to improved outcomes for the OSU breeding program.
7. Identify Oregon wheat lines with potentially valuable novel quality traits.
8. Participate in the PNW wide effort to establish soft white wheat quality targets and to investigate the feasibility of a third, higher strength, sub-class of the SW market class.

PROCEDURES:

OWQEP lab testing

The OWQEP conducts relevant wheat quality testing for Oregon wheats. In 2003, grain was collected from the replicated trial plots of the Oregon Elite Winter Variety Trials at these sites throughout Oregon; Pendleton (Rugg-Barnett), Moro (Sherman County Experiment Station), Corvallis (Hyslop Research Farm), Moro (Chris Kaseberg), Arlington (Eric Anderson), Hermiston (Kent Madison). A single replicate of grain from each variety by site combination was sent to the WWQL for flour milling end-use suitability testing. This constituted 198 samples (33 lines x 6 sites, Table 1) of near-release lines and released varieties. A single replicate was used to fit with the existing WWQL experimental design and organization of the historical quality data. WWQL will provide analyses of these key traits; kernel hardness, wheat protein, flour yield, break flour yield, flour ash and protein, Mixograph absorption and mix type, baking absorption and loaf volume (hard wheats), sugar snap cookie diameter (soft wheats), alkaline noodle color.

This testing at WWQL is complemented by supplementary testing at OSU. A key component of the project is the inclusion of new quality tests. The criteria for inclusion of new tests are; a potential to streamline early generation selection, a potential to provide customers with a more complete quality profile of Oregon grown wheats. Traits to be examined at OSU include:

- Molecular weight distributions of gluten proteins, a potential early generation screening tool for dough strength.
- Quantitative analyses of high molecular weight glutenin composition, a method of determining the fundamental causality where dough strength differs, at different growth locations and equivalent protein content in the same variety.
- Noodle processing attributes and texture assessments
- Solvent retention capacity tests

- Wire-cut cookie performance, a complement to the sugar snap cookies and a test widely considered valuable by domestic soft wheat users.
- Steamed bread performance
- Gluten visco-elasticity, a simple test reported to predict noodle texture attributes

Table 1: Winter wheat lines harvested in 2003 that are to be tested at WWQL and OSU as part of the OWQEP

PLOT #	NURSERY	ENTRY#	I.D.	PLOT #	NURSERY	ENTRY#	I.D.
1	SWELT	1	STEPHENS	18	SWELT	27	OR9801695
2	SWELT	2	MADSEN	19	SWELT	30	OR9801757
3	SWELT	3	GENE	20	SWELT	31	OR9900553
4	SWELT	4	WEATHERFORD	21	SWELT	32	OR9900548
5	SWELT	5	TUBBS	22	SWELT	34	OR9900598
6	SWELT	6	FINCH	23	SWELT	35	OR9900547
7	SWELT	7	MOHLER	24	SWELT	38	OR9900513
8	SWELT	8	SIMON	25	HWELT	5	OR 943576
9	SWELT	12	CHUKAR	26	HWELT	7	OR 942496
10	SWELT	13	MEL	27	HWELT	8	OR 953475
11	SWELT	14	CLEARFIRST	28	HWELT	9	OR 952577
12	SWELT	15	IDO587CL	29	HWELT	16	OR2010399
13	SWELT	16	ORI2010051	30	HWELT	17	OR2010400
14	SWELT	17	ORI2010007	31	HWELT	23	OR2010696
15	SWELT	19	ORI2020015	32	HWELT		NUPLAINS
16	SWELT	20	OR 941611	33	HWELT		ELTAN*
17	SWELT	25	OR3970965				

*included in HWELT as PNW adapted noodle color and dough strength check

It is anticipated that activities in 2004 related to the last three items (above table 1) will consist of method development and adaptation for the OSU quality labs. To date the investigations of molecular weight distributions of gluten proteins are in progress. The overall testing strategy meets our goals of; maintaining the effectiveness of the WWQL in providing relevant quality data to OSU, obtaining complete compatibility with the region wide genotype & environment (G&E) database, generating synergies that enhance the overall effectiveness of the OSU breeding program, the Oregon preferred varieties lists, and the marketing of wheat into specific markets.

Early generation quality screening

In addition to the testing of elite lines, the OWQEP tests selected samples from the F4 and F5 generations. This testing greatly reduces the proportion of poor-quality lines that enter first-year yield trials. With support of Dr. Jae-Bom Ohm, critical quality tests were conducted after harvest of F4 and F5 headrows, but prior to re-planting of these selections into yield trials. In 2003, 1460 lines were screened for single kernel hardness and polyphenol oxidase activity between harvest and planting. The screening eliminated, prior to planting, nearly 34% of HW selections (mainly high PPO), 16% of SWW selections (mainly harder kernel texture), and nearly 50% of the hard-grained Hybritech selections (mainly high PPO). This means more selection pressure can then be brought to bear to improve grain yield, disease resistance, and adaptation.

Compilation of Preferred Variety Lists

These procedures are currently operational. For the 2003 lists, data was obtained from the WWQL 6-year G&E study of wheat quality. Few of the sites in the G&E study were from Oregon, and most were from Washington. After consultation with the WMC and WWQL, and with the approval of both OWC and OWGL, a subset of sites that were somewhat representative of Oregon growing conditions (rainfall, elevation, length of growing season) were selected from the available sites. These sites were used; (1997) Lind, Walla Walla, (1998) Ritzville, Walla Walla, Moses Lake, (1999) Ritzville, Lind, Walla Walla, (2000) Lind, Ritzville, Moses Lake, (2001) Reardan, Ritzville, Lind, Moses Lake, Ontario OR, Pendleton OR, Corvallis OR, (2002) Dayton, Moses Lake, Ritzville (Sites are from WA unless otherwise indicated). Data from sites in far northern, eastern, and other Washington sites that did not represent Oregon growing conditions were removed from the database. Additional Oregon sites used for ORCF101 data only were, (2000) Pendleton, (2002) Pendleton, Madras, Hermiston, Ontario, Moro.

The rankings on the Oregon soft wheat lists were derived using the same quality attribute weightings and statistical model developed by WWQL and WSU, and used by the WWC to derive their preferred soft wheat variety lists. The change in the database imposed by selecting a sub-set of sites required that the statistical “t-scores” be recalculated by Dr Jae Ohm of OSU. The t-scores were used to rank varieties in relation to the check varieties. For SWW the check variety was “Stephens”. The winter club check variety was “Rely”. The SWS the check variety was “Alpowa”.

For the Oregon Preferred Lists, the “t-scores” themselves were not presented. However, the t-scores were used to group the varieties into four categories. The categories were based on whether the overall t-scores were significantly higher, significantly lower, or not significantly different from the check varieties. When varieties were not significantly different from the check, but ranked higher, they were considered “desirable”. When varieties were not significantly different from the check, but ranked lower, they were considered “acceptable”. We have reserved the option of revising the statistical model used to rank varieties as time goes on, and as we consider the usefulness of alternative statistical approaches. Overall t-scores were a composite made up of the weighted average of t-scores for important intrinsic quality traits of SWW wheats. The traits and the score calculations are detailed below.

SWW and SWS common wheats

- Grain quality = (test weight x 0.2) - (wheat protein x 0.8)
- Milling quality = (milling score x 0.6) + (break flour yield x 0.4)
- End-use quality = (cookie diameter x 0.8) - (Mixograph absorption x 0.2)
- Overall Score = (grain x 0.1) + (milling x 0.4) + (end-use x 0.5)

Winter Club wheats

- Grain = (test weight x 0.2) - (wheat protein x 0.8)
- Milling = (milling score x 0.6) + (break flour yield x 0.4)
- End-product = (cookie diam. x 0.6) - (mixo. abs. x 0.4)

- Overall = (grain x 0.1) + (milling * 0.4) + (end-product x 0.5)

The lists were disseminated through vigorous outreach efforts by the PI, in conjunction with OWC and OWGL, and aimed at direct contact with growers, through appropriate print media, and through the internet via the OSU wheat breeding, genetics and quality website.

Use of data to support variety release documents and inclusion in regional testing programs

In principle, release of new genetic material will only occur after a new variety is shown to have desired agronomic and quality characteristics over at least 2 years of testing. Kernel, milling, flour, dough rheology, and end-use data will be compared with class-appropriate check varieties. To be released in Oregon a new variety should provide tangible improvement over existing varieties in at least one of three key areas, while holding the other two factors at least constant with long term crop averages. The three key areas are; disease resistance, adaptation & yield, end-use suitability. The precise nature of the data presentation is evolving even as the this report is being written. Comparisons with long term crop averages and, importantly, distributions of values of key quality attributes will be the basis of the data's use. This strategy (using both means and distributions of values) will also be applied for comparisons with appropriate check, and class leading varieties.

The OWQEP data will also guide the inclusion of suitable genetic material in the PNW Wheat Quality Council, Overseas Variety Assessment and Asian Product Collaborative testing programs. In addition, OSU will participate in the quality testing of the PNW Wheat Quality Council samples from 2004 onward. There are a number of benefits to accrue from this testing and these include; further integration of the OSU quality program into the regional quality testing programs, the opportunity for OSU to test the best new lines from other breeding programs, and participation of OSU in the proposed extension of the PNW WQC testing that is being designed to enable it to become an ongoing inter-laboratory collaborative testing program.

REPORT OF ACCOMPLISHMENTS TO FEB 12 2004:

The OWQEP has provided high quality fundamental and applied research and service support for the variety improvement effort in Oregon. To date the OWQEP has provided a number of high impact outcomes.

1 -The provision of the first SW winter and SW spring preferred variety lists for Oregon. The lists were generated with the unreserved cooperation of the Oregon and Washington Wheat Commissions, the Oregon Wheat Growers League, the USDA ARS WWQL, the OSU breeding program, and wheat quality specialists from Washington State University and the Wheat Marketing Center. The lists were supported by vigorous outreach efforts by the PI. These are detailed in "Related publications and presentations". In summary they included face-to-face contact at key industry meetings, plus the production of a video/DVD presentation for use when the PI was unavailable.

2 - The application of early generation selection pressure as part of an overall strategy to increase the genetic quality base of all market classes in the breeding program. OWQEP

staff supervised the acquisition of quality data by breeding program student workers. The data was then analyzed by OWQEP staff. Through this effort between 16% (SFW) and 50% (Hybritech) of the 1460 F3-F5 lines tested were eliminated on the basis of quality alone. Early generation quality screening at the F4 and F5 generations significantly improves our breeding efficiencies. Visual selection for high grain yield potential in headrows is inherently inefficient. With effective quality screening, more lines can be selected in the field, evaluated in the lab, and then quickly eliminated should they fail to meet quality standards.

3 - The setting in place of a strategy to capitalize on the use of the WWQL to generate core data on multilocation trials. The strategy is twofold. Firstly, the generation of the core milling, rheology and end-use data, using the WWQL as a central reference lab, allows Oregon specific data to be seamlessly integrated into region-wide quality improvement efforts. Secondly, the generation of the core data at WWQL frees up resources at OSU to test out new, or complementary, methods to enhance our overall ability to identify the best (or worst) genotypes, and to create a more complete understanding of the end-use quality potential of the most advanced lines.

4 - At the time of reporting, WWQL had made a timely delivery of 2003 data from this sample set (Table 1) for presentation to the Oregon Cereal Variety Advisory Committee with regard to the further progression of the lines OR9900553, OR9801757, and OR2010007.

5 - A technician already trained in many of the laboratory procedures required for the OSU component of the lab testing of the multilocation trials has been appointed. Caryn Ong worked on the previous OWC grant to the OSU wheat quality program and conducted a successful research project. With the appointment of Caryn, we are confident that the efforts to produce the complementary lab data and new method development planned until June 30 will proceed on-time, on budget, and successfully.

RELATION TO OTHER RESEARCH:

OSU wheat quality research is conducted in collaboration with researchers throughout Oregon, the PNW, the USA, and internationally. At OSU, the quality program is involved in two major research studies with the breeding program to investigate end-use quality improvement of hard white wheats. The first investigates the impact of moisture stress and N management on protein composition and Asian noodle quality. The second investigates the genetic relationships between protein composition, protein content, and Asian noodle quality. The samples generated from these projects are also vital to federal funding opportunities that, if successful, will greatly leverage the funding contributions received by the wheat quality program from OWC. Collaborations with the OSU Wheat breeding program, the Wheat Marketing Center, and ARS-WWQL continue to identify hard and soft wheat selections with superior end-use quality that will improve marketability and demand for Oregon wheat.

Other examples of collaborations within OSU exist. Grain samples from 2002 Hybritech Advanced nurseries are being used in an M.S. thesis study under my supervision. The study has evaluated fundamental and applied measurements of pentosans, including the application of solvent retention capacity tests, as predictors of end-use quality. The study cross-fertilizes the OWC funded efforts, both those presently being conducted, and those

recently completed, by providing additional data and a different perspective on common issues of end-use suitability.

The OWC funded studies are also related to nearly \$70,000 of essential capital equipment acquisition funded by the OSU research equipment reserves fund, and to starch protein interaction research funded by the Oregon Agricultural Research Foundation. The essential capital equipment purchases were a nitrogen (protein) analyzer, and a particle size analyzer.

ACKNOWLEDGEMENTS:

Our appreciation is extended to the Oregon Wheat Commission and the OWGL for their ongoing support and commitment to the wheat quality improvement effort. Sincere and generous appreciation is also extended to Dr Jae Ohm, without whom much of the laboratory work and statistical analyses, which are the foundation of this project, would be nearly impossible. I must also acknowledge the efforts of Caryn Ong, Sunida Asawaprecha, Karisa Asato, and Merry Yuliana, all OSU students. Their contributions extended far past their primary research projects, and greatly helped the progress of the whole wheat quality improvement effort in the last year.

RELATED PUBLICATIONS AND PRESENTATIONS:

Publications:

- Crosbie G.B., Ross A.S. 2004 [accepted] . “Noodles: Asian Wheat Flour”, in, The Encyclopedia of Grain Science, C.W. Wrigley, H. Corke, and C.E. Walker, eds. Academic Press, London.
- Ross A.S. 2003. Investigating the relationship between glutenin composition of wheat and noodle making performance. Oregon Wheat, 55 [4]; 9-11.

Theses:

- Ong Y.L. 2003. Effects of Gluten Composition and Molecular Weight Distribution on the Noodle Making Potential of Hard White Wheats. Thesis for BS in BioResource Research, BioResource Research Dept. Oregon State Univ. A.S. Ross, mentor.

Preferred variety lists:

- Preferred Wheat Varieties Lists for Oregon: Soft White Winter and White Club Wheats. 2003. A. S. Ross, J. –B. Ohm, T. Simpson. Oregon Wheat Growers League Newsletter, September 2003.
http://cropandsoil.oregonstate.edu/wheat/reports/preferred_wheat_var03.pdf
- Preferred Wheat Varieties Lists for Oregon: Soft White Spring Wheats. 2003. A. S. Ross, J. –B. Ohm, T. Simpson. Presented to Oregon Wheat Growers League Annual Convention Dec 2003.
http://cropandsoil.oregonstate.edu/wheat/reports/preferred_SWS_var03.pdf

Variety releases and Plant Variety Protection (PVP):

- C.J. Peterson, M. Verhoeven, M. Larson, B. Hoefler, W.E. Kronstad, R. Karow, J. Bassinette, C. Morris, D. Engle, A. Ross, J. Ohm, D. Ball, C. Mundt, R. Smiley, Z.

Chen, and G. Vollmer. 'ORCF-101' soft white winter wheat. Released January 3, 2003.

- PVP application for 'Tubbs' soft white winter wheat. Submitted, June, 2003.
- PVP application for 'ORCF-101', a CLEARFIELD* soft white winter wheat. Submitted, June, 2003.

Presentations – local, regional, national, international:

- End-use suitability of wheat: Breeding, identification, quality assurance, and classification; with C.J. Peterson. Oregon Wheat Growers League, Annual Convention, Tigard Oregon Dec 2003.
- Oregon: Quality Wheat for the World. Gilliam County 'Ag Day', Condon Oregon, 27th October 2003. Also captured on videotape for presentation in Baker, Malheur, Sherman, and other county growers' meetings throughout October and November 2003. also available at - <http://media.oregonstate.edu/ramgen/dbase/cropandsoil/wheat.rm>
- Recent advances from the OSU wheat quality program. Faculty Seminar, Department of Food science and Technology, Oregon State University, Corvallis Oregon. 8th October 2003.
- Cereal Chemistry: Functionality, structure and genetics of wheat kernel components. Bioresource Research Department, Oregon State University, Corvallis Oregon. 6th October 2003.
- Assuring the Quality of Oregon Wheat: Developing and growing the varieties our customers want. Oregon Wheat Growers League, Fall Workshop, Boardman Oregon. 4th September 2003.
- Oregon State University Wheat Quality Update. Columbia Basin Agricultural Research Center, Research Day, Pendleton Oregon, Sept 3 2003.
- Breeding for end-use suitability of wheat: with C.J. Peterson. Umatilla and Morrow Counties Wheat Marketing Tour and Wheat Quality Workshop, Wheat Marketing Center, Portland, Oregon, June 3, 2003 Sponsored by OSU Extension Service and the "Market analysis and strategies for Northeast Oregon" project funded by the Western Center for Risk Management Education
- Identification of end-use suitability of wheat: Umatilla and Morrow Counties Wheat Marketing Tour and Wheat Quality Workshop, Wheat Marketing Center, Portland, Oregon, June 3, 2003 Sponsored by OSU Extension Service and the "Market analysis and strategies for Northeast Oregon" project funded by the Western Center for Risk Management Education

Posters:

- Preferred wheat variety lists for Oregon: Soft White Winter and White Club. A. S. Ross, J.B. Ohm, T. Simpson. Oregon Wheat Growers League Annual Convention, December 2003, Tigard OR.
- Preferred wheat variety lists for Oregon: Soft White Spring. A. S. Ross, J.B. Ohm, T. Simpson. Oregon Wheat Growers League Annual Convention, December 2003, Tigard OR.
- Improving early generation quality screening in the OSU wheat breeding program;2003 A.S. Ross, Jae B. Ohm, C. James Peterson. Oregon Wheat Growers League Annual Convention, December 2003, Tigard OR.