

PRAIRIE RECOMMENDING COMMITTEE
FOR
WHEAT, RYE AND TRITICALE

OPERATING PROCEDURES

- FINAL DRAFT -

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1. INTRODUCTION

1.1 *Wheat Cultivar Registration and Market Classification in Canada*

The Canada Seeds Act and associated seeds regulations require that cultivars (varieties) of most agricultural crops be registered prior to seed sale in Canada and prior seed import into Canada (Seeds Act, 3. (1) (b)). The Canadian Food Inspection Agency (CFIA) under authority of the Canada Seeds Act registers cultivars of spring wheat, winter wheat and durum wheat. CFIA authorizes recommending committees to establish science-based criteria to determine suitability to be registered. The current variety registration system consists of three regulatory tiers of varying registration requirements (Schedule III, Parts I, II, and III).

Part I crops require testing prior to registration with official oversight and merit assessment to ensure that cultivars meet minimum standards. Registration requires a recommendation from a crop specific Registration Recommending Committee (RRC); e.g. cereals, pulses, flax, mustard. “Merit”, with respect to variety registration means that the variety is equal to or better than appropriate reference varieties with regard to any single characteristic or combination of characteristics that render the variety beneficial for a particular use in a specific area of Canada” (Seed Regulations 63). Merit is determined by the crop specific recommending Committees; not by any other party. Merit is only assessed for crops in Schedule III, Part I.

For western wheat varieties, the choice was made to have merit linked to the western grain classification system. Thus, registration testing of candidate cultivars is specific for the grain class to which they will be eligible if registered, as set out in the Canada Grains Regulations administered by the Canadian Grain Commission (CGC). The western wheat industry has decided that efficiencies are gained by determining the value for cultivation and the value for use (i.e. market classification) simultaneously. The PRCWRT has therefore established protocols for the concurrent determination of the value for cultivation and market classification so as to:

- increase predictability of market classification
- add value to experimental candidate cultivars
- increase the rate of new cultivar adoption

Candidate cultivars require merit assessment in registration trials that assess their suitability for a market classification; e.g. the Durum Wheat Cooperative Registration trial determines suitability for the Canada Western Amber Durum (CWAD) class and the Hard White Wheat Cooperative Registration trial determines suitability for the Canada Western Hard White Spring wheat (CWHWS) class.

Part II crops require testing prior to registration, with official oversight; i.e. a recommending Committee recommendation is required to verify that the testing was done. A demonstration of merit is not required.

Part III crops have basic registration requirements. Application is made directly to the CFIA-VRO.

1.2 Procedural Framework

This document outlines the merit testing and evaluation system operated by the Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT). The PRCWRT is responsible for testing and evaluation of wheat, rye and triticale candidate cultivars for registration in the various agro-ecozones of western Canada, excluding the lower British Columbia mainland. The purpose of these activities is to generate relevant, unbiased, and representative data for candidate cultivars of wheat, rye and triticale, and upon request by the sponsors (or designate) provide informed recommendations regarding their merit for registration by the CFIA-VRO.

Common wheat or durum lines that are not candidates for existing wheat classes may be eligible for interim or contract registration. Interim registration for market development purposes requires experimental grades under the aegis of the CGC. CFIA mandates that contract registration requires strict identity preservation and a detailed quality control manual. Testing of candidate cultivars for contract registration is detailed in Section 6.

Non-standard types of wheat (e.g. spelt, rivet, dinkel, einkorn, club wheat), spring rye and winter triticale may be tested using the rules in Section 3.8 – Introducing New Crop Kinds. The introduction of new types of wheat into western Canada has many implications for existing wheat classes. The approval of a registration trial protocol does not imply that the infrastructure to accommodate it will exist.

Candidates that have the potential to cause biological and/or environmental harm as defined by CFIA may be rejected for registration. The PRCWRT has no legal authority to refuse a recommendation for registration to the CFIA-VRO for candidates that have merit.

2. THE PRCWRT

2.1 Operating Procedures

The PRCWRT operating procedures are approved by the CFIA-VRO. The operating procedures will undergo a regular full review; however, changes may be proposed at any time. All changes to the operating procedures or their appendices require a Committee motion supported by a simple majority vote and approval by the CFIA-VRO. Amendments will be published in the annual PRCWRT minutes and updated operating procedures reflecting the changes will be posted to the PRCWRT website, following CFIA-VRO approval. Changes in operating procedure become effective on April 1.

Under exceptional circumstances, in order to be flexible and exercise good judgment, it may be necessary for the Committee to temporarily set aside the approved operating procedures. This should not be a regular occurrence and requires a motion to suspend regular procedures supported by a minimum two-thirds majority vote. The rationale for setting aside the regular procedures and the record of the empowering vote will form part of the recorded decision. In addition, the CFIA-VRO must be notified in writing of any candidate cultivar supported where regular guidelines have not been adhered to and the reasons for the special consideration.

Disagreements on procedural interpretation will be raised at the Committee meeting and settled by majority vote. New wording to clarify the offending procedure and its interpretation will be drafted.

2.2 Terms of Reference

PRCWRT mandates:

1. To establish test procedures and co-ordinate trials to evaluate the merit of potential cultivars of wheat, rye, and triticale.
2. To assess the merit of lines in registration trials and make recommendations to the CFIA-VRO regarding the suitability of candidate cultivars for registration in the various agro-ecozones of western Canada, excluding the lower British Columbia mainland.

Additional objectives:

1. To act as a forum for exchange of information relevant to the development of improved cultivars of wheat, rye and triticale for western Canada.
2. As a crop specific stakeholder group, to provide expert input to federal and provincial agencies regarding proposed or existing legislation and regulations governing wheat, rye, and triticale breeding and cultivar production.

2.3 Structure and Membership

2.3.1 Structure

The PRCWRT (the Committee) consists of three Evaluation Teams responsible for the merit assessment of agronomic performance, disease/pest resistance and end-use quality.

- Agronomic Evaluation Team (AET)
- Disease Evaluation Team (DET)
- Quality Evaluation Team (QET)

Each Evaluation Team must have a Chair and Secretary. These six individuals form the PRCWRT Executive from which the PRCWRT (Committee) Chair and Secretary will be selected. The Committee and Evaluation Team Chairs and Secretaries must be approved by a majority vote.

Terms for individual members of the Executive Committee will normally be three years. These terms are renewable and commence on April 1. For the sake of continuity, it is encouraged that secretaries take the position of Chair following completion of a three-year term.

In circumstances where a Chair is unavailable to act in the official capacity of the position, the Secretary will assume the role of Chair. In this case or where the Secretary is unavailable, the Chair (elected or acting) will appoint a temporary Secretary from among the membership of the Evaluation Team or Committee, whichever is appropriate.

2.3.2 Membership

The PRCWRT has two types of membership: full (voting) and associate (non-voting). New PRCWRT members are nominated by a current full member and are approved by a simple majority vote of the

Committee. Membership lists will be updated annually and provided to the CFIA-VRO for each Evaluation Team, indicating the elected Chairs and secretaries, and for the associate members.

All PRCWRT members will be provided access to the proprietary area of the PRCWRT website, which has the registration trial data associated with the three Evaluation Teams. All members must have internet access and an email address, as this is the primary method of communication by the Committee.

Individuals who do not qualify for full or associate membership but are interested or otherwise involved with the process may register for the meetings as guests. Guests have a voice in discussions and may provide input at the Evaluation Team and Committee levels, but do not have a vote.

2.3.2.1 Full Members (voting privileges)

Eligibility for full voting membership consists of crop value chain stakeholders who are actively engaged in the production, development, processing, marketing, and/or evaluation of potential wheat, rye and triticale cultivars and possess the expertise to do so.

Voting members of the three Evaluation Teams must represent a sector of the cereal stakeholder value chain. New members are considered based on their ability to contribute to the recommendation process rather than the organization they represent. To become a voting member, an individual must attend a complete PRCWRT meeting as a guest and be nominated by a full member to an Evaluation Team, based on the expertise that the nominee possesses. On becoming a full member, voting privileges are granted. It is expected that members will vote impartially, declare conflicts of interest, and attend the annual meeting regularly.

There is no membership cap on the number of voting members per Evaluation Team. All full members are allowed to vote at the Evaluation Team level; however, a maximum of 25 members per Evaluation Team will be allowed a vote on operational matters at the Committee level. If the number of Evaluation Team members attending the PRCWRT meetings is greater than 25, each Evaluation Team Chair will call for members to temporarily give up their voting privilege. In the event that there are insufficient volunteers willing to forego their voting privilege, the 25 voters will be determined randomly. A record of the members who have relinquished their vote will be kept so that they will be allowed a vote at the next annual meeting.

Full members who fail to attend the PRCWRT Annual Meeting for two consecutive years will be moved to Associate Member status unless an acceptable excuse is provided to the Committee Chair.

2.3.2.2 Associate Members (non-voting)

Associate members are individuals with a direct interest in Committee activities but do not meet the criteria for full membership or do wish to have the associated responsibilities. Associate members do not have voting privileges but are allowed a voice during Committee and Evaluation Team meetings and have full access to the proprietary area of the PRCWRT website.

2.4 Meetings

The PRCWRT normally meets annually in late February at a location determined at the previous annual meeting. The meeting location, room allocation, audio-visual equipment, food and refreshments are

organized by the Prairie Grain Development Committee (PGDC) but the PRCWRT is responsible for organizing all other meeting aspects. Extra-ordinary meetings may be called on 30 days notice or less upon the consensus of the membership.

Meetings are open to all interested parties but registration is mandatory. Graduate students will be allowed to attend the meetings without paying the registration fee. The Committee or Evaluation Teams may, by a majority vote, create members only portions of the meetings as necessary.

Meetings will operate under Robert's Rules of Order.

3. REGISTRATION TRIALS

3.1 *Purpose and Definitions*

The PRCWRT, as a variety registration recommending committee approved by the Minister, sanctions registration trials and establishes the testing protocols for the merit evaluation of wheat, rye, and triticale candidate cultivars. The purpose of registration trials is to provide representative data to the Committee for the determination of merit of the candidate cultivar and a final recommendation to the CFIA-VRO regarding variety registration.

Registration trials are replicated, multi-location agronomic performance tests supplemented with tests for disease/pest response, end-use quality, and/or other important traits as deemed appropriate by the Committee.

3.2 *Registration Trial and Protocol Endorsement*

Registration trials may be conducted by the public or private sector, individually or through collaborative arrangements. Prior to the commencement of registration testing, the protocols used in the conduct of the registration trial must be approved by each Evaluation Team as it relates to their expertise. The data collected must be relevant to the mission and agro-ecological zone of the registration trial. For existing registration trials with well-established and approved protocols, Committee approval is implicit if no concerns are raised by the membership, and there are no proposed changes to the traits collected, experimental protocols, or check cultivars used.

Where there is disagreement over the testing protocol, interpretation, or validity of data, the majority decision of the appropriate Evaluation Team will be final. It is recognized that consultation and discussion between Evaluation Teams may be necessary to arrive at a consensus and final decision.

The mission of each approved registration trial, the primary contact person, check cultivars, agronomic traits to be measured, disease resistance guidelines, end-use quality testing requirements, and the methods of evaluation will be reviewed annually and described in the following appendices:

- Appendix A: Registration Trial Missions
- Appendix B: Check Cultivars
- Appendix C: Measurement of Agronomic Traits
- Appendix D: Guidelines for Disease Resistance in Wheat and Triticale

- Appendix E: Disease Screening Protocols
- Appendix F: Wheat and Durum: Measurement of Quality Traits

Historically, members of the PRCWRT have collaborated for the efficient use of limited resources. This collaboration in operating the various registration trials resulted in the commonly used terms of “cooperative tests”, “co-ops”, and “C-Level” trials. Collaborators involved in the conduct of a registration trial will set its operating principles. For a set of principles developed by “cooperative test” collaborators, please see Appendix K.

3.3 New Registration Trials

A request and proposal for a new registration trial must be submitted to the PRCWRT no later than February 1 in the year of first planting. It is advised that all Evaluation Team Chairs be notified of the intent to request a private registration trial prior to the February 1 deadline to provide guidance to the requesting party and expedite the approval process.

Prior to the commencement of registration testing, the protocol used in the conduct of the registration trial must be approved by each Evaluation Team as it relates to their expertise. This review and approval step is to ensure that data on the appropriate traits are collected, and appropriate experimental protocols and check cultivars are used to facilitate assessment of the candidates by the Evaluation Teams and the Committee. Without registration trial and protocol endorsement, the collected data will not be considered by the PRCWRT.

Entities participating in a registration trial are reminded that changes in protocol may be mandated by the Evaluation Teams and thus, the protocol approved in the first year of testing may not be the same as that in years two and three. The registration trial coordinator is responsible for maintaining current knowledge of accepted procedures and implementing any required changes in protocol.

3.4 Merit Assessment

This section details merit assessment for candidate cultivars of wheat, rye and triticale under the auspices of the PRCWRT. For specifics on data requirements, traits measured, and trial reporting for candidates of CWGP wheat, fall rye, and spring triticale, please refer to sections 3.4.4 and 3.4.5.

3.4.1 Yield and other Agronomic Characteristics

3.4.1.1 Data Requirements and Traits Measured

The conduct of registration trials at multiple sites over several years provides the opportunity for merit assessment of yield and agronomic performance under a wide range of growing conditions. Registration testing of individual lines will normally encompass three consecutive years at an approved set of sites across a broad range of climate and soil types in the area of expected commercial production. One site per year may be altered from the approved list without prior consultation. A standard of eight sites of acceptable grain yield data per year, for a total of at least 24 site-years, collected over three years or more are required prior to consideration of a candidate for registration recommendation. With the exception of grain yield, data for the prescribed agronomic traits are required from at least three sites per year.

The agronomic traits to be measured for the registration trials sanctioned by the PRCWRT for the various wheat classes, fall rye and spring triticale are summarized in Appendix C.

The first year of registration testing for a candidate cultivar may occur outside of the formal merit assessment system provided that it emulates subsequent years of registration testing as outlined in this section (3.4 – Merit Assessment).

3.4.1.2 Check Cultivars

Check cultivars for each registration trial are chosen by the Committee to represent specific grain classes, types and adaptation. Check cultivars will include widely grown, established cultivars, special purpose cultivars (e.g. solid stem cultivars resistant to wheat stem sawfly), or recent cultivars of improved merit. An improved cultivar with an offsetting weakness in a particular trait (e.g. a high yielding cultivar with unusual susceptibility to bunt) may be included as a check without diminishing the selection standard for the trait in which it is deficient. Such check cultivars will be specifically excluded as a check for the trait(s) in which they are deficient at the time of their elevation to check status and all such exceptions are to be noted in the list of checks.

Changes in check cultivars must be approved by the Committee and will be recorded in the annual Committee minutes.

In the case that a newly recommended candidate cultivar is approved as a check, the data collected during its registration testing are considered to be check data.

Candidate cultivars will be assessed relative to the range of the appropriate checks of the class for which they are being considered. Note that because checks will change over time, they may not be the same as those when the line was entered into the registration trial.

Seed stocks for check cultivars used in the registration trials must be of reasonable purity. As a guideline, the standards for purity and germination should be similar to that required for Certified seed, as defined by the *Seeds Regulations, Part I*.

3.4.1.3 Quality Assurance

A. Experimental Design

Individual registration trials will be no larger than 36 entries, with a minimum of three complete replicates planted. Use of recognized experimental designs that permit localized error control through the use of sub-blocks is encouraged.

B. Site Inspections

The registration trial coordinator must ensure that at least one-third of the sites are inspected each year. Inspections are to be conducted by a recognized plant breeder who is independent of the test site. For example, the research trial coordinator may inspection test sites conducted by collaborators. Further, inspection of a registration trial by a plant breeder employed at the same location is permissible if there is no association with the trial.

Access to registration trials will be granted to the test coordinator, collaborators, and other parties with a bona fide interest in the test. Site collaborators should be contacted in advance to provide entrance to the site, treatment lists, randomizations, and other pertinent information.

Inspectors should discuss any concerns about the trial site with the individual responsible and, if possible, agree on corrective action. A brief, critical evaluation of the site should be written, identifying the areas that required attention and the solutions discussed. These reports are to be forwarded to the registration trial coordinator for follow-up and additional inspection if necessary. If the issues are not resolved to the satisfaction of the coordinator, notification of the PRCWRT Chair is required.

A form to assist in the inspection of registration trial sites is in Appendix J.

C. Statistical Acceptability of Data

Grain yield data will be considered acceptable if the coefficient of variation (CV) is less than 12%. Yield data may be acceptable if the CV is in the range of 12% to 15% and the appropriate F-test for genotypes is significant ($p < 0.05$), or in the range of 15% to 20% if the appropriate F-test for genotypes is highly significant ($p < 0.01$).

D. Loss of Data

The loss of data from natural causes (e.g.: drought, flooding, hail, complete winterkill) is often unavoidable; however, the loss of data due to pre-existing conditions (e.g. soil variability, salinity, weed problems) should be minimized. Where there is a shortfall from 24 broadly distributed site-years of acceptable grain yield data over three years, justification and Committee approval is required for acceptance of the data package in the *Request for Support of Registration* document.

3.4.2 Disease Resistance Characteristics

The Disease Evaluation Team evaluates the merit of candidate cultivars based on the resistance to the following diseases:

- stem rust (*Puccinia graminis*)
- leaf rust (*Puccinia triticina*)
- stripe rust (*Puccinia striiformis*)
- common bunt (*Tilletia caries* and *T. foetida*)
- Fusarium head blight (*Fusarium graminearum*)

These diseases must be assessed in a manner acceptable to the Disease Evaluation Team, using a mixture of races carrying all commonly occurring virulences. It is recommended that seedling reactions to common races of stem and leaf rust also be determined.

The assessment of additional disease resistance traits is for information purposes. Demonstrated resistance to other diseases may assist in presenting a positive case for recommendation of the candidate.

Disease resistance guidelines are published in Appendix D. The protocols to be used for disease screening are detailed in Appendix E.

3.4.3 End-use Quality Testing

Requirements for end-use quality evaluation vary depending on the wheat class for which the candidate is intended (Appendix F).

For quality assessment, grain from individual sites will be combined into composites for each check and candidate cultivar. The CGC will provide a site blending formula to be followed for all checks and candidate cultivars in the trial. These composites will be based on CGC determination of protein concentration and grade of the check cultivars from the individual trial sites. Inclusion of grain from some trial sites may be limited or eliminated based on protein concentration and degrading factors. More details on this process are provided in Appendix F.

3.4.4 Canada Western General Purpose Wheat

3.4.4.1 Data Requirements

A minimum of 15 site-years of agronomic data collected in western Canada over a period of three or more years, with at least two locations per province per year in at least two provinces, is required. Data must be collected from the area of adaptation and intended production. Use of pre-registration trial data may be used to meet the minimum requirement for 15 station-years of agronomic data, provided that it is of acceptable quality as defined in section 3.4.2.3 - Quality Assurance.

Three years of disease resistance data are required and may consist of one year of pre-registration trial data and two years of registration trial data. If it is deemed that there is insufficient disease resistance data to provide a recommendation, a third year of registration testing may be requested by the Disease Evaluation Team. The collection of additional disease resistance data will not necessitate additional agronomic testing.

3.4.4.2 Traits Measured

Please refer to Appendices C and D for the list of traits that must be measured, relative to appropriate check cultivars.

3.4.4.3 Trial Reporting

Registration trial reporting for the Canada Western General Purpose wheat class is the same as that outlined in section 3.6

3.4.5 Fall Rye and Spring Triticale

3.4.5.1 Data Requirements

A minimum of 15 site-years of agronomic data collected in western Canada over a period of three or more years is required. Data must be collected from the area of adaptation and intended production. Disease resistance data is required for at least two of the years of testing.

3.4.5.2 Traits Measured

Please refer to Appendices C and D for the list of traits that must be measured, relative to appropriate

check cultivars. If the candidate is intended as an animal feed or forage crop, inclusion of data indicating its suitability for the proposed purpose is appropriate and encouraged.

3.4.5.3 Trial Reporting

Registration trial reporting for fall rye and spring triticale is the same as that outlined in section 3.6.

3.4.6 Foreign Data

A total of four site-years of the required minimum of 24 site-years of grain yield data may come from Montana, North Dakota and/or Minnesota (states that share a border with the Canadian Prairie Provinces). This does not apply to Canada Western General Purpose and non-standard types of wheat, all rye, and all triticale, as these classes/crop kinds have reduced data requirements (see Section 3.4.4.1). Data collection from these foreign sites must emulate the registration trial protocols conducted in Canada and meet the merit assessment criteria as outlined in Section 3.4.2.

Disease resistance data from outside of Canada is acceptable provided that the candidate sponsor can demonstrate that the race mixture was similar to that in western Canada and that PRCWRT sanctioned protocols were used. Discussion by the Disease Evaluation Team and a subsequent vote accepting the data is required.

The composite sample used for end-use quality testing may contain grain from one foreign site each year. Conduct of the end-use quality testing (e.g.: milling, baking, etc.) may occur anywhere, provided that the appropriate protocols are followed, as defined by the Quality Evaluation Team.

3.5 Service Fees

Registration trials run by private entities may have access to disease and quality testing used within the public sector under a fee-for-service arrangement, if resources permit. The establishment of these arrangements is not a function of the PRCWRT.

3.6 Trial Reporting

Annual reports of the registration trials will be made available to the PRCWRT membership at least seven days prior to the February annual meeting. A draft report may be circulated in advance so that there is ample time to produce the *Request for Support of Registration* documents. In practice, the end-use quality evaluation reports will be made available as soon as possible before the meetings.

The registration trial annual report must include information on test collaborators, site conditions, planting date, plot size, fertilizer and pesticide use, and area harvested. Data for each agronomic trait must be summarized on a site and overall mean basis, with coefficients of variation (CV) and least significant differences (LSD) or standard errors reported for each data type, if possible. All disease resistance data must also be reported. The creation of a summary page reporting the means for each agronomic and disease resistance trait is encouraged.

If errors in the registration trial annual report are found by the membership, a clearly identified revised report will be made available and posted to the PRCWRT website within two weeks of the error being detected.

3.7 Canadian Wheat Workers Code of Ethics

While not a requirement for conduct of a registration trial, several collaborating institutions that operate and participate in registration trials have chosen to adhere to the principles outlined in the Canadian Wheat Workers' Code of Ethics (Appendix I). A copy of the code should be included in each registration trial report to which it applies. Registration trials conducted by individuals or collaborating entities in which the use of candidate cultivars is prevented or restricted must clearly communicate these requirements in the registration trial report.

3.8 Introducing New Crop Kinds

3.8.1 Preface

Spring rye, winter triticale, and non-standard types of wheat that are ineligible for existing wheat classes (e.g. spelt, rivet, dinkel, einkorn, club wheat) may be merit tested using the rules in this section.

Non-standard types of wheat require special planning prior to their entry into registration trials, particularly as it relates to appropriate quality testing. Quality testing to assess potential in existing or new markets must be performed in consultation with a grain marketing entity and the CGC prior to entry into an existing or new registration trial. It is the responsibility of the candidate proposer and marketing entity to determine how the new wheat type should be produced for early quality and market testing purposes.

Following early market testing of a new wheat type, if the developer wishes to proceed toward registration, a new registration trial may be required (see Section 3.3). Entry of a new wheat type into a registration trial must be accompanied by comments from the marketing entity regarding the market potential of the new wheat type, and CGC comments on initial plans for handling and segregation of the wheat type, if registered.

Registration testing of spring rye, winter triticale, and non-standard types of wheat will proceed as outlined in Section 3.4 (Merit Assessment), with the data requirements and traits measured as outlined below. It is strongly recommended that the Evaluation Teams are consulted to ensure that the testing regime and traits measured are appropriate.

3.8.2 Data Requirements

A minimum of 12 site-years of agronomic data collected over a period of three or more years is required and must be of acceptable quality as defined in section 3.4.2.3 - Quality Assurance. All data must be collected from the area of Canadian adaptation and intended production.

Disease resistance data is required for at least two of the years of testing.

3.8.3 Traits Measured

The following agronomic traits must be measured relative to appropriate check cultivar(s): grain yield, maturity, height, lodging, kernel weight, test weight and relevant disease resistance characteristics. For fall-seeded crops, winter survival must be reported. If the candidate is intended as an animal feed or

forage crop, inclusion of data indicating its suitability for the proposed purpose is appropriate and encouraged.

The collection of disease reactions for stem rust, leaf rust, stripe rust (2015), Fusarium head blight and common bunt according to Disease Evaluation Team protocols are required for three years.

Quality traits for spring rye and winter triticale should emulate those collected for fall rye and spring triticale, respectively. The end-use quality characteristics required for a non-standard type of wheat will be determined by the entities responsible for early quality and market testing (see Section 3.8.1.).

4. REQUESTS FOR SUPPORT OF REGISTRATION

4.1 Requirements for Full or Interim Registration

For crop kinds listed in Part I, Schedule III of the *Seeds Regulations*, a candidate cultivar must have a recommendation from a recognized registration recommending Committee (the PRCWRT in western Canada) in order to be registered by the CFIA-VRO. Recommendations to “support” or “object to” a candidate cultivar are made on the basis of merit determination which is assessed by the PRCWRT based on data collected and sanctioned by the Committee via the registration trials. Consideration of the candidate cultivar will be based on the sponsor providing a *Request for Support of Registration* document to the Committee members no later than the Monday, at least one week prior to the start of annual meeting.

A *Request for Support of Registration* will normally be for full registration. Except in very unusual circumstances, the Committee will only consider candidates that have demonstrated merit following three years of registration testing. If a candidate has been tested in registration trials for three years, but data are absent for a trait or set of traits through no fault of the sponsor, consideration of the candidate may proceed using the data that are available.

Interim registration following two or three years of registration testing may be requested if for market development purposes. Interim registration following one year of registration testing may be requested if there is a demonstrated urgent need and general benefit to the industry. It is advised that the CGC be consulted prior to seeking interim registration, since market classification and the establishment of experimental grades are necessary. Suspension of normal Committee procedure is required for all cases in which consideration for interim registration is sought. Note that all proposed motions to suspend normal operating procedures require a two-thirds majority vote to pass.

The maximum period for interim registration is five years. The Committee may make an initial recommendation for interim registration for up to 3 years, with the requirement of recommendation renewal to achieve the total of five years.

The CFIA-VRO must receive an *Application for Registration* by August 31, approximately 30 months after the recommendation vote. The PRCWRT will not conduct a revote on candidate cultivars that have missed this deadline.

Recommendation for registration does not include information on distinguishability of the candidate cultivar from other currently registered cultivars. Please note that the CFIA-VRO will require this type of

information in the application for variety registration. For more information on the application process and a current “objective description” for wheat, rye or triticale, please contact CFIA directly.

4.2 The Request Document

The *Request for Support of Registration* must be concise and error free. Legible copies of the request document must be available to the voting membership of the Committee no later than the Monday, one week prior to the start of the annual PRCWRT meeting. By majority vote, the Committee may refuse to consider a request on the grounds of late circulation, illegibility, or inaccuracy.

A *Request for Support of Registration* must be made for a candidate cultivar no later than two consecutive annual meetings following the completion and publication of the complete merit assessment requirements as defined by the Committee.

4.2.1 Description of the Candidate

The first page will contain the following information: the proposer and owner of the candidate, the crop kind and grain class for which the line is a candidate, the registration category being sought (full or interim), a brief description of the phenotype, testing history, all designations under which the candidate has been tested, all strengths and weaknesses of the candidate, the expected area of adaptation, expected end-use, and the rationale for registration. Disclosure of the parentage, derivation, and selection history is encouraged but not required if it reveals confidential business information.

4.2.2 Data Summaries

Second and subsequent pages will concisely summarize the agronomic performance and disease/pest resistance. A summary of available end-use quality should also be included; however, the Quality Evaluation Team will usually consider available quality information *in extenso*. Summaries should be based on all registration trials in which the candidate was tested, using the data as analyzed and reported in the registration trial reports.

The manner in which data are presented will be obvious, in accordance with accepted scientific practice and will not conceal any weakness of the candidate. It is suggested that data be organized by trait to simplify comparisons between years. The Committee may assume that a candidate is deficient in an important trait if it is excluded from the summary.

Data in the registration trial report may be reanalysed, and other supporting (supplementary) data may be introduced in support of specific or unusual claims of performance; however, this will not replace the registration trial summary and must be presented in separate tables.

A candidate proposed for registration must only be compared to the designated check cultivars in the registration trial(s) in which it was evaluated. The check cultivars are those that are so designated at the time the *Request for Support* is made. When interpreting results for a specific trait, a candidate will not be compared to a check cultivar known to perform poorly for that trait. Data collected for a check prior to its registration is considered to be check data. Performance of other candidates unregistered at the time the proposal is made is not relevant, nor is the performance of previously registered cultivars not designated as checks.

4.2.3 Definition of Merit

Under the authority of the Canada Seeds Act, candidate cultivars of wheat, rye and triticale must show merit to be eligible for registration. Candidates that show merit are equal to or better than the appropriate check cultivars with regard to any single characteristic or combination of characteristics that renders the candidate beneficial for a particular use in a specific area of Canada. The phrase "*equal to*" is defined as arithmetic equality to the mean of the checks. Relative to the check mean, the phrases "*better than*" and "*poorer than*" are defined as simple arithmetic differences as appropriate for the trait being considered.

The phrases "superior to" and "inferior to" will not be used unless statistical significance relative to the check mean is shown by a two-tailed test at the 5% probability level using the pooled error mean square as error.

In practice, few candidate cultivars reach the minimum standard in all of the important characteristics under consideration. Most will show a collection of strengths and weaknesses relative to the checks. In some cases deficiencies in one characteristic may be compensated for by strength in another (e.g. lower yield for earlier maturity). It is the overall merit of a candidate cultivar that is assessed when making a recommendation for or against registration.

4.2.4 Supplementary Data

Data collected external to the registration trials may be included in the *Request for Support of Registration* document to improve the case for registration or substantiate claims of specific or unusual performance. Registration trial data and supplementary data must be presented in separate tables and labelled appropriately. A motion to accept the supplementary data as part of the *Request for Support of Registration* must be passed by a two-thirds majority at both the Evaluation Team and Committee deliberations to be accepted as part of the registration data.

Except for those provisions outlined in Section 3.4.6 (Foreign Data), data collected outside the prairie region of Canada will be considered a supplement to the registration trial data, not a substitute for it.

4.3 Role and Conduct of the Evaluation Teams and Committee

4.3.1 Evaluation Team Deliberations

All full members may vote on operational matters pertaining to the Evaluation Team, including the Chair and Secretary. Voting is normally conducted by a show of hands. The quorum for Evaluation Team meetings is 50% of the voting members.

For the consideration of candidate cultivars proposed for registration, each Evaluation Team will consider merit according to their expertise (Agronomy, Disease Resistance, Quality) prior to the PRCWRT Committee meeting. Merit will be based on the ratings for each merit criterion upon which the candidate is assessed. These ratings are entered into a merit score calculation spreadsheet that provides an objective assessment of the Evaluation Team findings. Values for each merit criterion and threshold values for each level of endorsement will be determined by the responsible Evaluation Team. Changes to merit criteria and threshold values must be made during the annual PRCWRT meetings, a

year prior to the changes taking effect. The Evaluation Team Chair must communicate these changes to the membership during the PRCWRT Committee meeting.

At the Evaluation Team level, the merit score calculation will determine endorsement of the candidate cultivar in the following categories:

- Support: the collective attributes of the candidate for the traits being considered are “better than” those of the check cultivars or exceed the “Do-not-object” level.
- Do-not-object: the collective attributes of the candidate for the traits being considered are “equal to” those of the check cultivars or are equal to the “Do-not-object” level.
- Object: the collective attributes of the candidate for the traits being considered are “poorer than” those of the check cultivars or fail to meet the “Do-not-object” level.

Where the candidate for registration has received an endorsement from all of the Evaluation Teams (either Support or Do-not-object decisions), consideration at the PRCWRT Committee is not required. Candidates in which one or more Evaluation Teams have objected to its registration will be presented for consideration at the PRCWRT Committee meeting. Candidate sponsors are reminded that an “Object” based on the merit score calculation is only an alert that closer examination is required at the Committee level, where the overall attributes of the candidate (the balance of agronomic, disease resistance and end-use quality traits) are thoughtfully considered.

Non-binding guidance from the DET and QET is provided to the sponsors of candidate cultivars in the first- and second-years of registration testing based on the established merit criteria. The merit score tools may be used for this determination but it is not required.

4.3.2 Committee Deliberations

As outlined in Section 2.2 – Terms of Reference, the PRCWRT has two mandates.

1. To establish test procedures and co-ordinate trials to evaluate the merit of potential cultivars of wheat, rye, and triticale.
2. To assess the merit of lines in registration trials and make recommendations to the CFIA-VRO regarding the suitability of candidate cultivars for registration in the various agro-ecozones of western Canada, excluding the lower British Columbia mainland.

Mandate 1: All matters pertaining to operating procedure are to be ratified at the Committee meeting. For issues that require Committee approval, a maximum of 25 members per Evaluation Team are allowed a vote to provide a balanced approach. If the number of Evaluation Team members attending the PRCWRT meetings is greater than 25, each Evaluation Team Chair will call for members to temporarily give up their voting privilege. In the event that there are insufficient volunteers willing to forego their voting privilege, the 25 voters will be determined randomly. The Committee Chair and proposer of the candidate are also entitled to vote if they are among the 25 members provided this privilege. A record of the members who have relinquished their vote will be kept so that they will be allowed a vote at the next annual meeting. It is expected that all members will vote impartially. Quorum for Committee deliberations is 50% of members registered for the meetings and 50% of each of the attending Evaluation Team members at the beginning of the Committee meeting.

Mandate 2: At the Committee level, only candidate cultivars in which one or more of the Evaluation Teams have objected to registration will be considered. Voting on the candidates will be done by a

Cultivar Voting Panel (CVP) consisting of full PRCWRT members who represent various sectors of the wheat, rye and triticale value chain.

The Cultivar Voting Panel will consist of the following representatives:

	Value Chain Role	Sector
AET:	1. Producer representative – Alberta	Producer
	2. Producer representative – Saskatchewan	Producer
	3. Producer representative – Manitoba	Producer
	4. Agronomist	Public
	5. Private breeder	Private
	6. University breeder	Public
	7. AAFC breeder	Public
DET:	8. Stem rust expert	Public or Private
	9. Leaf rust expert	Public or Private
	10. Stripe rust expert	Public or Private
	11. Fusarium head blight expert	Public or Private
	12. Other diseases (Bunt, Smut, Leaf diseases, etc.)	Public or Private
	13. Chemical control (fungicide) representative	Private
	14. Producer organizations representative	Producer
QET:	15. Hexaploid wheat quality specialist	Public
	16. Durum wheat quality specialist	Public
	17. Milling industry representative	Private
	18. Baking Industry representative	Private
	19. Western Grain Elevator Assoc. representative	Private
	20. Canadian Grain Commission representative	Public
	21. Canada branding / technical & market support (CIGI)	Independent
Other:	22. Canadian Seed Growers Association representative	Producer
	23. Canadian Seed Trade Association representative	Private

Each Evaluation Team will elect appropriate individuals for the value chain roles. The CSGA and CSTA members will be elected at the Committee level. The term for CVP members is three years but may be renewed.

All CVP members are expected to be present at the candidate cultivar deliberations for their respective Evaluation Teams and must also be present for the Committee discussions. In the situation where a member is unable to attend the meeting, notice should be provided to the Committee Chair prior to the meetings so that a suitable alternate member can be elected.

At this level of consideration, the CVP will consider the overall attributes of the candidate (the balance of agronomic, disease resistance and end-use quality traits) based on interpretation of the data provided by the registration trials and any acceptable supplementary data, as presented in the *Request for Support for Registration* document. Each Evaluation Team Chair or Secretary will report a summary of the findings for each merit criterion and the recommendation. The breeder or designate of the line under consideration will then be given the opportunity to make a short presentation on the case for

recommendation. All full and associate members, including the Chair and Secretary may actively participate in these deliberations.

Paper ballots will be used by the CVP for voting on the candidate cultivars they consider. Following discussion of the candidate cultivar proposed for registration, the PRCWRT Chair will ask the CVP members to mark their ballots in the following categories:

- Support: the attributes of the candidate for the traits being considered are equal to or better than those of the check cultivars.
- Object: the attributes of the candidate for the traits being considered are poorer than those of the check cultivars.
- Abstain: abstentions are only expected in the absence of information on which to base a decision or in the case of a declared conflict of interest.

It is expected that all members of the CVP will vote impartially.

Votes will be counted by three PRCWRT associate members and audited after the meeting. The auditor will not be a member of the PRCWRT but must be agreed upon by the membership. Any variance between the initial vote counts and the auditor's review of the ballots will be communicated to the membership upon receipt of the vote auditor's report. The voting ballots will be kept for two years.

A simple majority will constitute a positive recommendation. In the event of a tie, a re-vote will be conducted in which the Chair will cast a vote.

It is the responsibility of the Committee Secretary to inform the Registrar, CFIA-VRO in writing of the decision of the Committee, with copies to the sponsor, and Committee Chair. Copies of the *Request for Support of Registration* document that was considered and the merit score calculation spreadsheets from each Evaluation Team (when implemented) will also be provided to the sponsor and to the CFIA-VRO.

4.4 Extra-ordinary Circumstances

4.4.1. Committee Votes Outside of the Annual Meeting

At the discretion of the Committee Chair, votes may be conducted using regular mail, facsimile or electronic mail. The quorum for this type of vote is a response from 50% of the voting members from each Evaluation Team.

4.4.2 Missing or Erroneous Data

If the *Request for Support of Registration* document or registration trial reports have missing or erroneous data, or omitted data formed the basis of a decision, the sponsor or Chair of an Evaluation Team may call for a re-vote. This request must be in writing to the PRCWRT Chair, with an explanation of the concern. The PRCWRT executive will then determine if there was an omission or error and if this information could have changed the decision. If so, the Committee will be informed and a re-vote will be conducted following the distribution of a revised data package. Since detection of these occurrences is likely to occur after the annual meeting was adjourned, the Committee Chair will determine how the vote will be conducted as per Section 4.4.1 – Committee Votes Outside of the Annual Meeting.

4.4.3 Appeal of Committee Recommendation

A PRCWRT recommendation to object to the registration of a candidate cultivar may be appealed by the sponsor on the following grounds:

- The Committee did not follow prescribed procedures.
- The recommendation was the result of erroneous data.

The criteria used in making the recommendation shall not be subject to appeal, as these criteria have been discussed and ratified by the Committee and form the basis of merit evaluation in the registration trial.

A sponsor who has grounds for an appeal must submit a written application to the PRCWRT Chair no later than March 31 of the decision year. The application must indicate the complete basis for the appeal and include a copy of the data package prepared for the candidate in question. The Committee Chair will convene an appeal board and notify the appellant and the CFIA-VRO of the decision by April 30.

The appeal board will consist of 5 to 7 full members. The number, composition and members of the appeal board will be determined by the PRCWRT Chair, who will inform the appellant of the composition of the appeal board, prior to hearing the appeal. The appellant may propose up to two alternative appeal board members, with acceptance of the alternates upon the discretion of the Chair. It is recommended that the appeal board be an odd number to avoid a tie vote.

Each Evaluation Team must be represented by at least one member. If the appeal is centered upon the actions of a particular Evaluation Team, more than one member of that Evaluation Team should be represented. The PRCWRT Chair will preside over the proceedings of the appeal, but will not vote. The appellant or a designate has the right to attend the appeal proceedings to present the case for the appeal, but does not have a vote. Following the hearing of arguments and any clarifications required by the appeal board, a secret ballot will be conducted and scrutinized by the PRCWRT Chair.

The Appeal may take one of several forms as decided by the appellant.

- A written case which is voted upon by the appeal board using regular mail, facsimile or electronic mail.
- A conference call where the appellant presents the case based on documentation previously distributed to the appeal board.
- A face-to-face meeting where the appellant submits arguments based on documentation previously distributed to the appeal board.

All appeal board travel and meeting expenses will be paid by the appellant. No additional appeals will be available at the recommending committee level.

5. APPLICATION FOR REGISTRATION

Applications for registration of the recommended candidate should be submitted using the *Variety Registration Application Form* available on the CFIA website (www.inspection.gc.ca). The application, along with other required supporting documentation, reference samples and the prescribed fee, must be sent to:

Variety Registration Office
Canadian Food Inspection Agency
59 Camelot Drive
Ottawa, ON K1A 0Y9

Telephone: 613-773-7148
Facsimile: 613-773-7261

For further information, please refer to the CFIA website:

<http://www.inspection.gc.ca/plants/variety-registration/eng/1299175847046/1299175906353>

6. CONTRACT REGISTRATION

6.1 Terms of Reference

Contract Registration is available for candidate cultivars where biochemical or biophysical characteristics distinguish them from the majority of registered cultivars of the same kind or species. Further, to qualify for Contract Registration, the owner/sponsor of the candidate cultivar must make evident the possibility of industry harm if granted an unrestricted registration.

The basis for industry harm is a scientific process in which agronomic performance, disease reaction, and/or end-use quality are assessed; socio-economic factors including market access of transgenic candidates are not to be considered. If it is shown that the candidate cultivar has characteristics that will cause harm toward cultivars registered for traditional commodity markets, or if it or its progeny may be detrimental to human or animal health, and/or safety of the environment, Contract Registration may apply.

As a general rule, Contract Registration is not to be used as a substitute for traditional forms of registration (full or interim) in situations where the PRCWRT has objected to the registration of the candidate cultivar based on a deficiency in merit. However, the PRCWRT may suggest that the candidate be considered for Contract Registration where there is rationale to do so. In this case, an extraordinary meeting of the Contract Registration Committee (CRC) may be required to consider the case and determine if the required conditions for Contract Registration have been met.

Contract Registration is a form of Restricted Registration and it can be either full or interim. Full Contract Registration is permanent and is granted for cultivars for which merit has been established. An Interim Contract Registration may be requested for initial periods of up to three years. Renewal of Contract Registration for a further term of up to an additional two years (a maximum of five years total) will require:

1. A review by the CRC and a determination of whether conditions of the initial Contract Registration have changed significantly.

2. A recommendation from the CRC to the PRCWRT.
3. Review and approval by the CFIA-VRO.

The PRCWRT does not have the authority to recommend cancellation of variety registration; however, it is expected that the PRCWRT will advise the CFIA-VRO of any potential harm that a cultivar (contract registered or otherwise) may cause.

6.2 Structure and Membership

The CRC will consist of five individuals appointed by the PRCWRT, with at least one from each of the following disciplines or areas of specialization:

- wheat or durum breeder
- cereal disease expert
- end-use quality expert

The terms of appointment will normally be for three years. A Chair of the CRC will be chosen from among these five individuals. In cases where confidentiality of data or conflict of interest is identified, the owner/sponsor of the proposed candidate may request the PRCWRT Chair to appoint alternative members. The CRC has the right to consult with other experts provided that the owner/sponsor (or designate) agrees with the choice of external consultants. The CRC will act to protect the confidentiality of data where required. There may be cases where the applicant will require confidentiality agreements to protect all parties involved in the deliberations.

Consideration or review of a contract registration application may occur at any time. Meetings of the CRC will normally be held during the annual PRCWRT meeting in February if there is a reason to do so. Other meetings may be called upon 30 days' notice or less upon the consensus of the CRC membership.

6.3 Eligibility Requirements for Candidates Considered for Testing

Where a candidate has not previously been tested in registration trials, the CRC must receive a written document from the owner/sponsor addressing the rationale for contract registration. The following points should be addressed in the document:

1. The candidate cultivar possesses unique biochemical or biophysical characteristics specific to a defined end-market and could cause industry harm if produced outside of a closed system.
2. An end user/purchaser exists for the contract registered crop.
3. A closed system for the production of the candidate is achievable.
4. The closed system provides assurance that "off-grade" production will not enter the normal marketing system for the commodity crop.

Upon a CRC endorsement that testing of the cultivar under contract registration procedures is required and appropriate, the CFIA-VRO will be informed of the decision and of any additional data requirements prescribed by the CRC.

Owners/sponsors of candidates being tested under contract registration procedures are urged to contact the CFIA-VRO for details on the required Quality Assurance Manual, which must accompany the variety registration application. The proponents should share their Quality Assurance Manual and receive support from the CGC prior to bringing the variety forward to the CRC. Support from the CGC

for the proposed closed-loop production system and quality assurance processes will be required for wheat or durum lines to be considered for recommendation of contract registration to the CFIA-VRO.

Current details of CFIA's quality control system (QCS) are outlined in the CFIA-VRO's guidance document: *Procedures for the Registration of Crop Varieties in Canada* (www.inspection.gc.ca). In addition to these requirements the owners/sponsors must also provide the following:

1. A risk assessment that takes into consideration the impact of the candidate cultivar on the viability of other classes and registered cultivars of wheat and durum, including any health, safety, environment, and marketplace impacts. It is recommended the owners/sponsors consult with the CFIA-VRO and the CGC at an early stage to discuss risk assessment issues.
2. The risk assessment must include production, handling, quality control, and financial costs such as monitoring, including sample acquisition, laboratory analysis and reporting. The owners/sponsors must identify the entity responsible for covering the costs of monitoring, and liability if problems associated with leakage of the contract registered cultivar from the closed-loop system occurs. Tolerance levels for such leakage should be identified and agreed to by the relevant industry stakeholders such as the Western Grain Standards Committee.

The assessment of production, handling, quality control, and other risks should provide the CRC with information to assess if the proposed cultivar is of high, medium or low risk to non-contract registered classes. This assessment should include (but need not be limited to) the following factors:

Factor	Comments	Risk: High, Medium or Low
Grain yield vs. alternative varieties?	Yield might be high relative to alternative varieties, making this factor "high" risk.	
Premium, discount or equivalent price (relative to alternative varieties) confirmed from identified market?	If the candidate is expected to provide a premium, there is less potential for it to be misrepresented as a conventional variety of lesser value.	
Identified market prepared to take off-grade product?	This is an absolute necessity as there is likely to be a level of production that will not meet the quality requirements.	
Quality differences against the typical class in which the variety could be co-mingled	Need to establish the risk level if co-mingling occurs.	
CGC grade designation issues	Are there special requirements for the CGC to allow this variety to be certified for shipments?	
Development of a test to allow detection that will be required in a monitoring program	How difficult will it be to detect this new product in a mixed sample?	
Geographic region of production	Will this allow selection of the candidate from a limited region or a few specific primary delivery points?	
Disease impact	Is there a disease susceptibility of major concern?	
Health and safety aspects	Are there specific characteristics of this candidate that will pose risks due to health and safety concerns?	

6.4 Contract Registration Recommendations

If the CRC is to be convened during at the PRCWRT annual meeting, the owner/sponsor of the candidate will provide the PRCWRT Chair written notification of their intent to approach the CRC at least 30 days in advance of the meeting. Appropriate documentation and/or data summaries must be included with the notice. The owner/sponsor of the candidate will be informed of the date and time of the CRC meeting and will be allowed to address the members. Following the meeting, the CRC will have up to 30 days to

rule on the suitability of the candidate for testing under Contract Registration procedures, prescribe additional data requirements over the minimum specifications, or make a recommendation on the request for Contract Registration. The CRC may seek external advice, recognizing that confidentiality may be of extreme importance. A simple majority vote will constitute the decision of the CRC. Votes will be cast in two categories: Support and Object.

The owner/sponsor or designate of the cultivar may contest a CRC decision in two general areas:

1. If the candidate is deemed ineligible for testing under contract registration procedures.
2. If the CRC objects to the contract registration of the cultivar.

A three-person appeal board will be selected: one by the appellant, one by the CRC Chair, and one neutral party agreed upon by the appellant and the PRCWRT Chair. The appeal board will choose its own Chair and determine its own procedure. The appellant will pay any expenses related to the appeal. The decision of the appeal board will be binding.

6.5 Conduct of Trials and Minimum Data Requirements

The following are minimum data requirements for the Contract Registration of a candidate cultivar. The CRC may set additional requirements within 30 days following the meeting to determine the suitability of the candidate for Contract Registration procedures.

Upon acceptance of a candidate for testing under Contract Registration procedures, the owner/sponsor agrees that the evaluation protocols and requirements for a Quality Control System by the CRC are appropriate and that these protocols and requirements, however defined, will not justify an appeal.

- a) A minimum of two years of testing is required.
- b) Testing must be conducted in the region where production is intended. The geographic region(s) may vary in area from all of western Canada to a smaller region within a province.
- c) Testing will provide comparisons with the appropriate checks for the crop kind, as currently used in regular registration testing, or as determined by the CRC.
- d) Agronomic data must be collected but will be used for descriptive purposes only. No minimum levels of performance are required for agronomic traits. A minimum of eight site-years of agronomic data are required, with a minimum of three site-years in each of two calendar years.
- e) Data quality assurance procedures must be followed as outlined in Section 3.4.2.3.
- f) Disease resistance evaluation must take place in each of the two years of testing and must follow the procedures outlined in Appendices D and E. Candidates must meet the merit requirements for disease resistance in place for traditional cultivars, unless the owner of the candidate can demonstrate that susceptibility to a particular disease will not endanger production of traditional cultivars.
- g) Agronomic performance and disease reaction data will not be considered confidential. Grain quality and the trait deemed to cause potential harm must be evaluated in each year of testing, relative to the appropriate check cultivars for the crop kind. Quality evaluation is required to confirm that the candidate has the quality claimed by the proposer and that such quality requires production within a closed-loop, contract system. Where data for a candidate for Contract Registration has been produced in regular registration trials, these data will be supplemental and not necessarily a substitute for the required two years of testing. However these data may be submitted to the CRC and CGC to determine if it is sufficient to proceed. In

consultation with the Chair and Secretary of the appropriate Evaluation Teams, the CRC has may allow supplemental data to be considered in lieu of the normal minimum testing requirements.

- h) All costs for data collection for Contract Registration shall be borne by the proposers of the candidate cultivar.
- i) Recommendations in support of contract registration will be made by the CRC and forwarded to the CFIA-VRO. The VRO will review the contract registration application and process it accordingly.

APPENDIX A: Registration Trial Missions

Central Bread Wheat Co-op: Adaptation of candidate cultivars of CWRS wheat to the rust areas of Manitoba and central and southern areas of eastern Saskatchewan.

Co-ordinator: H.S. Randhawa, AAFC - Lethbridge Research Centre (Lethbridge, AB)

Western Bread Wheat Co-op: Adaptation of candidate cultivars of CWRS wheat for the non-rust areas of southern and central Alberta and Saskatchewan including the sawfly area.

Co-ordinator: R. Cuthbert, AAFC - Semiarid Prairie Agricultural Research Centre (Swift Current, SK)

High Yielding Red Wheat Co-op: Adaptation of candidate cultivars of CPS and CWGP wheat in the black and brown soil zones and the central and southern parkland area.

Co-ordinator: F. Kirigwi, Syngenta, (Rosebank, MB); H.S. Randhawa, AAFC – Lethbridge Research Centre (Lethbridge, AB)

Parkland Wheat Co-op: Adaptation of candidate cultivars of CWRS, CPS and CWES wheat in the northern and central parkland area.

Co-ordinators: D.M. Spaner, U. Alberta (Edmonton, AB); D.G. Humphreys, AAFC – Cereal Research Centre (Winnipeg, MB)

Hard White Wheat Co-op: Adaptation of candidate cultivars of CWWS wheat for all growing areas of the Prairies.

Co-ordinator: R.M. DePauw, AAFC – Semiarid Prairie Agricultural Research Centre (Swift Current, SK)

Western Soft White Spring Wheat Co-op: Adaptation of candidate cultivars of soft white spring wheat to the irrigated areas of Alberta and Saskatchewan

Co-ordinator: H.S. Randhawa, AAFC – Lethbridge Research Centre (Lethbridge, AB)

Durum Wheat Co-op: Adaptation of candidate cultivars of durum wheat to southern and central areas of western Canada.

Co-ordinator: R.M. DePauw, AAFC – Semiarid Prairie Agricultural Research Centre (Swift Current, SK)

General Purpose Spring Wheat Co-op: Adaptation of candidate cultivars of spring wheat for the CWGP class in western Canada.

Co-ordinator: C.J. Pozniak, Crop Development Centre – University of Saskatchewan (Saskatoon, SK)

Western Winter Wheat Co-op: Adaptation of candidate cultivars of winter wheat for the CWRW and CWGP classes in western Canada.

Co-ordinator: R.J. Graf, AAFC - Lethbridge Research Centre (Lethbridge, AB)

Western Fall Rye Co-op: Adaptation of candidate cultivars of fall rye in western Canada.

Co-ordinator: J. Larsen, AAFC – Lethbridge Research Centre (Lethbridge, AB)

Western Spring Triticale Co-op: Adaptation of candidate cultivars of spring triticale to western Canada.

Co-ordinator: H.S. Randhawa, AAFC – Lethbridge Research Centre (Lethbridge, AB)

Western Feed Grain Development Coop Wheat Registration Trial: Adaptation of spring CWGP candidate cultivars from the WGFD Coop to western Canada.

Co-ordinator: D. Maxwell, AgQuest (Minto, MB)

Ag Quest Wheat Registration Trial: Adaptation of CWRS and CPSR candidate cultivars to western Canada.

Co-ordinator: D. Maxwell, AgQuest (Minto, MB)

ICMS Wheat Registration Trial: Adaptation of CWRS and CPSR candidate cultivars to western Canada.

Co-ordinator: B. Wright, ICMS (Portage la Prairie, MB)

Seed-Link Winter Wheat Registration Trial: Adaptation of candidate cultivars of winter wheat for the CWRW and CWGP classes in western Canada.

Co-ordinator: P. Bonis, Seed-Link (Lindsay, ON)

Spring Spelt Wheat Registration Trial: Adaptation of candidate cultivars of spring spelt wheat to western Canada.

Co-ordinator: P. Hucl, Crop Development Centre – University of Saskatchewan (Saskatoon, SK)

APPENDIX B: Check Cultivars – 2013

Central Bread Wheat Co-op (3 replicates)

Checks: Carberry
Glenn
Unity (Sm1 pure component)
5603HR

Western Bread Wheat Co-op (3 replicates)

Checks: Katepwa
Unity (Sm1 pure component)
Lillian
Carberry
Glenn
Exceptions: Lillian – check for yield of solid-stemmed candidates

High Yielding Red Wheat Co-op (3 replicates)

Checks: 5700PR
Glenn
Conquer (Sm1 pure component).
HY1610*

Note: Following the 2013 meeting, the coordinator, in consultation with the three evaluation teams replaced AC Tenacious (HY1615) with HY1610 as the preferred check.

Parkland Wheat Co-op (3 replicates)

Checks: Katepwa
CDC Teal
AC Splendor
CDC Osler

Hard White Wheat Co-op (3 replicates)

Checks: AAC Iceberg
Whitehawk
Snowstar

Western Soft White Spring Wheat Co-op (4 replicates)

Checks: AC Reed
AC Andrew
Sadash
Exceptions: AC Andrew – agronomic check only

Durum Wheat Co-op (4 replicates)

Checks: AC Avonlea
Brigade
AC Navigator
Strongfield

General Purpose Spring Wheat Co-op (3 replicates)

Checks: AC Andrew
Sadash
Pasteur

Western Winter Wheat Co-op (3 replicates)

Checks: CWRW: CDC Osprey
 AC Bellatrix
 Radiant
 CDC Buteo
 Flourish
 Moats
 CWGP: CDC Falcon
 Broadview
 Sunrise

Western Fall Rye Co-op (3 replicates)

Checks: Prima
 AC Rifle
 Hazlet

Western Spring Triticale Co-op (4 replicates)

Checks: Pronghorn
 AC Ultima
 Brevis
 AC Andrew
 Pasteur
 Exceptions: AC Andrew and Pasteur – check for yield of high yielding wheat

Western Feed Grain Development Coop Wheat Registration Trial:

Checks: AC Andrew
 Sadash
 Pasteur

Ag Quest Wheat Registration Trial:

Checks for CWAD, CWRS, CWGP, CWHWS, CWRW, CWRW(GP), CPS, Fall Rye, and Winter Triticale are the same as those specified for the Co-ops.

ICMS Wheat Registration Trial:

Checks for CWAD, CWRS, CWGP, CWHWS, CWRW, CWRW(GP), CPS, Fall Rye, and Winter Triticale are the same as those specified for the Co-ops.

Seed-Link Winter Wheat Registration Trial:

Checks: CWRW: CDC Osprey
 AC Bellatrix
 Radiant
 CDC Buteo
 Flourish
 Moats
 CWGP: CDC Falcon
 Broadview
 Sunrise

Spring Spelt Wheat Registration Trial:

Checks: AC Barrie
 CDC Nexon
 CDC Zorba
 CDC Origin
 CDC Silex
Exceptions: AC Barrie – check for yield of free-threshing CWRS wheat

APPENDIX C: Measurement of Agronomic Traits

Agronomic Traits Measured in each Co-operative Registration Trial

	Central Bread Wheat	Western Bread Wheat	High Yielding Red Wheat	Parkland Wheat	Hard White Wheat	Soft White Spring Wheat	Durum Wheat	General Purpose Wheat	Western Winter Wheat	Fall Rye	Spring Triticale
Number of Replicates	3	3	3	3	3	3	4	3	3	3	3
Grain Yield	+	+	+	+	+	+	+	+	+	+	+
Heading	-	-	-	+	-	-	-	-	+	-	-
Maturity	+	+	+	+	+	+	+	+	+	+	+
Height	+	+	+	+	+	+	+	+	+	+	+
Lodging	+	+	+	+	+	+	+	+	+	+	+
Shattering	-	-	-	-	-	+	-	-	-	-	-
Cleanout	-	-	-	-	-	-	-	-	-	-	-
Test Weight	+	+	+	+	+	+	+	+	+	+	+
Kernel Weight	+	+	+	+	+	+	+	+	+	+	+
Smudge	-	-	-	-	-	-	+	-	-	-	-
Black Point	-	-	-	-	-	+	-	-	-	-	-
Starchy Kernels	-	-	-	-	-	-	+	-	-	-	-
Sample Grade (site basis)	-	-	+	+	-	-	+	-	-	-	-
Wheat Stem Sawfly Cutting*	-	+	-	-	-	-	-	-	-	-	-
Winter Survival	-	-	-	-	-	-	-	-	+	+	-
Hagberg Falling Number	-	-	-	-	-	-	-	-	-	+	+

Cultural Conditions: Cultural conditions are representative of farming practices within the surrounding area and should produce seed of quality similar to the commercial commodity. Use of unregistered herbicides, or insecticides and seed applied fungicides should be avoided wherever possible. The use of foliar-applied fungicides or growth regulators is undesirable.

Experimental Design: Lattice or randomized block design, three or four reps, 36 entries or less.

Grain Yield: Plot yields should be converted to a yield per unit area (kg/ha). Equilibrate samples to similar moisture content within test sites. Record all reps.

Days to Heading: 50% heads emerged, recorded 3 times weekly. Calculated from planting date or from January 1, whichever is shorter. Record at least 2 reps.

Days to Maturity: 16 - 18% moisture content - kernels resist denting by fingernail. Recorded 3 times weekly. Calculated from planting date or January 1, whichever is less. Record at least 2 reps.

Plant Height: Straw length measured in cm from ground to top of heads excluding awns after extension growth has ceased. In the event of lodging, plants should be straightened before measurement. Record at least 2 reps.

Lodging: Record on a 1 - 9 scale, where 1 is bolt upright and 9 is completely prone, wherever significant lodging occurs. Record all reps.

Shattering: Record on a 1 - 9 scale, where 1 is undamaged and 9 is completely shattered, wherever significant shattering occurs. Record all reps.

Cleanout: Weight of cleaned sample expressed as a percentage of uncleaned sample. Record on all replicate composite.

Test Weight: Kilograms of cleaned sample (zero chaff) per hectolitre measured under standard conditions, e.g.: Dickey John Grain Analysis Computer, or to CGC standards. Record on composite of all replicates.

Kernel Weight: Milligrams per kernel based on a cleaned sample of at least 200 undamaged kernels from a composite of all replicates.

Smudge and Kernel Black point: Smudged or black pointed kernels expressed as a percentage by count or by weight of at least 10 g of the cleaned four rep composite wherever non-trace amounts of smudge or blackpoint are noted.

Percent Starchy Kernels: As determined by the Industry Services division of the Canadian Grain Commission from the cleaned composite of all replicates.

Sample Grade: As determined by Industry Services division of the Canadian Grain Commission from a composite of all replicates.

Wheat Stem Sawfly Cutting: Estimated percentage of stem girdled and subsequently toppled over from wheat stem sawfly infestation and cutting (% cut per 100 stems observed).

Winter Survival: Estimated to nearest 5% after spring regrowth wherever there is winterkill. Record all replicates.

Hagberg Falling Number: As determined using the prescribed method for the Hagberg Falling Number apparatus.

APPENDIX D: Guidelines for Disease Resistance in Wheat and Triticale

The operating guidelines for the Disease Evaluation Team (DET) of the PRCWRT are presented below for the various classes of Canadian wheat. The "Do-Not-Object-To" level of resistance described in the table is the level that would prevent significant economic loss. This is the minimum level of resistance expected in registered cultivars. The disease ratings for registered cultivars can be found in provincial seed guides, based on meetings of the Western Committee of Plant Diseases. The most common level of resistance presently found in registered cultivars is the level considered achievable within breeding programs. The "Do-Not-Object-To" level of resistance is the minimum acceptable level designated by the WRT DET. This level is agreed upon by breeders and pathologists for each disease and may change depending on virulence changes in the pathogen and availability of resistance. The "Do-Not-Object-To" level of resistance may not be sufficient to provide adequate disease control for some pathogens.

For each Priority 1 disease in each class of wheat or triticale, ratings by the DET are primarily based on the assessment of three years of disease data. The DET will "Object to" the registration of candidate cultivars that do not meet the "Do-Not-Object-To" level of resistance. The DET will "not object to" the registration of candidate cultivars that meet the "Do-Not-Object-To" level of resistance. The DET will "Support" the registration of candidate cultivars that exceed the "Do-Not-Object-To" level of resistance for one or more diseases and meet "Do-Not-Object-To" level of resistance for the other Priority 1 diseases.

Disease priorities are defined as follows:

Priority 1: Those diseases for which merit testing for registration is required and for which the "Do-Not-Object-To" level of resistance is required for a positive recommendation from the evaluation team.

Priority 2: Those diseases for which breeding and pathology research is being done in western Canada and a minimal level of resistance is desirable to reduce economic loss to producers.

Priority 3: Other diseases of wheat to which little or no breeding or pathology research is being done in western Canada but which are of localized or temporal significance.

A five point rating system of R, MR, I, MS and S is used to describe Priority 1 disease ratings where R= Resistant, S= Susceptible, M= Moderate, and I= Intermediate. The equivalent levels in provincial seed guides are: R=Very Good, MR=Good, I=Fair, MS=Poor, S=Very Poor.

The "Do-Not-Object-To" requirements for merit assessment of diseases are listed in Table 1 for the CWRS, CPS, CWGP, CWAD, CWES, CWHW, CWSWS, CWRW, Triticale, and Spelt classes. Pathologists running these disease tests will identify the check cultivars or selected check line(s) which represent the "Do-Not-Object-To" level of resistance for a particular registration trial. In cases in which the predominant resistance in a wheat class is susceptible and therefore the "Do-Not-Object-To" level of resistance is susceptible, routine registration trial disease testing may be suspended and instead selective testing would be done by special request of breeders where the potential for resistance in the line or lines is demonstrated by a combination of pre-registration trial and parental data. A minimum disease level should be attempted before testing is resumed.

External Data

For external data to be considered by the DET, it must be supplied by a recognized body or institution using procedures consistent with those in Appendix E. The required criteria include three years of data, the use of inoculum with appropriate races for the region, identification of the test location, the inclusion of a familiar susceptible check and a check with the "Do-Not-Object-To" level of resistance, and a description of the evaluation method. The DET will vote on the acceptability of external data. If the data is deemed unacceptable, the DET will report that no decision could be made because of insufficient data. If the data is acceptable, the DET will proceed to consider the data and vote as normal.

Establishing Disease Guidelines for New Classes and New Priority 1 Diseases

Priority 1 diseases are those diseases for which merit testing for registration is required and for which the “Do-Not-Object-To” level of resistance is necessary for a positive recommendation from the evaluation team. Where genetic resistance is available and a disease is considered to cause harm significant enough to warrant regulation through the registration process, new requirements and guidelines may be established. In general, registration test disease testing is provided for the major grain classes. In the case of new or minor classes of grain occupying or predicted to occupy a small acreage, external data collected in the prescribed manner may be requested. At the time of the development of a new class of wheat, Disease Guidelines will be established by the DET in consultation with the PRCWRT. Actual or forecasted area of production of significant acreage will be considered for the development of disease guidelines.

Disease Reports

DET members appointed by the chairperson prepare the disease reports. A separate report is prepared for each registration test. Prior to the PRCWRT meeting, a draft report is prepared that summarizes disease data for all entries in the registration trial. Recommendations for the advancement of lines are given on first and second year entries. A single summary disease rating of the three years data for each disease is provided on a five point rating scale of R, MR, I, MS and S where R= Resistant, S= Susceptible, M= Moderate, and I= Intermediate. Recommendations on support for registration are given on lines proposed for registration. Disease assessments and recommendations are discussed at the PRCWRT DET meeting and reports are updated prior to submission for inclusion in the minutes.

Members in charge of disease and reporting (See Appendix J for full DET membership list).

<u>Members</u>	<u>Disease Responsibility</u>	<u>Disease Report(s)</u>
Therese Despins	Common bunt	
Myriam Fernandez	Leaf spot diseases	Western Bread Wheat, Triticale
Tom Fetch ¹	Stem Rust	General Purpose
Denis Gaudet		Winter Wheat, SWS
	Leaf spot diseases, FHB	Central Bread Wheat
Steve Haber		Durum Wheat
Ron Knox		Hard White
Brent McCallum ²	Leaf Rust	Parkland, HYr (CPS/CWES)
Curt McCartney	Rust (Winter Wheat)	Spelt
Jim Menzies	Loose Smut	

¹ Chairperson

² Secretary

“Do-not-object” guidelines for merit assessment of diseases of the major classes of wheat and triticale in Western Canada.

								All Winter Wheat		Triticale	Spelt
Disease	CWRS	CPS	CWGP	CWAD	CWES	CWHW	SWS	East	West		
Leaf Rust	MR	I	I	MR	I	MR	-	I	I	MR	MR
Stem Rust	I	I	I	MR	MR	I	-	I	I	MR	-
Common Bunt	I	I	I	MR	I	I	-	I	I	I	MS
FHB	I	I	I	MS	I	I	-	-	-	MS	MS
Stripe Rust	-	-	-	-	-	-	MR	-	-	-	-

Desirable levels of disease resistance for other diseases affecting the major classes of wheat and triticale in Western Canada.

								All Winter Wheat		Triticale	Spelt
Disease	CWRS	CPS	CWGP	CWAD	CWES	CWHW	SWS	East	West		
Leaf spots	MS	MS	MS	I	MS	MS	-	-	-	-	MR
Loose Smut	MR	MS	MS	MS	MR	MS	-	-	-	-	-
Powdery Mildew	-	-	-	-	-	-	I	-	-	-	-
Black Point	-	-	-	-	-	-	MS	-	-	-	-

For the disease resistance ratings of many of the registered cultivars, please refer to the Western Committee on Plant Diseases section on the Western Forum on Pest Management website (www.westernforum.org).

APPENDIX E: Disease Screening Protocols

Protocol for evaluating reaction to loose smut in wheat (Jim Menzies)

Ten to 12 seeds of each wheat line are sown per hill plot in May at the CRC field station at Glenlea, Manitoba. At heading, three spikes of each hill are selected for inoculation. The chosen spikes are at mid-anthesis (the anthers at either end of the spike are dehiscent, while those in the middle are yellow). About 1 cm is cut off the tips of each inoculated spike with scissors to mark the inoculated heads.

The partial-vacuum method described by Nielsen (1983) is used for inoculation. With this method, the spikes are placed in an inoculation cylinder and immersed under vacuum in a suspension of water and teliospores of *U. tritici* at a concentration of about 4 g teliospores per L of water. The vacuum is maintained for two to three seconds and then released, allowing the teliospore suspension to drain into a reservoir. Without removing the spikes from the inoculation cylinder, this procedure is immediately repeated once.

The loose smut races T2, T9, T10, and T39 (Nielsen 1987) are employed in the inoculum suspension; each at 1 g teliospores L⁻¹ of water. These four races represent the common races of *U. tritici* in western Canada (Thomas and Menzies, *unpublished data*). A fresh mixture of inoculum is prepared each day.

Each spike is harvested and threshed individually. The seed are sown in a soil bed in the greenhouse during the following winter. At heading, the numbers of healthy and smutted plants are recorded and the percentage of smutted plants determined.

Nielsen, J. 1983. Spring wheats immune or highly resistant to *Ustilago tritici*. Plant Dis. 67: 860-863.

Nielsen, J. 1987. Races of *Ustilago tritici* and techniques for their study. Can. J. Plant Pathol. 9: 91-105.

Protocol for evaluating reaction to common bunt in wheat (Denis Gaudet)

Spring wheat bunt reaction nurseries are sown on fallow land at the earliest possible date, which is about mid April in Lethbridge. Winter wheat is as late as possible to ensure good winter survival. Seeds are sown to a depth of 6 cm in cool soil, with row lengths from 4.5-6 m. Inter-row spacing is set at 25 cm. Guard rows at the start of the plot are infested with common bunt to pre-contaminate the seed drill. Check lines are included every tenth row. At maturity, each plot is visually evaluated for bunt and percent bunt infection estimated for each row. The test is seeded at two locations, one under dryland conditions and one with access to irrigation.

Seed is inoculated to excess with a 1:1 composite of the bunt species *Tilletia tritici* and *T. laevis* in a 1:1:1:1:2:2 mixture of the races T-1, T-6, T-13, T-19, L-1, L-16. This composite represents the virulence spectrum of most locally collected bunt isolates. The population dynamics of the races may vary from year to year and location to location depending on environmental conditions. Spores are collected by grinding bunt infested heads with a Wiley mill grinder fitted with a 4 mm screen. Seed envelopes or trays are then infested with the mixed spore mixture within the seed envelope (0.04 g bunt/10 g seed). The bunt is not pre-weighed but only scooped into the envelope at an estimated amount. Envelopes are bound together with elastic bands and inserted in seeding trays. The trays are then placed on an agitator and allowed to agitate until seed is thoroughly infested. Envelope size and elastic band placement must be considered to ensure seed can freely agitate within the envelope while on the shaker.

Just prior to maturity, as the wheat is turning, plots are visually rated for bunt. Care must be taken to check the shorter tillers which are more prone to being bunted. The major check line Neepawa is inserted every twenty rows. Minor check entries are inserted into the nursery occurred every hundred rows. The minor checks are Barrie, Fielder, Foremost, Laura, and McKenzie. The reactions of the lines are divided into 6 classes, as defined by bunt scores compared to the intermediate major check, Neepawa. Lines falling within a single standard deviation on either side of the Neepawa mean are defined as intermediate. Lines falling within 2 standard deviations around the Neepawa mean are moderately resistant and moderately susceptible. Lines greater than 2 standard deviations

to the left of Neepawa are resistant, whereas lines 2 standard deviations to the right are susceptible. All lines greater than 3 standard deviations to the right of the Neepawa mean are classed as highly susceptible.

Protocol for evaluating reaction to wheat stem rust (Tom Fetch)

Co-op entries are screened in field stem rust nurseries (adult stage) as well as in seedling tests in the greenhouse. Data from both sources are considered in determining a rating.

Co-op entries in the field stem rust nurseries are seeded in short rows, between spreader rows consisting of a mix of susceptible lines. Spreader rows are inoculated with a mixture of stem rust races (TPMKR, TMRTK, RKQSR, RHTSK, MCCFR, RTHJT, and QTHST). These races were chosen to represent a wide range of virulence to ensure adequate levels of resistance are maintained in wheat cultivars, i.e. More than one *Sr* gene for resistance.

The field nurseries are rated for disease when symptom expression is optimal, as indicated by the reaction of the check cultivar 'Columbus'. Two ratings are given for each line; (1) severity of the disease expressed as percentage of stem coverage, and (2) reaction or pustule type ranging from R - RMR - MR - MRMS - MS - MSS - S. Infection levels may vary from year to year depending on environmental conditions, but the inoculum mixture is the same. The cultivar 'Columbus' is intermediate in resistance, which corresponds to the "Do Not Object" level.

For seedling tests, Co-op entries are seeded in hills using fibre flats, and inoculated at the first leaf fully expanded stage (7-8 d). Races TPMKR, TMRTK, RKQSR, RHTSK, MCCFR, RTHJT, and QTHST are individually inoculated for each entry. Inoculation and incubation protocols are published and available online (<http://pubs.nrc-cnrc.gc.ca/tcipp/cjplant27-04.html>; Fetch, T. pp 572-580). Lines are rated for infection type on a 0-4 scale (0, ;, 1, 2, 3, 4). Reaction types of 0, ;, 1, and 2 are considered resistant, and types 3 and 4 are usually considered susceptible (3⁺ reactions may show some level of resistance).

Protocol for evaluating reaction to wheat leaf rust (Brent McCallum)

Co-op entries are screened in a field leaf rust nursery (adult stage) as well as in seedling tests indoors. Data from both sources are considered in determining a rating.

The field leaf rust nursery is seeded in short rows with spreader rows of a susceptible variety at regular intervals. Spreader rows are inoculated with a mixture of leaf rust races that were collected during the leaf rust disease survey from the previous year. To determine the composition of this inoculum, check the wheat leaf rust publication from the previous year in the Canadian Journal of Plant Pathology.

The field nursery is rated for disease when symptom expression is optimal. Two ratings are given for each line; (1) severity of the disease expressed as percentage of leaf coverage, (2) reaction or pustule type ranging from R - RMR - MR - MRMS - MS - MSS - S.

Seedling tests: Lines are seeded in flats and inoculated at the two leaf stage. Races MBDS, TBJJ, MBR, MGB are used for the seedling test. Lines are rated for pustule type ;, 1, 2, 3, 4. Reaction types ;, 1, and 2 are considered resistant and types 3 and 4 are usually considered susceptible (some type 3 reactions may show some level of resistance). Inoculation and rating methods are detailed in the annual wheat leaf rust survey publication.

Protocol for evaluating reaction to leaf spots (Jeannie Gilbert)

Leaf spot reaction of Co-op materials is assessed on plots that have only been exposed to natural field inoculum. Three replicates at the "C" level and two at the "B" level are planted. Percent severity of flag (F) leaves and the F-1 leaves are recorded between milk and soft dough stage of ripeness. The prevalent leaf spot pathogens infecting the Co-op entries are subsequently determined from leaf tissue samples collected from the check varieties. Samples are collected at the time of scoring, surface sterilized, then incubated under cool white light for 5 days at 20° C to promote pathogen sporulation and facilitate identification of the organism(s) causing disease.

Protocol for evaluating reaction to Fusarium head blight in the field (Jeannie Gilbert)

Identify rows at 50% anthesis (spray paint of different colours to denote each date). Inoculate plants with 50 ml spore suspension ($50,000$ conidiospores ml^{-1}) per meter of row when 50% heads are in anthesis. Inoculate the same rows 3-4 days later to infect later tillers. Mist or irrigate in the evening of each inoculation.

Visual Rating Index (VRI):

In the field, rate infected rows using two digits at 21 d after inoculation. The first digit/number (0-10 scale) represents the incidence (percent of heads with infection), while the second digit/number (0-10 scale) represents the severity (average amount of infection on infected heads). The VRI is the product of Incidence $\times$ Severity.

In the greenhouse, screening may be done by spray inoculation or by single floret inoculation (SFI). The spray method closely follows the field inoculation procedure, except that the head is subjected to inoculum (approximately 2 ml/head at $50,000$ conidiospores ml^{-1}) and humidity just once. SFI provides a measure of spread of the fungus in the head. 10ul of a spore suspension of $50,000$ conidiospores ml^{-1} is placed inside the floret at anthesis. Plants are provided with 100% RH for 24 h. Rating is done 21 d later as percent infected spikelets.

Assessment - Disease development is especially dependent on the right environmental conditions. High temperatures on the day of inoculation may cause little disease to develop. Check varieties are planted at regular intervals throughout the nursery and ratings have to take conditions and check reactions into account. A low score may mean escape rather than resistance. It is therefore very difficult to make an arbitrary statement about levels of disease being rated as MS or MR etc, although we are attempting to. Relative to the checks the level required for each rating category may change from year to year.

Appendix F. Wheat and Durum: Measurement of Quality Traits

The Canadian Grain Commission (CGC) is the federal agency with the authority to classify new wheat and durum varieties at registration. To be considered for support by the Quality Evaluation Team of the PRCWRT and to ensure a candidate line meets the class-specific quality requirements, data from the registration trial material must meet the criteria specified in the following four parts:

- Part 1: Submission of registration trial material
- Part 2: Quality factors to be tested for each registration trial category
- Part 3: Laboratory testing methodology
- Part 4: Reporting of data

Part 1. Submission of registration trial material:

The purpose of this section is to provide the breeding institution and trial coordinator with instructions on how to put together a composite from the various trial locations. The trial check samples are used to determine the desired composite percentage to be selected from each location. The same percentages will then be used for all of the line entries from that location. The CGC will review the checks for protein, grade and degrading factors and then calculate the desired location blend for quality submission purposes.

1. CGC conducts preliminary grading on individual check samples from each location
 - Sample size: 250 – 500 g
 - Breeders (trial coordinators) to provide protein content and test weight
 - CGC to provide preliminary grade and grading factors
2. Development of recipes for making final composites for quality analysis (CGC and breeders)
 - Selection/elimination of sites based on the grades of the check samples
 - Aiming for No. 2 grade or better, with a target protein content range for the checks, and checks should be ranked as “usual” for their protein contents.
 - Development of formulas (% from each site) which depend on grade, grading factors, protein content, and seed availability, etc.
3. Breeders prepare quality composites for individual checks and lines
 - Breeders to provide wheat samples (bread wheat: 8-12 kg; durum wheat: 6-8 kg).
 - CGC to provide final official grade for each composites based on grading of 1 kg sample size.

Part 2: Quality Criteria and tests for each registration trial category

CRITERIA	TESTS/PARAMETERS	Hard Red Spring	Hard White Spring	High Yield Spring	Hard Red Winter	Soft White Spring	Durum
WHEAT CHARACTERISTICS	Grade	✓	✓	✓	✓	✓	✓
	Test weight, kg/hl						✓
	Hard vitreous kernels, %						✓
	Cadmium, ppb						✓
	Protein, %	✓	✓	✓	✓	✓	✓
	Falling number, seconds	✓	✓	✓	✓	✓	✓
MILLING PERFORMANCE	Milling yield, clean wheat basis, %	✓	✓	✓	✓	✓	✓
	Milling yield, 0.50% ash basis, %	✓	✓	✓	✓		
	Semolina yield, %						✓
FLOUR / SEMOLINA ANALYSIS	Protein, %	✓	✓	✓	✓	✓	✓
	Protein loss (wheat to flour), %	✓	✓	✓	✓	✓	
	Ash, %	✓	✓	✓	✓	✓	✓
	Amylograph peak viscosity, BU	✓	✓	✓	✓	✓	
	Starch damage (Megazyme), %	✓	✓	✓	✓	✓	
	Solvent retention capacity, %					✓	
	PolyPhenolOxidase activity	✓	✓	✓	✓		
	Semolina colour						✓
	Gluten index, %						✓
	Yellow pigment, ppm						✓
DOUGH PROPERTIES	Farinograph - Water absorption, % - Dough development time, min - Mixing tolerance index, BU - Stability, min	✓	✓	✓	✓	✓	
	Alveograph - P (height x 1.1), mm - L (length), mm - P/L - W, x 10⁻⁴ joules					✓	✓ *
END-PRODUCT QUALITY	Bread quality (Canadian Short Process/Remix-to-peak) - Baking absorption (%) - Mixing time (min) - Mixing energy (Whr /kg) - Loaf volume (cm³/100g flour)	✓	✓	✓	✓		
	Spaghetti quality Colour (L*, a*, b*)						✓
	Noodle quality (Yellow alkaline/white salted) - Sheet colour (L*, a*, b*) - Sheet speckiness	✓	✓	✓	✓		
	Cookie quality (Sugar snap) - Spread (mm) - Ratio (width/ thickness)					✓	

* Only on those durum lines where Gluten Index is greater than 75

Part 3. Laboratory testing methodology

The following list of tests are provided by the CGC-Grain Research Laboratory as their official methods used in determining classification of varieties. Any laboratory that considers performing alternate methods should first have the testing protocol reviewed and approved by request to the Quality Evaluation Team chair and secretary. Quality data is compiled from the results of tests performed by a grain quality testing laboratory. These tests are conducted according to standardized procedures and methods. Each time a test is performed on a composite sample, the method for that test must be closely followed in order to assure reliable and accurate quality data that can be compared from year to year.

Unless otherwise specified:

- Analytical results for wheat are reported at 13.5% moisture content.
- Analytical results for flour and semolina are reported at 14.0% moisture content.
- AACC methods cited are from The American Association of Cereal Chemists (AACC): Approved Methods of the American Association of Cereal Chemists, Tenth Edition, 2000.
- ICC methods cited are those of the International Association for Cereal Science and Technology (ICC): ICC Standards: Standard Methods of the International Association for Cereal Science and Technology, 7th supplement, 1998.

Testing Methods Employed by the Canadian Grain Commission - Grain Research Laboratory

Common Wheat Testing

Amylograph Peak Viscosity

Sixty-five grams of flour and 450 millilitres of distilled water are used with the Brabender amylograph and the pin stirrer. Other details are as in AACC Method 22-10.01. Peak viscosity is reported in Brabender units

Ash content

To determine wheat, flour or semolina ash content, AACC Method 08-01.01 is used with the following modifications. Samples are incinerated overnight in a muffle furnace at 600°C. Please refer to modifications listed below.

GRL Modified Step	AACC Method
Place samples in muffle furnace at 450 °C, Ignite samples. After they burn off close furnace door and increase temp to 600°C.	Place in muffle furnace at 550°C for soft wheat flours or 575-590°C for hard wheat flours.
Incinerate overnight.	Incinerate until light gray ash is obtained or to constant weight.

Canadian Short Baking Process (refer to Appendix F2 for a detailed description)

The Canadian short process baking test, (Preston et al. 1982), C.I.F.S.T. Journal 15: 29-36, uses 150 ppm ascorbic acid as the oxidant and reducing the salt to 2%. Dough is mixed in a Swanson type 100-200 gram pin mixer (National Manufacturing Co., Lincoln NE) at 116 rpm. Loaves are produced from 200 grams of flour in baking pans with cross-sectional dimensions similar to Canadian commercial baking pans. Loaf volume is reported on a 100-gram flour basis. Mixing energy is reported in watt-hours per kilogram (W-h/kg) of dough. Note that additional mathematical transformation of the data from this curve is required so that final mixing energy may be reported as watt-hours per kilogram of dough.

Cookie test

The sugar-snap cookie test is performed according to AACC Method 10-50.05.

The wire-cut cookie test is performed according to AACC Method 10-53.01; however it is not a mandatory criteria.

Falling number

The falling number is determined on a 7-gram sample of ground wheat or semolina by AACC Method 56-81.03. A 300-gram sample of wheat is ground in a Falling Number Laboratory Mill 3100 according to ICC Standard Method No. 107. The falling number test is used to evaluate the amount of sprout damage in Canadian wheats.

Farinogram (refer to Appendix F1 for a detailed description)

This test is conducted using AACC Method 54-21.02, following the procedure for constant flour weight using the small bowl.

- Farinograph absorption is the amount of water that must be added to flour to give the required consistency. It is reported as a percentage.
- Dough development time (DDT) is the time required for the curve to reach its maximum height reported to nearest 0.25 minute.
- Mixing tolerance index (MTI) is the difference, in Brabender units, between the top of the curve at the peak and the top of the curve measured five minutes after the peak is reached.
- Stability is defined as the difference in time, to the nearest 0.5 minute, between the point at which the top of the curve first intersects the 500-BU line (arrival time) and the point at which the top of the curve leaves the 500-BU line (departure time).

For CWES, farinograph absorption is determined at 63 rpm. Remaining quality parameters are measured at 90 rpm based on absorption obtained at 63 rpm. For additional details, see the *Farinograph Handbook*, AACC, 1960.

Flour Milling

CGC GRL Allis-Chalmers Wheat Flour Milling Procedure - Temporary Milling Protocol

1. **IMPORTANT:** Complete the following check list before starting the mill.
2. Trouble lights are placed in the drawers under the B3/ S1, S2/S3 and M1 to M4 roll stands. Lights must be warming rolls a minimum of 16 hours prior to milling. M1 roll temperature should be 37.5-39C for milling.
 - 2.1. B3/S1 Sylvania soft white 75W/120V
 - 2.2. S2/S3 Haskellite standard 75W/130V
 - 2.3. M1-M4 Haskellite standard 75W/130V
3. Verify that the vibratory feed settings on roll stands are set as follows:
 - 3.1. B1 setting 3
 - 3.2. B2 setting 4
 - 3.3. B3/S1 setting 4.3
 - 3.4. S2/S3 setting 4 and 4.2 respectively
 - 3.5. M1-M4 setting 4.6 (M1) and 4.9 (M2 to M4)
4. Check room temperature and relative humidity. For optimum milling conditions readings should be 21C (70F) and 60%RH. Humidity tolerances are +/- 4% and temperature tolerances are +/- 2 degrees.

IMPORTANT: The following procedures must be followed to ensure satisfactory accuracy and precision of mill results:

1. A 2 kg check sample should be milled on a daily basis. Flour yield, moisture, farinograph, and Minolta spectrophotometer CM-5 colour value should be recorded for every check milling to document mill performance (see Appendix I).
2. Once a month a check sample should be milled and the weights of all drawers of stock produced in the milling process should be recorded (see Figure 2).
3. At the end of each day the flour sieves (160N) should be removed from each sifter and vacuumed clean.
 - 3.1. After the milling of either Soft Wheat or Eastern Wheat classes, a more thorough cleaning is required. All sieves are removed from the sifters and are blown clean using the high pressure air hose. A check sample should be milled after this so the sieves are once again 'seasoned' and ready for the next sample.

Milling Procedure: Note this is a temporary protocol

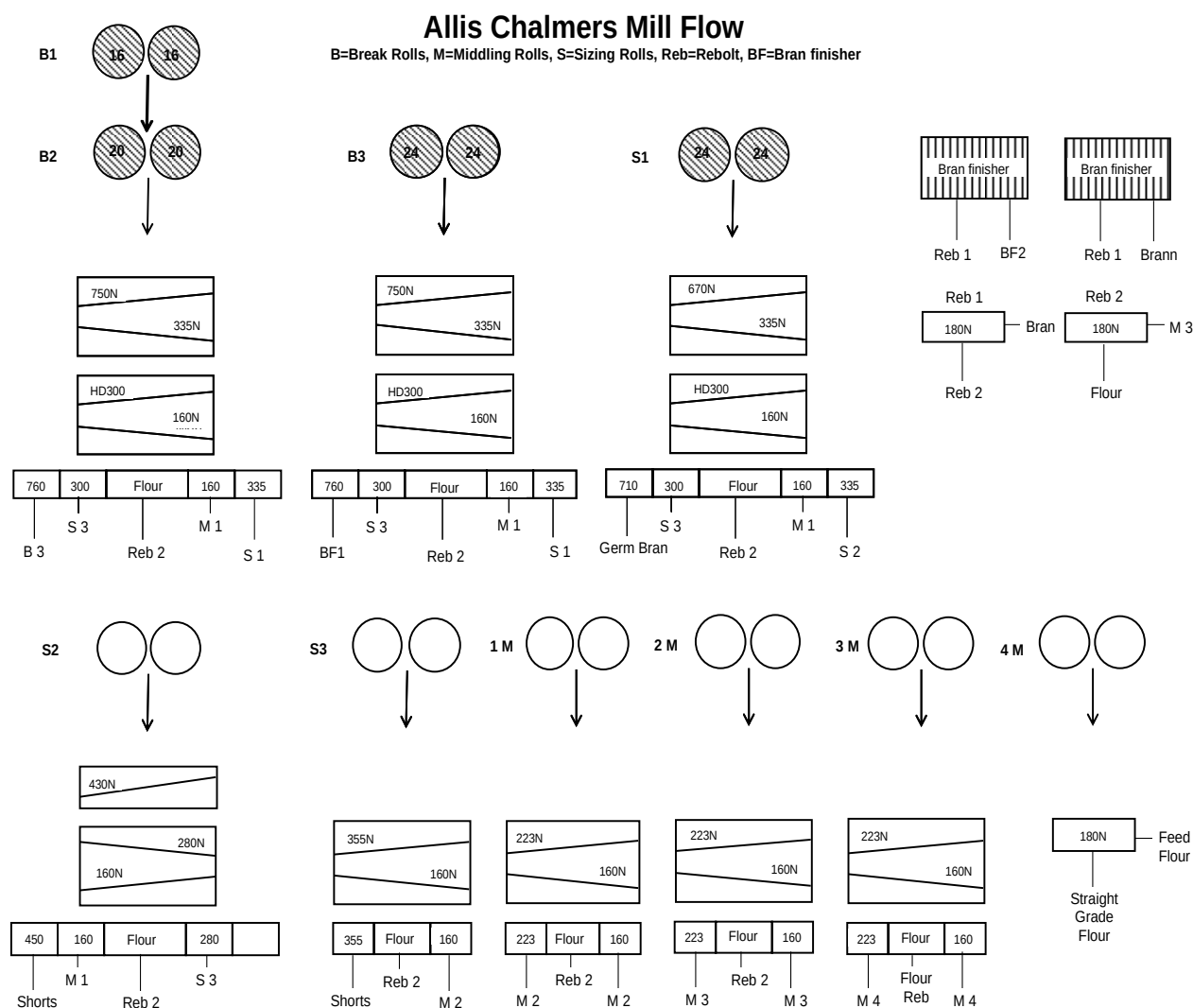
1. Prepare samples for milling according to the CGC GRL wheat sample preparation for milling procedure.
2. Check the conditioning moisture of all samples to be milled. Optimum tempering moisture for CWRS wheat is 16.3%. Samples <16.0% or >16.6% should not be milled.
3. Weigh tempered wheat to the appropriate amount on a 14.0% moisture basis (1028g at 16.3% moisture content equals 1 kg at 14% moisture).
4. The routine GRL wheat flour mill flow is illustrated in Figure 1.
5. Feed wheat to B1 roll stand. Maximum sample capacity under the rolls is 3 kg. Samples in excess of that amount should be split into portions and fed to the B1 stand separately.
6. Feed stocks from B1 roll stand directly to B2 roll stand without sifting.
7. Sift the stock from B2 on the first GRL sifter. Maximum capacity in the 760N drawer is 2.5 kg. If there is a larger sample, separate the overs of the 760N sieve by stopping the GRL sifter half way through sifting and feeding the overs of the 760N sieve into the B3/S1 rolls. Continue sifting and feed the remainder of the 760N overs into the B3/S1 rolls.
8. **Soft Wheat Note:** Wheat such as Soft White Spring and Eastern Soft Red Winter are milled differently. Follow the above procedure to step #7. The branny material collected in the 750 drawer is fed through the B3/S1 roll stand for a second time. This material is then sifted once again on the first GRL sifter.
9. Sift the stock from the B3/S1 rolls on the first GRL sifter. Clean the sifter down completely using a wooden mallet and short bursts of air. The overs of the 335N sieve have been collected from the previous siftings and are fed into the B3/S1 roll stand.

10. The bran is fed into the bran finisher. Once it works its way through turn the machine off. Withdraw the bran drawer and run through the bran finisher again. Tap down the bran finisher and clean the sieve into the flour tray.
11. The other 3 drawers are shifted into the corresponding slots under the second GRL sifter.
12. The stock from the B3/S1 rolls is sifted on the second GRL sifter. Clean down sifter. Weigh the overs of the 710N sieve and record as fine bran. Feed the overs of the 335N sieve into the S2/S3 roll stand. Shift the remaining 3 drawers to the corresponding slots under the third GRL sifter.
13. Sift the stock from the S2/S3 rolls on the third GRL sifter. Clean down sifter. Weigh the overs of the 450N and record as shorts. Discard. Feed the overs of 280N into the S2/S3 roll stand.
14. **Soft Wheat Note:** Continue procedure as above until step #12. Take the overs of the 160N and sift over the 180 sieve in the box sifter (10 seconds for a 2 kg sample and 15 seconds for a 3 kg sample). Weigh the overs of the 180 sieve and record as coarse midds. Feed this material over the M1-M4 roll stand. The throughs of the 180 sieve are added to the flour drawer. Continue procedure as below.
15. Weigh the stock collected as overs of the 160N sieve and record as coarse midds. Once recorded, feed stock into M1-M4 roll stand. Shift the flour drawer to the corresponding slot under the fourth GRL sifter.
16. While stocks run through the S1/S2 and M1-M4 roll stands, sift the flour from the bran finisher's flour tray over the 180N sieve in the box sifter. Weigh and record the bran and bran flour. Discard the bran. Add the bran flour to the flour drawer under the fourth GRL sifter.
17. Sift stock from the S2/S3 rolls on the last GRL sifter and the stock from the M1-M4 roll stand on the fourth GRL sifter. Clean down the sifters.
18. Combine the stock from the overs of the 160N sieve on the last GRL sifter and the overs of the 223N and 160N sieves on the fourth GRL sifter. Feed through the M1-M4 roll stand (M2). Add the flour from the last sifter to the flour drawer under the fourth GRL sifter. Weigh the overs of the 355N sieve on the last sifter and record as shorts. Discard.
19. **Soft Wheat Note:** For M2-4, feed the overs of 160N on the fourth GRL sifter into the mill first. Sift the overs of the 223N on the box sifter with a 600N sieve to break up flour balls before feeding into the mill. Place the sieved flour (step 17 and 18) in a separate container for soft wheat milling. ***This step is also used on Western Winter Wheat.***
20. Sift the M2 stock on the fourth GRL sifter. Clean down sifter. Combine the 2 end drawers and feed through the M1-M4 roll stand (M3). Take the flour and slowly feed into the box sifter, sifting over the 180N sieve until there is approximately 30g of stock left on the sieve. Add this stock to the other M3 stock running through the rolls.
21. Sift the M3 stock on the fourth GRL sifter. Clean down sifter. Combine the 2 end drawers and feed through the M1-M4 roll stand (M4). Take the flour and sift over the 180N sieve in the box sifter until there is approximately 5-10g of stock left on the sieve. Add this stock to the other M4 stock running through the rolls.
22. Sift the M4 stock over the 243N and 180N sieve in the box sifter for 10 seconds each, scalping lightly. Weigh the overs of the 243N and 180N and record as feeds. Discard, clean down box sifter and weigh flour. Pour flour into tumbler and tumble for 10 minutes. Transfer flour into cleaned sample pail.

Acceptable tolerances for check milling results.

1. Flour moisture content should be within ± 0.3 % of the long term average. If not, this is indicative of improper conditioning moisture, a problem with the moisture oven, or improper room conditions. If room conditions are correct and the problem persists with the next check sample the moisture meter and/or moisture oven should be examined.
2. Minolta spectrophotometer CM-5 colour should be within $\pm 2\%$, flour yield should be within $\pm 1\%$ and most importantly farinograph reading should be within $\pm 0.5\%$ of the long term averages of previous check millings. If any of these tolerances are exceeded another check sample should be milled immediately. If the anomaly persists the mill should be reset.

Figure F1.



Flour yield

Wheat is cleaned, scoured and tempered overnight to optimum moisture as described by Dexter and Tipples (1987), Milling 180(7):16, 18-20. All millings at the Canadian Grain Commission's Grain Research Laboratory are performed in rooms with environmental control maintained at 21°C and at 60% relative humidity.

- Common wheat is milled on an Allis-Chalmers laboratory mill using the Grain Research Laboratory sifter flow as described by Black et al. (1980), Cereal Foods World 25:757-760.
- Flour yield is expressed as a percentage of cleaned wheat on a constant moisture basis. For Canada Western Red Spring (CWRS) wheat, flour yield also is expressed at a constant ash content of 0.50%, as described by Dexter and Tipples (1989), Milling 182(8):9-11.

Moisture content - flour

To determine the moisture content of flour, a 10-gram sample is heated for one hour in a semi-automatic Brabender oven at 130°C.

Moisture content - wheat

The moisture content of wheat is determined using the Model 919 moisture meter calibrated against the AACC method 44-15.02, following the procedure for two-stage air-oven.

Noodle colour

- Colour is determined on a raw noodle sheet using a Hunterlab Labscan XE spectrophotometer using the CIE (1976) L*, a* and b* colour scale with a D65 illuminant and a viewing angle of 10°.
- L* is a measure of brightness.
- a* indicates red-green chromacity. Positive values indicate increased redness.
- b* indicates yellow-blue chromacity. Positive values indicate increased yellowness.

1. Calibrate the Hunterlab LabScan XE

- 1.1. Place the black glass tile provided with equipment over the port, select 'Standardize' and accept the port size message, (1.75" area, 2.00" port)
- 1.2. Replace the black tile with the standard white tile supplied with instrument, hit enter, accept the message about the white tile being read.
- 1.3. When the message 'Sensor successfully standardized' appears, take a reading of **THE STANDARD WHITE TILE USING 'READ SAMPLE'**.
- 1.4. Replace with the diagnostic green tile and take a reading of it using 'Read Sam'. Label in a consistent manner.
- 1.5. Repeat the calibration and colour standards every four (4) hours. The software will prompt you to do this.
- 1.6. Click on Active View icon and change the scale from CIELAB to XYZ.
- 1.7. Compare the XYZ data to tile information. Tolerance is +/- 0.3 on all. Typically we are within
- 1.8. Select Active View once again and return to CIELAB scale.

2. Noodle Colour Reading

- 2.1. Place the sample so that it completely covers the port. Cover the sample with the black painted cover.
- 2.2. Using the Mouse Choose 'Read Sample' or the keyboard "Alt" 'R' 'S'.
- 2.3. Record readings at 3 separate positions on the noodle sheet.

3. Noodle preparation

- 3.1. Noodles are prepared following the method of Kruger et al (1994), Cereal Chemistry 71:177- 182. Yellow alkaline noodles are prepared with a 1% kansui reagent (9:1 sodium and potassium carbonates) at a 32% water absorption. *A detailed protocol follows for the Hobart mixer.*

4. Apparatus

- 4.1. Temperature and humidity controlled room, Liebert HVAC unit and humidity retaining fresh air exchanger.
- 4.2. Ohtake noodle machine (Osaka, Japan).
- 4.3. Circulating heating/cooling water bath set at 28° C feeding the Ohtake rollers.
- 4.4. Hobart Mixer, N-50, bowl, paddle and slotted acrylic cover.

5. Preparatory work in the Noodle Testing Room at 24°C:

- 5.1. Calibrate the HunterLab XE for raw noodle color measurement as described above and calibrate the speck counter as outlined in the NoodleScan protocol calibrating the necessary scanner(s) as described.
- 5.2. Weigh 200 g (14% mb).
- 5.3. Weigh out sufficient water for 32% absorption (on a 14% flour mb).
- 5.4. Add 1% w/w of flour weight of salt or kansui to the required water (ie. ~2.0 g) and dissolve. (Kansui consists of a 9:1 w/w ratio of sodium carbonate:potassium carbonate).

6. Noodle flour mixing and sheeting: *(This is a timed process)*

- 6.1. **Room setup:** Ohtake noodle machine's water bath which circulates water through the roll stands at 28°C. Room equilibrated at 24°C and 50% RH. The electronic gap indicator on the Ohtake noodle machine set at 3.00 mm.
- 6.2. **Mixing:** Place flour into the Hobart bowl, put cover in place.
- 6.3. Mixer speed is set at 1. Start timer and mixer together, mix for 30 seconds.
- 6.4. Add solution during the **next** 30 sec at a slow steady speed. At the right speed of pouring, the stream of liquid should break into droplets before reaching the flour. Continue to mix for another 30 sec.
- 6.5. Stop mixer, change to speed 2 and restart. Mix for 1 min.
- 6.6. Stop mixer, change speed to 1 and restart. Mix for 3 min. Total mixing time **5:30 min**.
 - 6.6.1. Place the clear tygon tubing across the gap (3mm gap), with it curving upwards in the middle (frowning), push down with fingers till it closes off gap space thus preventing crumbs from dropping through.
- 6.7. **Sheeting:** Place clear tygon tubing across width of sheeting gap to retain the dough. Pour the dough from the bowl onto the rollers. With your fingers make sure that the crumbs are spread evenly and right into the corners. Start the rolls and press the crumbs in evenly with the stick provided.
- 6.8. Fold the initial noodle sheet in half, end to end (within ½" of other end) and pass through the rolls a 2nd time. Trim dough sheet to 25 cm length, weight and record length and weight in log.
- 6.9. Start the timer and pass the sheet through the rolls a third time the at 3.00 mm gap. Stop the rolls. Adjust the gap to 2.55 mm, restart rolls, wait until timer shows 45 sec and then feed the noodle sheet into the rolls. Continue in this fashion for these gap settings and times:

<u>Time</u>	<u>Gap</u>
0:00	3.00 mm
0:45	2.55 mm
1:30	2.15 mm
2:15	1.85 mm
3:00	1.55 mm
3:45	1.35 mm
4:30	1.10 mm

- 6.10. After the last pass (1.10 m) through the rolls, measure the length of the dough sheet and record in log.
- 6.11. Cut a portion of the sheet for colour and image analysis, usually ~ 20 cm. Label and place in sealed plastic bag for color (HunterLab XE) and image analysis (NoodleScan) as described.
- 6.12. Reset all equipment to starting settings.

7. Wash mixer bowl, paddle and solution beaker

Noodle Dough Sheet Speckiness (NoodleScan)

1. Test is performed at 2 and 24 h after production on a 5 x 5 cm piece of dough sheet which has been stored in a sealed plastic bag since manufacture at room temperature (24°C).
2. A commercial MicroTek 8700 scanner is used to perform the test after it has been calibrated with a Kodak Q60 Colour chart standard. This calibration is done twice a day.
3. Analysis is performed using in-house developed software (NoodleScan, based upon Carl Zeiss KS400 software) which allows the operator to set the minimum size (0.003mm²) and minimum delta grey level (5) of a speck from the background noodle matrix. (Note the background noodle matrix changes in color over time due to oxidation and hydration effects and the software measures and accounts for this).
4. A minimum of two separate preparations of the noodle dough sheet are measured.

PPO Method-YSI Oxygen Consumption

1. **Equipment:** Yellow Springs Instrument Co. (YSI) Model 5300 Biological Oxygen Monitor as per Hatcher & Kruger (1993 Cereal Chem.70, 51-55)
2. **Solutions Used:**
 - 2.1. McIlvaines buffer pH 6.8 working solution 0.1M
 - 2.2. Make fresh daily.

2.3. *Catechol solution 0.8M substrate solution*

- 2.4. Make fresh daily. Place 0.44 g of pyrocatechol into 5 ml volumetric flask. Add 3.5 ml of McIlvaines working solution, dissolve, make to mark. Store in metal container away from light. Discard at end of day.

3. Electrode stability

- 3.1. Circulate the water bath water through the cell assembly holder for one hour.
- 3.2. Equilibrate the working McIlvaines solution in the water bath with slow aeration for a minimum of 20 minutes. Gas should be about 6-8 psi. Aerate the McIlvaines solution throughout the testing period.
- 3.3. Establish the electrode stability by monitoring the drift in the recorder trace using 4.0 mls of McIlvaines solution.

4. Substrate (Catechol Alone) slope correction factor

- 4.1. Use gas type syringe to inject catechol. Rinse the syringe 3-4 times with catechol. Rinse with DW at end of day.
- 4.2. Inject 100 μ L of 0.8M catechol into the 4 mls of McIlvaines solution in chamber.
- 4.3. Start timer immediately. Recorder is on. Run the trace for 5 minutes. Shut off paper.
- 4.4. Calculate the slope/min.
- 4.5. Use as this as correction factor for the *substrate oxidation* calculation.

5. PPO Sample Analysis

- 5.1. Normal analysis, sample size is: 0.2 gms for flour, but may vary depending on PPO levels.
- 5.2. Establish a 100% reading with 4 mls of McIlvaines solution alone.
- 5.3. Once reading stabilizes, adjust knob to 100%, let run for 3 minutes with paper running.
- 5.4. Stop the paper.
- 5.5. While the solution is stirring, remove plunger, add sample. Break up any aggregates and remove any obvious bubbles.
- 5.6. Replace plunger. Stop stirrer. Ensure all air bubbles are removed by gently twisting the plunger allowing them to escape up the plunger's grooved path.
- 5.7. Start stirrer. Once the system is free of air, initiate the trace.
- 5.8. When the trace is smooth, run for 3 minutes to obtain the *baseline O₂ consumption*. The slope of this curve is the baseline oxygen consumption for the sample.
- 5.9. While the sample is still running, inject 100 μ L of the catechol substrate solution into the cell via the side groove. Start timer immediately. Run for 5 minutes and stop. The slope achieved is the sample's oxygen consumption which must be corrected for baseline O₂ and catechol alone slope.
- 5.10. $\text{PPO Slope} = (\text{sample} + \text{substrate slope}) - \text{baseline oxygen consumption} - \text{the slope correction factor of the substrate alone.}$
- 5.11. $\text{PPO Activity} = ((\text{PPO slope \% basis}) \times 199 \text{ nmoles O}_2/\text{ml} \times \# \text{ of mls in cell}) / \text{g of sample}$
- 5.12. $\text{PPO Activity} = \text{nmols O}_2 / \text{min} / \text{g of sample}$

Protein content (N (nitrogen) x 5.7)

Protein content (N (nitrogen) x 5.7) of the composite samples is determined by combustion nitrogen analysis (CNA). Samples are ground on a UDY cyclone sample mill fitted with a 1.0-millimetre screen. Sample size is 250-milligrams and samples are not dried before analysis. Protein content is calculated from total nitrogen as determined using a LECO Truspec N CNA analyzer calibrated with EDTA and reported on a constant moisture basis. Moisture content is determined by the AACC Method No. 44-15.02, following the procedure for one-stage air-oven. The method for Dumas CNA analysis is explained in Williams, Sobering, and Antoniszyn. 1998. Protein testing methods at the Canadian Grain Commission. In: *Wheat Protein Symposium: Proceedings*; 1998 March 9-10; Saskatoon, Saskatchewan.

A detailed protocol is listed below:

Determination of Crude Protein – Combustion Method

1. References

AACC International Method 46-30.01 Crude Protein – Combustion Method

AACC International Method 44-15.02 Moisture – Air-Oven Methods

FP628 Nitrogen Determinator Instruction Manual. Version 1.2x November 2012

TruSpec N Nitrogen Determinator Instruction Manual. Version 2.5x May 2011

2. Reagents

Ultra High Purity Helium 99.99% ,Ultra High Purity Oxygen 99.99%, Compressed Air, Oil and Water free, LecoSorb 502-174-HAZ, Magnesium Perchlorate 501-171-HAZ, Furnace Reagent 501-609, N-Catalyst 502-049, Copper Sticks 502-304, Magnesium Oxide 502-359 (TruSpec N only), Alumina Oxide Pellets 502-188 (TruSpec N only).

3. Apparatus

Leco TruSpec N Nitrogen Analyzer with Sartorius Balance, Leco FP628 Nitrogen Analyzer with Sartorius Balance, Fisher Scientific Forced Air Oven with Sartorius Balance.

4. Sample Preparation

Daily check standard (PC DRY), weekly precision check sets (set of 11 samples), and monthly flour mill check wheat samples are all ground on the UDY grinder in B46.

5. Results

The following table shows the Correction factors and moisture basis that all samples are corrected to. If the samples do not come pre-dried, the moisture test must be performed.

Type of Sample	N Correction Factor	Moisture Basis
Wheat, Triticale	5.7	Whole 13.5%, Flour 14%
Durum	5.7	Whole 13.5%, Semo 14%

6. Procedures

- 6.1 Moisture: Samples of 2.0 ± 0.1 g are weighed into metal tins. Samples are then placed in the convection oven for 65 minutes as per AACC 44-15.02 method. Samples are taken out of the oven, cover placed on top of tin, and placed in dessicator until cool. Tins are then reweighed and the difference in weights is the moisture lost which is then converted into a percentage.
- 6.2 Protein Combustion
 - 6.2.1 **Calibration:** Calibration on the Leco is performed at the initial setup or after a major part is changed such as the detector. PC DRY (or whatever daily check), EDTA, Soy flour (Leco standard), and Corn flour (Leco standard) are all used for the calibration and run 5 times each. Select all standards once run and go to the calibration function in the toolbar. Remove any outliers from the equation and then save to implement it under the method that they were run on.
 - 6.2.2 **Blank:** Blanking must be performed before calibration as well as each time the oxygen tank is changed. A minimum of 10 blanks should be run (could also start with conditioners) until at least three blank values are consistent, near zero (depending on calibration), and not trending up or down. For example, three values in order 0.020, 0.022, 0.024 is not acceptable. Three values in order 0.028, 0.032, 0.030 is acceptable. Select the three blank values and find the blank function in the toolbar under *Configuration* → *Blank*.
 - 6.2.3 **Daily Start-up:** First thing to check every morning is that there is sufficient gas as well as all of the maintenance is completed for at least half a day of samples. The compressed air tank should not be run down past 100 psi and the oxygen and helium tanks should not be run down past 200 psi. Doing so may lead to contamination of the gas lines. To check the maintenance schedule, go to *Configuration* → *Counters* and perform maintenance on

anything that is close to expiring. All maintenance procedures are outlined in detail in their respective instruction manual. **The daily run should be started with a minimum of 5 conditioners, 2 blanks, and then 3 PC DRY samples. If the blanks or PC DRY samples are not consistent, this set should be repeated before any other samples are run.**

- 6.2.4 **Samples:** Once the machine is conditioned and shown to be consistent, samples can be subsequently run. Samples are entered in sets of approximately 15 with at least one PC DRY between each set.
- 6.2.5 **Drifting:** The PC DRY check sample is used as the drift standard. If the PC DRY is not within 16.50 ± 0.1 % protein range, drifting must be performed. Select the check samples to be used, go to *Configuration* → *Drift* → *Drift...* and select 'OK'. Now, select the samples to be drifted, right click in the 'Row' column and select 'Recalculate'.
- 6.2.6 **Check Samples:** A set of 11 samples, ranging in protein content between 10% and 17% is run twice a week on each machine. This provides information on the long term trends of each machine.
- 6.2.7 **Machine Parameters:** Combustion Tube – 950°C, Afterburner Tube – 850°C, Reduction Tube – 700°C

Remix-to-peak baking test (refer to Appendix F3 for a detailed description)

The remix-to-peak baking test is a modification of the remix baking test of Irvine and McMullan (1960), Cereal Chemistry 37:603-613, as described in detail by Kilborn and Tipples (1981), Cereal Foods World 26:624-628. Dough is mixed to peak consistency at the second mixing stage. Dough is mixed in a Swanson type 100-200 gram pin mixer (National Manufacturing Co., Lincoln NE) at 90 rpm. Loaves are produced from 200 grams of flour in baking pans with cross-sectional dimensions similar to Canadian commercial baking pans. Loaf volume is reported on a 100-gram flour basis.

Solvent retention capacity (SRC)

Solvent retention capacity is determined using AACC Method 56-11.02 *with the modifications listed below* using deionized water and lactic acid (5% w/w) as the solvents.

GRL Method / CIGI METHOD	AACC Method 56-11.02
Set timer for 20 min add solvent to first tube and replace cap. Invert tube and tape on the bench work surface 25 times holding the cap (check that no flour remains in the conical bottom). Shake tube ten times (back and forth) and then vortex for 5 sec. Begin timer after the first tube. Repeat with next tube. This should take ~ 3 to 5 minutes in total. Place tubes in test tube rack let shake at ~ 160 RPM for the remainder of the time on the timer.	Start timer and add solvent to each tube containing flour. Put cap on tube and shake vigorously to suspend flour ~5 sec. Allow solvent to swell for 20 min, shaking at 5, 10, 15, and 20 min (for ~ 5 sec. each time).
Decant supernatant place centrifuge tube in tube holder and invert for ten min on towel. Blot end of tube dry. Put cap back on and weigh tube, cap, and pellet to the nearest 0.01 gram.	Decant supernatant and drain tube at 90° angle for ten minutes on a paper towel. Put cap back on and weigh tube, cap, and pellet.

Starch damage

Starch damage is determined using AACC Method 76-31.01 Damaged Starch with the *following modifications* : Spectrophotometric Method. Starch damage is expressed as a percentage of flour weight. The method is also referred to as the Megazyme method.

GRL Modified Steps	AACC Method
Add 1ml Hexokinase and 3 mls water	Add 4 mls GOPOD Reagent
After addition of hexokinase and water let stand for 5 to 10 minutes.	After GOPOD is added let samples incubate in water bath for at least 20 minutes.
Read on spectrophotometer at 340nm.	Read on spectrophotometer at 510 nm.
GRL Calculations:	AACC Calculation:
$((\Delta E/6.3)*180*(4.2/1000)*20*6*0.9)*100/\text{weight in mg}$	$(\Delta E * F) * 120 * 1/1000 * 100 / w * 162/180$
Where: Delta E = sample Absorption Reading –Blank Absorption Reading 6.3 =mM extinction coefficient of 6.3 for glucose 180= mWt of glucose (Converts mM glucose/L to mg glucose /L) 20= is the multiplier required to convert sample volume added to Hexokinase to 1 ml i.e.: Use .05ml Supernatant so .05*20=1.0 ml 4.2/1000= 4.2 is the total volume used i.e.: 1 ml Hexokinase +3 ml water +50ul water +50ul supernatant +100ul Amyloglucosidase (4.2ml) Divided by 1000 to convert from ul to ml. 6= in the initial stage, volume digested is diluted to 6 mls. 0.9= Factor to convert glucose to starch (162/180 adjustment from free glucose to anhydrous glucose (i.e.: Starch) W= Weight (mg, as is basis) of flour analyzed. Note: GRL reports all % Starch Damage corrected to 14 % moisture basis.	Where: Delta E = sample Absorption Reading –Blank Absorption Reading F =150ug glucose/ Absorption for 150ug glucose- Absorption Blank 120= Volume correction (50ul taken from 6.0ml) 1/1000 = conversion from micrograms to milligrams 100/W = Factor to express Starch damage as a percentage of flour weight. 162/180= Adjustment from free glucose to anhydro glucose i.e.: Starch (.9) W = the weight in milligrams (“as is “) of the flour analyzes.

Test weight

Test weight is determined using the 0.5 litre measure, a Cox funnel to standardize the pouring rate, and a striker to level the contents of the container. The grain in the container is poured into the pan of an approved electronic scale for weighing. The scale connects to a computer which calculates the test weight of the grain in kilograms per hectolitre (kg/hL) from grams weighed by the scale. If the computer interface is not available, test weight conversion charts are used.

Wet gluten content – flour

ICC Standard Method No. 137/1 is followed using the Glutomatic System 2200 with 80-micrometre metal sieves.

Canada Western Amber Durum Specific Tests

Alveogram – semolina

Alveograms are obtained using the Chopin Alveograph NG following AACC Method 54-30.02. Following milling, semolina samples are stored at room temperature for at least three days prior to analysis.

Cadmium levels

Cadmium levels are determined as per Gawalko, E. J., Nowicki, T. W., Babb, J., Tkachuk, R., Wu, S. 1997. *Comparison of Closed-Vessel and Focused Open-Vessel Microwave Dissolution for Determination of Cadmium, Copper, Lead, and Selenium in Wheat, Wheat Products, Corn Bran, and Rice Flour by Transverse-Heated Graphite Furnace Atomic Absorption Spectrometry*, Journal of AOAC International Vol: 80 (2) 1997 Page: 379-387.

Gluten index - semolina

Durum semolina gluten index is determined using AACC Standard Method 38-12.02, following the procedure for whole meal.

Semolina colour

Durum semolina colour is determined using a Minolta colorimeter model CR-410 with a D65 illuminant. Colour readings are expressed on the CIE (1976) colour space system for L* (lightness), a* (red-green) and b* (yellow-blue). Differences in particle size have a significant effect on colour readings. Semolina samples with similar particle size distributions are used for comparability.

Semolina yield and milling yield of durum wheat

Durum wheat is milled on a four stand Allis-Chalmers laboratory mill in conjunction with a laboratory purifier as described by Black (1966), Cereal Science Today 11:533-534, 542. The mill flow is described by Dexter et al. (1990), Cereal Chemistry 67:405-412. For the calculation of yield, semolina is defined as having less than 3% pass through a 149-micrometre sieve. Milling yield is the combination of semolina and flour. Both milling and semolina yields are reported as a percentage of the cleaned wheat on a constant moisture basis.

All semolina analysis and pasta processing is conducted using granular products with a constant extraction of 70%. Semolina granulars are prepared by adding the most refined flour stream(s) to semolina until 70% extraction is reached.

Spaghetti

Spaghetti is processed from semolina using a customized micro-extruder (Randcastle Extrusion Systems INC, New Jersey, U.S.A.). The barrel of the extruder has 3/4 inch internal diameter with a 12:1 working length to diameter ratio. The screw extends into the hopper where agitators are attached to enhance dough crumb conveying. The hopper can be covered, and the system can be sealed with vacuum. Temperature can be precisely controlled along the extruder barrel. Semolina (200 g) and water (30% absorption) are first mixed in an asymmetric centrifugal mixer (DAC 400 FVZ SpeedMixer) to generate fine and uniform dough crumbs consistent with commercial requirements. The dough crumbs are placed in the hopper, then vacuum is applied to eliminate introduction of air bubbles. A four-hole, 1.8 mm, Teflon coated spaghetti die is used for extrusion. Spaghetti is dried in a pilot pasta drier (Bühler, Uzwil, Switzerland) at the Canadian International Grains Institute.

Spaghetti colour

Spaghetti colour is determined using a Minolta colorimeter model CR-410 with a D65 illuminant with at a 2° angle. Colour readings were expressed on the CIE (1976) colour space system for L* (lightness), a* (red-green) and b* (yellow-blue). For colour measurement, a 6.5-centimetre band of spaghetti strands is mounted on white cardboard using double-sided tape.

Spaghetti firmness

Cooked spaghetti firmness is determined using the Stable Micro Systems TA.XT2i Texture Analyser with accompanying Texture Expert software. The basic principle for the firmness measurement was based on Oh, N.H.

et al. (1983), Cereal Chemistry 60:433-438. Cooking time is fixed at 8 min for spaghetti samples with a diameter of 1.7-1.8 mm. Cooked spaghetti is drained and immediately aligned on the base plate for cutting test without rinsing in cold water. A fixed compression depth of 4.9-millimetre is used (crosshead height calibrated to 5.0-millimetre). The crosshead speed is 1.0 mm/sec. Cutting forces of five strands are recorded at a compression depth of 25% and 50% of the cooked strand diameter, and at fixed distances of 0.8 and 1.2 mm of penetration into the spaghetti.

Semolina Speck count

Speck count is determined using the software RAR-SpecCnt(S) developed by RAR Software Systems (Winnipeg, Manitoba). A semolina sample is compressed to 1 cm in thickness in a sample holder with a clear glass top, and then scanned using a flatbed scanner to acquire a 5 cm x 5 cm image for processing. The image is used to identify potential specks within the sample using object detection algorithms. Each detected object is then evaluated for the average darkness (%GL), the average colour of each component (%RGB), the average colour of each component within the darkest region of the object (%RGB Max), and the size (total area). If the detected object falls within previously specified ranges, the object is identified as a speck. Once all the specks have been identified, they are categorized by the darkness (low, medium and high) as well as the size (small, medium and large) of the speck. Total, dark, and large specks are averages of at least five replicates and their numbers are expressed in 50 cm² of semolina sample surface.

Wet gluten content - semolina

Semolina wet gluten content is determined using AACC Standard Method 38-12.02, following the procedure for whole meal.

Yellow pigment content

Yellow pigment content of durum semolina is determined using AACC Method 14-50.01. The GRL is currently running a modified method using a reduced sample size in order to conserve material using the protocol outlined in the paper entitled "*Pigment loss from semolina to dough: Rapid measurement and relationship with pasta colour*" by Fu et al. 2013, Journal of Cereal Science, 57:560-566.

Appendix F1: Method for Evaluation of Rheological Behaviour of Flour by Farinograph (Constant Flour Weight Procedure)

1. Scope and Field of Applications

The Farinograph method measures water absorption of wheat flours and the resistance of dough to mixing. The method described here is on the constant flour weight basis.

2. Principle

Dough is prepared in the measuring mixer of the Farinograph under defined and reproducible conditions. During the test the dough exerts resistance on the mixer blades and is visualized by graphical display. The torque proportional to this resistance is a measure of viscosity and consistency of the dough. The measured data are evaluated automatically in compliance with international standards. The Farinogram provides information about the water absorption and processing quality of the dough.

3. References

- AACC International. Approved Methods of Analysis, 11th Ed. Method 54-21.02. Rheological behavior of flour by farinograph: constant flour weight basis. Approved January 6, 2011. AACC International, St. Paul, MN, U.S.A. <http://dx.doi.org/10.1094/AACCIntMethod-54-21.02>
- Brabender OHG. 2004. Instruction manual for farinograph E with USB port. C.W. Brabender Instruments Inc., Hackensack, NJ, USA.

4. Materials

4.1 Equipment

- 4.1.1 Farinograph instrument (C. W. Brabender Instrument Inc.) equipped with a small (50 g flour) or large (300 g flour) mixing bowl. Instrument operation and test evaluation is controlled by Brabender Farinograph software.
- 4.1.2 Cooling/heating water circulating bath able to control temperature at 30 ± 0.2 °C.
- 4.1.3 Balance with accuracy of 0.01 g.

5. Procedure

5.1 Equipment Preparation

5.1.1 Farinograph

- 5.1.1.1 Ensure that appropriate mixing bowl (50 g or 300 g) is connected securely to the instrument including electric plug. Test it by pressing simultaneously two-hand control buttons. Ensure that no dry dough is present at the back of the mixing bowl (especially 50 g). Lubricate blades with water and allow mixing blades to turn for few minutes. Dry the mixer blades.
- 5.1.1.2 Connect the water bath at 30 ± 0.2 °C (supply line at the bottom and discharge line at the top part of mixing bowl). Insert angular thermometer into the corresponding bore on the mixer bowl. Temperature should read 30 °C

5.1.2 Water Bath

- 5.1.1.1 Ensure an adequate water level in the water bath tank (between minimum and maximum lines).
- 5.1.1.2 Set and operate the water bath at 30 ± 0.2 °C.
- 5.1.1.3 To prevent microbial growth add 0.1 % (w/v) benzoic acid. Empty bath and disconnect tubing if not used for periods beyond of one month.

5.1.3 Balance

- 5.1.2.1 Ensure that suitable balance is leveled and calibrated. Balance must be able to weigh 300 g of flour plus sample holder weight with accuracy ± 0.01 g. Shield the balance from excessive air drafts and static.

5.2 Mixing Protocol

- 5.2.1 Turn on the computer and start the Brabender Farinograph software. Start a new test by going to <File> and then <New> which open the test parameters window. Indicate appropriate size of mixer bowl and enter rest of information (sample name, moisture, predicted FAB at 500 BU*, time of test and operators name). Comments can be inserted either before or after completion of the test.
- 5.2.2 Start the test by starting farinograph motor and clicking on <Start test> button. The software will start empty mixing bowl and initiate (zero) test. At the end of initiation process software will request defined amount of flour to be placed in the mixing bowl.
- 5.2.3 Lift the mixing bowl deck (it will automatically stop moving mixing blades), fill with defined amount of flour adjusted to 14 % moisture (50 g for small mixing bowl and 300g for large mixing bowl), cover the mixing bowl and press green <start> button on the farinograph. The new screen with farinograph chart will open and baseline line is recorded. Ensure that baseline is steady and close to zero on the vertical axis.
- 5.2.4 Continue mixing flour for 1 min while placing room temperature water filled burette into the central hole in the deck. Add as quickly as possible prescribed amount of distilled water into mixing bowl. Note: Be aware of existence of various types of burettes, i.e. with scales indicating dispensed water in mL and/or percentage. Ensure that you use Farinograph burette is specific for small or large mixing bowl.
- 5.2.5 Immediately after water addition use a plastic scraper to push flour or dough off the mixing bowl sides into mixer. Place the lid on the bowl's deck. In case of some soft wheats, the water addition and side-scraping has to be done within 30 -35 seconds due to extremely short dough development times.
- 5.2.6 Duration of the test depends on the wheat type. General rule is that upper curve envelope has to be below 500 BU line (or adjusted 500 BU line) and the dough must mix for 5 minutes past peak development. Note: be aware of a double peak presence with some "extra strong" wheat. Second peak will be taken as actual peak development.
- 5.2.7 After the test is deemed to be completed, press red <stop> icon on Farinograph software taskbar. Confirm aborting of the test with <Yes> and then <OK> for <End of Test>. Stop the mixing blades either by pressing red STOP button or by lifting mixing bowl deck. Note: stopping the mixer before farinograph software will result in "unsightly" curve but it will not affect the results.

5.3 Cleaning

- 5.3.1 **Mixing bowl:** Clean immediately after the test by adding "dry" flour into mixing bowl and start the motor. The amount of flour will depend on the mixing bowl size and dough consistency at the end of the test. General rule is to get dough consistency of 800-900 BU within 1 min of mixing. This will allow for easy removal of most of the dough from mixing bowl. Finish cleaning by using small toothbrush, wet- and dry- towel. Remove dough and water that accumulates between mixing blades and the mixer wall. Remove any dough that "migrated" out the mixing bowl.
- 5.3.2 **Burette:** Clean in regular intervals using glass cleaning detergent followed by extensive rinsing with distilled water. In case of algae growth use 10:1 concentrated sulfuric acid:potassium dichromate solution. Commercial cleaning solution such as Fisherbrand Cleaning Solution™ could also be used. Extreme care has to be taken due to the corrosive nature of such solutions. Keep the burette, including tip, filled with water at all times.

6. Evaluation and Interpretation of the results

Computerized farinograph automatically evaluates and records the results. Here is the summary of major rheological parameters obtained by the instrument:

- 6.1 *Farinograph absorption (FAB)* is the amount of water it takes to obtain dough with peak consistency of 500 BU. It is expressed as a percentage and adjusted to 14 % flour moisture. Farinograph absorption of 70 % means that 50 g flour with 14 % moisture content can absorb 35 ml of water. Similarly, 300 g flour with 14 % moisture content can absorb 210 ml of water to achieve peak dough consistency of 500 BU.

- 6.2 *Dough development time (DDT)* is the time, to nearest 0.5 min, from first addition of water to the point of maximum consistency range (i.e. 500 BU). This value has also been referred as the “peak” of “peak time”. In case of long flat peak, the midpoint of that flat portion of curve will be taken as peak.
- 6.3 *Stability* is the time difference, to the closest 0.5 min, between the point where the top of the curve first intersects the 500 BU line (*arrival time*) and the point where the top of the curve leaves the 500 BU line (*departure time*). If the curve is not exactly centered at the 500 BU line, the software will automatically redraw new 500 BU line, parallel to the old 500 BU line, that intersects actual peak consistency point.
- 6.4 *Mixing tolerance index, MTI* is the difference in BU from top of the curve at the peak to the top of the curve measured at 5 min after the peak is reached.

Appendix F2: Method for Canadian Short Process Bread Baking

1. Scope and Field of Application

This method was developed to assess the bread making quality of the Canadian wheat flours using the processing conditions but with shorter fermentation time (?), and additives used in the baking industry.

2. Principle

The Canadian short process baking test, as described by Preston *et al.* (1982), uses 150 ppm ascorbic acid as the oxidant and reduces the salt to 2%. Dough is mixed in a Swanson type 100-200 gram pin mixer (National Manufacturing Co., Lincoln NE) at 116 rpm. Loaves are produced from 200 grams of flour in baking pans with cross-sectional dimensions similar to Canadian commercial baking pans. Loaf volume is reported on a 100-gram flour basis. Mixing energy is reported in watt-hours per kilogram (W-h/kg) of dough.

3. References

- Preston, K.R., Kilborn, R.H. and Black, H.C. 1982. The GRL pilot mill II. Physical dough and baking properties of flour streams milled from Canadian red spring wheats. *Can. Inst. Food Sci. Technol. J.* 15:29-36.
- AACC 10-05.01 – Guidelines for Measurement of Volume by Rapeseed Displacement

4. Materials

4.1 Labware

- Laboratory glassware of various types and sizes including beakers, graduated cylinders, reagent bottles and volumetric flasks
- Bottle top dispensers – Dispensette with variable volume; 0.5-5 mL, 1-10 mL and 5-50 mL
- Metal tin, 250 mL
- Magnetic stir bars
- Baking crock with metal lid
- Baking pans
- Timers
- Thermometer/Hygrometer combo

4.2 Equipment and Apparatus

- Circulating water bath (Fisher Scientific)
- Pin-type mixer (National Mfg. Co.)
- Warming/resting cabinet (GRL)
- Sheeter (GRL)
- Molder (GRL)
- Fermentation cabinet (National Mfg. Co.)
- Electric reel oven (National Mfg. Co.)
- Proof height gauge
- Cooling rack
- Bread cabinet (Card Bros. Mfg. Co.)
- Volumeter (National Mfg. Co.)
- Electronic balances
- Stir plate

5. Formula and Ingredients

5.1 Formulation (% of flour weight, i.e. baker's percent)

- | | |
|---------|-------|
| • Yeast | 3.0 % |
| • Salt | 2.0% |
| • Sugar | 4.0% |

- Ammonium phosphate 0.1 %
- Shortening 3.0 %
- Whey powder 4.0 %
- Malt 0.08 %
- Ascorbic acid 150 ppm
- Flour 100 %

5.2 Ingredients

- Yeast, compressed, commercial
- Salt, noniodized fine sodium chloride, commercial grade
- Sucrose, fine granulated, commercial grade
- Ammonium phosphate, monobasic, reagent grade
- Ascorbic acid, reagent grade
- Malt syrup
- Shortening (must be at room temperature), Crisco
- Whey powder
- Flour
- Distilled water, reverse osmosis

6. Solutions

6.1 Yeast suspension (3% of flour weight)

Note: Prepare a fresh solution every time you bake.

- 6.1.1 Weigh 60 g of freshly crumbled yeast and add about 150 mL distilled water.
- 6.1.2 Stir to make a suspension.
- 6.1.3 Bring to 250 mL with distilled water in a volumetric flask.
- 6.1.4 Transfer the solution with a magnetic stirrer to a 1 L dispensing bottle fitted with a 50-mL variable pump dispenser set and calibrated to dispense 25 mL.
- 6.1.5 Keep stirring the solution until the required volume for each sample has been dispensed.

6.2 Salt (8% w/v) and sugar (16% w/v) solution (2 and 4% of flour weight, respectively)

- 6.2.1 Weigh 160 g sugar and 80 g salt into a beaker and add about 500 mL distilled water.
- 6.2.2 Stir until dissolved.
- 6.2.3 Bring the solution to 1 L with distilled water in a volumetric flask.
- 6.2.4 Store for up to one week in a 1 L dispensing bottle fitted with a 50-mL variable pump dispenser set and calibrated to dispense 50 mL.

6.3 Ammonium phosphate solution (10% w/v or 0.1% of flour weight)

- 6.3.1 Weigh 25 g ammonium phosphate into a beaker and add about 150 mL distilled water.
- 6.3.2 Stir until dissolved.
- 6.3.3 Bring to 250 mL with distilled water in a volumetric flask.
- 6.3.4 Store for up to 1 month in a 250-mL dispensing bottle fitted with a 5-mL variable pump dispenser set and calibrated to dispense 2 mL.

6.4 Malt stock solution

- 6.4.1 Weigh 50 g of malt and add about 100 mL distilled water.
- 6.4.2 Stir well to obtain a uniform consistency.
- 6.4.3 Bring to 200 mL with distilled water in a volumetric flask.
- 6.4.4 Transfer to a 250 mL reagent bottle.
- 6.4.5 Store at 4°C for up to one week.

6.5 Malt baking solution (0.08% of flour weight)

- 6.5.1 Gently shake the bottle of stock solution (6.4) before preparing the baking solution.

- 6.5.2 Using a 25-mL graduated cylinder, measure 20 mL of stock solution into a beaker.
- 6.5.3 Add 60 mL of distilled water and stir well.
- 6.5.4 Store the malt baking solution for up to one week in a 250-mL dispenser bottle fitted with a 5-mL variable pump dispenser set and calibrated to dispense 2 mL.

6.6 Ascorbic acid solution (150 ppm of flour weight)

Note: Prepare this solution every time you bake.

- 6.6.1 Weigh 0.75 g ascorbic acid and add about 70 mL distilled water.
- 6.6.2 Stir until dissolved.
- 6.6.3 Bring to 100 mL with distilled water in a volumetric flask.
- 6.6.4 Store the solution in a 100-mL dark dispenser bottle (to protect from light) fitted with a 5-mL variable pump dispenser set and calibrated to dispense 4 mL.

7. Procedure

7.1 Equipment and Labware Set-up

Note: Set up equipment 1.0 to 1.5 hours before starting. Throughout the procedure, verify that all equipment is running properly.

- 7.1.1 Turn on the water bath (4.2.1), set at 30°C to circulate through mixing bowl jacket.
- 7.1.2 Remove the mixing bowl from the mixer (4.2.2), turn it on, allow the mixer to run (116 rpm) to warm up and equilibrate calibration, and set up the P2M software.
- 7.1.3 Turn on the warming (resting) cabinet (4.2.3), set to 30°C, no humidity control.
- 7.1.4 Turn on the proofer (4.2.6) with settings at dry bulb 38°C, wet bulb 33°C (80% RH), fill the water reservoir (located on top) if the level is below half.
- 7.1.5 Place in the oven one (or two) 1L metal containers filled with water.
- 7.1.6 Turn on the oven (4.2.7) and set to 400°F (205°C)
- 7.1.7 Verify if there is a need to calibrate the molder weight and if the molder belt requires tightening.
- 7.1.8 Grease baking pans and place inside the warming cabinet.

7.2 Sample Mixture Preparation

Note: Include at least one blank and one check sample every time. Since the CSP bake method determines the proofing time for the samples to be tested based on the time it takes the check sample to reach a proof height of 120 mm, the check flour should be the first sample after the blank.

- 7.2.1 Prepare one bake card per sample. Record sample number (sample ID), bake date, check off bake method, moisture content (if this value is old, a new moisture content should be taken), and farinograph absorption (14% mb).
- 7.2.2 Print a baking schedule to track the processing time for each sample.
- 7.2.3 Weigh 200 g flour (corrected to 14 % moisture basis) into a 250-mL metal tin (pre-weigh all flour samples in advance before starting the first mix and place into numbered tins, each number corresponding to the sample number).
- 7.2.4 Weigh 6 g shortening (must be at room temperature) and add into each metal tin containing the pre-weighed flour sample.
- 7.2.5 Weigh 8 g whey powder and add into each metal tin containing the pre-weighed flour sample and shortening.
- 7.2.6 Cover the metal tin(s) until ready to mix.

7.3 Mixing

- 7.3.1 In a 600 mL beaker, weigh the amount of distilled water required based on calculations found in [\\Wpg17\breadwht\Bake Lab Methods\Water Calculation for All Bake Methods draft1.xlsx](#)
- 7.3.2 To the water, dispense 50 mL salt-sugar solution (6.2), 2.0 mL ammonium phosphate solution (6.3) and 2.0 mL malt baking solution (6.5). Set the beaker aside. \
- 7.3.3 Place the dry ingredients (7.2.6) into the 200-g National mixer bowl.

- 7.3.4 Create a depression in the centre of the dry ingredients by pushing some of the mixture on the sides of the bowl.
- 7.3.5 Dispense 25 mL yeast suspension (6.1) and 4.0 mL ascorbic acid solution (6.6) (this is added last because it is light sensitive) into the beaker containing the previously combined wet ingredients (7.3.2).
- 7.3.6 Pour the combined solutions into the depressed centre of the dry ingredients in the mixer bowl.
- 7.3.7 Stop the mixer warm up.
- 7.3.8 Secure the bowl onto the mixer.
- 7.3.9 Start the mixer and P2M software.
- 7.3.10 Mix the dough to 10% past peak (the P2M software will indicate this by moving the red line to peak).
- 7.3.11 Once the optimum peak is reached, immediately stop the mixer and P2M software.
- 7.3.12 Grease the baking crock (numbered according to the sample number), balance pan and your hands.
- 7.3.13 Remove the dough from the mixer bowl and mixer pins and place on the greased balance pan. Record dough weight on the baking schedule and in the P2M software.
- 7.3.14 Transfer the dough into the appropriate numbered greased baking crock and cover with the metal lid.
- 7.3.15 Put the covered baking crock with the dough in the warming cabinet and let the dough rest for 15 minutes.
- 7.3.16 At this point, the next sample can be mixed following the baking schedule.

7.4 **Punching**

- 7.4.1 Remove the crock from the warming cabinet.
- 7.4.2 Grease your hands and remove the dough from the crock.
- 7.4.3 Punch the dough 7 times (gently slap against your hand and roll) then round into a ball.
- 7.4.4 Place the dough ball back into crock and return to the warming cabinet for another 15 minutes.

7.5 **Sheeting and Moulding**

- 7.5.1 Remove the crock from the warming cabinet.
- 7.5.2 Sprinkle flour onto the countertop.
- 7.5.3 Remove the dough from the crock and dust its surface by rolling it onto the flour-dusted countertop. Tap any excess flour off the dough.
- 7.5.4 With the ragged edge facing toward you, sheet the dough one pass through gap #1. As the dough passes through the gap, catch it as it exits from underneath.
- 7.5.5 Place the dough on the molder belt and adjust the sheeting gap to #2.
- 7.5.6 Sheet the dough one pass through gap #2. As the dough passes through gap #2, catch it as it exits from underneath.
- 7.5.7 Place the dough on the molder belt and adjust sheeting gap to #3.
- 7.5.8 Sheet the dough one pass through gap #3. As the dough passes through gap #3, catch it as it exits from underneath.
- 7.5.9 Place the bottom of the dough sheet so it is lying on the molder belt closest to the roller. Gently stretch this end to make it "square" (leading edge parallel to the moulding rolls) then manually create a roll by rolling the dough edge up and towards you (3 times).
- 7.5.10 Lift the dough and place the rolled end into the rollers.
- 7.5.11 Drop the top roll onto the dough piece.
- 7.5.12 Start the moulder and guide the dough sheet into the rolls. The dough will mould for 30 seconds (automatic timer).

7.6 **Panning**

- 7.6.1 In a pre-warmed greased baking pan, put the appropriate numbered, full-length label face down in the bottom of the pan.
- 7.6.2 Remove the dough roll from the molder and place on the countertop.

- (i) Manually evaluate the stickiness by touching each end with your index fingers.
- (ii) If the dough sticks to your fingers but recovers to original form, the bake absorption is considered acceptable.
- (iii) If the dough is sticky and does not recover to original form, make a note (record on the baking card) to decrease the water absorption for the next bake rep.

7.6.3 If the dough does not stick to your fingers, it is considered too dry. Make a note to increase water absorption for the next bake rep.

7.6.4 Place the dough roll into the greased baking pan so that it is pushed to one side and the seam is straight and facing down (by doing this way the break on bread will be on one side only, making it easier to evaluate).

7.6.5 In the pan, dust your fingers with flour and tuck the ends under.

7.7 Proofing

7.7.1 Place the pan with dough into the proofer and verify that thermometers and hygrometers are at 38°C and 80 % RH, respectively.

7.7.2 Record the temperature and RH at regular intervals throughout the bake schedule.

7.7.3 After 65 minutes, remove the pan containing the “check” dough from the proofer.

7.7.4 Measure the height of the “check” dough:

- (i) If the height after 65 minutes proofing is at 120 mm, the yeast is considered very active and proof time for all samples that day must be decreased. Then for subsequent bakes with that same yeast, decrease the amount of dry yeast by 0.3 g and proof for 70 minutes.
- (ii) If the height after 65 minutes proofing has not reached 120 mm, return the check dough back to the proofer for an additional 5 minutes (total of 70 minutes).
- (iii) If the height after 70 minutes proofing is still below 120 mm, the yeast is considered less active and proof time for all samples that day must be increased. Then for subsequent bakes with that same yeast, increase the amount of dry yeast by 0.3 g and proof for 70 minutes.

Note: The “check” dough is allowed to proof to a height of 120 mm after approximately 70 minutes. The proof time is recorded and used to make adjustments for all subsequent samples.

7.8 Baking

7.8.1 After 70 minutes proofing (or equivalent time to achieve 120 mm height), place the pan in the rotary oven.

7.8.2 Bake for 30 minutes at 205°C (400°F).

7.8.3 Remove the pan from the oven; remove the loaf from the pan and immediately weigh the loaf, then place it on the baking rack to cool.

7.9 Loaf Evaluation

7.9.1 After one hour, measure the loaf volume (<\\Wpg17\breadwht\Bake Lab Methods\Official Methods AACC\10-05 LV by Rapeseed Displacement.pdf>).

7.9.2 Place the loaf into the bread cabinet overnight.

7.9.3 The following day record visual scores, take C-Cell and Minolta colour measurements; when required, take photographs.

Appendix F3: Method for the Remix Bake Method

1. Scope and Field of Application

This method is applicable for untreated flour experimentally or commercially milled for the production of yeast raised bread. It provides a test which ranks flours according to baking strength.

2. Principle

The remix-to-peak baking test is a modification of the remix baking test of Irvine and McMullan (1960), as described in detail by Kilborn and Tipples (1981). Dough is mixed to peak consistency at the second mixing stage. Dough is mixed in a Swanson type 100-200 gram pin mixer (National Manufacturing Co., Lincoln NE) at 90 rpm. Loaves are produced from 200 grams of flour in baking pans with cross-sectional dimensions similar to Canadian commercial baking pans. Loaf volume is reported on a 100-gram flour basis.

3. References

Irvine, G.N. and McMullan, M.E. 1960. The "remix" baking test. Cereal Chem. 37:603-613.

Kilborn, R.H. and Tipples, K.H. 1981. Canadian test baking procedures. I. GRL Remix method and variations. Cereal Foods World. 26:624-628.

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4. Materials

4.1 Labware

- Laboratory glassware of various types and sizes including beakers, graduated cylinders, reagent bottles and volumetric flasks
- Bottle top dispensers – Dispensette with variable volume; 0.5-5 mL, 1-10 mL and 5-50 mL
- Metal tin, 250 mL
- Magnetic stir bars
- Baking crock with metal lid
- Baking pans
- Timers
- Thermometer/Hygrometer combo

4.2 Equipment and Apparatus

- Circulating water bath (Lauda, Ecoline)
- Pin-type mixer (National Mfg. Co.)
- Warming/resting cabinet (GRL)
- Sheeter (GRL)
- Molder (GRL)
- Fermentation cabinet (National Mfg. Co.)
- Electric reel oven (National Mfg. Co.)
- Cooling rack
- Bread cabinet (Card Bros. Mfg. Co.)
- Volumeter (National Mfg. Co.)
- Electronic balances
- Stir plate

5. Formulation and Ingredients

5.1 Formulation (% of flour weight, i.e. baker's percent)

- | | |
|----------------------|--------|
| • Yeast | 3.0 % |
| • Salt | 1.0 % |
| • Sugar | 2.5 % |
| • Potassium bromate | 15 ppm |
| • Ammonium phosphate | 0.1 % |

- Malt 0.6 %
- Flour 100 %

5.2 Ingredients

- Yeast, compressed, commercial
- Salt, noniodized fine sodium chloride, commercial grade
- Sucrose, fine granulated, commercial grade
- Potassium bromate, reagent grade
- Ammonium phosphate, monobasic, reagent grade
- Malt syrup
- Flour
- Distilled water, reverse osmosis

6. Solutions

6.1 Yeast suspension (3% of flour weight)

Note: Prepare a fresh solution every time you bake.

- 6.1.1 Weigh 60 g of freshly cut small pieces of yeast and add about 150 mL distilled water.
- 6.1.2 Stir to make a suspension.
- 6.1.3 Bring to 250 mL with distilled water in a volumetric flask.
- 6.1.4 Transfer the solution with a magnetic stirrer to a 1 L dispensing bottle fitted with a 50-mL variable pump dispenser set and calibrated to dispense 25 mL.
- 6.1.5 Keep stirring the solution until the required volume for each sample has been dispensed.

6.2 Salt (4.0% w/v) and sugar (10% w/v) solution (1.0 and 2.5% of flour weight, respectively)

- 6.2.1 Weigh 110 g sugar and 44 g salt into a beaker and add about 1018 mL distilled water.
- 6.2.2 Stir until dissolved.
- 6.2.3 Store for up to one week in a 1 L dispensing bottle fitted with a 50-mL variable pump dispenser set and calibrated to dispense 50 mL.

6.3 Bromate (0.15% w/v) – phosphate (10% w/v) solution (15 ppm and 0.1% of flour weight, respectively)

- 6.3.1 Weigh 1.5 g potassium bromate and 100 g ammonium phosphate into a beaker and add about 500 mL distilled water.
- 6.3.2 Stir until dissolved.
- 6.3.3 Bring to 1 L with distilled water in a volumetric flask.
- 6.3.4 Store for up to 1 year (if the solution becomes cloudy, discard) in a 250-mL dispensing bottle fitted with a 5-mL variable pump dispenser set and calibrated to dispense 2 mL.

6.4 Malt stock solution

- 6.4.1 Weigh 50 g of malt and add about 100 mL distilled water.
- 6.4.2 Stir well to obtain a uniform consistency.
- 6.4.3 Bring to 200 mL with distilled water in a volumetric flask.
- 6.4.4 Transfer to a 250 mL dispenser bottle fitted with a 5-mL variable pump dispenser set and calibrated to dispense 2 mL.
- 6.4.5 Store at 4°C for up to one week.

7. Procedure

7.1 Equipment and Labware Set-up

Note: Set up equipment 1.0 to 1.5 hours before starting. Throughout the procedure, verify that all equipment is running properly.

- 7.1.1 Turn on the water bath (4.2.1), set at 30°C to circulate through mixing bowl jacket.

- 7.1.2 Remove the mixing bowl from the mixer (4.2.2), turn it on, allow the mixer to run (90 rpm) to warm up and equilibrate calibration.
- 7.1.3 Turn on the proofer (4.2.6) with temperature setting at 30°C and 83% RH.
- 7.1.4 Turn on the warming (resting) cabinet (4.2.3), set to 30°C, no humidity control.
- 7.1.5 Turn on the oven (4.2.7), set to 425°F (218°C).
- 7.1.6 Verify if there is a need to calibrate moulder weight and if the moulder belt requires tightening.
- 7.1.7 Grease baking pans and put inside the warming cabinet.

7.2 Sample Preparation

Note: Include at least one blank and one check sample every time.

- 7.2.1 Prepare one bake card per sample. Record sample number (sample ID), bake date, check off bake method, moisture content (if this value is old, a new moisture content should be taken), and farinograph absorption (14% mb).
- 7.2.2 Print a baking schedule to track the processing time for each sample.
- 7.2.3 Weigh 200 g flour (corrected to 14 % moisture basis) into a 250-mL metal tin (pre-weigh all flour samples in advance before starting the first mix and place into numbered tins, each number corresponding to the sample number).
- 7.2.4 Cover the metal tins until ready to mix.

7.3 Mixing

- 7.3.1 Place the flour sample (7.2.4) into the 200-g National mixer bowl.
- 7.3.2 Create a depression in the centre by pushing some of the flour on the sides of the bowl.
- 7.3.3 In a 600 mL beaker, weigh the amount of distilled water required based on calculations found in \\Wpg17\breadwht\Bake Lab Methods\Water Calculation for All Bake Methods_draft1.xlsx
- 7.3.4 To the water, dispense 50 mL salt-sugar solution (6.2), 2.0 mL malt baking solution (6.4), 2.0 mL bromate-phosphate solution (6.3) and 25 mL yeast suspension (6.1).
- 7.3.5 Pour the combined solutions into the depressed centre of the flour sample in the mixer bowl.
- 7.3.6 Stop the mixer warm up.
- 7.3.7 Secure the bowl onto the mixer.
- 7.3.8 Start and run the mixer for 3.5 minutes at a speed of 90 rpm.

7.4 Proofing

- 7.4.1 Remove the dough from the mixer bowl and pin.
- 7.4.2 Round the dough lightly seven times by hand.
- 7.4.3 Place the dough into the appropriate numbered greased baking crock and cover with the metal lid.
- 7.4.4 Put the covered baking crock with dough into the proofer for 2.75 hours.
- 7.4.5 At this point, remaining sample can be mixed following the baking schedule, for example: \\Wpg17\breadwht\Bake Lab Methods\Method - Bread Remix Baking Schedule (5 min).doc

7.5 Remixing

- 7.5.1 A few (5) minutes before remixing, sign into the computer and open the P2M software.
- 7.5.2 Transfer the dough from the baking crock into the mixer bowl.
- 7.5.3 Mix the dough to its peak (the P2M software will indicate this by moving the red line to peak).
- 7.5.4 Stop the mixer when the peak starts to decline.

7.6 Proofing

- 7.6.1 Remove the dough from the mixer and pin
- 7.6.2 Round the dough lightly seven times.
- 7.6.3 Place the dough back into the same baking crock.
- 7.6.4 Put the crock with dough into the proofer for 25 minutes.

7.7 Sheeting and Moulding

- 7.7.1 Remove the crock from the proofing cabinet.
- 7.7.2 Sprinkle flour onto the countertop.
- 7.7.3 Remove the dough from the crock and dust the surface by rolling it onto the flour-dusted countertop. Tap any excess flour off the dough.
- 7.7.4 With the ragged edge facing toward you, sheet the dough one pass through gap #1 (set at 11/32"). As the dough passes through the gap, catch it as it exits from underneath.
- 7.7.5 Place the dough on the molder belt and adjust the sheeter gap to #2 (set at 7/32").
- 7.7.6 Sheet the dough one pass through gap #2. As the dough passes through gap #2, catch it as it exits from underneath.
- 7.7.7 Place the dough on the molder belt and adjust sheeter gap to #3 (set at 5/32").
- 7.7.8 Sheet the dough one pass through gap #3. As the dough passes through gap #3, catch it as it exits from underneath.
- 7.7.9 Place the bottom of the dough sheet so it is lying on the molder belt closest to the roller. Gently stretch this end to make it "square" then manually create a roll by rolling the dough edge up and towards you (3 times).
- 7.7.10 Lift the dough and place the rolled end into the rollers.
- 7.7.11 Drop the top roll onto the dough piece.
- 7.7.12 Start the molder and guide the dough sheet into the rolls. The dough will mold for 30 seconds (automatic timer).

7.8 Panning

- 7.8.1 In a pre-warmed greased baking pan, put the appropriate numbered, full-length label face down in the bottom of the pan.
- 7.8.2 Remove the dough roll from the molder and place on the countertop.
- 7.8.3 Manually evaluate the stickiness by touching each end with your index fingers.
 - (i) If the dough sticks to your fingers but recovers to original form, the bake absorption is considered acceptable.
 - (ii) If the dough is sticky and does not recover to original form, make a note (record on the baking card) to decrease the water absorption for the next bake rep.
 - (iii) If the dough does not stick to your fingers, it is considered too dry. Make a note to increase water absorption for the next bake rep.
- 7.8.4 Place the dough roll into the greased baking pan so that it is pushed to one side and the seam is straight and facing down (by doing this way the break on bread will be on one side only, making it easier to evaluate).
- 7.8.5 In the pan, dust your fingers with flour and tuck the ends under.

7.9 Proofing

- 7.9.1 Place the pan with dough into the proofer.
- 7.9.2 Proof for 55 minutes.

7.10 Baking

- 7.10.1 Transfer the pan with dough in the rotary oven.
- 7.10.2 Bake for 25 minutes at 218°C (425°F).
- 7.10.3 Remove the pan from the oven; remove the loaf from the pan and immediately weigh the loaf, then place it on the baking rack to cool.

7.11 Loaf Evaluation

- 7.11.1 After one hour, measure the loaf volume ([\\Wpg17\breadwht\Bake Lab Methods\Official Methods AACC\10-05 LV by Rapeseed Displacement.pdf](#)).
- 7.11.2 Place the loaf into the bread cabinet overnight.

7.11.3 The following day record visual scores, take C-Cell and Minolta colour measurements; when required, take photographs.

Part 4: Reporting of data

All data from testing of check varieties and candidate lines for each trial must be reported in a standardized spreadsheet for evaluation by the PRCWRT Quality Evaluation Team.

1. Check varieties and candidate lines are entered in rows with check varieties first, followed by mean of checks (calculated) followed by candidate lines (third year entries followed by second year entries followed by first year entries)
2. Appropriate test results for each registration trial are listed in columns starting with wheat tests followed by milling data followed by flour data followed by rheological data followed by end-use tests.
3. Data for Hard Red Spring, Hard White Spring, High Yield Spring and Hard Red Winter trials all follow the same format. Trials for Soft White Spring and Durum have some unique testing and data reporting requirements but will follow the same general format.

The Canadian Grain Commission can provide the Microsoft Office Excel spreadsheet for each of the trial formats. Contact Dr. Bin Xiao Fu, binxiao.fu@grainscanada.gc.ca. Tel.: 204-984-5605

Data for some parameters can be rated based on established ranges in order to assist review and give a visual (colour) profile of test results. See next page as an example template. For more detail on reporting data, contact the Canadian Grain Commission, Dr. Bin Xiao Fu, binxiao.fu@grainscanada.gc.ca. Tel.: 204-984-5605

Variety	Yr in Test	Grade	Wheat Pro	Flour Pro	Pro Loss	FN	Amyl Peak	Clean Wht Flr Yld	Flr Yld PB 0.50 Ash	Flour Ash	Flour Color L*	Flour Color a*	Flour Color b*	Starch Dmg	PSI	Farino Abs	Farino DDT	Farino MTI	Farino Stab	CSP Abs	CSP Pk Time	CSP WHR/ KG	CSP LV	CSP App	CSP Crumb Struct	CSP Crumb Modifiers ¹	CSP Color
Excellent			1.0	1.0		80	250	1.7	1.7	-0.06				-1.7		3.0				5			100	8.0	6.8		8.0
Improvement = Values in excess of:			0.3	0.3		35	145	0.7	0.7	-0.02				-0.7		1.4				2			45	7.7	6.3		7.7
Flag = Values in excess of:			-0.3	-0.3	0.4	-35	-145	-0.7	-0.7	0.02				0.7		-1.4				-2			-45	7.2	5.8		7.2
Poor			-1.0	-1.0		-80	-250	-1.7	-1.7	0.06				1.7		-3.0				-5			-100	7.0	5.6		7.0
Mean of Checks			15.9	15.1	0.8	475	750	76.2	75.8	0.46	94.0	0.64	9.9	8.6	57	68.7	7.25	25	11.0	68	3.8	9.4	1155	7.6	6.2		7.8
Excellent			16.9	16.1		555	1000	77.9	77.5	0.40				6.9		71.7				73			1255				
Improvement = Values in excess of:			16.2	15.4		510	895	76.9	76.5	0.44				7.9		70.1				70			1200				
Flag = Values in excess of:			15.6	14.8	1.2	440	605	75.5	75.1	0.48				9.3		67.3				66			1110				
Poor			14.9	14.1		395	500	74.5	74.1	0.52				10.3		65.7				63			1055				

APPENDIX G: Data Release Policy

Operating Procedures used by the PRCWRT will be available.

The PRCWRT minutes are available at the PGDC website page:

http://pgdc.ca/committee_wrt/committees_wrt_p.html and posted by April 1 following the annual meeting. Included in this report will be the voting results (Evaluation Team and Committee votes) for each candidate cultivar considered. The report will consist of the meeting minutes of each Evaluation Team and the Committee.

Developers, owners and marketing institutions may use the data for their lines without request for permission. Comparisons may only be made with check cultivars in the trials in which the candidate was evaluated.

Data for candidates supported for registration may be used in “provincial government variety guides” without request for permission.

Disclaimer to be published with the PRCWRT minutes:

The data contained in these documents are the copyright property of the Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT). The information contained herein may not be reproduced, published or disseminated in any form other than in its entirety, without the express written consent of the PRCWRT.

The data contained in this document are collected from several sources. The PRCWRT does not guarantee the veracity of subsets of these data.

The members/experts of the PRCWRT evaluate the merit of genotypes/cultivars using a pool of performance parameters collected over several years and multiple locations. Any subset of these data cannot be considered a reliable indication of overall merit.

Requests for permission to use portions of this document must be forwarded, in writing, to the PRCWRT Chair. Guidelines to the Chair in granting permission to use portions of PRCWRT data are as follows:

- a) Permission to use data subsets will be refused in situations where, in the considered opinion of the Chair, the data will be presented in a misleading manner.
- b) The data for the checks is considered public domain and a request for use will be approved unless it conflicts with point (a).
- c) The use of data specific to entries may be approved with the express written consent of the relevant breeder/sponsor.
- d) The Chair, in granting permission to use the data, will consider and respect information that is proprietary.
- e) If Registration Trial data is used outside of the PRCWRT, proper acknowledgement of who provided the data should be made.

APPENDIX H: Conflict of Interest Guidelines

The PRCWRT has as one of its mandates, the responsibility “to advise on the performance of lines in registration trials and make recommendations regarding the registration of candidates to the Variety Registration Office, Canadian Food Inspection Agency.” While members are expected to vote impartially, abstaining from a vote is appropriate when sound ethical judgment indicates a ‘Conflict of Interest’.

A Conflict of Interest arises when an individual acting in an official capacity (public official, employee, professional, etc.) has private or personal interests sufficient to appear to influence the objective exercise of their duties. Conflicts of Interest interfere with professional responsibilities by clouding objective, professional judgment (Michael McDonald, Centre for Applied Ethics, University of British Columbia).

There are three key elements in defining a Conflict of Interest:

- **Private or personal interest:** The pursuit of private or personal interests does not create a conflict of interest unless it occurs during the exercise of official capacity.
- **Exercise of official capacity:** Duties and obligations that are part of an office or official capacity must prevail over private or personal interests.
- **Responsibility to use objective professional judgment:** Professionals are expected to provide sound, objective and independent advice. Factors that interfere (or appear likely to interfere) with professional objectivity are a matter of legitimate concern to those who rely on this advice.

In addition to *actual* Conflicts of Interest, *apparent* and *potential* conflicts should be avoided.

- **Apparent Conflict of Interest:** a situation in which a reasonable person would believe that the professional’s judgement is likely to be compromised.
- **Potential Conflict of Interest:** a situation that could develop into an actual conflict of interest.

The key in discovering a personal Conflict of Interest is to determine if the situation is likely to interfere, or appears to interfere, with the independent judgement expected in performing your official duties. Trust is the core issue. Conflicts of Interest involve an abuse (actual or potential) of the trust that people have in professionals. In addition to direct damage to particular clients and employers, Conflicts of Interest injure the entire profession by reducing the confidence that people have in professionals.

An excellent diagnostic tool is the “trust test”: *Would relevant others (employer, clients, colleagues, general public) trust my judgment if they knew I was in this situation?*

When a personal Conflict of Interest is recognized, the ethical responses are:

- Reveal your private interest to the relevant parties.
- Remove yourself from the decision making process or advice-giving role.

APPENDIX I: The Canadian Wheat Workers Code of Ethics

This seed is being distributed (or received) in accordance with the “Canadian Wheat Workers’ Code of Ethics,” last revised by the Canadian Wheat Improvement Network on 25 February 2010.[†]

1. The originating breeder, institution or company has certain rights to the germplasm. These rights remain with the originator and are not waived with the distribution of seeds or plant material. A seed recipient is defined as an individual who directly contributes data for the trial in which the germplasm is being evaluated.
2. The recipient of seeds or plant material shall make no secondary distribution of the germplasm without the permission of the owner/breeder.
3. The owner/breeder, in distributing seed or other propagating material of the germplasm, grants permission for its use in trials under the recipient’s control and as a male parent for making crosses from which selection will be made. As a courtesy, it is suggested that the owner/breeder be notified of the intent to use the germplasm in crosses.
4. Uses of all germplasm for which written approval of the owner/breeder is required include the following:
 - a) Testing in regional trials or international nurseries.
 - b) Use as a check in registration trials.
 - c) Increase and release as a cultivar.
 - d) Reselection from within the stock.
 - e) Use as a parent of a commercial F₁ hybrid, synthetic, or multi-line cultivar.
 - f) Use as a recurrent parent.
 - g) Mutation breeding.
 - h) Selection of somaclonal variants.
 - i) Use as a recipient parent for asexual gene transfer, including gene transfer using molecular genetics techniques.
5. Germplasm distributed in public registration trials shall not be used for seed increase except for the purpose of creating a common seed source for further testing. Reasonable precautions to ensure retention or recovery of the germplasm shall be taken.
6. Germplasm with patented traits (e.g.: Clearfield[®] herbicide resistance) falls under these guidelines. When a line with a patented trait is used as a parent for crossing, active selection against the trait must be practiced. The consent to cross to germplasm with patented traits does not constitute any type of agreement with the owner of the trait.
7. The Canadian Wheat Workers’ Code of Ethics does not apply to lines in private trials unless explicitly stated by the owner of the germplasm.
8. It is encouraged that a copy of this code accompanies any distributed germplasm to which it will apply. It is further suggested that the individual distributing the germplasm should sign and list the distributed material on the back of the copy. Signatures are not required for germplasm distributed in Canadian public registration trials.

[†] Although this code was developed for lines entered into publicly run trials, it is hoped that the distribution of all germplasm will be done in a spirit of collaboration, as demonstrated herein. The Canadian Wheat Workers’ Code of Ethics is based on a similar code developed by the National Wheat Improvement Committee of the USA.

APPENDIX J: Registration Trial Inspection Report

Year: _____
 Registration Trial: _____
 Inspection Date: _____
 Crop Stage: _____

Location: _____
 Contact Name: _____
 Contact Tel/Cell: _____

GPS Coordinates: North: _____ West: _____

1. Based on the randomization, do the check cultivars appear in the right places?

Check Variety	Rep 1	Rep 2	Rep 3	Rep 4

Check Variety	Rep 1	Rep 2	Rep 3	Rep 4

2. Do distinguishable lines appear in the right places within each rep? _____

3. Does the trial have adequate border plots? _____

4. Are there any visible gradients within the trial area? Within reps? Within plots?

5. Problems? E.g. uneven stand, winter kill, plant stress, poor weed control, herbicide damage, animal damage, prevalent diseases, lodging, shattering, other.

6. Recommendation: Acceptable: _____ Unacceptable: _____ Conditional: _____

Comments: _____

Inspected By: _____ Signature: _____

Appendix K: Operating Principles used in the Cooperative Registration Trials

Traditionally, plant breeders, agronomists, plant pathologists, and cereal quality specialists worked together to evaluate candidate cultivars in each market class of wheat, as well as winter rye and spring triticale. These collaborative trials became known as “Co-operative Registration Trials”, “Co-ops”, or “C-Level Tests”. The operation of co-op trials is the responsibility of the co-operators in the test, subject to Committee approval. Co-operators in a particular co-op trial are those scientists and field trial managers responsible for conducting the various tests and sponsors submitting candidate cultivars to the registration trial.

The following general principles apply to the Co-operative Registration trials:

- a) **Locations:** Locations are determined by the test co-operators. They may be conducted by the private or public sector and are chosen to represent areas of adaptation for the crop. Growing tests in multiple environments provides the opportunity for assessment of agronomic and end-use quality performance under different growing conditions.
- b) **Acceptance of entries for testing:** As a general principle, six station years of data from the area of its intended commercial production, along with that of appropriate check cultivars, are required for entry into co-operative tests. The test co-ordinator decides the eventual list of entries that are tested, consulting with submitters of entries as required. It is expected that only lines competitive with the checks will be submitted. Plants known to have novel traits (PNT) must have unconfined release status for such material before acceptance into co-operative tests. Plants known to have novel traits that do not have unconfined release can only be tested in Private Registration Trials (Section 2.2). If a failed entry is to be re-entered into a registration trial, permission by the Committee is required.
- c) **Limits on entry numbers:** Every attempt is made to accept all qualified entries. However, resource restrictions require limits to be imposed. The co-operators, subject to approval by the Committee, determine the acceptance of entries.
- d) **Security of entries:** Test co-ordinators and co-operators will take reasonable precautions to ensure the security of test entries.
- e) **Check varieties:** Check varieties are chosen by the Committee to represent specific classes, types and adaptation. Check varieties are normally the best commercially available cultivars for each class or type. In some instances checks are chosen to provide a basis of comparison for quality or disease evaluation. Candidate cultivars will be compared to the appropriate check(s) of the class for which they are being considered. Note that this may not be the same check as the one used when the line was entered into the registration trial. The candidate will not be compared to other lines in the test for registration recommending purposes. When interpreting results, a candidate will not be compared to a check variety for a specific trait when the check is known to perform poorly for that trait.
- f) **Disposition of entries:** The owner of a line can withdraw it at any time. Lines are retained in the registration trials based on the request of the owner and the approval of the co-operators and the Committee. A line will only be kept in trials for a year beyond the minimum testing requirement upon agreement of the Committee.
- g) **Fees:** The PRCWRT may establish a fee structure and a mechanism for handling the fees to ensure that they are applied to the costs of operating the tests. Such fees are subject to annual review. Contact the test co-ordinator for details.
- h) **Condition of acceptance:** It shall be a condition of acceptance of a candidate cultivar for testing, that the party submitting the candidate cultivar agrees that the testing and evaluation procedures used by the PRCWRT are appropriate and that these testing and evaluation procedures, however defined, shall not justify an appeal of a Committee decision.
- i) **Limitation of liability:** It is a condition of acceptance of a candidate cultivar for testing that the party submitting the candidate cultivar acknowledges that neither the PRCWRT nor its members and agents shall in any way be liable for any error or omission occurring as a result of the testing and evaluation process.

- j) Ethical conduct: Co-operative Registration Trials are subject to the provisions of the Canadian Wheat Workers' Code of Ethics as defined and periodically updated by the Canadian Wheat Improvement Network (CWIN).

Co-op trials are managed on behalf of the Committee by a test co-ordinator and the co-operating group. It is the collective responsibility of the participants in the co-op trial to ensure unbiased and accurate testing of the candidates. A current list of co-ordinators can be obtained from the PRCWRT Secretary.

Test co-ordinators are appointed by the co-operators in the test, subject to approval by the Committee. Co-ordinators are responsible, in consultation with the co-operators, for deciding on admission of new candidates, general co-ordination of the trial, for compiling and analysing the data, and for preparation and distribution of the annual report. Annual reports of the Registration Trials must be available to the PRCWRT membership at least seven days prior to the February annual meeting, where the tests and the disposition of entries are reviewed. Co-ordinators are reminded that participants in the Registration Trial will require the reports in advance of general availability so that *Requests for Support of Registration* can be prepared. Revised reports are included in the Committee minutes and are circulated to the membership following the meeting.

Candidate cultivars in a co-op trial will have sufficient merit to warrant registration testing and the consumption of limited research resources. Lines are admitted or retained by consensus among the co-operators based on the performance of the candidates relative to the check cultivars and the likelihood of their ultimate registration. Numbers of entries in the co-op will be kept low enough to ensure precision and avoid undue demands on those performing the testing. Candidates accepted for testing under Contract Registration Procedures (Section 4) will not normally be tested in co-op trials.

Entry of candidates into a co-op trial typically requires six station-years of acceptable yield data from the targeted agro-ecological zone, plus satisfactory evaluations for important agronomic, disease and end-use quality traits. To control the number of qualified candidates in a co-op trial, entry requirements may be temporarily waived or increased by consensus of the co-operating group. There is no guarantee that all lines proposed for co-op testing will be admitted. Where there is serious concern that the requirements for testing a particular candidate(s) would seriously jeopardize the normal operation of the co-op trial, the co-operating group may refuse entry to the registration trial.

Seed stocks for candidate cultivars used in the registration trials must be of reasonable purity. As a guideline, the standards for germination should be similar to that required for Certified Seed, as defined by the *Seeds Regulations, Part I*.

As candidate cultivars have not been through the rigors of breeder seed development, morphological off-types may be expected, but should not exceed five percent. Acceptable off-types are those plants that exhibit phenotypes or genotypes that can be reliably removed during the process of breeder seed development; for example, seed colour, plant height, rust reaction. A line that has a trait that is difficult to reliably select against during breeder seed development will not be acceptable. The testing conditions, number of plants in yield plots (typically about 1000), and proximity to other cultivars precludes reliable detection of variants.

Retention of candidates for second and third years of testing should focus on performance in the co-op trial. Justification for retention will be required for lines that have been rejected by any of the Evaluation Teams. Candidates will not be tested beyond the three years required for registration unless there is agreement among the co-operating group to do so. In some cases, candidates retained for a second or third year of testing in one co-op trial may "cross-over" to another co-op trial if a suitable case is made (e.g.: Western Bread Wheat co-op to Central Bread Wheat co-op).

Candidate cultivars that fail to meet end-use quality specifications of the intended wheat quality class following a year of registration testing will not be re-entered into the same registration trial without agreement by the appropriate Evaluation Team Chair.

In the event of an unresolved conflict within a co-operating group, the decision of the Committee will be final.

Co-operators should meet all reasonable requirements set by the test co-ordinator with regard to quality, quantity, and time for submission of seed, provision of data for consideration of candidates, and attendance at meetings to determine the disposition of candidates. Failure to meet these requirements may result in deletion of the candidate from the co-op trial. While the co-ordinator may arrange for increase of the candidates under test, roguing and monitoring of seed purity is the responsibility of the sponsor of the candidate.

Although co-op trials may be run without charge, co-operators are reminded that testing candidate cultivars is expensive. The Committee has the authority to institute a system of charges if the costs and benefits of operating the co-op trials become unbalanced. Institutions that do not make a substantial contribution towards the co-op testing system may be charged a candidate entrance fee to help defray the costs of testing. An offer of payment for testing does not assure entry or retention of a candidate in the co-op trial. A description of any such charges will be documented in the appendices as a requirement for entry.

Appendix L: 2013-2014 PRCWRT Membership (Approved February 2013)

	Last Name	First Name	Title	Company/Institution	Committee position
1	Beres	Brian	Dr.	Agriculture & Agri-Food Canada	AET/Chair
2	Pozniak	Curtis	Dr.	University of Saskatchewan	AET/Secretary
3	Aljarrah	Mazen	Mr.	Alberta Agriculture & Food	AET
4	Etienne	Mark	Dr.	Dow AgroSciences	AET
5	Bonis	Peter	Mr.	Seed Link	AET
6	Brûlé-Babel	Anita	Dr.	University of Manitoba	AET
7	Chapman	Bill	Mr.	Alberta Agriculture & Food	AET
8	Cooper	Blake	Dr.	Limagrain	AET
9	Rothenburger	Patti	Dr.	Manitoba Agriculture, Food & Rural Initiatives	AET
10	Cuthbert	Richard	Dr.	Agriculture & Agri-Food Canada	AET
11	Davies	John	Dr.	WestBred	AET
12	Degenhardt	Keith	Dr.	Western Grains Research Foundation	AET
13	DePauw	Ron	Dr.	Agriculture & Agri-Food Canada	AET
14	Durand	Claude	Mr.	Syngenta Seeds Canada	AET
15	Ferguson	Tim	Mr.	Viterra	AET
16	Fotheringham	Doug	Mr.	Syngenta	AET
17	Fowler	Brian	Dr.	University of Saskatchewan	AET
18	Fox	Stephen	Dr.	Agriculture & Agri-Food Canada	AET
19	Goyal	Aakash	Dr.	Bayer Crop Science	AET
20	Graf	Robert	Dr.	Agriculture & Agri-Food Canada	AET
21	Holmstrom	Darrell	Mr.	Alberta Rye and Triticale Association	AET
22	Hucl	Pierre	Dr.	University of Saskatchewan	AET
23	Humphreys	Gavin	Dr.	Agriculture & Agri-Food Canada	AET
24	Huvenaars	Richard	Mr.	Alberta Soft Wheat Producers Commission	AET
25	Japp	Mitchell	Mr.	Saskatchewan Ministry of Agriculture	AET
26	Kirigwi	Francis	Dr.	Syngenta Seeds Canada	AET
27	Kubinec	Anastasia	Ms.	Manitoba Agriculture, Food & Rural Initiatives	AET
28	Larsen	Jamie	Dr.	Agriculture & Agri-Food Canada	AET

29	Love	Rick	Mr.	Canterra Seeds Ltd.	AET
30	Markert	Ron	Mr.	Canadian Seed Growers Association	AET
31	Mercer	Lloyd	Mr.	Alberta Winter Wheat Producers Commission	AM
32	Meyer	Leo	Mr.	Leo Meyer Grain Production Ltd.	AET
33	Moore	Martin	Mr.	B.C. Grain Producers Association	AET
34	Nelson	Ken	Mr.	AG Solutions Inc	AET
35	Ntiamoah	Charles	Dr.	World Wide Wheat, LLC	AM
36	Ottmar	Philipp	Dr.	Plantomar LTD	AET
37	Randhawa	Harpinder	Dr.	Agriculture & Agri-Food Canada	AET
38	Maxwell	Dana	Ms.	Ag-Quest	AET
39	Rutherford	Rick	Mr.	Winter Cereals Canada	AET
40	Sajjad	Rao	Dr.	AgQuest Inc	AET
41	Spaner	Dean	Dr.	University of Alberta	AET
42	Tsai	Shaan	Mr.	Canterra Seeds Ltd.	AET
43	Vos	Henry	Mr.	Alberta Wheat Commission	AET
44	Woods	Bill	Mr.	CWB Director	AM
45	Zatorski	Tom	Mr.	Bayer Crop Science	AET
46	Chopra	Satinder	Mr	Syngenta Seeds Canada	DET
47	Comeau	André	Dr.	Retired AAFC Geneticist	DET
48	Court	Randy	Mr.	Court Seeds	DET
49	DeRocquigny	Pam	Ms.	Manitoba Agriculture, Food & Rural Initiatives	DET
50	Despins	Therese	Ms.	Agriculture & Agri-Food Canada	DET
51	Fernandez	Myriam	Dr.	Agriculture & Agri-Food Canada	DET
52	Fetch	Tom	Dr.	Agriculture & Agri-Food Canada	DET
53	Foroud	Nora	Dr.	Agriculture & Agri-Food Canada	DET
54	Gaudet	Denis	Dr.	Agriculture & Agri-Food Canada	DET
55	Gilbert	Jeannie	Dr.	Agriculture & Agri-Food Canada	DET
56	Haber	Steve	Dr.	Agriculture & Agri-Food Canada	DET
57	Hiebert	Colin	Dr.	Agriculture & Agri-Food Canada	DET
58	Khan	Jahangir	Dr.	AgQuest (Alta), Inc.	DET
59	Knox	Ron	Dr.	Agriculture & Agri-Food Canada	DET

60	Kutcher	Randy	Dr.	Crop Development Centre	DET
61	Lefsrud	Ed	Mr.	Seed Grower	DET
62	Martin	Richard	Dr.	Agriculture & Agri-Food Canada	DET
63	McCallum	Brent	Dr.	Agriculture & Agri-Food Canada	DET
64	McCartney	Curt	Dr.	Agriculture & Agri-Food Canada	DET
65	Mclean	Eric	Mr.	Manitoba Seed Growers Association	DET
66	Menzies	James	Dr.	Agriculture & Agri-Food Canada	DET
67	Tekauz	Andy	Dr.	Agriculture & Agri-Food Canada	DET
68	Turkington	Kelly	Dr.	Agriculture & Agri-Food Canada	DET
69	Xi	Kequan	Dr.	Alberta Agriculture & Food	DET
70	Arney	Sheilagh	Ms.	ADM Milling Co.	QET
71	Assefaw	Esey	Mr.	Canadian International Grains Institute	QET
72	Beswitherick	Daryl	Mr.	Canadian Grain Commission	QET
73	Briggs	Connie	Ms.	University of Saskatchewan	QET
74	Butti	Cathy	Ms.	Syngenta	QET
75	Dupuis	Brigitte	Dr.	Canadian Grain Commission	QET
76	Durand	Valerie	Ms.	Canada Bread Fresh Bakeries	QET
77	Dyck	Adam	Mr.	Warburtons	QET
78	Edwards	Nancy	Dr.	Cereal Grain Consultant	QET
79	Entz	Peter	Mr.	JRI (representing Country Elevators Association)	QET
80	Fu	Bin Xao	Dr.	Canadian Grain Commission	QET
81	Hatcher	David	Dr.	Canadian Grain Commission	QET
82	Kieper	Richard	Mr.	Paterson Grain LTD (Terminal Elevator Assoc.)	QET
83	Lekhi	Arun	Mr.	P&H Milling	QET
84	Nemeth	Lisa	Ms.	Consultant	QET
85	Niziol	Dave	Mr.	Agriculture & Agri-Food Canada	QET
86	Santangelo	Paulo	Mr.	Ellison Milling Co.	QET
87	Sapirstein	Harry	Dr.	University of Manitoba	QET
88	Sarkar	Ashok	Mr.	Canadian International Grains Institute	QET
89	Scanlon	Martin	Dr.	University of Manitoba	QET
90	Schlichting	Linda	Ms.	Canadian Grain Commission	QET

91	Sopiwnyk	Elaine	Ms.	Canadian International Grains Institute	QET
92	Supeene	Yvonne	Ms.	Canadian International Grains Institute	QET
93	Worden	Graham	Mr.	Paterson Global Food	QET
94	Alderson	Dale	Mr.	ICMS Inc.	AM
95	Bertholet	Jeff	Mr.	BASF Canada	AM
96	Downey	Jim	Mr.	SeCan Association	AM
97	Eamer	Brenda	Mrs.	Agriculture & Agri-Food Canada	AM
98	Gehl	David	Mr.	Agriculture & Agri-Food Canada	AM
99	Greig	Fred	Mr.	Canterra Seeds Ltd.	AM
100	Grenier	Mike	Mr.	Gowan Agro Canada	AM
101	Loiselle	Marc	Mr.	Saskatchewan Organic Directorate	AM
102	Nakonechny	Marvin	Mr.	Progressive Seeds	AM
103	Nyachiro	Joseph	Dr.	Alberta Agriculture & Food	AM
104	Richardson	Sheldon	Mr.	World Wide Wheat LLC	AM
105	Smith	John	Mr.	Seed Depot	AM
106	Thompson	Wayne	Mr.	Western Grains Research Foundation	AM
107	Weik	Ron	Mr.	FP Genetics	AM
108	Wright	Brent	Mr.	ICMS Inc.	AM