6 Canadian Wheat

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6.1 Introduction

The vast majority of Canadian wheat is produced in western Canada (Manitoba and provinces to the west). A large proportion of western Canadian wheat is exported, and it is marketed in a highly regulated fashion. As soon as western Canadian wheat is delivered by producers to a grain elevator the wheat becomes the property of the Canadian Wheat Board, which is a single desk seller for western Canadian wheat. Approval for registration into any of the eight classes of wheat in western Canada is based on merit according to disease resistance, agronomic performance and processing quality.

Wheat is also produced in eastern Canada, primarily in southern Ontario. Eastern Canadian wheat is also registered on the basis of merit, although processing quality models are not quite as strictly defined as for western Canada. There is no single desk seller for eastern Canadian wheat, which is marketed by private trading companies and the Ontario Wheat Producers Marketing Board. Approximately 50% of eastern Canadian wheat disappears domestically.

The Canadian Grain Commission (CGC), a Department within Agriculture and Agri-Food Canada (AAFC), oversees quality assurance of Canadian grains, oilseeds, pulses and special crops. The CGC is headquartered in Winnipeg, Manitoba and has regional offices across Canada. The CGC derives its authority from the Canada Grain Act, an Act of Parliament, enacted in 1912, and revised most recently in 1995. Subject to the Canada Grain Act, the CGC *"shall, in the interests of grain producers, establish and maintain standards of quality for Canadian grain and regulate grain handling in Canada, to ensure a dependable commodity for domestic and export markets."* The CGC quality assurance system is in effect from the time producers deliver their crops until they are received by the customer. In fulfilling its role, the CGC:

- acts as an unbiased regulator in the best interest of all elements of the Canadian grain industry;
- licenses grain elevators, monitors their operations, and ensures that facilities are in good operating condition and free of infestation;
- sets grade standards in consultation with the industry;
- supervises weighing of incoming grain at terminal elevators and assigns a grade;
- supervises weighing during loading for export, and continuously takes samples and grades the grain during loading;
- issues certificates that report the weight and grade of export shipments;
- conducts scientific research in support of quality assurance and grain marketing;
- monitors the quality and safety of Canadian wheat;
- provides technical assistance to marketers and customers, and investigates if there is a disagreement concerning quantity or quality of a shipment;
- participates in quality testing of wheat breeding lines and supports wheat marketing programmes.

More information on the duties and responsibilities of the CGC can be found on the CGC website at www.grainscanada.gc.ca.

Organizations

CGC	=	*Canadian Grain Commission*
GRL	=	*Grain Research Laboratory*
OWPMB	=	*Ontario Winter Wheat Producers' Marketing Board*
PRRCG	=	*Prairie Regional Recommending Committee for Grain*
AAFC	=	*Agriculture and Agri-Food Canada*

6.2 Overview of the Canadian Wheat Quality Assurance System

An effective grain quality assurance system considers the best interests of all segments of the industry, and must be flexible and responsive to evolving industry needs. The Canadian wheat quality assurance system overseen by the CGC is modelled on that basis, but there are fundamental principles that remain constant. They include reliable supply, safety, cleanliness, uniformity and consistency, and superior processing performance.

Canada supplies high quality wheat reliably year-to-year because on average over 20 million metric tonnes (mio t) are produced annually in the vast fertile plains of western Canada, and Canadian consumption of milling wheat is only about 2.5 mio t. Dockage must be removed from Canadian wheat prior to export according to standards set by the CGC. Dockage-free wheat is less dusty, and requires less intense cleaning in preparation for milling. Removing dockage also improves wheat storage stability, and may alleviate import restrictions associated with noxious weed seeds. Removal of genetically modified impurities, such as soybeans, canola and maize, is becoming increasingly important to millers as more customers require assurance that milled products meet strict GMO content limits.

Insect infestation is rarely a problem with Canadian wheat because of the harsh winter weather conditions in western Canada. The main form of storage in western Canada is on-farm in steel silos. CGC entomologists and grain sanitation officers work closely with the industry to minimize infestation in grain handling facilities, and to ensure that problems are dealt with promptly and effectively.

Consumers are demanding assurances of food safety more and more, and in response, wheat importers are increasingly requesting safety statements of assurance or safety certification for shipments. CGC research and monitoring programmes provide in-depth knowledge of what toxic contaminants and constituents could possibly be in Canadian grain (Nowicki, 1993). Depending on the request of each customer, the CGC will issue a letter of assurance based on historical data, or carry out analyses to certify levels of pesticide residues, mycotoxins, toxic trace elements, radio nuclides and noxious weed seeds. CGC monitoring programmes have shown that Canadian grain is not only safe, but meets the strictest Canadian and international tolerances for all potential toxic contaminants.

Millers want uniformity and consistency in order to meet flour or semolina specifications demanded by their customers. End-users want uniformity and consistency to make products acceptable to consumers without continually changing the processing conditions. Consistent quality from shipment to shipment of the same class and grade of wheat, for which Canadian wheat is well known, is an obvious asset. Of almost equal importance is uniformity within and between holds of a given shipment.

The goal of the Canadian wheat quality assurance system is to allow customers to select a class and grade of Canadian wheat that best meets their requirements, with confidence that it will perform as expected. To accomplish this goal for Canadian wheat:

- quality models for western Canadian wheat classes are carefully and clearly defined;
- western Canadian wheat classes must be visually distinct from each other to allow efficient segregation;
- CGC wheat grade standards have a scientific basis;
- the CGC protocol during loading of wheat export cargoes is designed to maintain uniformity and consistency and to assure processing quality;
- post-shipment monitoring of end-use quality is conducted by the CGC;
- an ongoing dialogue is maintained with users of Canadian wheat.

6.3 Wheat Grading and Classification in Canada

21 A specific kernel size, shape and colour is reserved for each wheat class grown in western Canada (Fig. 23). A requirement for registering a wheat variety in western Canada is that it must have the visual appearance reserved for the class for which it qualifies. This unique feature of the Canadian wheat grading and classification system is referred to as kernel visual distinguishability (KVD). KVD ensures that wheat classes are easily and cost effectively kept distinct throughout the handling system. This preserves the unique attributes of each class; admixing of classes results in a product with less processing value. In eastern Canada, KVD is a requirement only for registration into the Canada Eastern White Winter (CEWW) wheat class.

Physical condition is a primary determinant of wheat processing value. Physical condition is determined primarily by growing conditions. In Canada, wheat is graded according to grade standards established by the CGC (2003a). The grade standards are set to mitigate differences in quality year-to-year. The amount of wheat grading into the top grades will be less in years when growing conditions are not ideal, but the quality of a given class and grade must be comparable to previous years (Preston *et al.*, 1988).

Canadian Wheat Classes

CEHRW	=	*Canada Eastern Hard Red Winter*
CER	=	*Canada Eastern Red*
CERS	=	*Canada Eastern Red Spring*
CESRW	=	*Canada Eastern Soft Red Winter*
CEWW	=	*Canada Eastern White Winter*
CEWW	=	*Canada Eastern White Winter*
CPSR	=	*Canada Prairie Spring Red*
CPSW	=	*Canada Prairie Spring White*
CWAD	=	*Canada Western Amber Durum*
CWES	=	*Canada Western Extra Strong*
CWHW	=	*Canada Western Hard Wheat*
CWRS	=	*Canada Western Red Spring*
CWRW	=	*Canada Western Red Winter*
CWSWS	=	*Canada Western Soft White Spring*

Grade definitions are established under the authority of the Canada Grain Regulations with direction from the CGC. Tables of specifications provide structure for assigning grades to grains. Specifications include factors such as minimum test weight, and maximum tolerances for factors such as foreign material, contrasting wheat classes, damaged kernels and broken kernels. There are two sets of standards: primary and export. Primary standards are used to grade wheat upon delivery into grain facilities, including export terminals. Prior to arrival at terminals, the grading is done by private grain handling companies. Wheat arriving at export terminals is graded by the CGC. The grade assigned to a lot by the CGC is the basis for payment.

Export standards are used to grade wheat destined for export. The CGC is solely responsible for grading of export cargoes from terminal facilities. Some factors such as foreign material and contrasting classes have stricter tolerances in export standards than for primary standards. Important export grade standards for Canada Western Red Spring (CWRS) wheat and Canada Western Amber Durum (CWAD) wheat, the two largest classes of wheat grown in Canada, are shown in Tab. 17 and Tab. 18. All CGC primary and export standards, definitions of various types of damage, and methodologies employed by CGC inspectors may be found in the Official Grain Grading Guide (CGC, 2003a) which is available on the CGC website at www.grainscanada.gc.ca.

Fig. 23: Kernel visual distinguishability. Each class of wheat grown in western Canada has a distinct kernel size, shape and colour to permit efficient visual segregation. Classes from left to right: Canada Western Red Spring, Canada Western Red Winter, Canada Western Extra Strong, Canada Prairie Spring Red, Canada Prairie Spring White, Canada Western Soft White Spring and Canada Western Amber Durum

Tab. 17: Tolerances for some Canada Western Red Spring wheat export grade determinants[a]

Determinant		No 1 CWRS	No 2 CWRS	No 3 CWRS
Test weight	kg/hL	79.0	77.5	76.5
HVK[b]	%	65	35	-
Other classes	%	1.5	3.0	5.0
Included contrasting classes	%	0.5	1.5	2.5
Ergot	%	0.01	0.02	0.04
Total foreign material	%	0.4	0.75	1.25
Shrunken kernels	%	4.0	4.0	4.0
Fusarium damage	%	0.25	1.0	2.0
Severely sprouted	%	0.1	0.2	0.3
Total sprouted	%	0.5	1.0	3.0
Smudge	%	30K[c]	1.0	5.0

[a] *Complete CGC primary and export grade determinants may be found in the Official Grain Grading Guide (CGC, 2003a).*
[b] *HVK = hard vitreous kernels*
[c] *K = Number of kernel-size pieces in 500 g.*

Tab. 18: Tolerances for some Canada Western Amber Durum wheat export grade determinants[a]

Determinant		No 1 CWAD	No 2 CWAD	No 3 CWAD	No 4 CWAD
Test weight	kg/hL	80.0	79.5	78.0	75.0
HVK[b]	%	80	60	40	-
Other classes	%	2	2.5	3.5	10.0
Ergot	%	0.01	0.02	0.04	0.04
Total foreign material	%	0.5	0.8	1.0	3.0
Shrunken kernels	%	3.0	3.0	3.0	3.0
Fusarium damage	%	0.5	0.5	2.0	2.0
Severely sprouted	%	0.1	0.2	-	-
Total sprouted	%	0.5	2.0	8.0	12.0
Smudge	%	30K[c]	1.0	3.0	-

[a] *Complete CGC primary and export grade determinants may be found in the Official Grain Grading Guide (CGC, 2003a).*
[b] *HVK = hard vitreous kernels*
[c] *K = Number of kernel-size pieces in 500 g.*

Associated with each wheat grade, there is also a specification for degree of soundness. For example, degree of soundness for No 1 CWRS is defined as *"reasonably well matured, reasonably free from damaged kernels"*, for No 2 CWRS it is defined as *"fairly well matured, may be moderately bleached or frost-damaged, reasonably free from severely damaged kernels"* and for No 3 CWRS it is defined as *"may be frost-damaged, immature or weather-damaged, moderately free from severely damaged kernels"*. These definitions relate to factors such as frost damage, mildew and degree of maturity which are difficult to measure objectively. Standard samples are prepared as visual aids in accessing degree of soundness. The standard

samples are prepared by the CGC every autumn, following the harvest, to reflect the visual appearance associated with growing conditions from the most recent harvest. The CGC submits the standard samples for approval to the Western and Eastern Grain Standards Committees, which are composed of producers, exporters, processors and scientific and technical specialists. Once approved they are distributed to CGC offices, and to inspection offices of private grain companies.

An important feature of the grading standards for all western Canadian wheat classes, and for CEWW in eastern Canada, is variety designation. This relates to the strict variety registration process in Canada, which will be discussed in more detail later. The only varieties eligible for the milling grades of Canadian wheat classes with variety designation are those with processing quality proven to conform to the quality model established for the class. The CGC designates which varieties are eligible for each class of wheat. Variety designation assures that intrinsic quality is the same for all grades within a given class. Processing quality differences between milling grades then are solely attributable to grade tolerances, and differences in protein content.

The Canadian wheat grading system has a scientific substructure. The Grain Research Laboratory (GRL), the scientific branch of CGC, and Industry Services, the branch of CGC responsible for setting grade standards, investigate the effects on end-use quality of the grading factors encountered in Canada so that grade tolerances can be realistically set (Dexter and Edwards, 1998a, 1998b).

The combination of a strict wheat variety registration requirement, and a grading system with a scientific basis, provide a direct linkage between the visual appearance and the processing quality of Canadian wheat classes with variety designation. That linkage, together with KVD, allows the segregation of Canadian wheat quickly and efficiently according to processing potential.

Throughout loading from a terminal elevator, the CGC continuously samples and grades the wheat, and officially weighs it. The CGC has a strict loading protocol that must be followed. At all times wheat must remain within the export standards established for the grade ordered. When the wheat has been loaded, the CGC issues a Certificate Final certifying the grade and exact weight of the shipment. The Certificate Final is the customer's guarantee that if there is a disagreement concerning quantity or quality of a shipment, the CGC will investigate.

6.4 Development of New Wheat Varieties in Canada

6.4.1 Factors Determining Wheat Quality Requirements

The definition of wheat quality is diverse because it varies from region to region, market to market, and company to company. Wheat quality is also continuously evolving in response to changing consumer preference and changing processing technology. Globalization impacts on wheat quality requirements because multi-national companies apply similar quality specifications worldwide. Another factor affecting quality requirements is the influence of other cultures. An example is the emergence, in many countries, of North American-style fast food chains. To make high quality buns, a strong high protein bakery flour is required. This can open up significant demand for better quality wheat in markets that have traditionally not been quality conscious. In many countries, competition from imported wheat products drives wheat quality shifts.

Throughout the world the wheat industry is deregulating. The collapse of centrally planned economies in eastern Europe caused a general decline in demand for wheat imports, and lowering of quality standards in some countries within that region. Elsewhere deregulation has increased demand for higher quality wheat. Deregulation has had a great impact on wheat quality requirements in Latin America. Free trade agreements necessitated that state-

owned buying agencies be disbanded. In general those agencies purchased wheat with minimal consultation with millers, and assigned wheat to millers on a quota basis. When deregulation occurred millers were faced with true competition. Millers began purchasing wheat independently and paid more attention to wheat quality in order to protect their market share.

Wheat processing technology impacts on wheat quality requirements. An obvious example that affects Canada is the diversity of baking processes and formulas in markets that import CWRS wheat. CWRS varieties must perform well in bakeries using short mechanical dough development processes and those using long fermentation processes.

Processing technology advances that become generally accepted can influence wheat quality models quickly and dramatically. An example is the quality model for CWAD (Dexter and Marchylo, 1997). An important milestone for international acceptance of CWAD quality was the registration of Hercules in 1969. The gluten strength and pasta colour of Hercules was much better than for previously released Canadian durum wheat varieties. The quality of Hercules was a direct response to international demand for durum wheat with stronger gluten and better colour. The importance of gluten strength in determining pasta texture became more widely recognized as reliable tests to determine gluten strength and pasta texture became available. Pasta colour and appearance became important aesthetic marketing tools for premium pasta because of advances in pasta-making technology. Continuous extrusion under vacuum reduced yellow pigment loss, and the use of Teflon™ inserts in dies greatly improved pasta surface characteristics.

The registration of Hercules coincided with a rapid increase in CWAD production in Canada due to overwhelming market acceptance. Durum wheat production in Canada rose from less than 500,000 t in the 1960s to over two mio t in the 1970s. Over the past five years durum wheat production in Canada has averaged about 5 mio t. As will be discussed later, the CWAD model is again undergoing review to ensure it continues to meet the demands of current durum wheat milling and pasta-making technology.

6.5 The Canadian Wheat Variety Registration Process

Development of improved western Canadian wheat varieties is closely linked to wheat market development. The process begins with onsite evaluation of the wheat processing industry in target markets by experts from the Canadian Wheat Board, Canadian International Grains Institute, Agriculture and Agri-Foods Canada and the CGC. Dialogue with processors identifies the strengths and the weaknesses of Canadian wheat. Information is shared with Canadian wheat breeders to expedite the development of breeding lines with desirable attributes. In response to market feedback, the quality model for a given wheat class may be revised, or new classes may be developed in response to market requirements.

Western Canadian plant breeders are responsible for the testing of breeding lines up to about the F8 generation[9]. The final stage of testing in western Canada is known as the Cooperative Test (C-Test). Promising lines are grown at numerous locations across western Canada to reflect the diversity in environment and soil. There are a range of C-Tests for each class and/or region in western Canada. C-Test quality evaluation is coordinated by the GRL.

Most of the quality testing is performed at the GRL, although the heavy amount of testing requires some collaboration with other institutes.

The lines entered in each C-Test are evaluated by the Wheat, Rye and Triticale Subcommittee of the Prairie Regional Recommending Committee for Grain (PRRCG). Three teams of

[9] F8 = 8th filial generation, the offspring of a genetically specified mating. F1 = first filial generation, the offspring of parents of contrasting genotypes; second filial generation (F2), the offspring of two F1 individuals; third filial generation (F3), the offspring of two F2 individuals, etc.

experts consider wheat agronomic merit, disease resistance and processing quality, respectively. Lines must exhibit satisfactory performance in all three categories for three consecutive years. All lines being tested for a third year must be supported by all three teams before they can be considered for registration. If the line is promising, and the breeder has the support of the PRRCG, he or she can apply to the Variety Registration Office of the Canadian Food Inspection Agency for registration in western Canada. Once registered, the variety becomes eligible for the milling grades of the class of western Canadian wheat for which it qualifies.

There is a similar process for registration of wheat varieties in eastern Canada. The Eastern Expert Committee on Cereals and Oilseeds assesses the agronomic, disease resistance and quality merit of wheat lines in eastern field trials. If a line has support, then the breeder applies for registration in eastern Canada to the Variety Registration Office of the Canadian Food Inspection Agency.

If a new wheat variety represents a significant quality breakthrough, it undergoes extensive test marketing. New quality types or "special" quality types intended for specific "niche" markets that do not conform to the quality models of existing western Canadian wheat classes may be assigned temporary registration for contract production within the Experimental class during test marketing. In western Canada the Canadian Wheat Board, in cooperation with grain handling companies, uses contract growing programmes to expedite seed increase and to encourage production. Quality is evaluated on a laboratory-scale at GRL, and on a pilot-scale at the Canadian International Grains Institute. Small samples are distributed to customers of Canadian wheat for laboratory-scale testing to obtain initial market feedback. As more wheat becomes available, larger quantities are shipped to allow pilot-scale commercial testing. If possible, technical experts from Canada accompany the larger shipments to observe the processing, and to exchange technical information.

6.6 Western Canadian Wheat Classes

6.6.1 Canada Western Red Spring (CWRS) Wheat

CWRS is the largest class of wheat grown in western Canada with an annual average production of about 15 mio t. The availability of three milling grades, several guaranteed protein content levels, and carefully defined processing characteristics, give it the flexibility to be exported to over 60 markets annually. Major uses of CWRS are pan bread, hearth bread and as a strong blending wheat. It also finds use for noodles, pasta and flat breads in some markets.

The strength range among CWRS varieties is kept relatively narrow in order to maintain uniformity of strength within and between cargoes (Preston *et al*., 1988 and 2001). The most widely grown CWRS variety at present (2004) is AC Barrie. Physical dough properties of Neepawa, AC Barrie and Laura are shown in Tab. 19 to illustrate the range of strength deemed acceptable for CWRS varieties.

Many CWRS target markets use physical dough parameters as specifications. The variety Neepawa exhibits the minimum physical dough strength required of CWRS varieties. Varieties with less strength are not suited to markets that use rigorous long fermentation baking processes. Adequate strength is also required to satisfy markets that blend high protein CWRS with lower quality wheat to improve baking quality. Laura is representative of varieties that exhibit the maximum limit of physical dough strength permitted for CWRS. Cultivars that are stronger have extended mixing times, making them poorly suited to short mechanical development baking processes. The three varieties produce bread of equivalent quality whether baked by a short mechanical development process similar to that used by many Canadian bakeries, or by a sponge-and-dough process, which has a 4-hour sponge fermentation time. This assures marketing flexibility. In the case of short process baking,

Tab. 19: Physical dough properties and baking quality of some CWRS varieties[a]

Property		Neepawa	AC Barrie	Laura
Farinograph				
Absorption	%	65.9	63.8	64.9
Development time	min	4 3/4	6 1/4	8 1/4
Stability	min	8	10 1/2	21 1/2
Extensograph				
Length	mm	21	21	21
Maximum height	BU	410	705	815
Area	cm^2	125	200	225
Short process bread				
Absorption	%	68	68	69
Mixing time	min	7.0	10.6	9.8
Loaf volume	mL	1,105	1,060	1,130
Sponge and dough bread				
Absorption	%	66	66	67
Mixing time	min	8.0	11.2	8.2
Loaf volume	mL	1,225	1,210	1,240

[a] *Source: Western Bread Wheat Trials of the Prairie Regional Recommending Committee for Grain (1999). Test methods as described in CGC (2003b)*

the mixing requirements of all three varieties are short enough to ensure adequate dough development within the mixing time constraints for maximum throughput of commercial short process bakeries.

Other quality attributes required of CWRS varieties are high test weight, high protein content, resistance to preharvest sprouting (i.e. high Falling Number) and good milling performance. Milling performance is judged on the basis of flour yield and flour refinement (ash content and brightness). High water absorption is also a requirement. High water absorption is associated with longer bread shelf-life, and also assures bakers a high yield of bread per unit of flour. Dexter (1993) has reviewed the quality requirements of CWRS in detail.

There are three milling grades of CWRS. No 1 and No 2 CWRS are routinely marketed at guaranteed protein levels. The most frequent protein guarantee is 13.5% (13.5% m.b.) because the long-term average protein content of CWRS is 13.6%. Processing characteristics of No 1 CWRS from the 2003 CGC harvest survey are shown at three protein levels in Tab. 20.

6.6.2 Canada Western Amber Durum (CWAD) Wheat

CWAD is the second largest class of western Canadian wheat, with average annual production near 5 mio t. Recently the quality model for CWAD wheat has undergone revision in response to changing market requirements (Dexter and Marchylo, 2000). As mentioned earlier, the variety Hercules is the foundation for international acceptance of CWAD wheat. Since then advances in drying cycles and press technology have improved pasta colour. As a result, there is more emphasis on pasta colour in many markets. Also, increasing use of gluten strength measurements such as the SDS sedimentation test, gluten index and Alveograph has made durum wheat processors

Tab. 20: Quality of No 1 CWRS from the 2003 western Canadian harvest [a,b]

Property		No 1 CWRS - 14.5	No 1 CWRS - 13.5	No 1 CWRS - 12.5
Wheat				
Test weight	kg/hL	82.2	82.4	82.7
Protein content	%	14.8	13.8	12.8
Falling Number	s	420	395	405
Flour yield	%	75.4	75.7	75.5
Flour				
Protein content	%	14.3	13.3	12.2
Ash content	%	0.48	0.46	0.48
Farinograph				
Absorption	%	66.3	65.7	65.3
Development time	min	6 1/2	5 3/4	4 1/2
Stability	min	10	11	9 1/2
Extensograph				
Length	cm	22	21	22
Maximum height	BU	715	690	670
Area	cm^2	205	190	195
Short process bread				
Absorption	%	68	69	68
Mixing time	min	7.0	9.8	10.3
Loaf volume	mL	1,105	1,130	1,075

[a] *Source: Quality of 2003 western Canadian wheat (CGC, 2003b). BU = Brabender units.*
[b] *Data reported on a 13.5% m.b. for wheat and a 14.0% m.b. for flour.*

more aware of gluten strength, and has increased the demand for varieties with stronger gluten.

In response to these changing market demands, Canada released several new CWAD varieties with better colour and stronger gluten than Hercules. In 1999 two varieties with very strong gluten, AC Pathfinder and AC Navigator, were granted interim registration for test marketing as Extra-Strong (ES) CWAD. AC Navigator was well accepted, and it now has full registration. AC Navigator is marketed identity-preserved from other CWAD varieties to take full advantage of market demand for strong gluten durum, and also to maintain uniform gluten strength within regular CWAD shipments.

The direction of the Canadian durum wheat breeding programme is apparent from quality data of breeding lines from the 1999 Amber Durum Wheat C-Test (Tab. 21). Kyle, registered in 1984 and still accounting for nearly 50% of CWAD production in 2003, is comparable in gluten strength to Hercules, as measured by sodium dodecyl sulphate (SDS) sedimentation, gluten index (GI), and Alveograph P/L (APL) and W (AW) values. AC Avonlea, registered in 1997, has Hercules-type strength, but improved wheat protein content, and has consistently exhibited superior pasta cooking quality. AC Avonlea also has improved pasta yellowness as indicated by higher b* values for spaghetti dried at 70 °C and 90 °C. AC Morse, registered in 1996, and AC Napoleon, registered in 1999,

Tab. 21: Quality data for some Canadian amber durum wheat cultivars [a,b]

Variety	WPR %	SDS mL	GI %	APL	AW J·10^{-4}	70^{b}*	90^{b}*	70CS units	90CS units
Hercules Model									
Hercules	14.0	55	40	0.19	109	66.1	67.9	28	43
Kyle	13.8	43	22	0.31	90	68.2	68.3	29	48
AC Avonlea	14.5	50	40	0.34	114	69.4	69.0	45	57
IS Model									
AC Morse	14.4	60	62	0.48	177	67.9	69.0	40	58
AC Napoleon	14.1	55	62	0.39	140	72.8	72.8	40	53
ES Model									
AC Pathfinder	13.6	74	93	0.67	260	68.0	69.1	39	49
AC Navigator	13.7	63	86	0.71	192	74.1	74.2	45	52

[a] *Source: Amber Durum Wheat Trials of the Prairie Regional Recommending Committee for Grain (1999). Wheat analytical data expressed on 13.5% m.b.; flour analytical data expressed on 14% m.b. Test methods as described in CGC (2003b)*

[b] *WPR = wheat protein content; SDS = SDS-sedimentation volume; GI = gluten index; APL = Alveograph P/L; AW = Alveograph W; 70b* and 90b* = b* of spaghetti dried at 70 °C and 90 °C; 70CS and 90CS = cooking score of spaghetti dried at 70 °C and 90 °C, respectively; IS = intermediate strength; ES = extra strong*

are typical of the new CWAD quality model that all future CWAD varieties must meet. AC Napoleon exhibits improved pasta yellowness. AC Morse and AC Napoleon both exhibit significantly stronger gluten properties than the Hercules model. Another durum wheat line with improved quality, Strongfield (formerly DT 712), was supported for registration in 2003.

AC Navigator and AC Pathfinder, the ES-CWAD varieties, exhibit a further incremental increase in gluten strength, as evident from much higher SDS, GI, APL and AW. Test marketing of the ES-CWAD varieties met with positive response by some customers of CWAD, whereas other customers expressed preference for more conventional CWAD strength. For example, dough extensibility is required for production of fresh pasta, which is usually sheeted. In markets that expressed preference for ES-CWAD, AC Navigator met with greater acceptance than AC Pathfinder due to superior pasta yellowness. This underscores the emerging importance of pasta yellowness in the international marketplace. In 2004 Commander, which has comparable pasta colour and stronger gluten than AC Navigator, was supported for registration.

Other Abbreviations

70CS	=	*cooking score for spaghetti dried at 70 °C*
90CS	=	*cooking score for spaghetti dried at 90 °C*
*L**	=	*white/black tristimulus colour coordinate (brightness)*
*a**	=	*red/green tristimulus colour coordinate*
*b**	=	*blue/yellow tristimulus colour coordinate*
APL	=	*Alveograph P/L ratio*
AW	=	*Alveograph W value*
BU	=	*Brabender units*
C-Test	=	*Cooperative Test*
DNA	=	*deoxyribonucleic acid*
ES	=	*extra strong*
FN	=	*Falling Number*
GI	=	*Gluten Index*
GM	=	*genetically modified*
GMO	=	*genetically modified organism*
HVK	=	*hard vitreous kernels*
IS	=	*intermediate strength.*
K	=	*kernel size pieces per 500 g*
KVD	=	*kernel visual distinguishability*
m.b.	=	*moisture basis*
NIRS	=	*near-infrared spectroscopy*
RVA	=	*RapidVisco Analyzer*
SDS	=	*sodium dodecyl sulphate*
t	=	*metric tons (tonnes)*
VED	=	*variety eligibility declaration*
WPR	=	*wheat protein content*

Tab. 22: Quality of No 1 CWAD and AC Navigator from the 2003 western Canadian harvest [a,b]

Property		No 1 CWAD	No 1 AC Navigator
Wheat			
Test weight	kg/hL	82.3	82.5
Protein content	%	13.6	13.4
Falling Number	s	420	440
Semolina yield	%	65.4	66.7
Milling yield	%	74.1	76.2
Semolina			
Protein content	%	12.5	12.4
Gluten index	%	21	59
Ash content	%	0.62	0.63
Agtron colour	%	86	82
Alveograph			
P (height · 1.1)	mm	47	67
Length (L)	mm	106	104
P/L		0.4	0.6
W	$J \cdot 10^{-4}$	106	202
Spaghetti dried at 70 °C			
L*		77.8	76.4
a*		2.5	4.5
b*		68.6	74.4
Cooked firmness	g cm	1,012	1,064

[a] *Source: For CWAD: Quality of 2003 western Canadian wheat (CGC, 2003b). For AC Navigator: unpublished CGC data.*

[b] *Data reported on a 13.5% m.b. for wheat and a 14.0% m.b. for flour.*

As seen in Tab. 21, when used on their own, the extra-strength of the new CWAD and ES-CWAD varieties does not seem to offer much of a cooking quality advantage over less strong varieties. However, an advantage of the extra strength of AC Pathfinder and AC Navigator is that when they are blended with weak low protein varieties, gluten strength and pasta texture of the blends are improved more than when weak low protein varieties are blended with less strong durum varieties (Dexter *et al.*, 2001).

All CWAD varieties must have high test weight to ensure high semolina yield. Semolina refinement is equally important – semolina millers must meet maximum ash and/or minimum brightness specifications, so CWAD varieties must produce bright semolina with a low ash content. Protein content must be high because it is the primary factor associated with pasta texture. Not only must pasta be intensely yellow (high b*), but it must show no evidence of browning (high L* and low a*) because of the importance of colour in marketing premium pasta.

There are four milling grades of CWAD. If requested, the top two grades of CWAD are marketed on a guaranteed protein content basis. The quality of both No 1 CWAD and No 1 AC Navigator from the 2003 western Canadian harvest is shown in Tab. 22. The future direction of the CWAD breeding programme will be determined by dialogue with users of Canadian durum wheat.

6.6.3 Minor Classes of Western Canadian Wheat

There are six other classes of common wheat in western Canada: Canada Western Extra Strong (CWES), Canada Western Red Winter (CWRW), Canada Prairie Spring Red (CPSR), Canada Prairie Spring White (CPSW) and Canada Soft White Spring (CWSWS). Another hard white spring wheat class was established in 2004, after undergoing successful test marketing. There are two milling grades for CWES, CPSR and CPSW, but because of relatively small quantities they are usually exported under the grade designation "No 2 or better". There are three milling grades for CWRW, CWSWS and CWHW. Typical quality for 2002 export cargoes for CWES, CWRW, CPSR and CPSW are shown in Tab. 23. CWSWS has not been exported in significant quantities in recent years.

Canada Western Extra Strong (CWES) Wheat

CWES strong wheat is a hard red spring wheat with extraordinarily strong gluten. Annual production of CWES

Tab. 23: Quality of No 2 CWES, No 2 CWRW, No 2 CPS-R and No 2 CPSW export cargoes [a,b,c]

Property		No 2 CWES	No 2 CWRW	No 2 CPSR	No 2 CPSW
Wheat					
Test weight	kg/hL	80.9	80.1	82.0	81.5
Protein content	%	13.3	11.0	11.5	11.8
Falling Number	s	310	365	340	360
Flour yield	%	75.3	75.7	75.0	75.3
Flour					
Protein content	%	12.8	10.0	10.9	11.0
Ash content	%	0.56	0.46	0.50	0.53
Farinograph					
Absorption	%	63.2 [c]	54.9	61.9	63.2
Development time	min	6 [c]	3 1/4	5 1/4	4
Stability	min	-	6 1/2	5	5
Extensograph					
Length	cm	24	22	21	20
Maximum height	BU	715	450	535	380
Area	cm^2	240	140	155	110

[a] *Source: Quality of western Canadian wheat exports. February 1 to July 31, 2002 (CGC, 2002a). Test methods as described in CGC (2003b).*
[b] *Data reported on a 13.5% m.b. for wheat and a 14.0% m.b. for flour. BU = Brabender units.*
[c] *Farinograph data determined at 90 min^{-1} because CWES is too strong to develop at normal Farinograph speed of 63 min^{-1}.*

averages about 500,000 t, although in 2002 and 2003 production declined, partly due to drought and also due to less market demand. There are two milling grades of CWES. CWES is intended as a dough strength "correctional", or blending wheat. The very strong gluten allows millers to strengthen dough properties by adding relatively small amounts of CWES flour.

Canada Western Red Winter (CWRW) Wheat

CWRW is a hard red winter wheat class. Annual production averages less than half a mio t, but it has been increasing recently. Formerly CWRW was grown primarily in southern Alberta where rust is less prevalent than in the rest of western Canada, but production has moved east into Saskatchewan and Manitoba with the development of varieties with improved rust resistance. A major goal of the CWRW breeding programme is to increase protein content, which typically is about 2% less than for CWRW, and increase flour water absorption. CWRW can be blended with higher protein wheat and milled for high volume pan breads. On its own it is suited for hearth breads, flat bread and some types of Asian noodles.

Canada Prairie Spring Red (CPSR) Wheat

Despite intensive efforts to breed high quality Hard Red Winter for western Canada, combining sufficient winter hardiness with satisfactory processing quality has been very difficult. The CPSR class was introduced in 1985 as a hard red spring wheat

substitute for hard red winter wheat. CPSR is intended for markets that require good milling and baking quality but do not require the high protein content associated with CWRS wheat. CPSR wheat varieties are about 1.5 to 2% lower in intrinsic protein content than CWRS varieties, which makes CPSR lower in price per t than CWRS. Producers of CPSR are compensated for that difference by the significantly higher yield potential of CPSR compared to CWRS.

It takes over ten years from the time a cross is made to the time a new variety is registered. It is therefore to the credit of Canadian wheat breeders that in 1996, just eleven years after the CPSR class was launched, AC Crystal, a CPSR variety with much improved dough strength and better flour water absorption compared to previous CPSR varieties, was released. AC Crystal has received very favourable response during subsequent test marketing. Two other CPSR varieties, PR 5700, registered in 2001, and PR 5701, registered in 2002, with even stronger dough than Crystal, are undergoing test marketing. They promise to impart further improvement in milling quality, dough strength and baking quality for the class.

Annual production of CPSR is approximately 1.5 mio t. CPSR is widely used domestically in the Canadian feed industry because of its high yield. CPSR has proved itself in diverse markets where it has been used to produce high quality hearth bread, crackers and Asian noodles. Like AC Crystal, PR 5700 and PR 5701 replace previously released varieties, thereby improving the quality of the class; the amount exported should increase.

Canada Prairie Spring White (CPSW) Wheat

The Canada Prairie Spring White (CPSW) wheat class was launched in 1990. The goal of the CPSW breeding programme is to develop a class of hard white spring wheat that will find acceptance in high quality Asian noodle markets and Middle East flat bread markets, where white wheat is preferred. As with CPSR, intrinsic protein content is 1.5 to 2% lower than for CWRS, but producers are compensated for lower price by higher yields.

The quality of the class has been substantially improved with the registration of AC Vista in 1996, and AC 2000, which was supported for registration in 2001. However, production is well below half a mio t, and in decline. The recent development of high quality hard white spring wheat of higher protein content, which is discussed later, has made the future of the CPSW class uncertain.

Canada Western Soft White Spring (CWSWS) Wheat

CWSWS wheat is a lower protein, soft wheat with weak dough properties. Flour milled from this class is best suited for confectionery products (cookies, cakes and biscuits). It also has been used for crackers, flat bread, steamed bread and some types of Asian noodles. Most CWSWS wheat is grown under irrigation to minimize protein content for the domestic confectionery industry. In recent years production of this class has been less than 10,000 t, making none available for export.

Canada Western Hard White (CWHW) Wheat

The newest wheat class in western Canada is CWHW wheat. In February, 2000, BW 263 (now AC Kanata) and BW 264 (now AC Snowbird), hard white spring wheat lines that have comparable protein content and dough strength to CWRS wheat, were recommended for interim registration in western Canada for test marketing.

The Canadian Wheat Board promoted increase of these varieties through contract programmes, and following successful international test marketing the CWHW wheat class was formally established in 2004.

Tab. 24 and Tab. 25 show quality data from field trails of AC Kanata and AC Snowbird, compared to the most widely grown CWRS variety, AC Barrie. The CWHW cultivars match the milling performance of AC Barrie at traditional western flour extraction rates. Ambalamaatil *et al.* (2002) showed that when

Tab. 24: Milling and baking quality of the CWRS variety AC Barrie compared to the CWHW wheat varieties AC Kanata and AC Snowbird [a]

Property		AC Barrie	AC Kanata	AC Snowbird
Wheat				
Test weight	kg/hL	82.0	80.9	81.1
Falling Number	s	405	425	415
Protein content	%	14.2	14.5	14.2
Flour yield	%	75.8	75.7	74.8
Flour				
Protein content	%	13.4	13.7	13.6
Ash content	%	0.44	0.42	0.42
Farinograph				
Absorption	%	64.8	66.3	67.3
Development time	min	5 1/2	5 3/4	5 1/2
Stability	min	8 1/2	9 1/2	7 1/2
Short process bread				
Absorption	%	70	70	71
Mixing time	min	10.2	13.4	10.9
Loaf volume	mL	1,135	1,105	1,125

[a] *Source: Central Bread Wheat Trials of the Prairie Regional Recommending Committee for Grain (2000). Wheat analytical data expressed on 13.5% m.b.; flour analytical data expressed on 14% m.b. Test methods as described in CGC (2003b)*

Tab. 25: Yellow alkaline noodle properties of the CWRS variety AC Barrie compared to the CWHW wheat varieties AC Kanata and AC Snowbird [a]

Property		AC Barrie	AC Kanata	AC Snowbird
Colour and appearance				
L*		77.8	78.1	78.2
a*		0.66	0.29	-0.03
b*		27.0	25.3	26.4
Visible specks		199	41	30
Texture				
Firmness	g/mm	28.8	28.1	27.8
Recovery	%	33.9	35.6	36.0

[a] *Source: Central Bread Wheat Trials of the Prairie Regional Recommending Committee for Grain (2000). Test methods as described in CGC (2003b). Noodle specks determined as described by Hatcher and Symons (2000).*

milled to high extraction (> 80%) the CWHW cultivars give an increasing flour colour advantage over CWRS wheat as the flour extraction rate increases.

AC Kanata and AC Snowbird are doubled haploid lines developed from a cross between the CWRS variety AC Domain and a white seeded derivative of an elite hard red spring wheat breeding line. Therefore, as might be expected, the CWHW cultivars exhibit high water absorption, strong, well balanced dough properties and high loaf volume, similar to CWRS, and are fully interchangeable with CWRS with, at most, minimal milling and baking adjustments.

In Asian noodle markets CWHW is intended as multi-purpose wheat for production of high quality bread and noodles, particularly yellow alkaline noodles which are made from high protein flour. A major advantage of CWHW wheat over red seed coated wheat like CWRS

is much improved yellow alkaline noodle appearance, as evident from far fewer visible bran specks compared to AC Barrie (Tab. 25). Yellow alkaline noodle brightness (L*), redness (a*) and yellowness (b*) values are also excellent. Yellow alkaline noodle texture is equal to or better than CWRS.

6.7 Eastern Canadian Wheat Classes

Approximately 1.2 mio t of wheat is produced annually in the southern Ontario peninsula between the Great Lakes (5-year average from 1998 to 2002). There are four wheat classes grown in Ontario:

- Canada Eastern White Winter (CEWW),
- Canada Eastern Soft Red Winter (CESRW),
- Canada Eastern Hard Red Winter (CEHRW)
- Canada Eastern Red Spring (CERS).

Approximately 150,000 t of wheat is produced annually in southern Quebec, almost exclusively hard red spring wheat. In the Maritimes production is variable, but in a typical year about 30,000 t of red winter wheat and about 70,000 t of spring wheat is produced annually. There are three milling grades of CEWW, CESRW, CEHRW and CERS. KVD was removed as a criteria for red wheat registration in Eastern Canada in 1989, but is still required for white winter wheat varieties. When red wheat is delivered, the class is declared for binning and grading. If the class is not declared, the wheat is binned and graded as Canada Eastern Red (CER) wheat with no class designation. CER is marketed at a lower price than designated red wheat.

Until 2001, the Ontario Wheat Producers' Marketing Board (OWPMB) was the sole marketing agency for Ontario wheat. Ontario now has a dual marketing system. Producers may deliver to the OWPMB, or may obtain an exemption and sell their product to an agent authorized to buy wheat. All wheat produced in Quebec and the Maritimes is marketed privately. Typical quality of eastern Canadian wheat is represented by quality data from the CGC 2002 Ontario wheat harvest survey in Tab. 26. CEWW and CESRW are both soft wheat classes with low protein and weak gluten, which makes them well suited to confectionery products. CEHRW and CERS are used primarily for baking by the domestic milling industry, in blends with western Canadian wheat.

Tab. 26: Quality of No 1 grades of Ontario CEWW, CESRW, CEHRW and CERS from the 2002 harvest [a]

Property		CEWW	CESRW	CEHRW	CERS
Wheat					
Test weight	kg/hL	79.2	79.1	81.1	82.3
Falling Number	s	350	350	350	310
Protein content	%	9.3	11.1	13.4	14.0
Flour yield	%	76.5	74.7	75.5	75.2
Flour					
Protein content	%	8.5	8.7	10.9	13.1
Ash content	%	0.50	0.47	0.54	0.51
Farinograph					
Absorption	%	49.8	50.0	58.3	65.3
Development time	min	1	1 1/4	3 1/4	5 1/2
Stability	min	2 1/2	3	5 1/2	9

[a] *Source: Quality of Ontario wheat 2002 (CGC 2002b). Wheat analytical data expressed on 13.5% m.b.; flour analytical data expressed on 14% m.b. Test methods as described in CGC (2003b)*

6.8 Future Trends in Grading and Classification of Canadian Wheat

6.8.1 More Objective Grading

The visual grading system used by the CGC is fast and efficient, but it is often criticized for being too subjective. In response to this criticism the CGC is evaluating rapid objective test procedures in support of grading, and investigating whether there is an alternative to using standard samples to estimate the degree of soundness.

Rapid objective test procedures being evaluated by the CGC include near-infrared spectroscopy (NIRS), image analysis (also referred to as machine vision) and RapidVisco™ Analyzer (RVA). NIRS is well established for estimating wheat protein content and moisture content in Canada (Williams *et al*., 1978). Pawlinsky and Williams (1998) reported that NIRS has potential to predict bread-making functionality as well as wheat composition, but this has yet to be conclusively demonstrated. Preliminary investigations indicate that NIRS might be able to estimate durum wheat HVK levels accurately and reliably (Dexter *et al*., 2002).

Machine vision has been touted by many as an effective objective support to visual grading. Machine vision classifies kernels on the basis of size, shape and texture. Symons *et al*. (2003) described a CGC machine vision system that classifies individual durum wheat kernels according to degree of vitreousness, which allows a percentage HVK to be computed. The instrument has yet to be evaluated in a grain handling environment. Machine vision grading instruments are becoming commercially available for grading wheat and other commodities. Nutech Analytical (formerly Maztech MicroVision) have introduced the SPY Grain Grader (www.nutechanalytical.com) which has various applications, including identifying *Fusarium* damage in red wheat, and diseased and discoloured kernels in durum wheat. Under the name Acurum™ (www.acurum.com), Dupont Canada is promoting a machine vision system developed by Agriculture and Agri-Food Canada that reportedly can classify and measure the degree of damage to individual wheat kernels and other grains, pulses and oilseeds.

RVA is being evaluated by the CGC as a rapid test to segregate sprouted wheat from sound wheat according to activity of the enzyme α-amylase. Sprout damage is a serious grading factor because sprouted kernels contain high levels of α-amylase, which can seriously harm bread-making quality (Dexter and Edwards, 1998a). The Falling Number (FN) is internationally recognized as the best objective measurement of α-amylase activity in wheat, but the test cannot be performed within the time constraints for making binning decisions in a high-throughput grain receiving facility. Visual estimation of sprout damage is a rapid and useful management tool for protecting bulked wheat from excessive levels of α-amylase, but it is unable to predict α-amylase accurately in individual lots of wheat. RVA stirring number relates strongly to FN, and RVA is a more rapid test than FN. Pre-harvest sprouting was a major grading factor for the 2002 western Canadian wheat harvest. RVA was used successfully by the CGC following the 2002 harvest to efficiently segregate individual wheat lots arriving at grain terminals by degree of sprout damage (CGC and CWB, 2002).

As described earlier, standard samples are prepared by the CGC every autumn, following the harvest, as visual aids to accessing the degree of soundness. Standard samples have proved effective in rapidly assessing degree of frost, mildew damage and immaturity. However, preparation of standard samples is labour-intensive, and getting them to grain grading locations promptly after the harvest is a challenge. Research is currently underway to determine whether numerical tolerances for mildewed, frosted and immature kernels can be established that simulate soundness limits similarly to standard samples, without increasing the time needed to assign a grade.

6.8.2 Alternatives to KVD

KVD has been used by Canada successfully for many years to keep wheat classes separate. As discussed previously, KVD works because Canada has a strict variety registration system that requires that varieties conform to the prescribed kernel features for its class. But KVD is a limitation to developing improved varieties.

KVD is under pressure due to proliferation of wheat classes in western Canada, and increasing demand for varieties with specific quality attributes for niche markets. For example, AC Navigator extra-strong gluten durum wheat is indistinguishable from conventional strength CWAD varieties, CWHW wheat varieties are indistinguishable from soft white spring wheat, and soft white spring wheat varieties with specific starch pasting properties cannot be distinguished. At the time this article was written (2004), no genetically modified (GM) wheat varieties were registered in Canada, but there may be applications for registration of GM cultivars that are indistinguishable from non-GM wheat within a few years.

Accordingly, development of rapid variety identification methods to facilitate and monitor purity of variety-specific segregation is a major research emphasis in Canada. Separation of wheat storage protein by electrophoresis (Tkachuk and Mellish, 1980) and reversed-phase high performance liquid chromatography (Marchylo *et al.*, 1988) are well established and effective methods of determining variety composition at the CGC, but they are too costly, slow and complex to be used in a high-throughput grain handling facility.

22 DNA fingerprinting is under investigation by the CGC for variety identification (CGC and CWB, 2000). Regions of DNA are analyzed to identify differences in DNA coding sequences that uniquely distinguish one variety from another. These sequences can then be used as probes to identify the DNA of varieties commingled in grain shipments. The goal of the CGC is to provide Canada with rapid, automated, portable and cost effective DNA fingerprinting technology to support identity preservation systems, and to allow certification of shipments for a desired variety or varieties.

In 2001 the CGC formed an advisory committee, including representatives from producer groups, grain companies and marketers to review KVD. A rapid variety identification test to replace KVD is still years away. They therefore recommended a variety eligibility declaration (VED) system. Under VED, every time wheat changes hands there would be a declaration that the lot is comprised of a variety or varieties eligible for a specific class. Documentation and sampling would make it possible to trace grain in a cargo right back to elevators and farmers who made deliveries, allowing monitoring and enforcing accountability, thereby assuring the quality of wheat shipments.

In 2003 the CGC conducted broad consultation on VED with all stakeholders in the Canadian grain industry. There was widespread agreement that an effective alternative to KVD would be desirable, but concerns were raised about accountability and liability, logistics and benefits versus costs. In response to these concerns, a committee of producers and industry representatives was charged by the CGC to address logistical issues, and the CGC initiated a cost-benefit analysis. In December 2003 the CGC announced that mandatory VED would not be implemented because cost outweighed benefit. However, the CGC acknowledged that it was likely that variety declarations will increasingly be used in private, commercial transactions, and that eventually variety declarations will form an integral part of the Canadian grain production, marketing and handling system.

In the interim, the CGC has proposed a wheat quality assurance strategy with three elements:

- development of rapid, affordable variety identification technology;

- increased CGC monitoring of rail and vessel shipments for nonregistered varieties, and downgrading shipments if they contain nonregistered varieties in excess of grade tolerances;

- development of a proposal to restructure the western Canadian wheat classes to enable the development, registration and handling of non-milling wheats, such as high yielding feed varieties.

6.9 Canadian Wheat Classes and their Uses

6.9.1 Classes of Western Canadian Wheat and their Uses

CWRS wheat is a high protein content hard red spring wheat with superior milling and baking quality. It is offered at various protein levels, to enhance processing flexibility. Main uses include pan bread, hearth bread, Asian noodles, and as a strong blending wheat.

CWAD wheat is a high protein content durum wheat that produces a high yield of bright amber semolina. Main uses are for pasta and *couscous*.

CWES wheat is a hard red spring wheat with extra-strong gluten suitable for blending purposes.

CPSR wheat is a hard red spring wheat of medium protein content suitable for production of hearth breads, flat breads, steamed breads, noodles and related products.

CWRW wheat is a hard red wheat of moderate protein content suitable for a wide variety of products including French breads, flat breads, steamed breads, noodles and related products.

CWHW wheat has similar properties to CWRS but has a white seed coat. The white seed coat gives CWHW a flour colour advantage at high flour extraction, and produces Asian noodles with less visible bran specks even at low flour extraction rate.

CPSW is a hard white wheat of medium protein content and medium gluten strength suitable for the production of various types of Asian noodles, flat breads, *chapattis* and related products.

Tab. 27: Canadian wheat flour qualities for specific applications

Application	Primary wheat type	Flour protein, %	Flour ash, %
Pan bread & buns	CWHW, CWRS	11.5-13.0	0.48-0.56
Hearth breads	CWHW, CWRS[b]	11.5-14.5	0.48-0.68
Flat breads	CWHW, CWRS[b]	10.5-12.5	0.50-0.54
Asian noodles[a]	CWHW, CWRS[b]	10.5-14.0	0.46-0.50
Doughnuts	CWHW, CWRS[b] & CEWW CESRW	9.5-11.5	0.46-0.52
Crackers	CWHW, CWRS[b] & CEWW CESRW	9.0-10.5	0.48-0.52
Biscuits & cookies	CEWW CESRW[c]	8.0-11.0	0.48-0.54
Home use	CWHW, CWRS	11.0-13.0	0.40-0.50
Pasta	CWAD	12.0-13.0	0.55-0.75

[a] *Protein range for noodles - Chinese (yellow alkaline) style noodles = 11.5-14.0, white salted and instant = 10.5-11.5*
[b] *CPSR, CPSW, CWRW, CEHRW, CERS can also be used in some applications. CWES may be used at low levels to increase flour strength*
[c] *CWSWS may be used in place of CEWW or CESRW.*

Tab.27 summarizes the Canadian wheat flour qualities and the uses.

CWSWS wheat is a soft white spring wheat of low protein content for production of cookies, cakes and pastry as well as some forms of flat breads, Asian noodles, steamed bread and *chapattis*.

6.9.2 Classes of Eastern Canadian Wheat and their Uses

CERS is a high protein content hard red spring wheat used primarily for bread baking by the domestic industry. Small quantities are occasionally available for export.

CEHRW is a medium protein content hard red winter wheat used primarily for bread baking by the domestic industry. Small quantities are occasionally available for export.

CESRW is a low protein content soft red winter wheat used primarily for crackers, biscuits and cakes. Small quantities are available for export.

CER wheat is a non-specified blend of hard red spring, hard red winter, and soft red winter for general purpose use.

CEWW is a low protein content soft white winter wheat with exceptional quality for the production of cakes, and some types of biscuits, primarily by the domestic industry. Small quantities are occasionally available for export.

6.10 Acknowledgment

We thank the Prairie Registration Recommending Committee for Grain for permission to reproduce data from reports of the Wheat, Rye and Triticale Subcommittee.

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