Canadian Grain Commission
Commission canadienne des grains

Quality of Western Canadian malting barley 2018

Annual Harvest Report

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Total barley production in Western Canada in 2018 is estimated at 7,997,000 tonnes, which represents an increase of 6.4% compared to 2017. The higher barley production in 2018 has been attributed to an increase in barley-seeded area this year. The total area planted with barley in Western Canada in 2018 was 2,501,000 hectares, indicating a 12.7% increase compared to the 2017 acreage. The average yield for barley in Canada is estimated at 65.0 bushels per acre in 2018 compared to 69.4 bushels per acre in 2017.

The 2018 spring planting, in most areas of Western Canada, was completed by the first week of June. Dry conditions in the southern regions created some establishment problems, especially for late seeded crops. The dry weather and hot conditions through the summer months over most of Western Canada reduced yield expectations. The dry growing season resulted in minimal disease pressure in most barley growing areas. The above-normal temperatures during the growing season boosted crop development, which allowed harvest to begin during the middle of August in the southern and central growing regions. Quality of the early harvested crop was very good. However, the harvest was interrupted by snowfall, frost, and wet conditions in September. Among the three western provinces, Alberta has been the most severely affected by the weather issues. The cool temperatures combined with persistent light to moderate rain/snowfall delayed the resumption of harvest until the second week of October. There was significant quality degradation in unharvested crops in the northern grain belt.

The 2018 barley harvest survey conducted by the Grain Research Laboratory (GRL) and the Canadian Malting Barley Technical Centre (CMBTC) was based on composites of individual varieties representing over two million tonnes of barley selected in Western Canada for malting by grain handling and malting companies.

CDC Copeland (46.3%), AC Metcalfe (29.8%), and AAC Synergy (11.2%) dominated the portfolio of malting barley cultivars grown in Western Canada in 2018, representing together 87.3% of total area seeded with malting barley. Overall, the quality of barley selected for malting in 2018 was good. The content of protein in barley grain averaged at 11.9% dry basis (db) in 2018, slightly higher compared to the last year (11.5% db) and to the long-term average values (11.6% db).The average kernel size and kernel weight of barley grain in 2018 were higher than last year and long-term average values. The rapid visco analysis (RVA) test indicated that the majority of barley samples tested in 2018 survey were sound, with very low incidence of pre-harvest sprouting.

Barley exhibited excellent germination energy and showed little evidence of water sensitivity. The levels of enzymes (diastatic power and α-amylase) in malts of the most common barley cultivars (CDC Copeland and AC Metcalfe) were slightly higher in 2018 compared to the last year and long-term average values. Malt made from 2018 barley resulted in malt extract levels, close to the long-term average values. Wort was characterized by slightly higher than average levels of β-glucans, but viscosity remained acceptable. The brewing trials indicated that malts made from CDC Copeland, AC Metcalfe, and AAC Synergy performed satisfactorily without posing any processing difficulties.

Growing and harvest conditions in 2018

The 2018 growing season began slowly, as winter-like weather lingered across the Prairies during March and April. The Prairie region was three to five degrees below normal during both months, which delayed snowmelt and the onset of planting.

Another concern was the dry conditions that were the result of the 2017 drought and the accompanying lack of subsoil moisture reserves. The winter precipitation was close to normal and even slightly above normal in most areas of the Prairies. The exceptions were Manitoba and the central and northern areas of Alberta, which received significantly below normal precipitation through the winter months.

Temperatures improved dramatically in May (Fig. 1.1), which resulted in rapid planting progress in most areas. The precipitation during the month was well below normal, which helped boost planting progress. Rains during the last week of the month in northern growing areas caused some planting delays, but provided beneficial moisture. The dry weather persisted into June in most regions, but heavy rainfall was reported in the border region of Manitoba and Saskatchewan and northern Alberta.

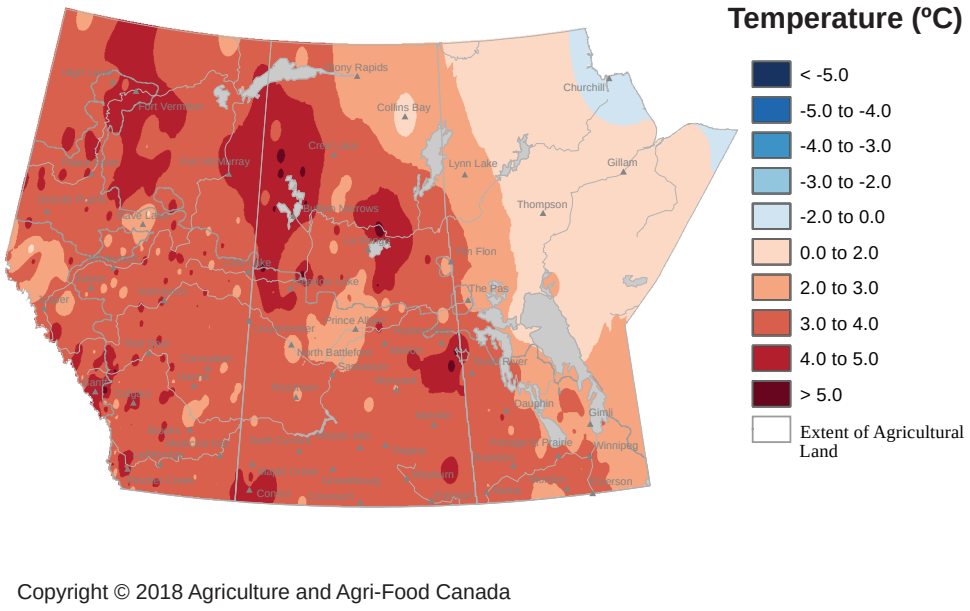


Figure 1.1 Mean temperature differences from normal for May 2018.

The pattern of dry conditions in the southern regions and rainfall in the north persisted into August (Fig. 1.2). Above-normal temperatures also continued into the first half of July, but temperatures moderated by late July and August. The above-normal temperatures during the growing season boosted crop development, which allowed harvest to begin during the middle of August in the southern and central growing regions. The quality of the early harvested crop was very good.

The first significant frost in the northern growing areas was reported in the first week of September, causing some damage to immature crops. The cooler than normal temperatures persisted through most of September (Fig. 1.3) and October. The cool temperatures combined with persistent light to moderate rain/snowfall delayed the resumption of harvest until the second week of October. Two weeks of mild weather in October allowed most farmers in the northern areas to near completion of the harvest. There was significant quality degradation in unharvested crops in the northern grain belt.

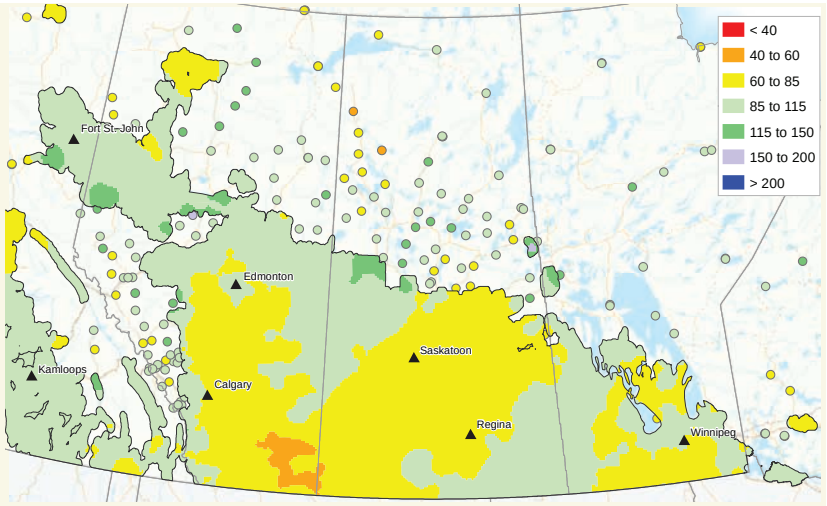


Figure 1.2 Percent of average precipitation (Prairie Region) from April 1 to October 31, 2018.

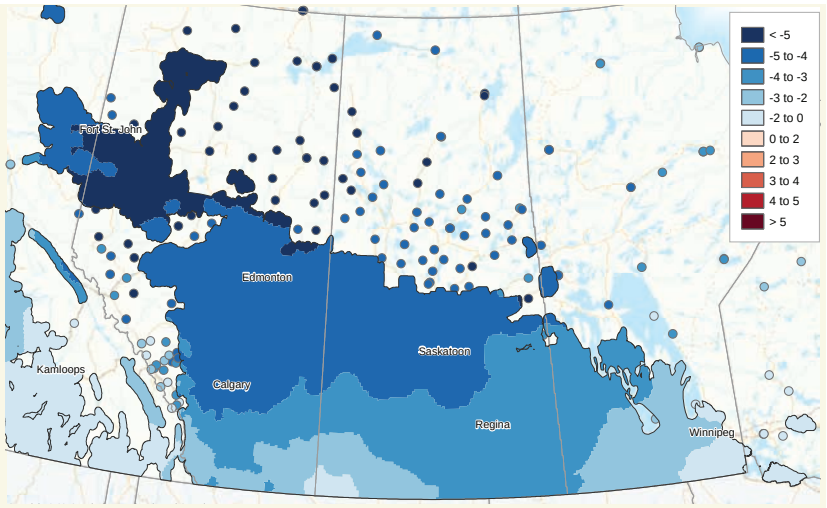


Figure 1.3 Mean temperature differences from normal for September 2018.

Barley production in 2018

2.1 Annual statistics

The total area planted with barley in Western Canada in 2018 was 2.501 million hectares, indicating a 12.7% increase compared to the 2017 acreage (Table 2.1). The production of barley in Western Canada in 2018, estimated at about 7.997 million tonnes, was about 6.4% higher than in 2017 (Table 2.1). The average yield for barley in Canada (entire country) is estimated at 65.0 bushels per acre in 2018, compared to 69.4 bushels per acre in 2017 (Statistics Canada, CANSIM Table 32-10-0359-01).

Barley production in Alberta (including the northeastern part of BC), Saskatchewan, and Manitoba increased by 2.9%, 9.7% and 14.4% respectively, compared to last year. Figure 2.1 shows the annual barley acreage and production in Western Canada since 2008. In 2018, the area seeded with barley was about 7.7% lower than the 10-year average, and the production of barley was 2.8% lower than the 10-year average (2008-2017).

Table 2.1 Yearly comparison of barley seeded area and production in Canada[1]

	Seeded area (million hectares)				**Production** (million tonnes)			
	2018	2017	2016	2008-2017 average	2018	2017	2016	2008-2017 average
Manitoba	0.131	0.107	0.168	0.192	0.501	0.438	0.588	0.613
Saskatchewan	1.089	0.941	1.002	1.046	3.439	3.135	3.375	3.036
Alberta & British Columbia	1.280	1.170	1.405	1.471	4.057	3.944	4.457	4.563
Western Canada	**2.501**	**2.219**	**2.575**	**2.710**	**7.997**	**7.516**	**8.419**	**8.225**
Canada	**2.628**	**2.336**	**2.702**	**2.870**	**8.380**	**7.891**	**8.839**	**8.716**

[1] Statistics Canada, *Table 32-10-0359-01*, updated December 6, 2018

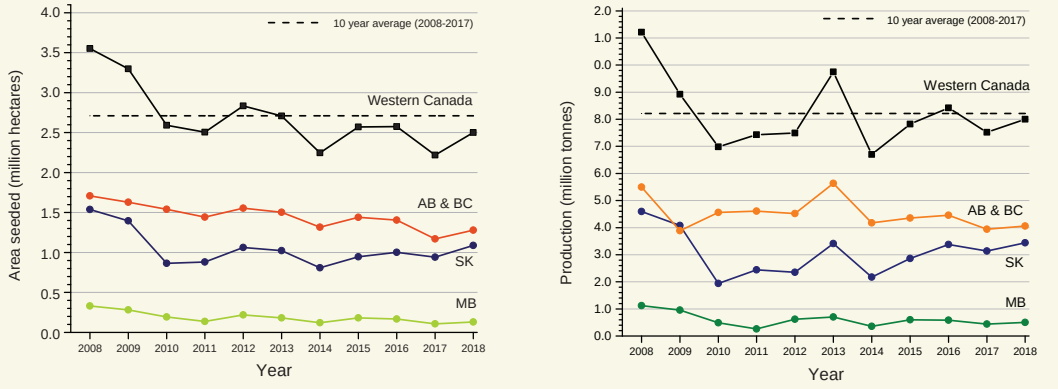


Figure 2.1 Barley seeded area (left) and barley production (right) in Western Canada from 2008 to 2018.

Barley is a versatile crop grown for malting, food, and general purposes (feed and forage) across the Canadian Prairies. This year in Alberta, general purpose barley accounted for 51.2% of total barley seeded area compared with malting barley at 45.3% (Fig. 2.2 left). In Saskatchewan, the majority of the seeded area (71.1%) was planted with malting barley varieties (Fig. 2.2 left). In Manitoba, about 45.6% of barley seeded area was allocated to malting varieties and 49.1% to general purpose varieties (Fig. 2.2 left). Overall in Western Canada, malting barley accounted for 56.3% of seeded area in 2018 compared to 53.2 to 60.8% in previous years (Fig. 2.2 right). General purpose barley accounted for 36.5% of seeded area in 2018. Food barley continued to occupy a relatively small percentage of seeded area in each province. Overall, this year the area seeded with food barley in Western Canada was higher than in previous years (Fig. 2.2 right).

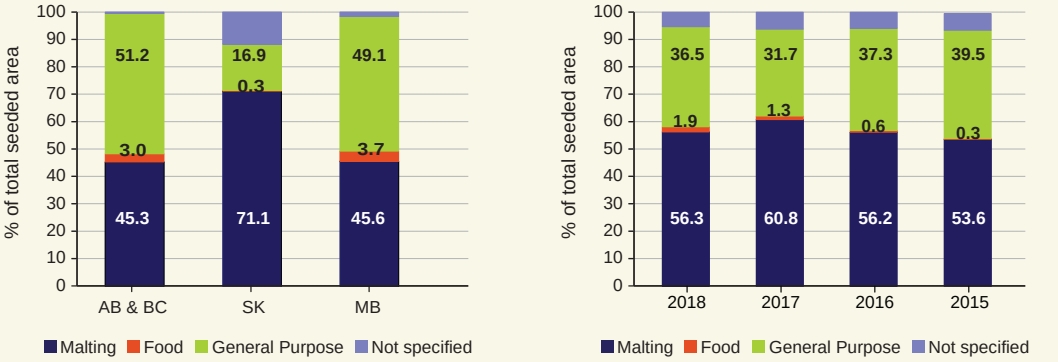


Figure 2.2 Distribution of barley classes as a percentage of total area seeded with barley in each province in 2018 (left) and overall in Western Canada from 2015 to 2018 (right).

In 2018, CDC Copeland and AC Metcalfe continued to dominate the portfolio of malting barley cultivars being grown in Western Canada, representing about 76.1% of total area seeded with malting barley (Table 2.2). The area seeded with CDC Copeland (46.31%) significantly exceeded the acreage seeded with AC Metcalfe (29.79%). The third most popular variety in 2018 was AAC Synergy, whose acreage has continuously increased since 2014. The areas planted with several recently registered two-rowed cultivars, including CDC Bow, AAC Connect, CDC Platinum Star, CDC Clear, CDC Fraser, and Lowe, continue to grow but remain relatively small in 2018. Together they account for about 2.66% of area seeded with malting barley varieties in Western Canada (Table 2.2).

Table 2.2 Distribution of malting barley cultivars as percentage (%) of area seeded with malting barley in Western Canada[1] from 2014 to 2018.

Two-rowed cultivars (% of area seeded with malting barley in Western Canada)					
	2018	2017	2016	2015	2014
CDC Copeland	**46.31**	48.76	44.70	35.38	29.81
AC Metcalfe	**29.79**	32.04	34.20	38.50	38.87
AAC Synergy	**11.22**	7.43	5.19	0.84	0.21
Newdale	**2.19**	2.27	3.07	5.23	5.69
Bentley	**1.41**	1.84	2.71	3.35	2.37
CDC Bow	**0.91**	0.26	0.01		
AAC Connect	**0.77**	0.11	0.01		
CDC Meredith	**0.74**	0.72	1.84	5.24	9.81
CDC PlatinumStar	**0.68**	0.38			
CDC Kindersley	**0.38**	0.49	0.91	1.70	0.95
CDC Clear	**0.17**	0.02			
CDC PolarStar	**0.15**	0.44	0.93	1.44	2.05
Merit 57	**0.081**	0.06	0.20	0.67	0.65
Major	**0.069**	0.02	0.13	0.43	0.75
Harrington	**0.059**	0.14	0.04	0.16	0.27
CDC Fraser	**0.032**	0.01			
Cerveza	**0.030**	0.04	0.04	0.02	0.03
Sirish	**0.020**				
Lowe	**0.014**	0.01			
CDC Copper	**0.013**				
Other	**0.28**	0.14	0.33	0.55	0.23
Total	**95.33**	**95.16**	**94.30**	**93.50**	**91.70**

Six-rowed cultivars (% of area seeded with malting barley in Western Canada)					
	2018	2017	2016	2015	2014
Legacy	**3.19**	3.21	3.17	3.25	4.45
Celebration	**0.85**	0.79	1.17	1.31	1.14
Tradition	**0.35**	0.42	0.63	0.90	1.27
Stellar-ND	**0.06**	0.04	0.12	0.15	0.50
Robust	**0.06**	0.04	0.09	0.16	0.23
CDC Battleford	**0.04**	0.04	0.09	0.13	0.11
CDC Yorkton	**0.03**	0.13	0.11	0.22	0.33
CDC Anderson	**0.01**	0.09	0.10	0.07	0.03
Other	**0.07**	0.08	0.18	0.27	0.35
Total	**4.67**	4.85	**5.67**	**6.46**	**8.41**

[1] Sask Crop Insurance, Alberta Ag Financial Services Corp., Manitoba Agricultural Services Corporation, BC Crop Insurance

The production of six-row malting barley continued to decline. In 2018, the six-row cultivars occupied only about 4.67% of the total area seeded with malting barley. Legacy, Celebration and Tradition remained the top three six-row varieties (Table 2.2).

Table 2.3 shows the distribution of malting barley cultivars in each province as percentage of area seeded with malting barley in Western Canada in 2018. The production of two-row cultivars dominated in each province. In Alberta and BC, CDC Copeland was the most popular variety; in Saskatchewan, CDC Copeland and AC Metcalfe dominated the acreage seeded with malting barley. Compared to Alberta and Saskatchewan, the area seeded with malting barley in Manitoba was relatively low. In 2018, the most popular cultivars seeded in Manitoba were AC Metcalfe, CDC Copeland, and AAC Synergy (Table 2.3).

Table 2.3 Distribution of malting barley cultivars as percentage (%) of area seeded with malting barley in Western Canada in 2018[1]

Two-Rowed cultivars
(% of area seeded with malting barley in Western Canada)

	AB & BC	SK	MB
CDC Copeland	22.31	22.95	1.05
AC Metcalfe	7.91	20.76	1.12
AAC Synergy	6.34	3.88	1.00
Newdale	0.63	0.94	0.62
Bentley	1.01	0.24	0.16
CDC Bow	0.74	0.17	0.01
AAC Connect	0.46	0.16	0.15
CDC Meredith	0.42	0.29	0.02
CDC Kindersley	0.17	0.17	0.04
CDC PolarStar	0.01	0.15	
CDC PlatinumStar		0.68	
Harrington	0.07	0.03	
Cerveza	0.03		
CDC Clear		0.14	0.02
CDC Fraser	0.03		
Lowe	0.01		
Other	0.43	0.03	0.01
Total two-rowed	**40.53**	**50.59**	**4.21**

Six-Rowed cultivars
(% of area seeded with malting barley in Western Canada)

	AB & BC	SK	MB
Legacy	0.35	2.74	0.09
Celebration		0.23	0.62
Tradition		0.03	0.32
CDC Yorkton	0.02		0.01
CDC Anderson	0.01		
Olli	0.03		
Stellar-ND			0.06
Robust	0.02		0.04
CDC Battleford	0.04		
Excel	0.01		
Conquest			0.02
Total six-rowed	**0.50**	**3.00**	**1.17**

Total malting	**41.03**	**53.59**	**5.38**

[1] Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, Manitoba Agricultural Services Corporation, BC Crop Insurance

2.2 Recommended malting barley varieties for 2019-20

The Canadian Malting Barley Technical Centre (CMBTC) recommended list is designed to provide producers with an indication of which malting barley varieties have the greatest potential for selection and marketing. Each variety on the recommended list has been pilot scale tested at the CMBTC and all exhibit good malting and brewing characteristics. All varieties on the list are registered with the Canadian Food Inspection Agency (CFIA).

Recommended varieties

Variety	Type	Market comments	Seed distributor
CDC Copeland	Two row	Established Demand	**SeCan**
AC Metcalfe	Two row	Established Demand	**SeCan**
AAC Synergy	Two row	Growing Demand	**Syngenta**
AAC Connect	Two row	Growing Demand	**CANTERRA SEEDS**
CDC Bow	Two row	Growing Demand	**SeCan**
Legacy	Six row	Limited Demand	**FP Genetics**

- Marketing opportunities remain for **Newdale** (FP Genetics) and **Bentley** (CANTERRA SEEDS) in certain regions. Contact Canada Malting in Calgary for contracting opportunities.
- **CDC PlatinumStar** (CANTERRA SEEDS) is a closed-loop variety. Contact Prairie Malt/Cargill in Biggar for contracting opportunities.
- Demand for six-row malting barley is limited. Contact Viterra in Regina for **Legacy** contracting opportunities. Contact Malteurop in Winnipeg for **Tradition** (FP Genetics) and **Celebration** (CANTERRA SEEDS) contracting opportunities.
- In Eastern Canada, **AC Metcalfe**, **Newdale**, and **AAC Synergy** have had the greatest success in selection in recent years.

Varieties in Development

Variety	Comments	Market comments	Seed distributor
CDC Fraser	Two-Row	Undergoing seed propagation	SeCan
Lowe	Two-Row	Undergoing seed propagation	SeCan

These newly registered varieties are undergoing seed propagation and commercial market development. Contact the seed distributor for opportunities to trial these promising new varieties.

Annual harvest survey

3.1 Sampling and survey methodology

The 2018 malting barley survey was based on 88 varietal composites, representing over two million tonnes of barley selected for domestic malt processing or for export as malting barley by several grain handling and malting companies: Cargill Ltd., Prairie Malt Ltd., Canada Malting Ltd., Rahr Malting Canada Ltd., Richardson International, Viterra Ltd., and Malteurop Canada Ltd. The tonnage included in this survey represents a portion of the total volume of malting barley selected in Western Canada and does not reflect the actual amounts selected. Samples were received from the beginning of harvest until the end of October 2018. All results (unless otherwise stated) presented in this report represent weighted averages based on tonnage of composite samples received and analyzed.

3.2 Quality of barley selected for malting in 2018: general trends and annual statistics

The quality of barley that was selected for malting in 2018 was very good. The average level of barley proteins (11.9%) in 2018 was slightly higher than the 10-year average (11.6%) (Figure 3.1). Barley exhibited excellent germination vigour and energy (Figure 3.2). This year's barley had very high average 1000 kernel weight (46.7 g), higher than the 10-year average (44.5 g) (Figure 3.3). Kernel plumpness, a measure of kernels remaining on the 6/64" slotted screen, averaged 95.6%, which was higher than the 10-year average (92.9%) (Figure 3.4). The average kernel diameter and kernel weight were also determined for individual varieties using the Single Kernel Characterization System. The results, presented in Figure 3.5, indicated differences among barley varieties with newer varieties, such as AAC Synergy, Bentley, AAC Connect, CDC Fraser, and CDC Bow, having bigger and heavier kernels than CDC Copeland and AC Metcalfe.

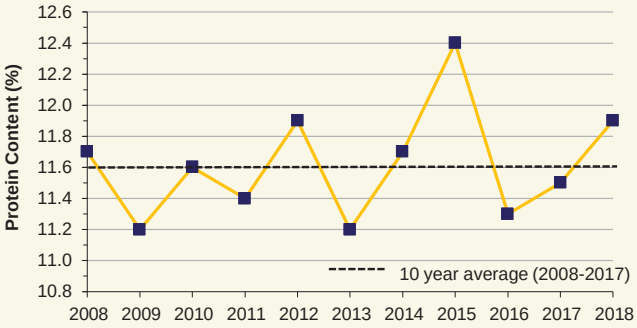


Figure 3.1 Average protein content in barley selected for malting from 2008 to 2018.

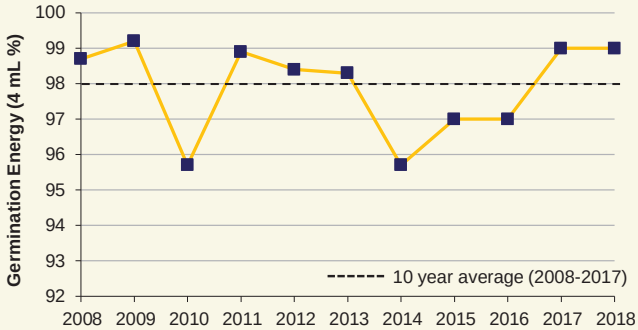


Figure 3.2 Average germination energy of barley selected for malting from 2008 to 2018.

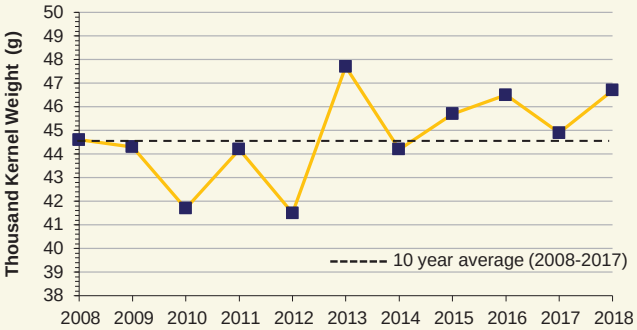


Figure 3.3 Average 1000 kernel weight of barley selected for malting from 2008 to 2018.

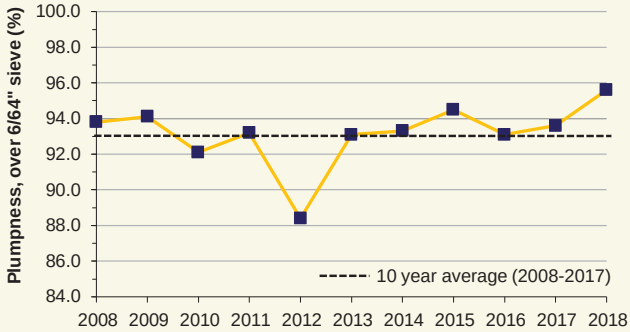


Figure 3.4 Average plumpness of barley selected for malting from 2008 to 2018.

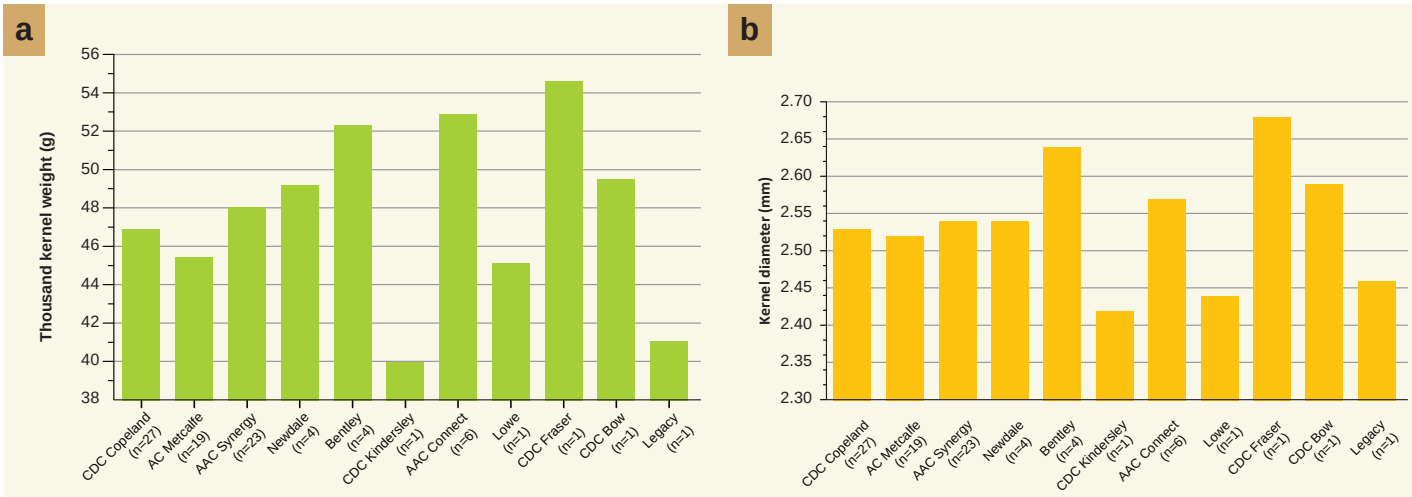
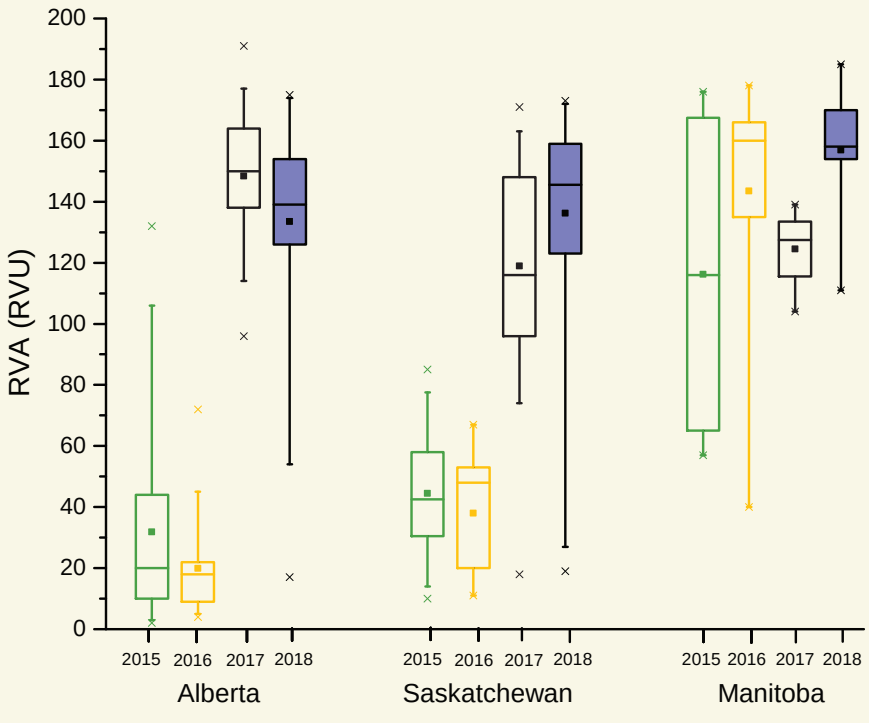


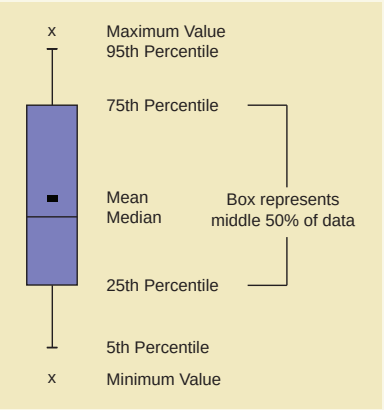
Figure 3.5 Average 1000 kernel weight (a) and average kernel diameter (b) for two-row barley cultivars selected for malting in 2018. Kernel diameter values were determined using the Single Kernel Characterization System.

Pre-germination is the premature sprouting of grain while still in the ear as a consequence of prolonged spells of wet weather when mature grain remains uncut in the field or swathed and not yet combined. This event is called pre-harvest sprouting. One of the enzymes produced very early during germination is α-amylase. Since the level of α-amylase in sound grain is very low compared to its level in the germinating grain, the content of α-amylase in grain can be used as a marker of germination. Rapid visco analysis (RVA) indirectly estimates the amount of α-amylase in barley by measuring the viscosity of ground barley in water. The results are expressed as viscosity in Rapid Visco Units (RVU) that can be converted to centipoise (cP) (1 RVU = 12 cP).

Barley selectors use RVA to identify sound barley, moderately and strongly pre-germinated barley, and to manage their supply accordingly. Samples with final viscosity values > 120 (RVU) are considered sound, and the probability that they will retain germination energy (GE) after storage is very high. Samples with RVA values 50-120 (RVU) are moderately pre-germinated, whereas samples with RVA values < 50 (RVU) are substantially pre-germinated and the probability that they will lose GE during storage is high. They should be malted as soon as possible. To predict safe storage time more accurately, not only the RVA values, but also the storage conditions (temperature and relative humidity) and the initial moisture content of the grain have to be taken into account.

The majority of barley sample tested in 2018 survey was sound as indicated by high RVA values (>120 RVU). This year's high RVA values have been attributed to dry growing conditions and dry harvest conditions, especially during the early harvest. Lower RVA values were observed for a small percentage of barley samples harvested at later date.





Risk of germination loss in storage	RVA Viscosity (RVU)
Low	≥120
Intermediate	50-120
High	<50

Figure 3.6 RVA results for barley selected for malting in 2018 in comparison with previous years.

3.3 Malting conditions and methodologies

Initial malting trials indicated that this year's barley needed slightly longer immersion periods during steeping to achieve adequate hydration levels. Accordingly, sufficient steep out moisture levels were achieved using two wet steep cycles at 14ºC. The germination and kilning steps were conducted according to the same schedules as last year. All analytical methods used in this survey to assess the barley, malt and wort quality are listed in the Appendix I.

Table 3.1 Malting conditions used with GRL Phoenix Micromalting System in 2018

Steeping	10 hours wet steep, 16 hours air rest, 10 hours wet steep, 13 hours air rest @ 14°C
Germination	96 hours @ 15°C
Kilning	12 hours @ 60-65°C, 6 hours@ 65°C, 2 hours @ 75°C, 5 hours @ 83-85°C

3.4 Malting quality in 2018 - Highlights

- The dry and hot growing season in 2018 produced lower yield, but the quality of the early harvested crop was very good. The harvest, however, was interrupted by snowfall, frost, and wet conditions in September. The cool temperatures combined with persistent light to moderate rain/snowfall delayed the resumption of harvest until the second week of October. There was significant quality degradation in unharvested crops in the northern grain belt.
- CDC Copeland (46.3%), AC Metcalfe (29.8%), and AAC Synergy (11.2%) dominated the portfolio of malting barley cultivars being grown in Western Canada in 2018, representing together 87.3% of total area seeded with malting barley.
- The content of protein in barley grain averaged at 11.9% (db) in 2018 and was slightly higher compared to the last year (11.5% db) and to the long-term average values (11.6% db).
- The average kernel size and kernel weight of barley grain in 2018 were higher than the previous year and long-term average values. The average 1000 kernel weight for CDC Copeland was 47.0 g, compared to 45.2 g in 2017, and 45.5 g for AC Metcalfe compared to 44.1 g in 2017. The average kernel size and kernel weight of the newer Canadian malting barley varieties such as AAC Synergy, AAC Connect, Bentley, CDC Bow, and CDC Fraser were noticeably higher than those of CDC Copeland and AC Metcalfe.
- The majority of barley tested in this survey was sound and showed very high germination energy (99%) with little evidence of water sensitivity.
- The levels of enzymes (diastatic power and α-amylase) in malts of the most common barley cultivars (CDC Copeland and AC Metcalfe) were slightly higher in 2018 compared to the previous year and long-term average values. Malt made from 2018 barley resulted in average levels of malt extract.

CDC Copeland

CDC Copeland has remained the dominant malting barley variety grown in Western Canada in 2018. Its excellent brewing characteristics combined with lower protein and enzyme levels provide an excellent balance within the portfolio of malting barley varieties.

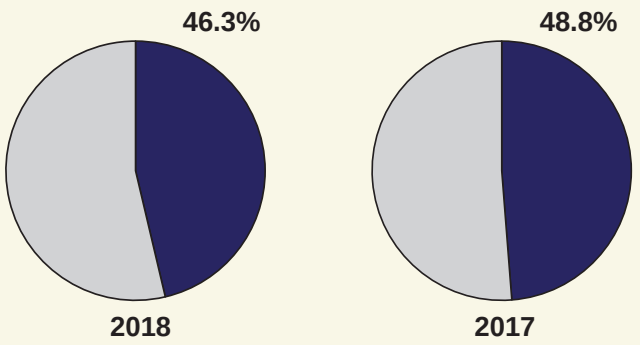


Figure 1. Percentage of the total malting barley area in Western Canada seeded with CDC Copeland in 2018 compared to 2017

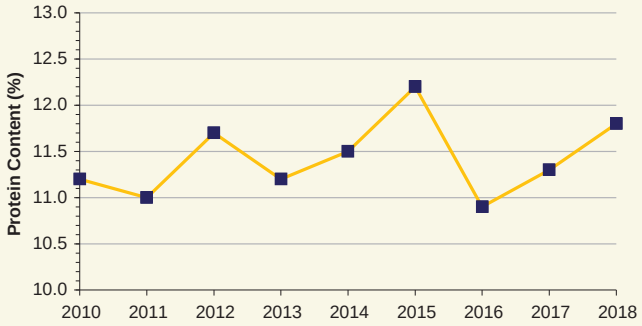


Figure 2. Average protein content in CDC Copeland selected for malting from 2010 to 2018

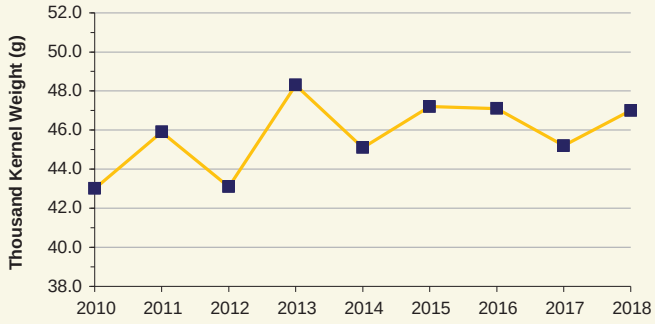


Figure 3. Average kernel weight of CDC Copeland selected for malting from 2010 to 2018

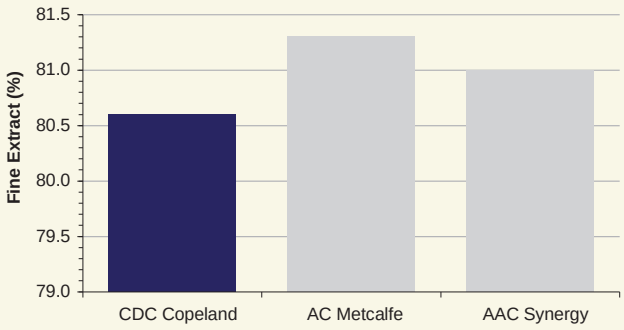


Figure 4. Comparison of average levels of extract by variety in 2018

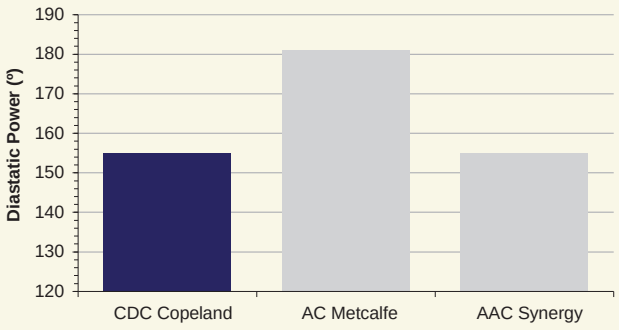


Figure 5. Comparison of average levels of diastatic power by variety in 2018

Table 4.1 Quality data for 2018 harvest survey composite samples of CDC Copeland malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba		Prairie provinces		
Crop year	**2018**	2017	**2018**	2017	**2018**	2017	**2018**	2017	2013-2017 average
Tonnage[2], thousand of tonnes	**281**	697	**699**	655	**106**	5.9	**1 087**	1 358	665
Barley									
Test weight, kg/hL	**67.7**	67.5	**69.1**	66.6	**68.6**	66.9	**68.7**	67.1	66.4
1000 kernel weight, g	**46.0**	45.9	**47.2**	44.5	**48.7**	45.8	**47.0**	45.2	46.6
Plump, over 6/64" sieve, %	**95.3**	94.2	**95.7**	93.0	**96.3**	93.5	**95.7**	93.6	93.9
Intermediate, over 5/64" sieve, %	**3.8**	4.6	**3.5**	5.6	**3.0**	5.6	**3.5**	5.0	4.5
Moisture[3], %	**11.4**	11.3	**10.6**	11.4	**13.0**	12.1	**11.0**	11.4	12.3
Protein, %	**11.8**	11.2	**11.7**	11.4	**12.1**	10.3	**11.8**	11.3	11.4
Germination, 4 ml (3 day), %	**99**	100	**99**	99	**99**	96	**99**	100	97
Germination, 8 ml (3 day), %	**99**	96	**97**	98	**96**	98	**97**	97	91
Malt									
Yield, %	**91.0**	91.1	**90.9**	90.8	**91.1**	91.7	**91.0**	91.0	91.1
Steep-out moisture, %	**45.4**	43.4	**45.6**	43.8	**45.9**	44.3	**45.6**	43.6	44.5
Friability, %	**75.5**	79.1	**77.1**	82.7	**73.0**	85.9	**76.3**	80.9	79.0
Moisture, %	**4.9**	4.8	**4.6**	4.7	**4.5**	5.0	**4.7**	4.7	5.2
Diastatic power, °	**149**	145	**157**	142	**157**	144	**155**	144	153
α-Amylase, D.U.	**68.1**	66.3	**76.3**	67.4	**76.0**	70.7	**74.1**	66.8	65.0
Wort									
Fine grind extract, %	**80.1**	80.7	**80.8**	80.7	**80.9**	81.5	**80.6**	80.7	80.8
Coarse grind extract, %	**79.4**	79.9	**79.6**	80.0	**79.8**	81.0	**79.6**	80.0	80.0
F/C difference, %	**0.7**	0.7	**1.2**	0.7	**1.0**	0.5	**1.0**	0.7	0.7
ß-Glucan, ppm	**84**	90	**91**	68	**91**	53	**89**	79	66
Viscosity, cP	**1.43**	1.44	**1.44**	1.44	**1.44**	1.43	**1.44**	1.44	1.43
Soluble protein, %	**4.29**	4.14	**4.49**	4.25	**4.82**	3.98	**4.47**	4.19	4.67
Ratio S/T, %	**35.6**	36.7	**36.6**	37.0	**38.5**	37.2	**36.5**	36.9	41.0
FAN, mg/L	**175**	175	**178**	178	**185**	177	**178**	177	205
Colour, ASBC units	**1.79**	1.73	**1.95**	1.80	**2.04**	1.75	**1.92**	1.76	2.12

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

AC Metcalfe

In 2018, AC Metcalfe occupied the second-largest area seeded with malting barley on the Prairies, but its production has steadily declined over the last three years. With high levels of extract and diastatic enzymes, AC Metcalfe exhibits excellent brewing performance and generates strong demand from both domestic and export markets. This variety continues to be one of the most dominant malting barley variety grown in Western Canada.

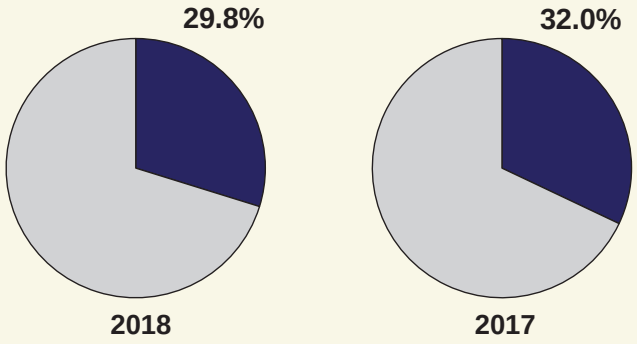


Figure 1. Percentage of the total malting barley area in Western Canada seeded with AC Metcalfe in 2018 compared to 2017

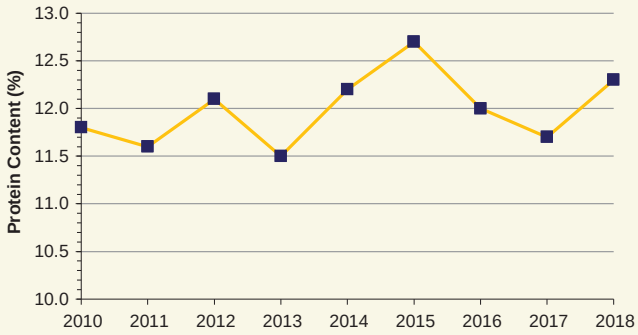


Figure 2. Average protein content in AC Metcalfe selected for malting from 2010 to 2018

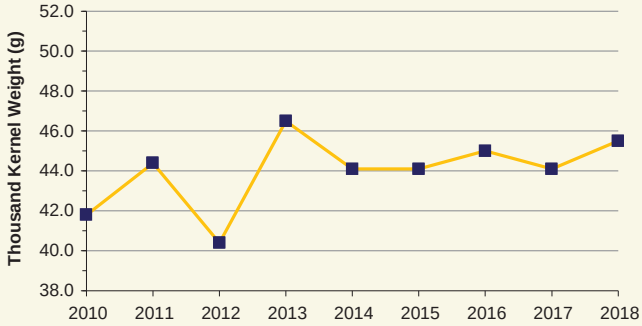


Figure 3. Average kernel weight of AC Metcalfe selected for malting from 2010 to 2018

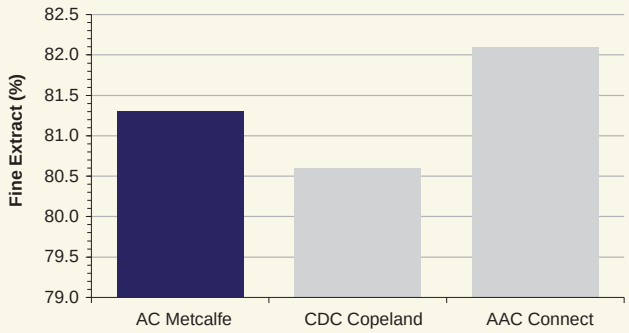


Figure 4. Comparison of average levels of extract by variety in 2018

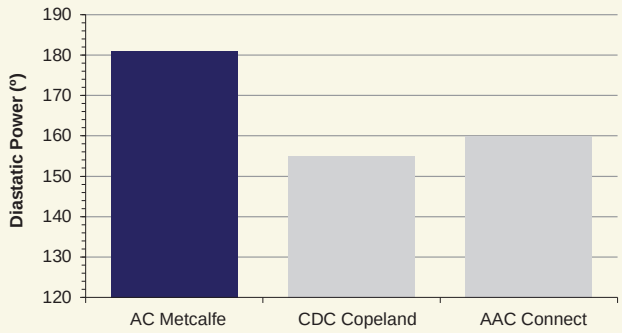


Figure 5. Comparison of average levels of diastatic power by variety in 2018

Table 4.2 Quality data for 2018 harvest survey composite samples of AC Metcalfe malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba		Prairie provinces		
Crop year	**2018**	2017	**2018**	2017	**2018**	2017	**2018**	2017	2013-2017 average
Tonnage[2], thousand of tonnes	**45**	435	**602**	659	**104**	21	**754**	1 115	524
Barley									
Test weight, kg/hL	**69.8**	68.9	**71.2**	69.5	**69.2**	68.5	**70.8**	69.2	68.0
1000 kernel weight, g	**46.0**	43.4	**45.4**	44.6	**45.9**	44.0	**45.5**	44.1	44.8
Plump, over 6/64" sieve, %	**95.0**	93.0	**95.0**	93.5	**95.6**	92.7	**95.0**	93.3	93.1
Intermediate, over 5/64" sieve, %	**4.0**	5.6	**3.9**	5.0	**3.5**	6.3	**3.8**	5.3	5.2
Moisture[3], %	**10.7**	11.3	**10.4**	11.7	**12.6**	12.1	**10.7**	11.5	12.1
Protein, %	**12.3**	11.9	**12.3**	11.6	**12.5**	11.1	**12.3**	11.7	12.0
Germination, 4 ml (3 day), %	**98**	98	**100**	98	**100**	100	**100**	98	97
Germination, 8 ml (3 day), %	**91**	94	**97**	95	**93**	94	**96**	96	88
Malt									
Yield, %	**91.4**	90.3	**90.8**	90.4	**90.3**	90.7	**90.7**	90.4	90.4
Steep-out moisture, %	**45.4**	44.2	**45.1**	44.0	**45.3**	44.4	**45.2**	44.1	44.8
Friability, %	**62.2**	68.9	**68.6**	70.9	**65.4**	79.4	**67.8**	70.3	69.1
Moisture, %	**5.2**	4.9	**4.9**	5.0	**4.9**	5.2	**4.9**	5.0	5.3
Diastatic power, °	**186**	167	**182**	169	**176**	175	**181**	168	177
α-Amylase, D.U.	**88.3**	84.5	**95.4**	83.7	**93.9**	93.8	**94.7**	84.2	85.9
Wort									
Fine grind extract, %	**80.6**	80.8	**81.4**	81.1	**81.2**	81.4	**81.3**	81.0	81.0
Coarse grind extract, %	**79.2**	80.3	**80.4**	80.7	**79.8**	81.2	**80.2**	80.6	80.2
F/C difference, %	**1.5**	0.5	**1.0**	0.3	**1.4**	0.2	**1.1**	0.4	0.7
ß-Glucan, ppm	**111**	65	**92**	63	**87**	57	**93**	63	65
Viscosity, cP	**1.44**	1.43	**1.44**	1.43	**1.43**	1.43	**1.44**	1.43	1.43
Soluble protein, %	**4.56**	4.29	**4.63**	4.38	**4.92**	3.96	**4.67**	4.34	4.86
Ratio S/T, %	**36.0**	35.6	**37.3**	37.1	**38.6**	35.2	**37.4**	36.5	40.8
FAN, mg/L	**181**	188	**190**	196	**202**	181	**191**	192	221
Colour, ASBC units	**2.06**	1.87	**2.13**	1.90	**2.32**	1.67	**2.16**	1.89	2.16

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

AAC Synergy

The third most popular variety grown on the Prairies in 2018 was AAC Synergy. Its acreage has continuously increased since 2014. AAC Synergy is a newer high-yielding variety with relatively high kernel weight and plumpness. AAC Synergy is characterized by relatively low grain protein content. AAC Synergy has a desirable malting quality profile with high malt extract, good protein modification, low levels of wort beta-glucans, and intermediate levels of starch-degrading enzymes. Overall, AAC Synergy's excellent combination of agronomic traits, disease resistance and malting quality makes it a desirable two-rowed malting barley variety for western Canadian producers and the malting and brewing industry.

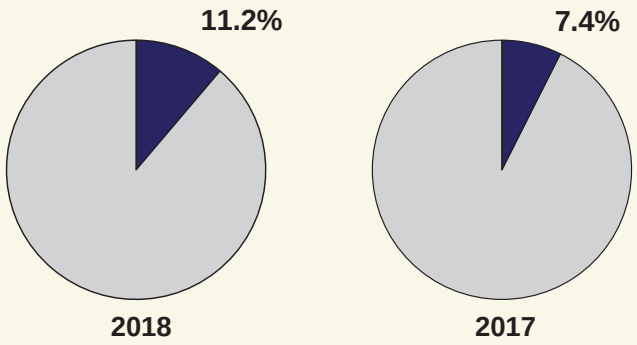


Figure 1. Percentage of the total malting barley area in Western Canada seeded with AAC Synergy in 2018 compared to 2017

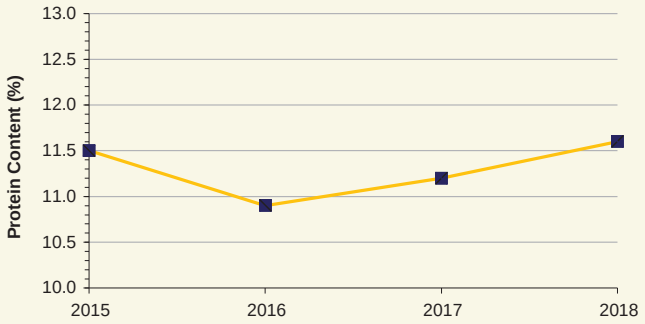


Figure 2. Average protein content in AAC Synergy selected for malting from 2015 to 2018

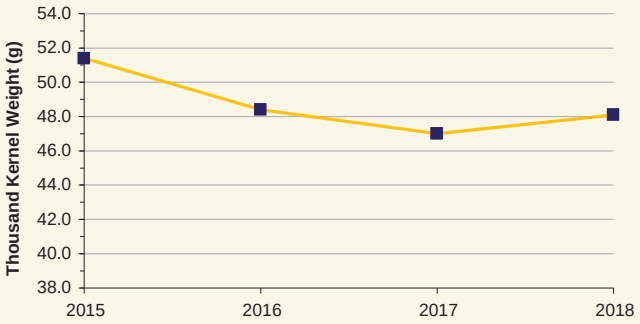


Figure 3. Average kernel weight of AAC Synergy selected for malting from 2015 to 2018

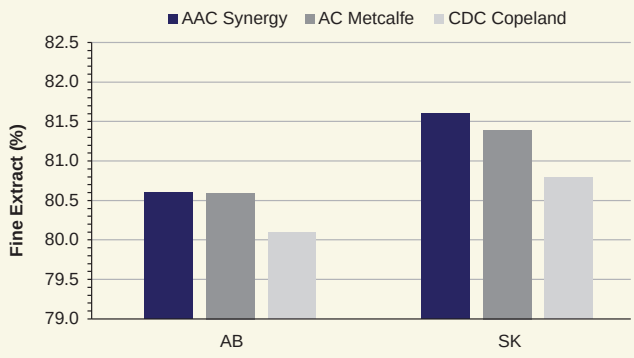


Figure 4. Comparison of average levels of extract by variety in 2018

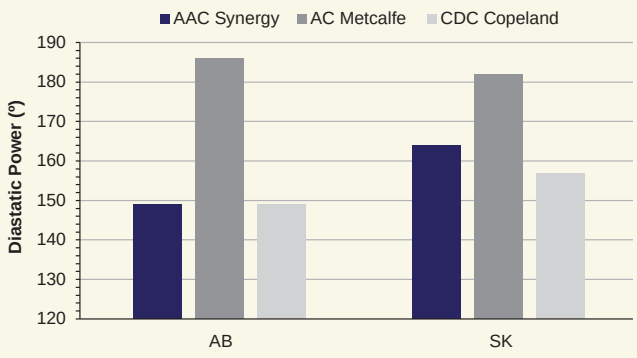


Figure 5. Comparison of average levels of diastatic power by variety in 2018

Table 4.3 Quality data for 2018 harvest survey composite samples of AAC Synergy malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba		Prairie provinces		
Crop year	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	2017	2015-2017 average
Tonnage[2], thousand of tonnes	**177**	52	**128**	71	**2**	1	**307**	125	59
Barley									
Test weight, kg/hL	**68.1**	68.4	**70.7**	68.0	**69.1**	66.4	**69.2**	68.2	66.4
1000 kernel weight, g	**47.9**	49.2	**48.4**	45.4	**49.1**	46.4	**48.1**	47.0	48.9
Plump, over 6/64" sieve, %	**96.2**	97.0	**96.7**	96.4	**95.9**	96.7	**96.4**	96.6	96.7
Intermediate, over 5/64" sieve, %	**2.9**	2.2	**2.6**	2.7	**3.0**	2.6	**2.8**	2.5	2.1
Moisture[3], %	**11.7**	12.1	**11.0**	10.8	**12.3**	14.4	**11.4**	11.4	12.5
Protein, %	**11.5**	10.9	**11.8**	11.5	**11.4**	9.8	**11.6**	11.2	11.2
Germination, 4 ml (3 day), %	**99**	99	**99**	99	**96**	97	**99**	99	99
Germination, 8 ml (3 day), %	**98**	98	**96**	91	**87**	98	**97**	94	92
Malt									
Yield, %	**91.4**	91.2	**80.8**	89.8	**90.0**	91.2	**91.1**	90.4	90.7
Steep-out moisture, %	**45.5**	43.9	**46.1**	45.2	**46.4**	45.8	**45.8**	44.7	45.3
Friability, %	**73.3**	75.5	**72.0**	80.0	**77.6**	97.5	**72.8**	78.3	75.4
Moisture, %	**4.9**	5.1	**5.0**	4.7	**5.2**	4.6	**5.0**	4.9	5.3
Diastatic power, °	**149**	149	**164**	159	**152**	129	**155**	154	159
α-Amylase, D.U.	**73.4**	70.1	**82.9**	77.0	**73.6**	60.4	**77.3**	74.0	79.9
Wort									
Fine grind extract, %	**80.6**	81.5	**81.6**	81.0	**82.4**	81.2	**81.0**	81.2	81.3
Coarse grind extract, %	**80.2**	81.2	**80.4**	80.7	**81.4**	80.9	**80.3**	80.9	80.7
F/C difference, %	**0.4**	0.3	**1.2**	0.4	**1.0**	0.3	**0.7**	0.3	0.6
ß-Glucan, ppm	**74**	48	**84**	42	**91**	38	**79**	45	40
Viscosity, cP	**1.41**	1.41	**1.42**	1.42	**1.45**	1.41	**1.42**	1.42	1.41
Soluble protein, %	**3.94**	3.92	**4.52**	4.62	**4.44**	3.80	**4.18**	4.32	4.44
Ratio S/T, %	**33.5**	36.1	**37.5**	40.0	**39.6**	38.6	**35.2**	38.4	40.6
FAN, mg/L	**149**	159	**178**	193	**178**	151	**161**	179	198
Colour, ASBC units	**1.64**	1.67	**1.90**	2.00	**2.34**	1.82	**1.75**	1.89	1.92

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

Newdale

The area seeded with Newdale continued to occupy a relatively small percentage of the total area seeded with malting barley in 2018. Its moderate levels of enzymes, soluble proteins, and FAN make this variety well suited for all-malt brewing.

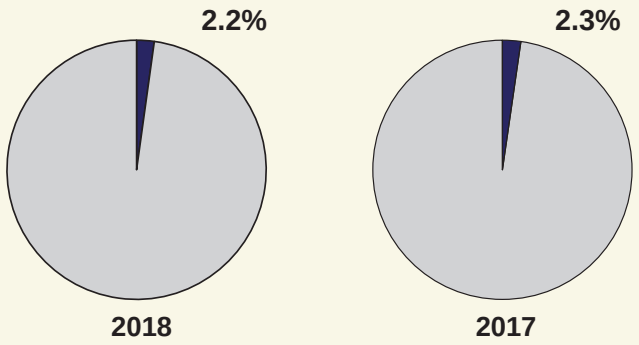


Figure 1. Percentage of the total malting barley area in Western Canada seeded with Newdale in 2018 compared to 2017

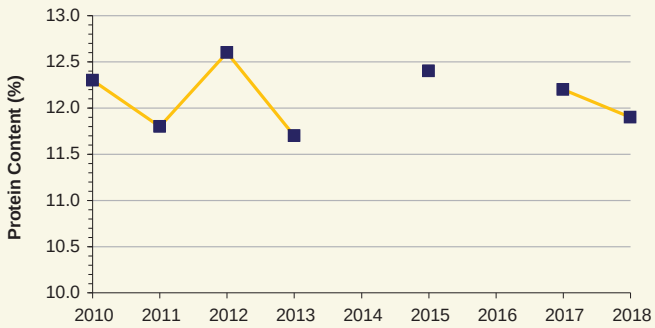


Figure 2. Average protein content in Newdale selected for malting from 2010 to 2018

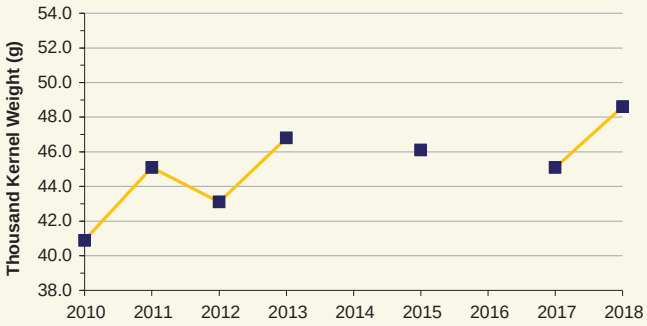


Figure 3. Average kernel weight of Newdale selected for malting from 2010 to 2018

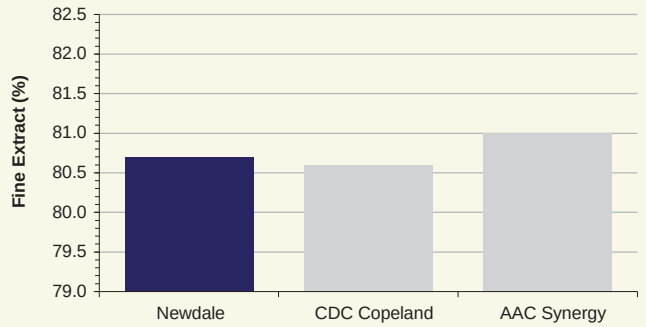


Figure 4. Comparison of average levels of extract by variety in 2018

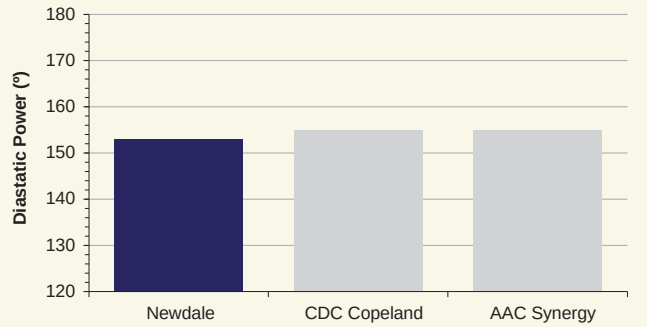


Figure 5. Comparison of average levels of diastatic power by variety in 2018

Table 4.4 Quality data for 2018 harvest survey composite samples of Newdale malting barley[1]

Origin of selected samples	Prairie provinces		
Crop year[2]	**2018**	2017	2011-2017 average
Tonnage[3], thousand of tonnes	**9.3**	20	19
Barley			
Test weight, kg/hL	**68.5**	68.7	66.2
1000 kernel weight, g	**48.6**	45.1	45.2
Plump, over 6/64" sieve, %	**96.0**	93.0	92.4
Intermediate, over 5/64" sieve, %	**3.2**	4.7	5.7
Moisture[4], %	**13.2**	12.4	12.7
Protein, %	**11.9**	12.2	12.1
Germination, 4 ml (3 day), %	**99**	99	98
Germination, 8 ml (3 day), %	**92**	93	91
Malt			
Yield, %	**90.7**	91.4	91.8
Steep-out moisture, %	**45.6**	44.1	44.8
Friability, %	**70.6**	63.1	74.9
Moisture, %	**4.8**	5.4	5.2
Diastatic power, °	**153**	160	150
α-Amylase, D.U.	**76.0**	80.7	66.0
Wort			
Fine grind extract, %	**80.7**	79.9	79.8
Coarse grind extract, %	**79.6**	79.3	79.2
F/C difference, %	**1.2**	0.6	0.6
ß-Glucan, ppm	**67**	106	62
Viscosity, cP	**1.42**	1.42	1.41
Soluble protein, %	**3.97**	3.90	4.57
Ratio S/T, %	**33.0**	31.5	37.8
FAN, mg/L	**156**	150	177
Colour, ASBC units	**1.80**	1.41	1.80

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Newdale was not included in the 2014 and 2016 Harvest Survey due to lack of sufficient number of samples.

[3] Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

[4] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

Bentley

The area seeded with Bentley decreased slightly in 2018 compared to 2017; however, still-significant quantities were grown and selected in 2018. With high yields and good disease resistance, Bentley is an attractive choice for producers. Bentley's consistently large kernels have the potential to deliver high levels of extract.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with Bentley in 2018 compared to 2017

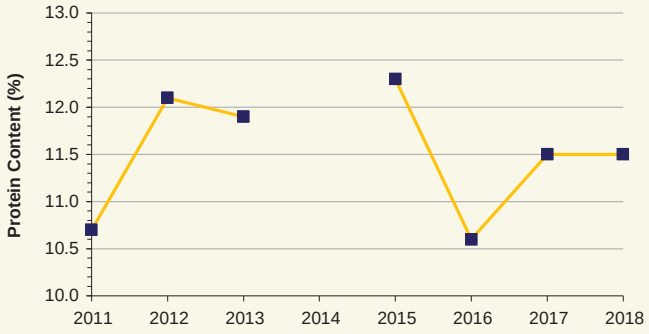


Figure 2. Average protein content in Bentley selected for malting from 2011 to 2018

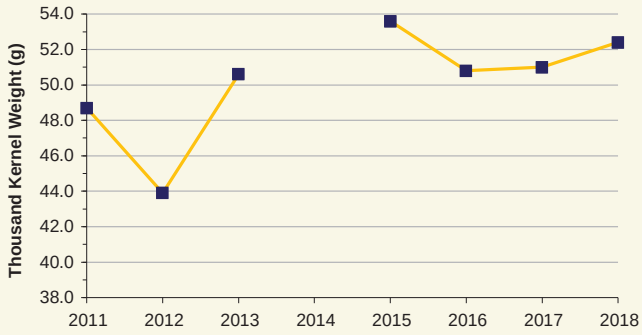


Figure 3. Average kernel weight of Bentley selected for malting from 2011 to 2018

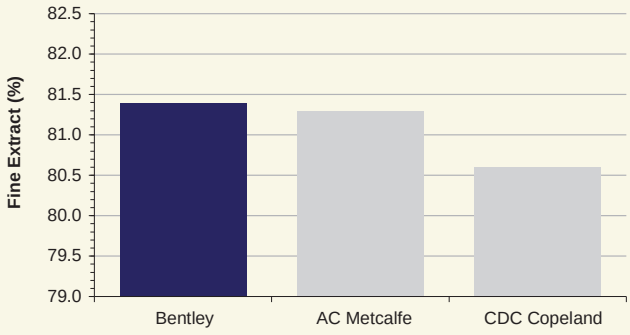


Figure 4. Comparison of average levels of extract by variety in 2018

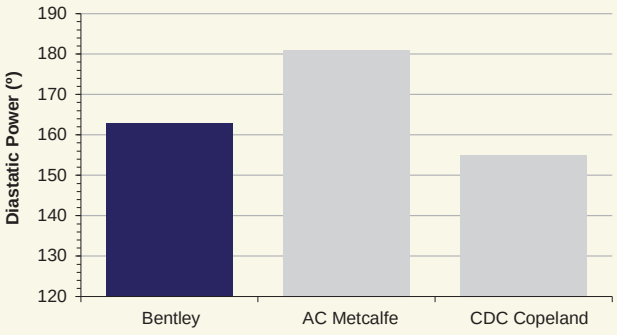


Figure 5. Comparison of average levels of diastatic power by variety in 2018

Table 4.5 Quality data for 2018 harvest survey composite samples of Bentley malting barley[1]

Origin of selected samples	Prairie provinces		
Crop year[2]	**2018**	2017	2013-2017 Average
Tonnage[3], thousand of tonnes	**3.0**	18.2	10.6
Barley			
Test weight, kg/hL	**66.7**	68.2	66.7
1000 kernel weight, g	**52.4**	51.0	51.5
Plump, over 6/64" sieve, %	**95.4**	96.4	96.3
Intermediate, over 5/64" sieve, %	**2.7**	2.4	2.1
Moisture[4], %	**13.5**	13.2	13.3
Protein, %	**11.5**	11.5	11.6
Germination, 4 ml (3 day), %	**97**	100	97
Germination, 8 ml (3 day), %	**87**	97	86
Malt			
Yield, %	**91.2**	91.7	91.0
Steep-out moisture, %	**45.2**	43.2	44.8
Friability, %	**65.6**	70.7	71.3
Moisture, %	**5.0**	5.1	5.5
Diastatic power, °	**163**	160	163
α-Amylase, D.U.	**72.9**	70.4	67.8
Wort			
Fine grind extract, %	**81.4**	81.5	81.4
Coarse grind extract, %	**80.6**	81.1	81.0
F/C difference, %	**0.8**	0.4	0.4
ß-Glucan, ppm	**77**	138	77
Viscosity, cP	**1.42**	1.45	1.44
Soluble protein, %	**4.52**	4.17	4.69
Ratio S/T, %	**38.3**	36.5	41.0
FAN, mg/L	**184**	174	213
Colour, ASBC units	**1.91**	1.54	1.99

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Bentley was not included in the 2014 Harvest Survey due to lack of sufficient number of samples.

[3] Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

[4] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

AAC Connect

AAC Connect is the recently registered (2016) high-yielding malting barley variety with excellent agronomic traits and disease resistance. Production of this cultivar in 2018 was higher than in 2017, but still limited; therefore, the quality results presented in this report represent the relatively small tonnage of samples received and analyzed.

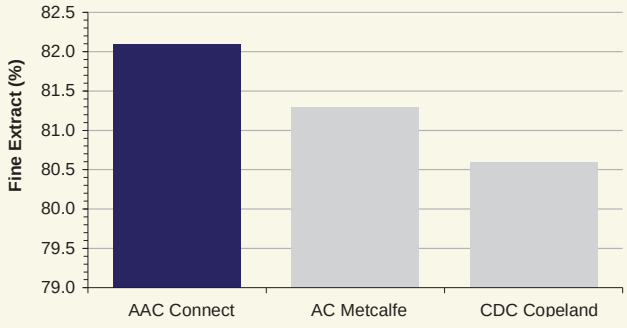


Figure 1. Comparison of average levels of extract by variety in 2018

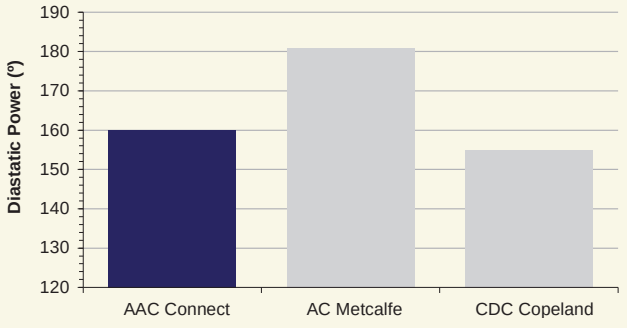


Figure 2. Comparison of average levels of diastatic power by variety in 2018

Table 4.6 Quality data for 2018 harvest survey composite samples of AAC Connect malting barley[1]

Origin of selected samples	Prairie provinces	
Crop year	**2018**	2017
Tonnage[2], thousand of tonnes	**7.7**	1.7
Barley		
Test weight, kg/hL	**67.8**	66.1
1000 kernel weight, g	**52.2**	50.0
Plump, over 6/64" sieve, %	**96.7**	94.2
Intermediate, over 5/64" sieve, %	**2.4**	4.6
Moisture[3], %	**12.9**	13.7
Protein, %	**11.3**	11.3
Germination, 4 ml (3 day), %	**99**	99
Germination, 8 ml (3 day), %	**97**	92
Malt		
Yield, %	**92.2**	91.1
Steep-out moisture, %	**45.6**	43.9
Friability, %	**83.0**	84.1
Moisture, %	**4.7**	5.2
Diastatic power, °	**160**	167
α-Amylase, D.U.	**70.5**	82.2
Wort		
Fine grind extract, %	**82.1**	81.7
Coarse grind extract, %	**81.4**	81.3
F/C difference, %	**0.7**	0.4
ß-Glucan, ppm	**71**	63
Viscosity, cP	**1.43**	1.42
Soluble protein, %	**3.77**	3.88
Ratio S/T, %	**33.9**	34.4
FAN, mg/L	**137**	141
Colour, ASBC units	**1.64**	1.71

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

CDC Bow

CDC Bow is the recently registered (2016) high-yielding malting barley variety with excellent agronomic traits and disease resistance. Production of this cultivar in 2018 was higher than in 2017, but still limited; therefore, the quality results presented in this report represent the relatively small tonnage of samples received and analyzed.

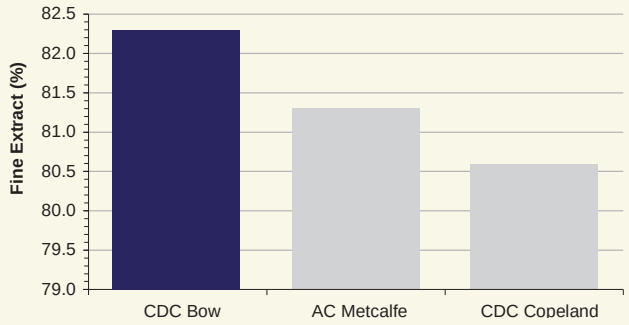


Figure 1. Comparison of average levels of extract by variety in 2018

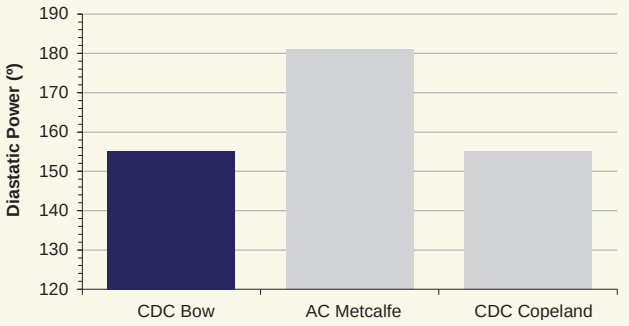


Figure 2. Comparison of average levels of diastatic power by variety in 2018

Table 4.7 Quality data for 2018 harvest survey composite samples of CDC Bow malting barley[1]

Origin of selected samples	Prairie provinces	
Crop year	**2018**	2017
Tonnage[2], thousand of tonnes	**2.0**	2.0
Barley		
Test weight, kg/hL	**67.8**	71.0
1000 kernel weight, g	**49.6**	53.6
Plump, over 6/64" sieve, %	**96.4**	97.6
Intermediate, over 5/64" sieve, %	**2.6**	1.5
Moisture[3], %	**12.0**	12.9
Protein, %	**10.8**	11.1
Germination, 4 ml (3 day), %	**100**	99
Germination, 8 ml (3 day), %	**98**	97
Malt		
Yield, %	**90.6**	91.5
Steep-out moisture, %	**46.1**	43.3
Friability, %	**83.7**	74.9
Moisture, %	**4.5**	4.8
Diastatic power, °	**155**	153
α-Amylase, D.U.	**74.3**	73.0
Wort		
Fine grind extract, %	**82.3**	82.3
Coarse grind extract, %	**82.2**	82.0
F/C difference, %	**0.1**	0.3
ß-Glucan, ppm	**80**	75
Viscosity, cP	**1.42**	1.45
Soluble protein, %	**4.82**	4.22
Ratio S/T, %	**44.8**	38.5
FAN, mg/L	**198**	175
Colour, ASBC units	**1.99**	1.73

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

CDC Fraser

In 2018, harvest quality results for CDC Fraser are reported for the first time. CDC Fraser is the recently registered (2016) high-yielding variety with excellent lodging resistance. Production of this cultivar in 2018 was still limited, therefore the quality results presented in this report represent the relatively small tonnage of samples received and analyzed.

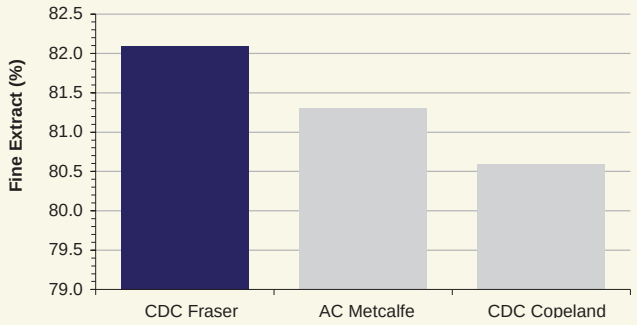


Figure 1. Comparison of average levels of extract by variety in 2018

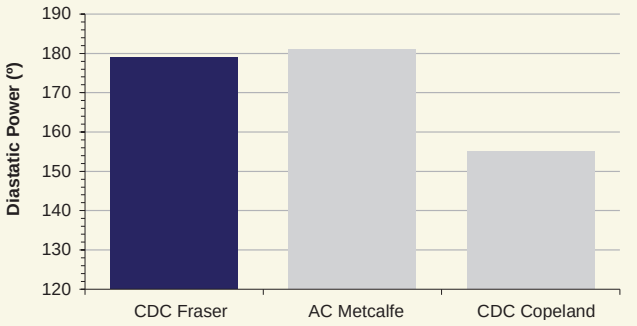


Figure 2. Comparison of average levels of diastatic power by variety in 2018

Table 4.8 Quality data for 2018 harvest survey composite samples of CDC Fraser malting barley[1]

Origin of selected samples	Prairie provinces
Crop year	**2018**
Tonnage[2], thousand of tonnes	**0.9**
Barley	
Test weight, kg/hL	**69.2**
1000 kernel weight, g	**54.7**
Plump, over 6/64" sieve, %	**99.5**
Intermediate, over 5/64" sieve, %	**0.1**
Moisture[3], %	**12.2**
Protein, %	**11.3**
Germination, 4 ml (3 day), %	**99**
Germination, 8 ml (3 day), %	**99**
Malt	
Yield, %	**91.1**
Steep-out moisture, %	**45.5**
Friability, %	**77.2**
Moisture, %	**5.5**
Diastatic power, °	**179**
α-Amylase, D.U.	**81.4**
Wort	
Fine grind extract, %	**82.1**
Coarse grind extract, %	**82.1**
F/C difference, %	**0.0**
ß-Glucan, ppm	**77**
Viscosity, cP	**1.42**
Soluble protein, %	**4.27**
Ratio S/T, %	**38.1**
FAN, mg/L	**185**
Colour, ASBC units	**1.84**

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

GRL Phoenix Micromalting System

GRL Segmented Flow Analyzer

CMBTC Malt Plant

CMBTC Brewery

Brewing trials in 2018

The brewing trials conducted by the CMBTC according to standard brewing conditions[1] indicated that malt made from 2018 AC Metcalfe, CDC Copeland and AAC Synergy performed well in process without posing any major processing issues.

AC Metcalfe exhibited slightly longer conversion and lautering time, as well as comparable time to clear in the lauter tun compared with the 2017 average. Average wort color was slightly lower (lighter) than 2017. The high attenuation limit indicated good fermentability for 2018 crop AC Metcalfe malt, which was significantly greater than the 2017 average.

CDC Copeland exhibited shorter conversion and lautering times along with a comparable time to clear in the lauter tun compared with 2017. Brewhouse efficiency was excellent, although attenuation limit was lower compared to the previous year. Average wort colour was lighter than the 2017 average. The high attenuation limit indicated good fermentability for 2018 crop CDC Copeland malt, although it was significantly lower than the 2017 average.

AAC Synergy exhibited a slightly longer conversion time, but a shorter time to clear and shorter lautering time. Its brewhouse efficiency was good although lower than the 2017 average. The high attenuation limit indicated very good fermentability of 2018 AAC Synergy malt, although it was slightly lower than the 2017 average.

[1]Brewing Conditions

1. 100% all malt brew with 40 kg of malt (water to malt ratio of 3.75:1)
2. Mashing: mashed in at 48˚C; 30-minute hold; temperature raised at 1.5˚C per minute to 65˚C; 30-minute hold (iodine conversion test every minute); temperature raised at 1.5˚C to 77˚C; one-minute hold. Mash transferred to lauter tun with 25L underlet water.
3. 10-minute rest in lauter tun followed by a vorlauf (wort clarification) until wort clarity reading is below 100 FTU. First wort collected into kettle followed by a hot water sparge of the grain bed using 125L of water at 77˚C to a total volume of 275L in brew kettle.
4. Wort boiled for 90 minutes at 9% evaporation rate. Hop additions: Magnum at 0 minutes into boil time and Mt. Hood at 85 minutes into boil time.
5. Wort transferred to whirlpool and rest for 15 minutes.
6. Wort fermented for 7 days using Nottingham Ale yeast at 19˚C until final attenuation and force ferment overnight using 100g of Nottingham Ale yeast and 600 ml of wort.

Table 5.1 Brewhouse observations for AC Metcalfe pilot brewing trials.

Parameter*	2018 AC Metcalfe Average (n= 2)	2017 AC Metcalfe Average (n= 2)	2016 AC Metcalfe Average (n= 5)	2015 AC Metcalfe Average
Conversion time (min.)	**16.5**	12.5	12	12
Time to clear (min.)	**5**	5	7	7
Lautering time (min.)	**51.5**	49	49	45
Brewhouse efficiency (%)	**86.4**	87.8	86.5	88.5
Wort pH	**5.55**	5.36	5.30	5.37
Wort colour (SRM)	**3.12**	3.42	4.42	5.57
Attenuation limit (%)	**88.1**	84.8	84.9	85.0

Table 5.2 Brewhouse observations for CDC Copeland pilot brewing trials.

Parameter*	2018 CDC Copeland Average (n= 2)	2017 CDC Copeland Average (n= 2)	2016 CDC Copeland Average (n= 4)	2015 CDC Copeland Average
Conversion time (min.)	**18.5**	22.5	16	16
Time to clear (min.)	**6.5**	6	7	5
Lautering time (min.)	**44**	49	49	46
Brewhouse efficiency (%)	**89.7**	89.1	87.8	88.0
Wort pH	**5.50**	5.35	5.34	5.51
Wort colour (SRM)	**2.33**	2.81	3.89	4.37
Attenuation limit (%)	**89.0**	90.7	88.9	87.6

Table 5.3 Brewhouse observations for AAC Synergy pilot brewing trials.

Parameter*	2018 AAC Synergy Average (n= 2)	2017 AAC Synergy Average (n= 2)	2016 AAC Synergy Average (n= 2)	2015 AAC Synergy Average
Conversion time (min.)	**18.5**	16	12	12
Time to clear (min.)	**5.5**	7	9	8
Lautering time (min.)	**49**	52	43	47
Brewhouse efficiency (%)	**87.5**	89.6	89.6	88.1
Wort pH	**5.58**	5.35	5.31	5.35
Wort colour (SRM)	**2.60**	2.58	4.34	5.43
Attenuation limit (%)	**90.0**	90.7	86.2	91.1

Appendix I - Methods

This section describes methods used at the Grain Research Laboratory. Unless otherwise specified, analytical results for barley and malt are reported on a dry weight basis.

α-Amylase activity

α-Amylase activity is determined according to ASBC method MALT 7B by segmented flow analysis, using ASBC dextrinized starch as the substrate, and calibrated with standards that have been determined by method ASBC Malt 7A.

Assortment

All samples are passed through a Carter Dockage Tester equipped with a No. 6 riddle to remove foreign material and two slotted sieves to sort the barley. Plump barley is the material retained on a 6/64" (2.38 mm) x 3/4" slotted sieve.

Intermediate Grade is barley that passes through the 6/64" x 3/4" sieve but is retained on a 5/64" (1.98 mm) x 3/4" slotted sieve.

β-Glucan content

β-Glucan content is determined in malt extract by segmented flow analysis using Calcofluor staining of soluble, high molecular weight ß-glucan (ASBC Wort-18B).

Diastatic power

Diastatic power is determined by segmented flow analysis, using an automated neocuproin assay for reducing sugars, which is calibrated using malt standards analysed using the official ferricyanide reducing sugar method, (ASBC Malt 6A).

Fine-grind and coarse-grind extracts

Extracts are prepared using an Industrial Equipment Corporation (IEC) mash bath and the Congress mashing procedure from 45°C to 70°C. Specific gravities are determined at 20°C with an Anton Paar DMA 5000M digital density meter (ASBC Malt-4).

Free Amino Nitrogen (FAN)

Free amino nitrogen is determined on the fine extract according to the official ASBC method Wort-12 by segmented flow analysis.

Germination energy

Germination energy is determined by placing 100 kernels of barley on two layers of Whatman #1 filter paper, in a 9.0 cm diameter petri dish, and adding 4.0 ml of purified water. Samples are controlled at 20 degrees Celcius and 90% relative humidity in a germination chamber. Germinated kernels are removed after 24 and 48 hours and a final count is made at 72 hours (ASBC Barley 3C).

Kolbach index (ratio S/T)

Kolbach index is calculated from the formula, (% Soluble protein/% Malt protein) x 100.

Micromalting

Malts are prepared using an Automated Phoenix Micromalting System designed to handle twenty-four 500 g samples of barley or forty-eight 250 g samples of barley per batch.

Malt mills

Fine-grind malt is prepared with a Buhler-Miag disc mill set to fine-grind. Coarse-grind malt is prepared with the same mill set to coarse-grind. The settings for fine- and coarse-grinds are calibrated quarterly, based on the screening of a ground ASBC standard check malt (ASBC Malt-4).

Moisture content of barley

Moisture content of barley is predicted using NIR equipment that has been calibrated by the standard ASBC method (ASBC Barley 5C).

Moisture content of malt

Moisture content of malt is determined on a ground sample by oven drying at 104°C for 3 hours (ASBC Malt-3).

Protein content (N x 6.25)

Protein content is predicted on dockage free barley using NIR equipment that has been calibrated by Combustion Nitrogen Analysis (CNA). CNA is determined on a LECO Model FP-628 CNA analyzer calibrated by EDTA.

Samples are ground on a UDY Cyclone Sample Mill fitted with a 1.0-mm screen. A 200-mg sample is analyzed as received (it is not dried prior to analysis). A moisture analysis is also performed and results are reported on a dry matter basis (ASBC Barley 7C).

Rapid Viscometric Analysis

The degree of pre-germination in barley was determined as described by Izydorczyk (2005); see the CGC website at http://www.grainscanada.gc.ca/research-recherche/izydorczyk/rva/rva-eng.htm .Samples were analyzed using the RVA-4 (Newport Scientific) and the Stirring Number Program. Final viscosity values were presented in Rapid Visco Units (RVU).

Viscosity

Viscosity is measured on fine grind Congress wort using an Anton Paar Lovis 2000 automated rolling ball viscometer (ASBC Wort-13B).

Water sensitivity

Water sensitivity is determined exactly as described for germination energy, except that 8.0 ml of purified water is added to each petri dish (ASBC 3C, IOB and EBC procedure). The water sensitivity value is the numerical difference between the 4ml and 8ml tests.

Weight per thousand kernels

A 500 g sample of dockage-free barley is divided several times in a mechanical divider to obtain one representative 40 g sub-sample. All foreign material and broken kernels are removed from one 40 g portion and the net weight determined. The number of kernels is then counted with a mechanical counter and thousand kernel weight is calculated (as is basis) (Institute of Brewing's Recommended Methods of Analysis, Barley 1.3 (1997)).

Wort-soluble protein

Wort-soluble protein is determined spectrophotometrically using ASBC method Wort-17.

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