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Quality of Western Canadian malting barley 2017

Annual Harvest Report

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Total barley production in Western Canada in 2017 is estimated at 7,516,400 tonnes, which represents a decrease of 10.2% compared to 2016. The lower barley production in 2017, compared to 2016, can be attributed to reduced barley yields and a decline in barley seeded area this year. The average barley yield in 2017 is estimated at 69.8 compared to 73.9 bushels per acre in 2016. The total area planted with barley in Western Canada in 2017 was 2,219,000 hectares, indicating a 10% decrease compared to the 2016 acreage.

The 2017 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. Above normal temperatures and mostly dry conditions prevailed during June and July over most of Western Canada. The primary barley growing areas in Western Canada experienced stress which reduced yield expectations. However, good subsoil moisture reserves and scattered rainfall in northern and central Saskatchewan helped keep yields from dropping significantly from normal. The dry growing season resulted in minimal disease pressure in most barley growing areas. The dry weather and warmer than normal conditions prevailed through August and early September which allowed the barley harvest to proceed at a rapid pace.

The 2017 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.

Overall, the dry growing season in 2017 resulted in ample supply of excellent malt quality barley with slightly lower than average protein levels, and heavier and plumper kernels compared with the 10-year average values. Barley exhibited very high germination energy and vigour with little evidence of water sensitivity. The rapid visco analysis (RVA) test indicated that the majority of barley samples tested in 2017 was sound with very low incidence of pre-harvest sprouting.

Malt made from 2017 barley resulted in high levels of malt extract. The levels of soluble proteins and free amino nitrogen (FAN) in worts were slightly lower than the long term average values. The levels of enzymes (diastatic power and α-amylase) in malts were adequate and close to the long term average values. Well-modified malts resulted in worts with low viscosity and low level of β-glucans. The brewing trials indicated that malts made from CDC Copeland, AC Metcalfe, and AAC Synergy performed satisfactorily without posing any processing difficulties.

Growing and harvesting conditions in 2017

Although the persistent rains last fall caused quality degradation for the 2016 harvest, the subsoil moisture reserves were adequately replenished. This stored soil moisture was critical for the 2017 growing season. The main concerns in the spring of 2017 was whether producers could finish the 2016 harvest and prepare land for planting before they ran out of time. Cool temperatures in Saskatchewan and Alberta during the month of April slowed the start of the spring fieldwork, especially in the central and northern areas of both provinces. The combination of rain-free days and slightly above normal temperatures in May allowed growers in most areas to complete spring planting by the first week of June. Dry conditions in the southern regions created some establishment problems, especially for late seeded crops. In some areas of the northern Prairies, planting was delayed by rains during the last week of May and growers were unable to sow their intended planted area.

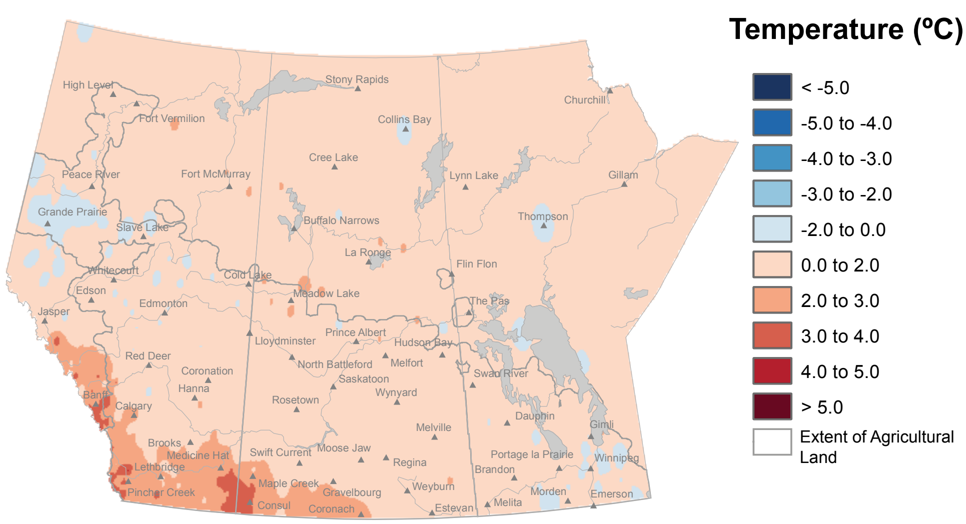


Figure 1.1 Mean temperature differences from normal for July 2017.

Above normal temperatures and mostly dry conditions prevailed during June and July over most of Western Canada (Figure 1.1). The primary barley growing areas in Western Canada experienced stress which reduced yield expectations. However, good subsoil moisture reserves and scattered rainfall in northern and central Saskatchewan helped keep yields from dropping significantly from normal. The dry growing season (Figure 1.2) resulted in minimal disease pressure in most barley growing areas.

The dry weather and warmer than normal conditions prevailed through August and early September which allowed the barley harvest to proceed at a rapid pace. The barley harvest in Saskatchewan and Alberta was 50 per cent complete by the first and second week of September, respectively. The Saskatchewan barley harvest was essentially complete by mid-October, while 35 to 40 per cent of the crop in Northern Alberta was yet to be harvested due to delays caused by persistent late September rains.

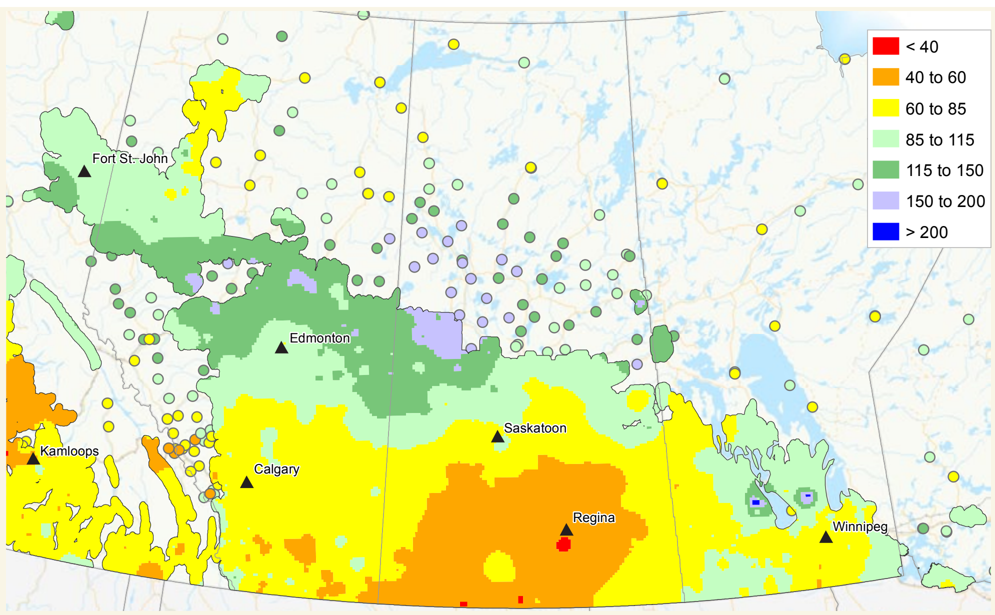


Figure 1.2 Percent of average precipitation (Prairie Region) from April 1 to September 25, 2017.

Barley production in 2017

2.1 Annual statistics

The total area planted with barley in Western Canada in 2017 was 2.219 million hectares, indicating a 10% decrease compared to the 2016 acreage (Table 2.1). The production of barley in Western Canada in 2017, estimated at about 7,516,400 tonnes, was about 10.2% lower than in 2016 (Table 2.1). The lower barley production in 2017, compared to 2016, was related to a decline in area seeded with barley and reduced barley yield. The average barley yield in 2017 is estimated at 69.8 compared to 73.9 bushels per acre in 2016 (Statistics Canada, CANSIM Table 001-0017).

Barley production in Alberta (including the northeastern part of British Columbia), Saskatchewan, and Manitoba decreased by 12%, 7%, and 19%, respectively, compared to last year. Figure 2.1 shows the annual barley acreage and production in Western Canada since 2007. In 2017, the area seeded with barley was about 23% lower than the 10-year average; the production of barley was 11% lower than the 10-year average (2007-2016).

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

	Seeded area (million hectares)				Production (million tonnes)			
	2017	2016	2015	2007-2016 average	2017	2016	2015	2007-2016 average
Manitoba	0.107	0.146	0.162	0.219	0.438	0.540	0.566	0.681
Saskatchewan	0.941	1.002	0.971	1.133	3.135	3.375	2.863	3.117
Alberta & British Columbia	1.170	1.318	1.380	1.538	3.944	4.457	4.357	4.680
Western Canada	**2.219**	**2.465**	**2.513**	**2.887**	**7.516**	**8.372**	**7.786**	**8.489**
Canada	**2.336**	**2.586**	**2.641**	**3.056**	**7.891**	**8.784**	**8.226**	**9.012**

[1] Statistics Canada, *CANSIM TABLE 001-0017*, updated to December 6, 2017

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 48.4% of total barley seeded area compared with malting barley at 49.5% (Fig. 2.2). In Saskatchewan, the majority of seeded area (76.5%) was planted with malting barley varieties (Fig. 2.2). In Manitoba, about 46.6% of barley seeded area was allocated to malting varieties and 47.9% to general purpose varieties (Fig. 2.2). Overall in Western Canada, malting barley accounted for 60.8% of seeded area in 2017 compared to 56.2% in 2016; general purpose barley accounted for 31.8% of seeded area in 2017 compared to 37.3% in 2016. Food barley continued to occupy a relatively small percentage of seeded area in each province, although this year the area seeded with food barley was higher than last year (1.3% in 2017 vs 0.6% in 2016).

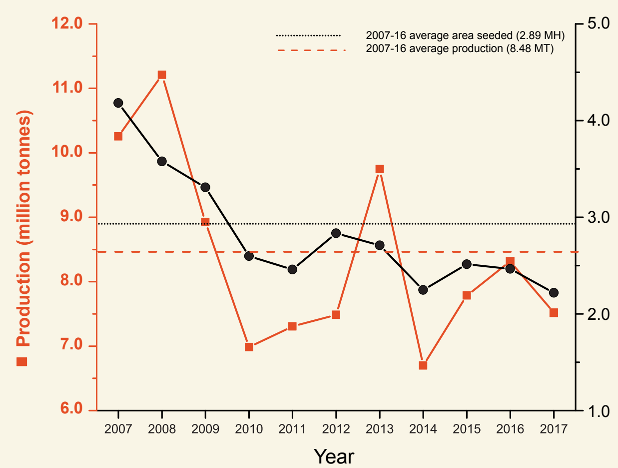


Figure 2.1 Barley production and barley seeded area in Western Canada from 2007 to 2017.

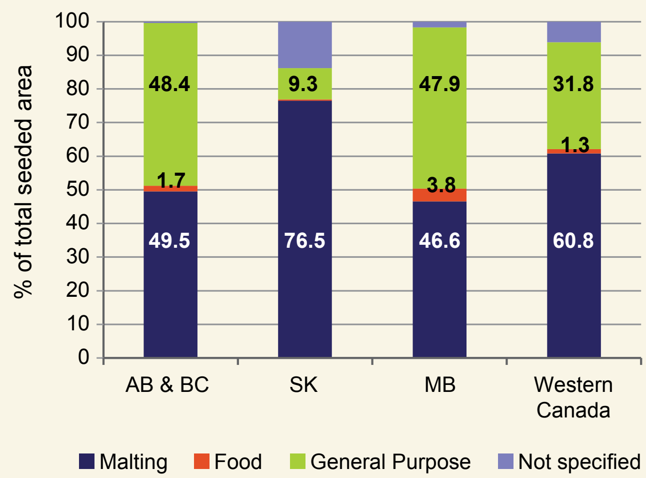


Figure 2.2 Distribution of barley classes as a percentage of total area seeded with barley in each province and overall in Western Canada in 2017.

In 2017, CDC Copeland and AC Metcalfe continued to dominate the portfolio of malting barley cultivars being grown in Western Canada, representing about 80.8% of total area seeded with malting barley (Table 2.2). For the second consecutive year, the area seeded with CDC Copeland (48.76%) significantly exceeded the acreage seeded with AC Metcalfe (32.04%). The third most popular variety in 2017 was AAC Synergy whose acreage has continuously increased since 2014. The area seeded with Newdale, Bentley, and CDC Meredith continued to decrease. The area planted with several recently registered two-rowed cultivars, including CDC PlatinumStar, CDC Bow, AAC Connect, CDC Clear, CDC Fraser, CDC Aurora Nijo, and Lowe remained relatively small in 2017, together accounting for about 0.8% of area seeded with malting barley varieties in Western Canada (Table 2.2).

The production of six-row malting barley continued to decline. In 2017, the six-row cultivars occupied only about 4.85% of the total area seeded with malting barley compared to 5.67% in 2016. Legacy, Celebration and Tradition remained the top three six-row varieties (Table 2.2).

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

Two-rowed cultivars (% of area seeded with malting barley in Western Canada)				
	2017	2016	2015	2014
CDC Copeland	**48.76**	44.70	35.38	29.81
AC Metcalfe	**32.04**	34.20	38.50	38.87
AAC Synergy	**7.43**	5.19	0.84	0.21
Newdale	**2.27**	3.07	5.23	5.69
Bentley	**1.84**	2.71	3.35	2.37
CDC Meredith	**0.72**	1.84	5.24	9.81
CDC Kindersley	**0.49**	0.91	1.70	0.95
CDC PolarStar	**0.44**	0.93	1.44	2.05
CDC PlatinumStar	**0.38**			
CDC Bow	**0.26**	0.01		
Harrington	**0.14**	0.04	0.16	0.27
AAC Connect	**0.11**	0.01		
Merit 57	**0.06**	0.20	0.67	0.65
Cerveza	**0.04**	0.04	0.02	0.03
Major	**0.02**	0.13	0.43	0.75
CDC Clear	**0.02**			
Merit 16	**0.01**	0.18		
CDC Fraser	**0.01**			
CDC Aurora Nijo	**0.01**			
Lowe	**0.01**			
Merit			0.24	
CDC Kendall		0.08	0.16	0.21
Other	**0.13**	0.09	0.19	
Total	**95.16**	**94.32**	**93.54**	**91.67**

Six-rowed cultivars (% of area seeded with malting barley in Western Canada)				
	2017	2016	2015	2014
Legacy	**3.21**	3.17	3.25	4.45
Celebration	**0.79**	1.17	1.31	1.14
Tradition	**0.42**	0.63	0.90	1.27
CDC Yorkton	**0.13**	0.11	0.22	0.33
CDC Anderson	**0.09**	0.10	0.07	0.03
Lacey	**0.06**	0.11	0.14	0.25
Stellar-ND	**0.04**	0.12	0.15	0.50
Robust	**0.04**	0.09	0.16	0.23
CDC Battleford	**0.04**	0.09	0.13	0.11
Excel	**0.01**	0.04	0.12	0.10
Other	**0.01**	0.03	0.00	
Total	**4.85**	**5.67**	**6.46**	**8.41**

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

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 2017. The production of two-row cultivars dominated in each province. In Alberta and British Columbia, CDC Copeland was the most popular variety; whereas in Saskatchewan, AC Metcalfe and CDC Copeland dominated the acreage seeded with malting barley. Compared to Alberta and Saskatchewan, the area seeded with malting barley in Manitoba was relatively low. In 2017, the most popular cultivars seeded in Manitoba were CDC Copeland, AAC Synergy, Celebration and AC Metcalfe (Table 2.3).

Table 2.3 Distribution of malting barley cultivars as percentage (%) of area seeded with malting barley in Western Canada in 2017[1]

Two-Rowed cultivars (% of area seeded with malting barley in Western Canada)			
	AB & BC	SK	MB
CDC Copeland	25.69	22.38	0.69
AC Metcalfe	8.86	22.65	0.52
AAC Synergy	4.06	2.72	0.65
Newdale	0.96	0.84	0.47
Bentley	1.34	0.33	0.17
CDC Meredith	0.44	0.24	0.04
CDC Kindersley	0.31	0.13	0.05
CDC PolarStar	0.02	0.42	
CDC PlatinumStar		0.38	
CDC Bow	0.21	0.05	
Harrington	0.09	0.05	
AAC Connect	0.11		0.01
Cerveza	0.04		
CDC Clear			0.02
CDC Fraser	0.01		
CDC Aurora Nijo	0.01		
Lowe	0.01		
Other	0.17	0.03	0.01
Total	**42.32**	**50.23**	**2.61**

Six-Rowed cultivars (% of area seeded with malting barley in Western Canada)			
	AB & BC	SK	MB
Legacy	0.37	2.79	0.05
Celebration		0.20	0.59
Tradition		0.09	0.34
CDC Yorkton	0.07	0.06	0.01
CDC Anderson	0.08		0.01
Lacey	0.03		0.03
Stellar-ND	0.00		0.04
Robust	0.01		0.03
CDC Battleford	0.04		
Excel	0.01		
Total	**0.60**	**3.13**	**1.10**
Total malting	**42.92**	**53.36**	**3.71**

[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 2018-19

The Canadian Malting Barley Technical Centre (CMBTC) in collaboration with its member organizations and other industry groups produces an annual Recommended Malting Barley Varieties List which is intended as a guide to assist producers in the selection of varieties for seeding in the coming year.

Two-Row Varieties

Variety	Market comments
CDC Copeland[1]	Established Demand
AC Metcalfe[1]	Established Demand
AAC Synergy[4]	Growing Demand
AAC Connect[2]	Under Commercial Market Development
CDC Bow[1]	Under Commercial Market Development

Six-Row Varieties

Variety	Market comments
Legacy[3]	Limited Demand
Tradition[3]	Limited Demand
Celebration[2]	Limited Demand

Notes: CDC PlatniumStar[2] and CDC PolarStar[2] are currently closed-loop varieties. For contracting opportunities contact Prairie Malt - Cargill Biggar. Marketing opportunities remain for the varieties Bentley[2] and Newdale[3] in certain areas.

The CMBTC and its members recommend:

- For contracting opportunities, contact your grain company representative, local elevator operators, malting companies, or the representative seed company foot noted.
- Talk with your local malting barley buyer about opportunities in your area to grow and market two-row and six-row malting barley varieties.
- Use certified seed to ensure varietal purity, reduce disease incidence and increase the likelihood of selection for malt.

New Varieties in Development

The following varieties have been registered with CFIA and are undergoing seed propagation. Both varieties have been pilot scale tested at the CMBTC and exhibit good quality characteristics suitable for all malt and/or adjunct brewing styles.

Variety	Comments
CDC Fraser[1]	Two-Row - Undergoing seed propagation
Lowe[1]	Two-Row - Undergoing seed propagation

The following companies have pedigreed seed distribution rights for those varieties that are footnoted:

1 - SeCan
2 - Canterra Seeds
3 - FP Genetics
4 - Syngenta

Annual harvest survey

3.1 Sampling and survey methodology

The 2017 malting barley survey was based on 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 Inc, Canada Malting Co. Ltd., Rahr Malting Co., Richardson International, and Viterra Inc. The tonnage included in this survey represents only a portion of the total volume of malting barley selected in Western Canada and does not necessarily reflect the actual amounts selected. Samples were received from the beginning of harvest until the end of October 2017. All results 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 2017: general trends and annual statistics

The quality of barley that was selected for malting in 2017 was excellent. The average levels of barley proteins (11.5%) in 2017 were slightly lower than the 10-year average (11.7%) (Figure 3.1). Barley exhibited excellent germination vigour and energy (Figure 3.2). This year's barley had very high average 1000 kernel weight (44.9 g), higher than the 10-year average (43.9 g) (Figure 3.3). Kernel plumpness, a measure of kernels remaining on the 6/64" slotted screen, averaged 93.6%, which was higher than the 10-year average (92.0%) (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 Bentley, AAC Synergy, CDC Bow, and AAC Connect having bigger and heavier kernels than other varieties tested this year.

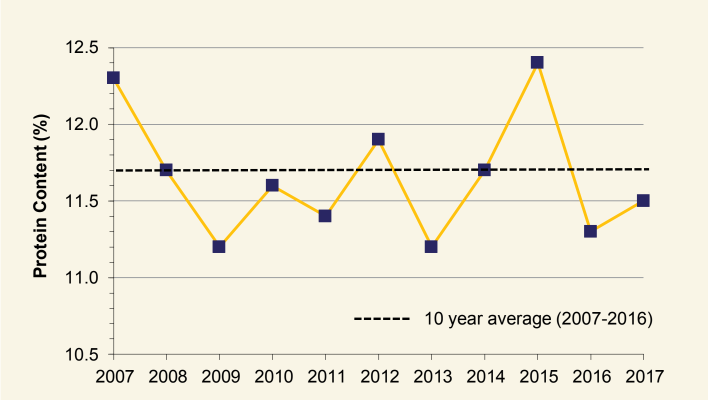


Figure 3.1 Average protein content in barley selected for malting from 2007 to 2017.

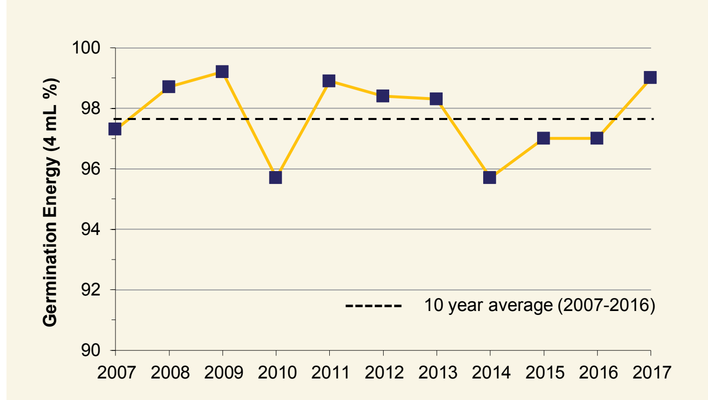


Figure 3.2 Average germination energy of barley selected for malting from 2007 to 2017.

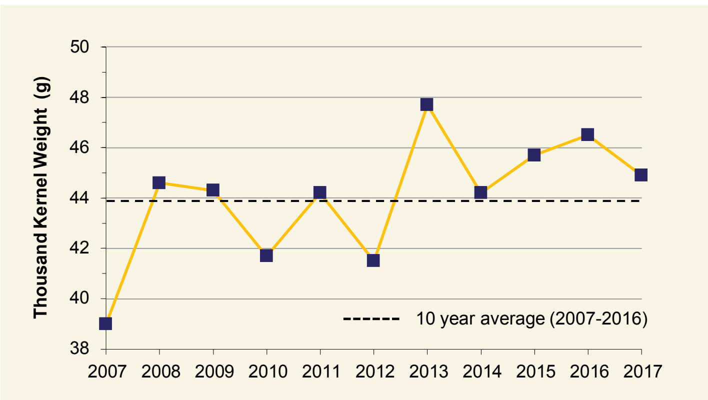


Figure 3.3 Average 1000 kernel weight of barley selected for malting from 2007 to 2017.

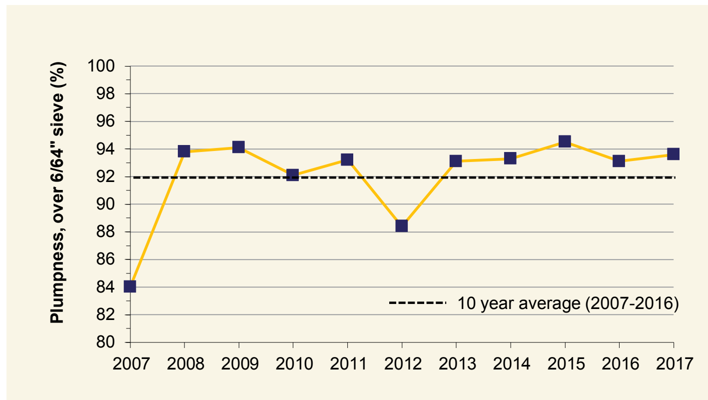


Figure 3.4 Average plumpness of barley selected for malting from 2007 to 2017.

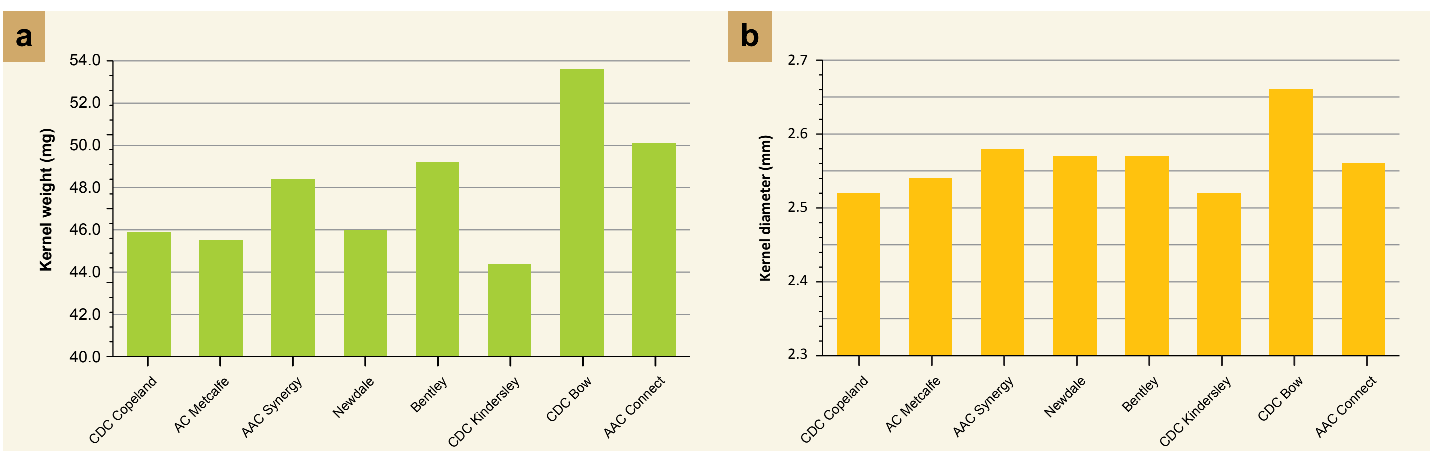
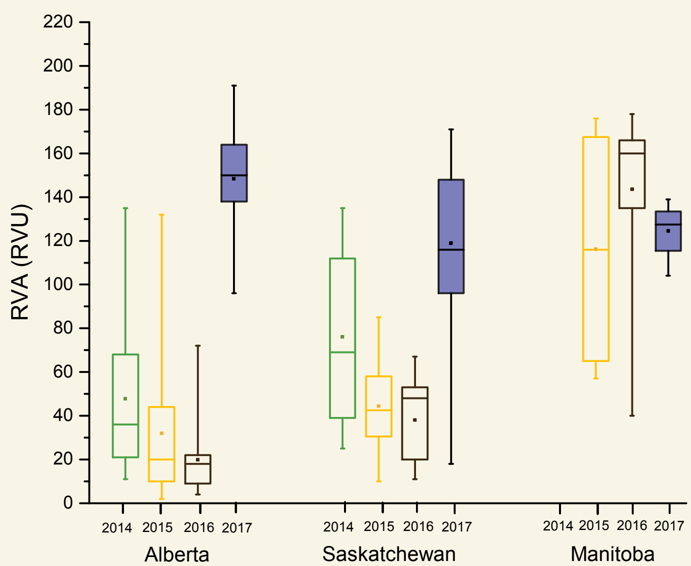


Figure 3.5 Average kernel weight (a) and average kernel diameter (b) for two-row barley cultivars selected for malting in 2017. Kernel weight and diameter values were determined using Single Kernel Characterization System.

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) than can be converted to centipoise (cP) (1 RVU = 12 cP).

RVA is used by barley selectors to identify sound, 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 samples tested in 2017 survey was sound as indicated by high RVA values (>120 RVU) (Figure 3.6). This year's high RVA values have been attributed to relatively early harvest and dry harvest conditions in Western Canada.



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

[1]The boxes in the graph shows the range of RVA values in the middle 50% of the analyzed samples; the horizontal line and the dot inside the box indicate the median and mean, respectively. The short horizontal lines outside of the box mark the minimum and maximum values.

Figure 3.6 RVA results for barley selected for malting in 2017 in comparison with previous years.

3.3 Malting conditions and methodologies

Initial malting trials indicated that, compared to 2016, 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 slightly longer 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 2017

Steeping	8 hours wet steep, 16 hours air rest, 7 hours wet steep, 15 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 2017 - Highlights

- The dry growing season in 2017 resulted in ample harvest of excellent malt quality barley.
- Protein levels in barley grain were slightly lower, whereas thousand kernel weights and kernel plumpness levels were higher than the long-term averages.
- The majority of barley tested in this survey was sound and showed very high germination energy (99%) with little evidence of water sensitivity.
- High kernel weight and plumpness combined with low protein content resulted in high levels of malt extract.
- The levels of soluble proteins and free amino nitrogen (FAN) in worts were slightly lower than the long term average values for the most common malting barley cultivars. The levels of enzymes (diastatic power and α-amylase) in malts were adequate and close to the long term average values.
- Well-modified malts resulted in worts with low viscosity and low level of β-glucans.

CDC Copeland

For the second consecutive year CDC Copeland has remained the dominant malting barley variety grown in Western Canada in 2017. Its excellent brewing characteristics combined with lower protein and enzyme levels, provides an excellent balance within the portfolio of malting barley varieties.

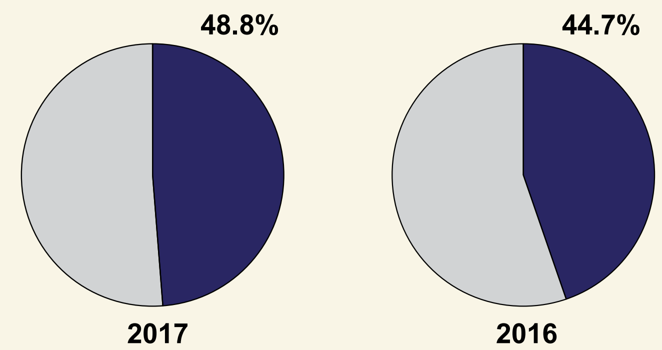


Figure 1. Percentage of the total malting barley area in Western Canada seeded with CDC Copeland in 2017 compared to 2016

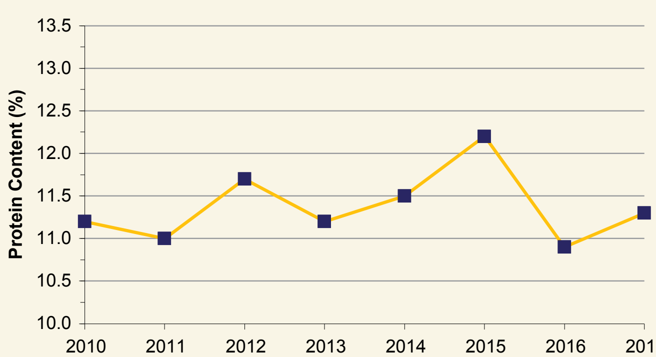


Figure 2. Average protein content in CDC Copeland selected for malting from 2010 to 2017

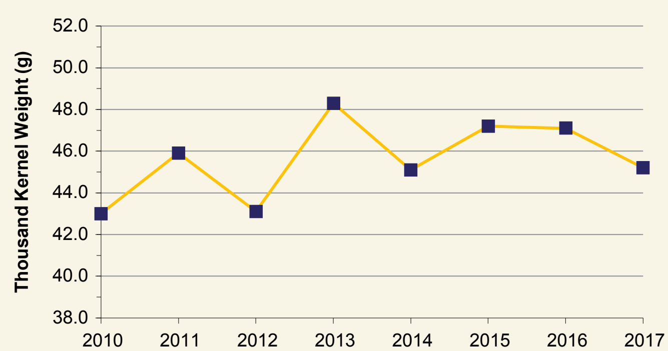


Figure 3. Average kernel weight of CDC Copeland selected for malting from 2010 to 2017

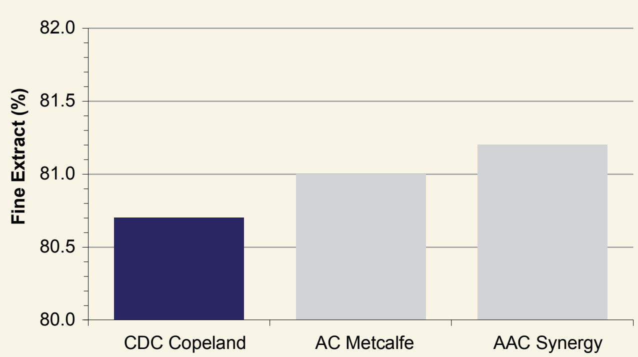


Figure 4. Comparison of average levels of extract by variety in 2017

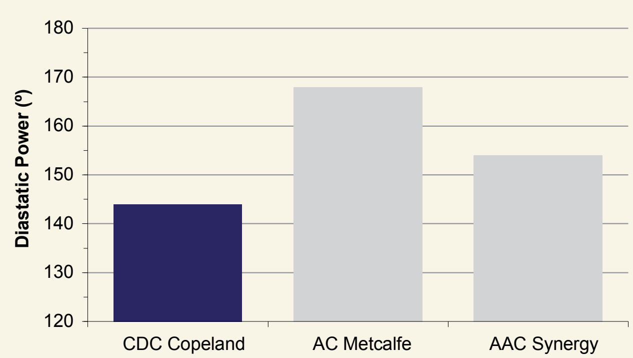


Figure 5. Comparison of average levels of diastatic power by variety in 2017

Table 4.1 Quality data for 2017 harvest survey composite samples of CDC Copeland malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba		Prairie provinces		
Crop year	**2017**	2016	**2017**	2016	**2017**	2016	**2017**	2016	2012-2016 average
Tonnage[2], thousand of tonnes	**697**	481	**655**	232	**5.9**	38	**1358**	761	440
Barley									
Test weight, kg/hL	**67.5**	66.1	**66.6**	65.3	**66.9**	66.2	**67.1**	65.8	65.9
1000 kernel weight, g	**45.9**	47.9	**44.5**	46.0	**45.8**	44.0	**45.2**	47.1	46.2
Plump, over 6/64" sieve, %	**94.2**	93.7	**93.0**	92.8	**93.5**	90.7	**93.6**	93.3	92.9
Intermediate, over 5/64" sieve, %	**4.6**	4.3	**5.6**	4.9	**5.6**	6.8	**5.0**	4.6	5.2
Moisture[3], %	**11.3**	13.1	**11.4**	12.6	**12.1**	11.9	**11.4**	12.9	12.2
Protein, %	**11.2**	10.8	**11.4**	11.0	**10.3**	11.1	**11.3**	10.9	11.5
Germination, 4 ml (3 day), %	**100**	97	**99**	97	**96**	98	**100**	97	97
Germination, 8 ml (3 day), %	**96**	90	**98**	91	**98**	93	**97**	90	90
Malt									
Yield, %	**91.1**	92.1	**90.8**	91.3	**91.7**	92.1	**91.0**	91.8	91.3
Steep-out moisture, %	**43.4**	44.9	**43.8**	45.3	**44.3**	44.0	**43.6**	45.0	44.7
Friability, %	**79.1**	75.9	**82.7**	76.6	**85.9**	83.3	**80.9**	76.4	78.4
Moisture, %	**4.8**	6.1	**4.7**	6.3	**5.0**	5.7	**4.7**	6.2	5.3
Diastatic power, °	**145**	161	**142**	170	**144**	164	**144**	164	153
α-Amylase, D.U.	**66.3**	70.5	**67.4**	76.2	**70.7**	79.4	**66.8**	72.6	61.6
Wort									
Fine grind extract, %	**80.7**	81.1	**80.7**	81.1	**81.5**	81.8	**80.7**	81.2	80.6
Coarse grind extract, %	**79.9**	80.5	**80.0**	80.7	**81.0**	80.9	**80.0**	80.6	79.8
F/C difference, %	**0.7**	0.6	**0.7**	0.5	**0.5**	0.9	**0.7**	0.6	0.8
ß-Glucan, ppm	**90**	105	**68**	69	**53**	68	**79**	92	64
Viscosity, cP	**1.44**	1.43	**1.44**	1.41	**1.43**	1.42	**1.44**	1.42	1.42
Soluble protein, %	**4.14**	4.39	**4.25**	4.75	**3.98**	4.92	**4.19**	4.52	4.83
Ratio S/T, %	**36.7**	40.1	**37.0**	41.9	**37.2**	43.9	**36.9**	40.8	41.8
FAN, mg/L	**175**	202	**178**	223	**177**	234	**177**	209	211
Colour, ASBC units	**1.73**	1.91	**1.80**	2.32	**1.75**	2.17	**1.76**	2.04	2.22

[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 2017, AC Metcalfe occupied the second largest area seeded with malting barley on the Prairies. Despite slightly lower production of AC Metcalfe in 2017 compared to 2016, this variety continues to be one of the most dominant malting barley variety grown in Western Canada. With high levels of extract and diastatic enzymes, its reputation for excellent brewing performance generates strong demand from both domestic and export markets.

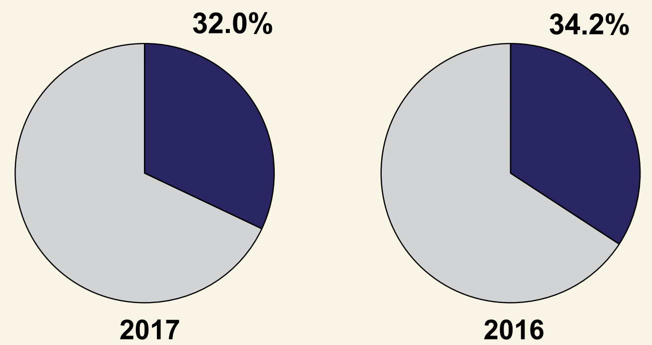


Figure 1. Percentage of the total malting barley area in Western Canada seeded with AC Metcalfe in 2017 compared to 2016

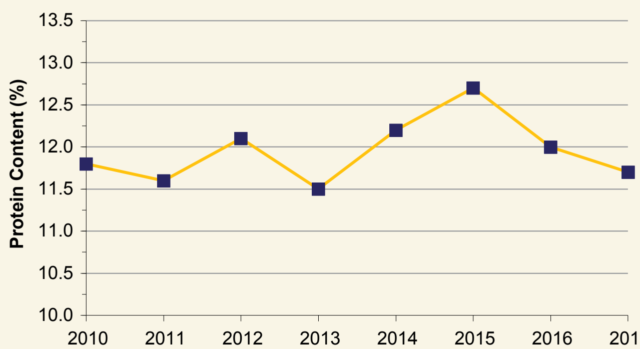


Figure 2. Average protein content in AC Metcalfe selected for malting from 2010 to 2017

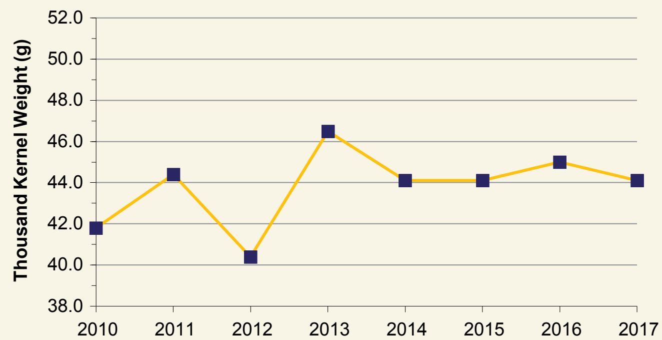


Figure 3. Average kernel weight of AC Metcalfe selected for malting from 2010 to 2017

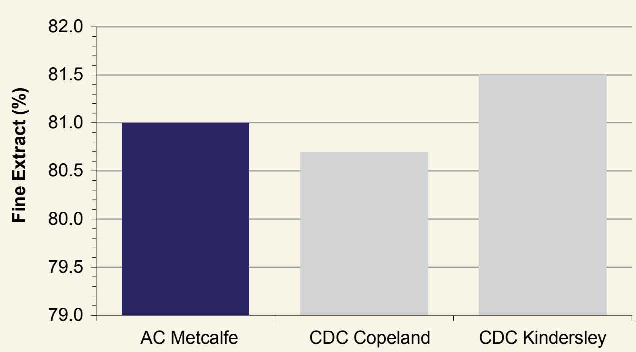


Figure 4. Comparison of average levels of extract by variety in 2017

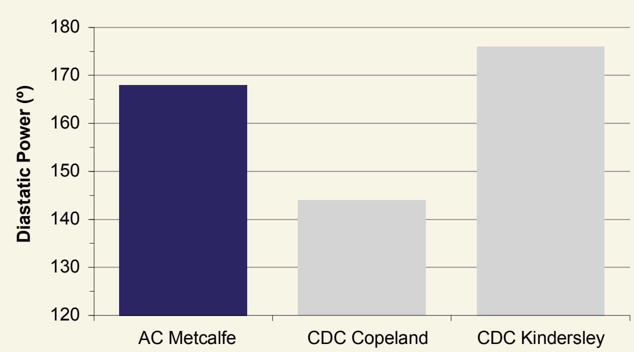


Figure 5. Comparison of average levels of diastatic power by variety in 2017

Table 4.2 Quality data for 2017 harvest survey composite samples of AC Metcalfe malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba		Prairie provinces		
Crop year	**2017**	2016	**2017**	2016	**2017**	2016	**2017**	2016	2012-2016 average
Tonnage[2], thousand of tonnes	**435**	131	**659**	226	**21**	9.7	**1115**	366	349
Barley									
Test weight, kg/hL	**68.9**	67.7	**69.5**	68.0	**68.5**	67.3	**69.2**	67.8	67.3
1000 kernel weight, g	**43.4**	45.6	**44.6**	44.8	**44.0**	42.7	**44.1**	45.0	44.0
Plump, over 6/64" sieve, %	**93.0**	93.0	**93.5**	92.2	**92.7**	88.9	**93.3**	92.4	92.0
Intermediate, over 5/64" sieve, %	**5.6**	4.8	**5.0**	5.5	**6.3**	8.0	**5.3**	5.3	5.8
Moisture[3], %	**11.3**	12.8	**11.7**	12.7	**12.1**	11.6	**11.5**	12.7	11.9
Protein, %	**11.9**	12.0	**11.6**	12.1	**11.1**	12.1	**11.7**	12.0	12.1
Germination, 4 ml (3 day), %	**98**	98	**98**	98	**100**	97	**98**	98	97
Germination, 8 ml (3 day), %	**94**	92	**95**	86	**94**	83	**96**	88	87
Malt									
Yield, %	**90.3**	91.1	**90.4**	91.2	**90.7**	92.3	**90.4**	91.2	90.6
Steep-out moisture, %	**44.2**	45.2	**44.0**	44.9	**44.4**	44.5	**44.1**	45.0	44.9
Friability, %	**68.9**	59.2	**70.9**	61.8	**79.4**	71.1	**70.3**	61.1	69.4
Moisture, %	**4.9**	6.4	**5.0**	6.5	**5.2**	4.9	**5.0**	6.4	5.4
Diastatic power, °	**167**	199	**169**	201	**175**	175	**168**	200	177
α-Amylase, D.U.	**84.5**	100.2	**83.7**	100.3	**93.8**	94.7	**84.2**	100.1	82.7
Wort									
Fine grind extract, %	**80.8**	81.1	**81.1**	81.4	**81.4**	81.5	**81.0**	81.3	80.8
Coarse grind extract, %	**80.3**	80.5	**80.7**	80.6	**81.2**	80.8	**80.6**	80.6	80.0
F/C difference, %	**0.5**	0.5	**0.3**	0.8	**0.2**	0.7	**0.4**	0.7	0.7
ß-Glucan, ppm	**65**	98	**63**	102	**57**	163	**63**	102	64
Viscosity, cP	**1.43**	1.42	**1.43**	1.42	**1.43**	1.44	**1.43**	1.42	1.42
Soluble protein, %	**4.29**	4.77	**4.38**	4.83	**3.96**	4.79	**4.34**	4.81	4.98
Ratio S/T, %	**35.6**	40.5	**37.1**	40.8	**35.2**	40.6	**36.5**	40.7	41.5
FAN, mg/L	**188**	222	**196**	229	**181**	241	**192**	227	225
Colour, ASBC units	**1.87**	1.93	**1.90**	1.42	**1.67**	2.22	**1.89**	2.07	2.21

[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 2017 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.

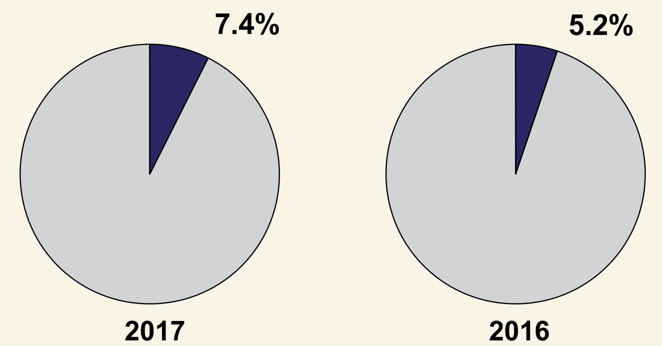


Figure 1. Percentage of the total malting barley area in Western Canada seeded with AAC Synergy in 2017 compared to 2016

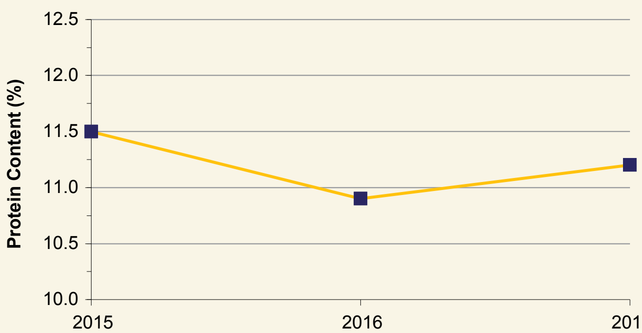


Figure 2. Average protein content in AAC Synergy selected for malting from 2015 to 2017

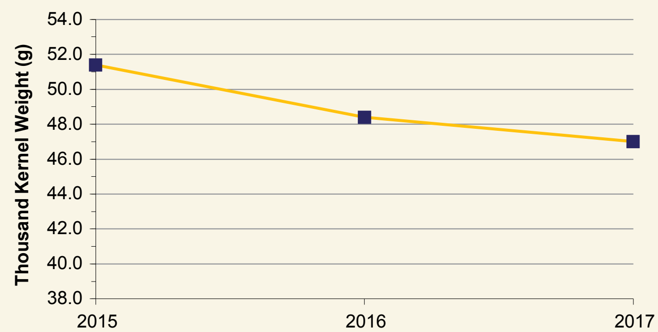


Figure 3. Average kernel weight of AAC Synergy selected for malting from 2015 to 2017

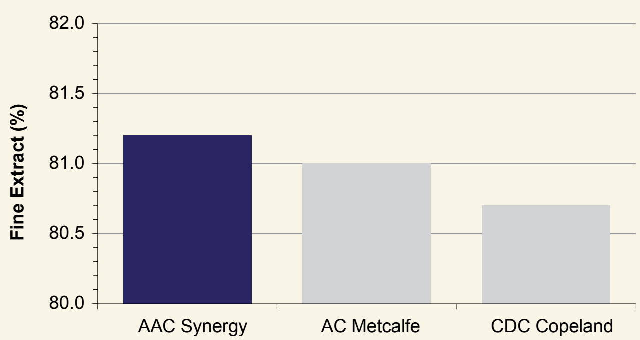


Figure 4. Comparison of average levels of extract by variety in 2017

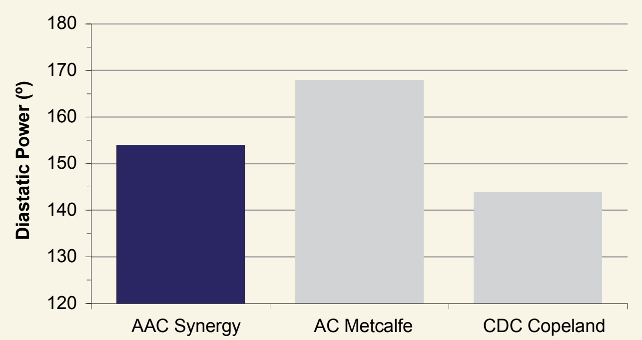


Figure 5. Comparison of average levels of diastatic power by variety in 2017

Table 4.3 Quality data for 2017 harvest survey composite samples of AAC Synergy malting barley[1]

Origin of selected samples	Alberta	Saskatchewan	Manitoba	Prairie provinces		
Crop year	**2017**	**2017**	**2017**	**2017**	2016	2015-2016 average
Tonnage[2], thousand of tonnes	**52**	**71**	**1**	**125**	44	26
Barley						
Test weight, kg/hL	**68.4**	**68.0**	**66.4**	**68.2**	64.4	65.6
1000 kernel weight, g	**49.2**	**45.4**	**46.4**	**47.0**	48.4	49.9
Plump, over 6/64" sieve, %	**97.0**	**96.4**	**96.7**	**96.6**	96.3	96.8
Intermediate, over 5/64" sieve, %	**2.2**	**2.7**	**2.6**	**2.5**	2.2	1.9
Moisture[3], %	**12.1**	**10.8**	**14.4**	**11.4**	13.4	13.0
Protein, %	**10.9**	**11.5**	**9.8**	**11.2**	10.9	11.2
Germination, 4 ml (3 day), %	**99**	**99**	**97**	**99**	99	99
Germination, 8 ml (3 day), %	**98**	**91**	**98**	**94**	86	91
Malt						
Yield, %	**91.2**	**89.8**	**91.2**	**90.4**	91.1	90.8
Steep-out moisture, %	**43.9**	**45.2**	**45.8**	**44.7**	45.9	45.7
Friability, %	**75.5**	**80.0**	**97.5**	**78.3**	75.5	74.0
Moisture, %	**5.1**	**4.7**	**4.6**	**4.9**	5.8	5.5
Diastatic power, °	**149**	**159**	**129**	**154**	171	162
α-Amylase, D.U.	**70.1**	**77.0**	**60.4**	**74.0**	85.7	82.9
Wort						
Fine grind extract, %	**81.5**	**81.0**	**81.2**	**81.2**	81.4	81.4
Coarse grind extract, %	**81.2**	**80.7**	**80.9**	**80.9**	81.0	80.7
F/C difference, %	**0.3**	**0.4**	**0.3**	**0.3**	0.4	0.7
ß-Glucan, ppm	**48**	**42**	**38**	**45**	49	37
Viscosity, cP	**1.41**	**1.42**	**1.41**	**1.42**	1.40	1.41
Soluble protein, %	**3.92**	**4.62**	**3.80**	**4.32**	4.43	4.51
Ratio S/T, %	**36.1**	**40.0**	**38.6**	**38.4**	41.4	41.7
FAN, mg/L	**159**	**193**	**151**	**179**	202	207
Colour, ASBC units	**1.67**	**2.00**	**1.82**	**1.89**	1.91	1.94

[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 decreased substantially in 2017 compared to 2016. With good friability and low levels of β-glucans, it performs well in the brewhouse. Its moderate levels of enzymes, soluble proteins and FAN make Newdale well-suited for all-malt brewing.

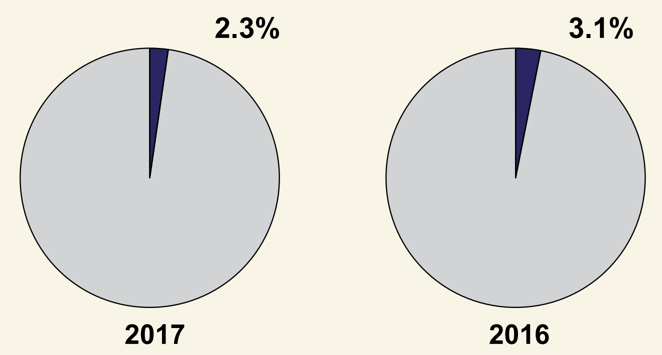


Figure 1. Percentage of the total malting barley area in Western Canada seeded with Newdale in 2017 compared to 2016

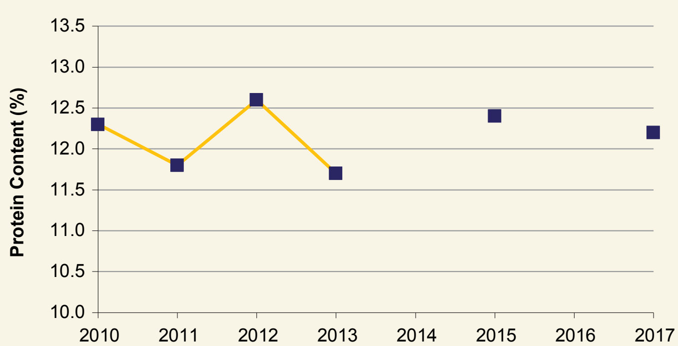


Figure 2. Average protein content in Newdale selected for malting from 2010 to 2017

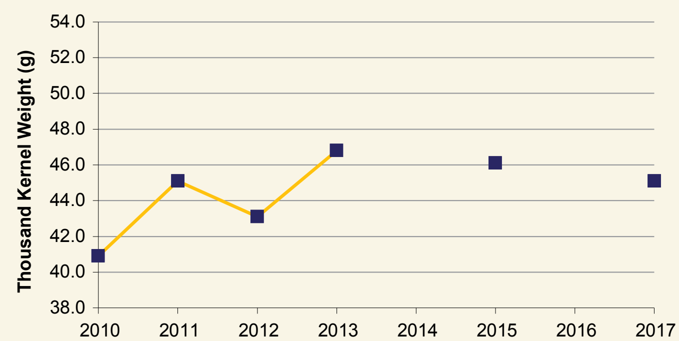


Figure 3. Average kernel weight of Newdale selected for malting from 2010 to 2017

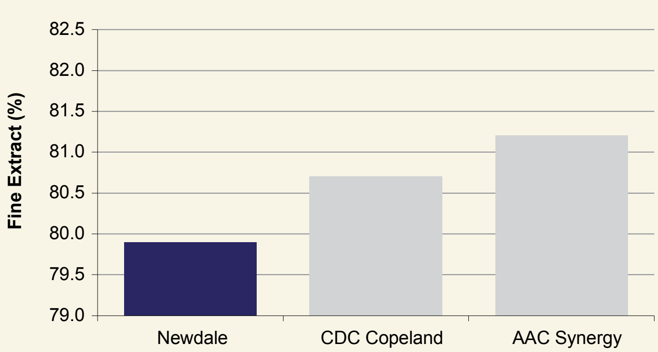


Figure 4. Comparison of average levels of extract by variety in 2017

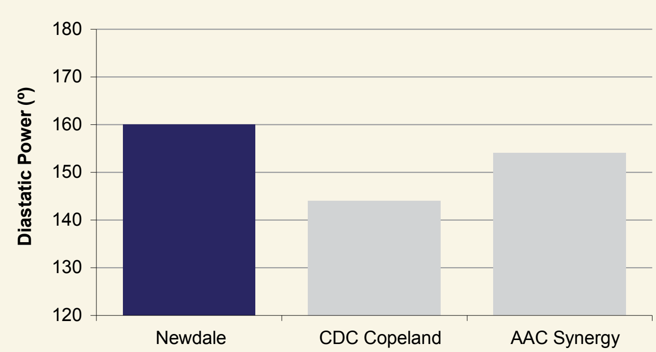


Figure 5. Comparison of average levels of diastatic power by variety in 2017

Table 4.4 Quality data for 2017 harvest survey composite samples of Newdale malting barley[1]

Origin of selected samples	Prairie provinces		
Crop year[2]	**2017**	2015	2010-2015 average
Tonnage[3], thousand of tonnes	**20**	14	16
Barley			
Test weight, kg/hL	**68.7**	65.1	64.9
1000 kernel weight, g	**45.1**	46.1	44.4
Plump, over 6/64" sieve, %	**93.0**	96.1	91.3
Intermediate, over 5/64" sieve, %	**4.7**	2.8	6.6
Moisture[4], %	**12.4**	14.0	13.1
Protein, %	**12.2**	12.4	12.2
Germination, 4 ml (3 day), %	**99**	96	98
Germination, 8 ml (3 day), %	**93**	88	89
Malt			
Yield, %	**91.4**	91.0	91.7
Steep-out moisture, %	**44.1**	45.5	46.1
Friability, %	**63.1**	72.6	77.2
Moisture, %	**5.4**	5.5	5.2
Diastatic power, °	**160**	152	147
α-Amylase, D.U.	**80.7**	61.1	61.6
Wort			
Fine grind extract, %	**79.9**	79.4	79.6
Coarse grind extract, %	**79.3**	78.4	78.9
F/C difference, %	**0.6**	1.0	0.6
ß-Glucan, ppm	**106**	46	57
Viscosity, cP	**1.42**	1.43	1.41
Soluble protein, %	**3.90**	4.58	4.75
Ratio S/T, %	**31.5**	38.4	39.3
FAN, mg/L	**150**	194	183
Colour, ASBC units	**1.41**	2.08	1.93

[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 in 2017 compared to 2016; however still significant quantities were grown and selected in 2017. 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.

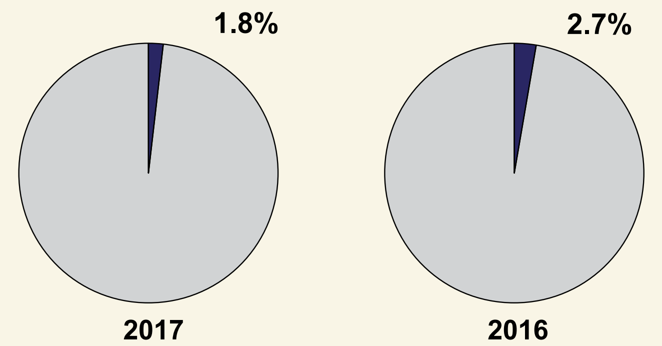


Figure 1. Percentage of the total malting barley area in Western Canada seeded with Bentley in 2017 compared to 2016

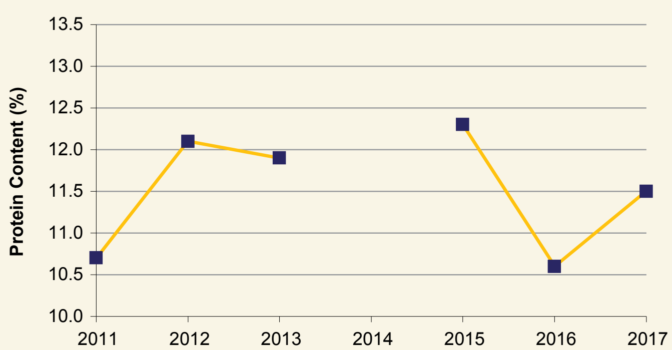


Figure 2. Average protein content in Bentley selected for malting from 2011 to 2017

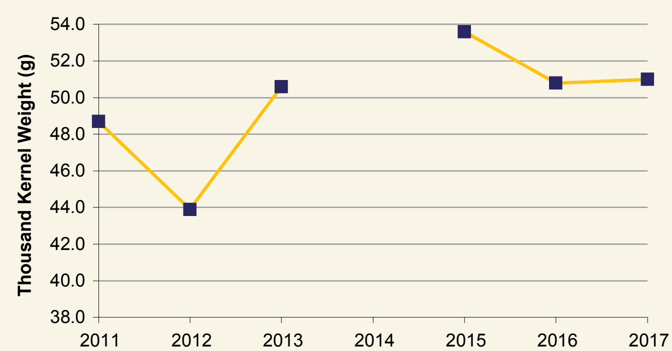


Figure 3. Average kernel weight of Bentley selected for malting from 2011 to 2017

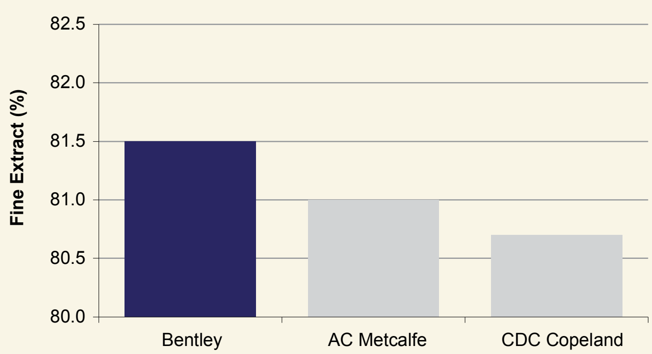


Figure 4. Comparison of average levels of extract by variety in 2017

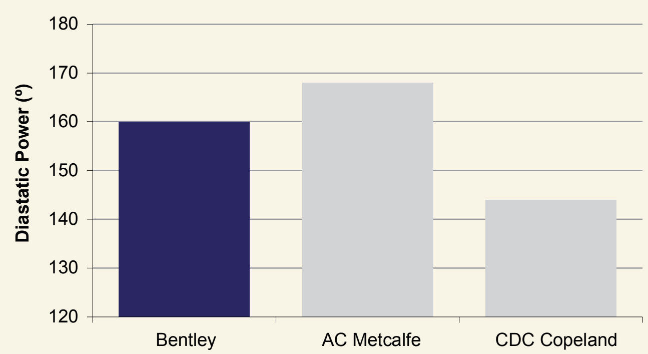


Figure 5. Comparison of average levels of diastatic power by variety in 2017

Table 4.5 Quality data for 2017 harvest survey composite samples of Bentley malting barley[1]

Origin of selected samples	Prairie provinces		
Crop year[2]	**2017**	2016	2012-2016 average
Tonnage[3], thousand of tonnes	**18.2**	9.0	6.6
Barley			
Test weight, kg/hL	**68.2**	67.4	64.8
1000 kernel weight, g	**51.0**	50.8	49.7
Plump, over 6/64" sieve, %	**96.4**	96.1	94.3
Intermediate, over 5/64" sieve, %	**2.4**	1.5	3.4
Moisture[4], %	**13.2**	13.4	13.5
Protein, %	**11.5**	10.6	11.7
Germination, 4 ml (3 day), %	**100**	99	96
Germination, 8 ml (3 day), %	**97**	84	81
Malt			
Yield, %	**91.7**	91.6	90.7
Steep-out moisture, %	**43.2**	44.8	45.6
Friability, %	**70.7**	75.5	72.5
Moisture, %	**5.1**	6.2	5.6
Diastatic power, °	**160**	174	163
α-Amylase, D.U.	**70.4**	78.7	66.0
Wort			
Fine grind extract, %	**81.5**	82.1	81.0
Coarse grind extract, %	**81.1**	81.8	80.6
F/C difference, %	**0.4**	0.3	0.4
ß-Glucan, ppm	**138**	86	53
Viscosity, cP	**1.45**	1.43	1.43
Soluble protein, %	**4.17**	4.43	4.90
Ratio S/T, %	**36.5**	43.0	42.4
FAN, mg/L	**174**	208	226
Colour, ASBC units	**1.54**	1.74	2.24

[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.

CDC Kindersley

CDC Kindersley is a newer early maturing, high yielding variety descended from CDC Kendall. CDC Kindersley modifies easily, resulting in high friability values and low levels of wort β-glucan. Its relatively high FAN and enzyme levels make it well suited for adjunct or high gravity brewing.

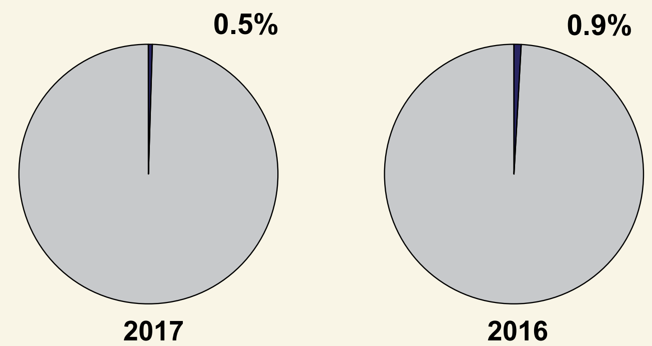


Figure 1. Percentage of the total malting barley area in Western Canada seeded with CDC Kindersley in 2017 compared to 2016

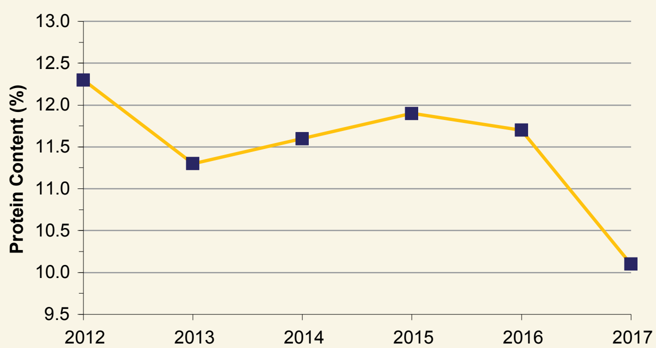


Figure 2. Average protein content in CDC Kindersley selected for malting from 2012 to 2017

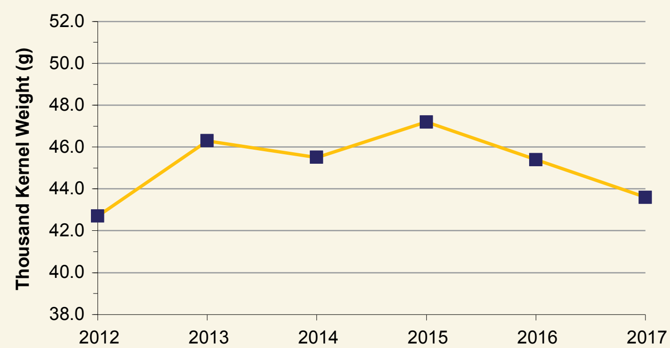


Figure 3. Average kernel weight of CDC Kindersley selected for malting from 2012 to 2017

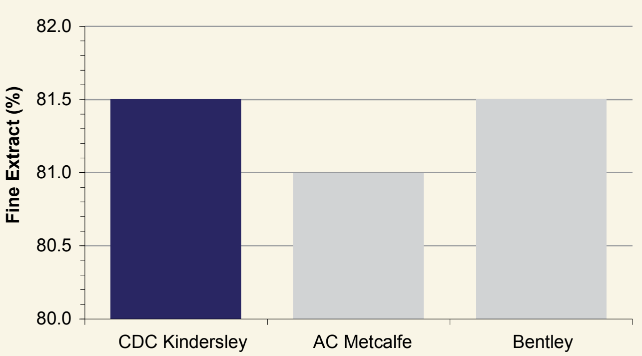


Figure 4. Comparison of average levels of extract by variety in 2017

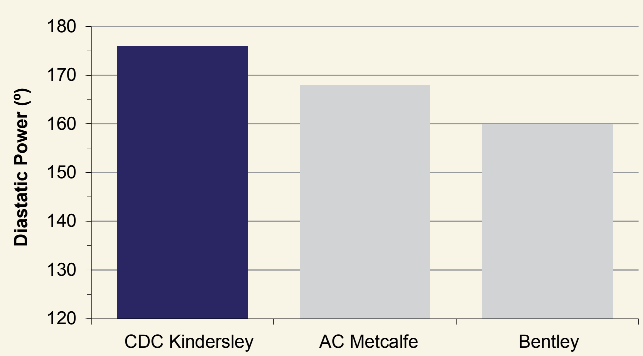


Figure 5. Comparison of average levels of diastatic power by variety in 2017

Table 4.6 Quality data for 2017 harvest survey composite samples of CDC Kindersley malting barley[1]

Origin of selected samples	**Prairie provinces**		
Crop year	**2017**	2016	2012-2016 average
Tonnage[2], thousand of tonnes	**3.9**	2.8	6.6
Barley			
Test weight, kg/hL	**67.5**	66.8	66.9
1000 kernel weight, g	**43.6**	45.4	45.4
Plump, over 6/64" sieve, %	**94.9**	92.8	93.6
Intermediate, over 5/64" sieve, %	**3.9**	5.0	4.5
Moisture[3], %	**13.0**	13.6	12.9
Protein, %	**10.1**	11.7	11.8
Germination, 4 ml (3 day), %	**98**	91	94
Germination, 8 ml (3 day), %	**95**	88	88
Malt			
Yield, %	**89.9**	90.2	90.3
Steep-out moisture, %	**45.9**	45.5	45.8
Friability, %	**84.9**	65.8	72.4
Moisture, %	**5.5**	6.3	5.5
Diastatic power, °	**176**	220	196
α-Amylase, D.U.	**80.1**	94.7	73.9
Wort			
Fine grind extract, %	**81.5**	81.6	80.9
Coarse grind extract, %	**81.5**	81.2	80.4
F/C difference, %	**0.0**	0.4	0.5
ß-Glucan, ppm	**40**	39	39
Viscosity, cP	**1.40**	1.40	1.41
Soluble protein, %	**4.36**	5.83	5.39
Ratio S/T, %	**42.6**	49.6	45.7
FAN, mg/L	**196**	285	241
Colour, ASBC units	**2.13**	2.80	2.52

[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

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

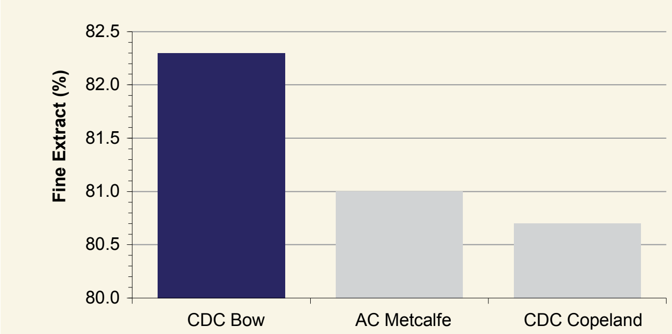


Figure 1. Comparison of average levels of extract by variety in 2017

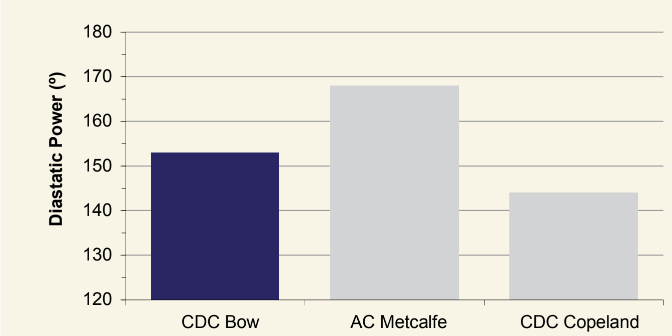


Figure 2. Comparison of average levels of diastatic power by variety in 2017

Table 4.7 Quality data for 2017 harvest survey composite samples of CDC Bow malting barley[1]

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

AAC Connect

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

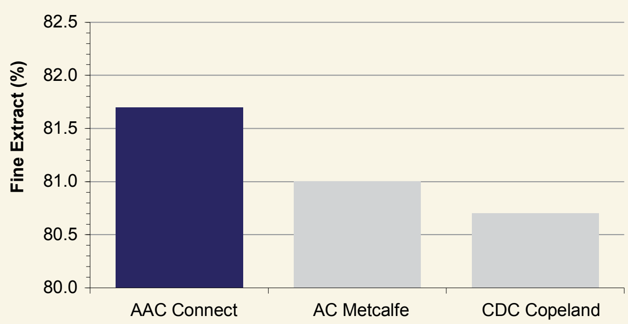


Figure 1. Comparison of average levels of extract by variety in 2017

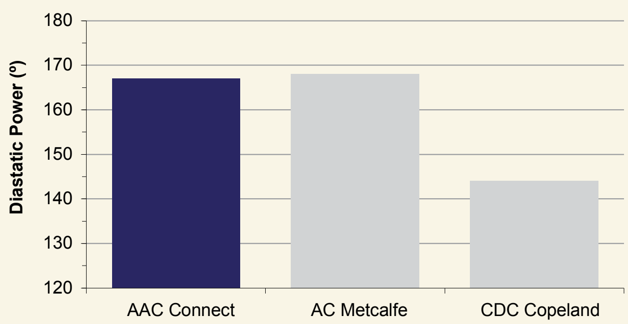


Figure 2. Comparison of average levels of diastatic power by variety in 2017

Table 4.8 Quality data for 2017 harvest survey composite samples of AAC Connect malting barley[1]

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

Brewing trials in 2017

The brewing trials conducted by the CMBTC according to the standard brewing conditions[1] indicated that malts made from AC Metcalfe, CDC Copeland and AAC Synergy performed satisfactory without posing any specific difficulties in brewing.

AC Metcalfe exhibited a similar conversion and lautering time as well as comparable brewhouse efficiency to the 2016 malt. Average wort color was significantly lighter than past two years. The high attenuation limit indicated good fermentability for 2017 crop AC Metcalfe malt, which was comparable to past two years.

CDC Copeland exhibited longer conversion time, but same lautering time and significantly higher brewhouse efficiency compared to 2016 malt. The average wort colour was significantly lighter than the past two years. The high attenuation limit indicated excellent fermentability of CDC Copeland malt in 2017.

AAC Synergy exhibited longer conversion time and longer lautering time, but its brewhouse efficiency was comparable to 2016 malt. The average wort colour was significantly lighter than last two years. The high attenuation limit indicated good fermentability of AAC Synergy malt in 2017.

[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 25 L 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 125 L of water at 77˚C to a total volume of 275 L in brew kettle.
4. Wort boiled for 90 minutes with 9% evaporation rate. Hop additions: Nugget at 0 minutes into boil time and Mt. Hood at 85 minutes into boil time.
5. Wort cooled and forced fermentation performed overnight using lager yeast.

Table 5.1 Brewhouse observations for AC Metcalfe pilot brewing trials.

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

Table 5.2 Brewhouse observations for CDC Copeland pilot brewing trials.

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

Table 5.3 Brewhouse observations for AAC Synergy pilot brewing trials.

Parameter*	2017 AAC Synergy Average (n= 2)	2016 AAC Synergy Average (n= 2)	2015 AAC Synergy Average
Conversion time (min.)	**16**	12	12
Time to clear (min.)	**7**	9	8
Lautering time (min.)	**52**	43	47
Brewhouse efficiency (%)	**89.6**	89.6	88.1
Wort pH	**5.35**	5.31	5.35
Wort colour (SRM)	**2.58**	4.34	5.43
Attenuation limit (%)	**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 segemented 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-428 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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