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Quality of Western Canadian malting barley 2014

Grain Research Laboratory
Annual Harvest Report

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Summary

Total barley production in Western Canada in 2014 was estimated at 6,700,000 tonnes, which represents a decrease of about 31% compared to 2013. This was largely attributed to loss of seeded acres due to flooding in Saskatchewan and Manitoba and due to lower production yields compared to last year.

The growing season was greatly affected by excess moisture continuing into fall, which resulted in a delayed harvest and downgrading of large portions of the crop affected by sprouting and weather damage. These growing conditions limited the quantity of barley selectable for malting purposes.

The 2014 barley harvest survey conducted by the Grain Research Laboratory was based on composites of individual varieties representing 793,550 tonnes of barley selected in Western Canada for malting by grain handling and malting companies.

Overall, malting barley selected in 2014 was of average quality. Thousand kernel weights and plumpness were close to long term averages. Protein levels were moderate, but higher than in 2013. Barley germination was adequate; however, some water sensitivity was present. RVA testing indicated high incidence of pre-harvest sprouting.

Malt made from 2014 barley resulted in average levels of extract, it showed good levels of protein modification, slightly elevated wort beta-glucan levels, and above average levels of enzyme activity promoting good brewing performance. Production of good quality malt was possible from 2014 barley through careful selection and timely malting with the application of appropriate processing conditions.

Part 1- Growing and Harvesting Conditions in 2014

1.1 Seeding

Seeding was delayed across the prairies due to cooler than normal temperatures in the early spring. Late season snowfall and above average amounts of rain during May and June further slowed seeding progress (Figure 1.1). Heavy rainfall in eastern Saskatchewan and western Manitoba contributed to reductions in total seeded acres. Overall planting progress was two to three weeks behind normal.

1.2 Growing season

Wet conditions continued into June with western Manitoba and eastern Saskatchewan receiving higher than average amounts of rainfall causing flooding and additional loss of acres which were previously planted. Hotter and drier weather prevailed for July and August across most growing regions which helped crops develop and also contributed to higher protein levels.

1.3 Harvest

Harvest proceeded slowly due to delayed maturity and continued high levels of precipitation in central and southern growing areas during late August and early September (Figure 1.2). Western Alberta received frost and snow in early September, which further delayed harvest and resulted in reductions in quality. Harvest progress was aided by drier conditions through the end of September, with the majority of the crop in the bin by late October.

Figure 1.1 Percent of average precipitation received from May 2 to June 30, 2014

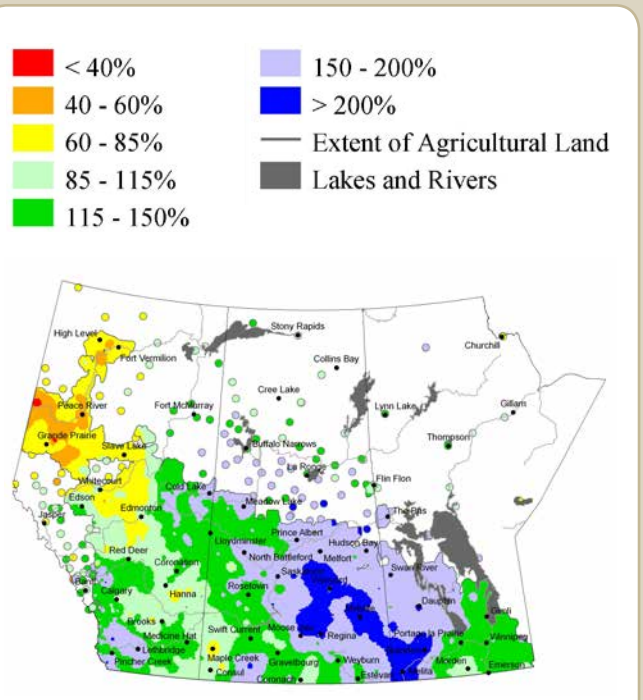
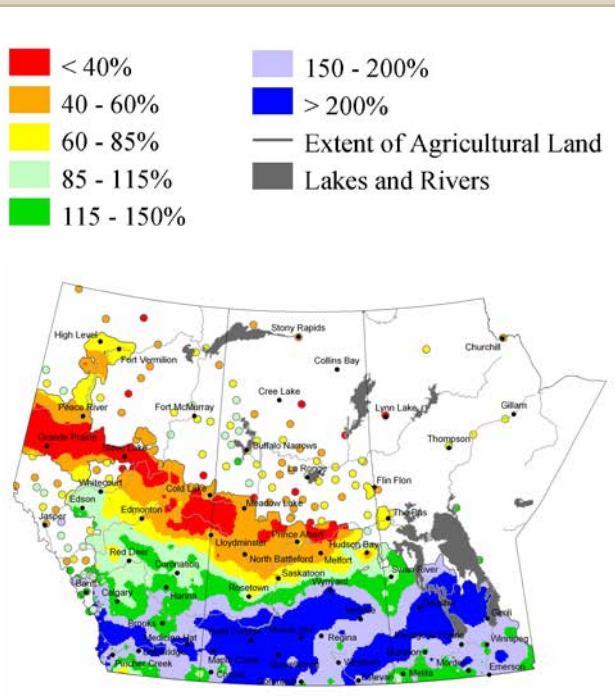


Figure 1.2 Percent of average precipitation received from August 24 to September 22, 2014



Part 2 - Barley Production

Total barley production in Western Canada in 2014 was estimated at 6,700,000 tonnes[1], representing a decrease of about 31% compared to 2013 (Table 2.1). Total area seeded to barley in Western Canada in 2014 also decreased by about 16% compared to 2013. Flooding that occurred in eastern Saskatchewan and in Manitoba in late June and early July contributed to a substantial loss of seeded acreage in these two provinces (Figure 2.1). The decrease in production in 2014 was, therefore, associated with the decreased barley acreage and with a return to relatively normal yields. The average yield of barley in 2014 (62 bushels per acre)[1] was dramatically smaller than the record harvest of 2013.

Figure 2.1 Annual production and area seeded to barley in Western Canada for 2005-2014

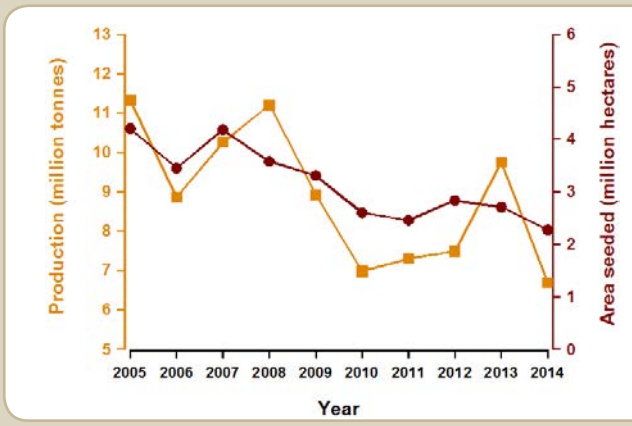


Table 2.1 Comparison of barley production in Western Canada for 2014 and 2013 with the ten year average production[2]

	Seeded area (millions of hectares)			Production (millions of tonnes)		
	2014	2013	2005-2014 average	2014	2013	2005-2014 average
Manitoba	**0.132**	0.182	2.594	**0.414**	0.705	0.750
Saskatchewan	**0.789**	1.024	1.274	**2.105**	3.412	3.353
Alberta[3]	**1.354**	1.503	1.626	**4.181**	5.631	4.779
Western Canada	**2.275**	**2.709**	**3.159**	**6.700**	**9.748**	**9.192**

[2] Statistics Canada, *CANSIM TABLE 001-0100,* accessed October 29, 2013

[3] Alberta figures include small amounts grown in British Columbia

Barley is a multi-purpose crop grown for food, malting and general purposes in a widespread area across the Canadian Prairies. In 2014 two rowed malting barley occupied the majority of acres in Saskatchewan, while the majority of barley produced in Alberta was grown for feed and forage purposes (Figure 2.2). In Manitoba, 44% of acres was seeded to malting barley, whereas 56% to general purpose barley. Food barley continues to occupy relatively small percentage of seeded acres in each province.

Figure 2.2 Distributions of barley classes as a percentage of total area seeded to barley in three Western Canada provinces in 2014

[1] Agriculture and Agrifood Canada; Outlook for Principal Field Crops, accessed November 21, 2014

In recent years, a small number of varieties has dominated the portfolio of malting barley cultivars currently being grown and selected in Western Canada. AC Metcalfe remained the most popular malting variety occupying 38.9% of total acres seeded to malting barley in 2014 (Table 2.2). CDC Copeland continued in second place with 29.8% of malting barley acres. Acres seeded to CDC Meredith decreased slightly from 13.7% in 2013 to 9.8% in 2014. Newer two-rowed cultivars, such as Bentley, CDC PolarStar, CDC Kindersley, Major, Merit 57, AAC Synergy were also grown in 2014 although in smaller quantities. Six-rowed malting barley, primarily produced in Manitoba, continues to decline in acres with Legacy remaining the top six-rowed malting variety but at just 4.4% of total malting barley acres (Table 2.3).

Table 2.2 Distribution of two-rowed malting barley cultivars as percentage of acreage seeded to malting barley in Western Canada[1]

	Alberta	Saskatchewan	Manitoba	Prairies	
	2014 %	2014 %	2014 %	2014 %	2013 %
AC Metcalfe	35.1	43.9	14.4	38.9	36.3
CDC Copeland	32.7	29.9	5.5	29.8	25.8
CDC Meredith	15.0	6.5	3.6	9.8	13.7
Newdale	5.3	4.4	23.5	5.7	7.2
Bentley	4.6	0.4	5.9	2.4	1.8
CDC PolarStar	0.6	3.3	0.0	2.0	1.0
CDC Kindersley	2.1	0.2	0.1	0.9	0.5
Major	0.7	0.8	0.1	0.8	2.5
Merit 57	1.6	0.0	0.0	0.6	0.3
AAC Synergy	0.4	0.1	0.1	0.2	0.0
Other	0.6	0.5	0.0	0.5	0.3

[1] Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, & Manitoba Management Plus Program

Table 2.3 Distribution of six-rowed malting barley cultivars as percentage of acreage seeded to malting barley in Western Canada[1]

	Alberta	Saskatchewan	Manitoba	Prairies	
	2014 %	2014 %	2014 %	2014 %	2013 %
Legacy	0.4	7.6	3.1	4.4	5.9
Celebration	0.0	0.5	17.2	1.1	1.9
Tradition	0.0	0.9	15.3	1.3	1.5
Stellar ND	0.0	0.6	3.9	0.5	0.4
CDC Yorkton	0.4	0.2	1.7	0.3	0.3
Lacey	0.2	0.1	2.7	0.3	0.2
Robust	0.1	0.1	2.4	0.2	0.3
Other	0.4	0.0	0.4	0.1	0.2

[1] Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, & Manitoba Management Plus Program

Part 3 - GRL Annual Harvest Survey

3.1 GRL sampling and survey methodology

The Grain Research Laboratory (GRL) at the Canadian Grain Commission conducts an annual survey to determine the quality of malting barley grown in Western Canada. The 2014 malting barley survey was based on varietal composite samples representing 793,550 tonnes of barley which had been selected for domestic malt processing or for export as malting barley by 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 19th of November, 2014. The reported average results represent weighted averages based on tonnage of composite samples received.

3.2 Quality of barley selected for malting in 2014: general trends and annual statistics

Figure 3.1 Average protein content in barley selected for malting from 2005-2014

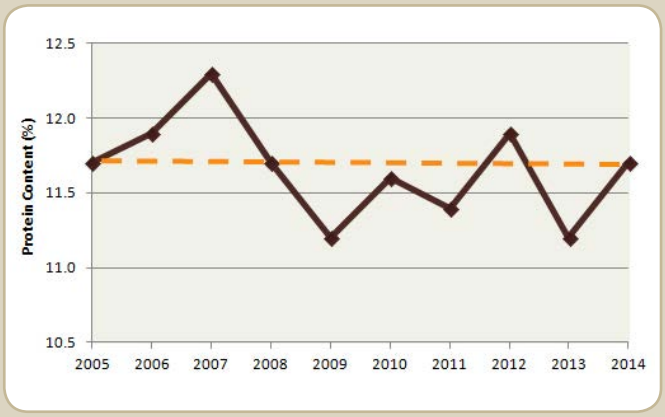


Figure 3.2 Average germination energy of malting barley selected from 2005 to 2014

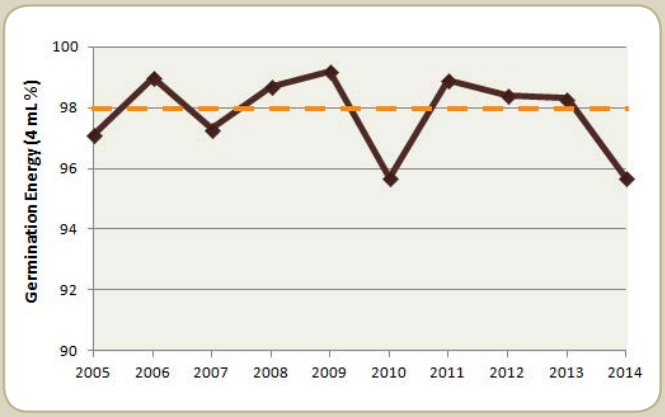
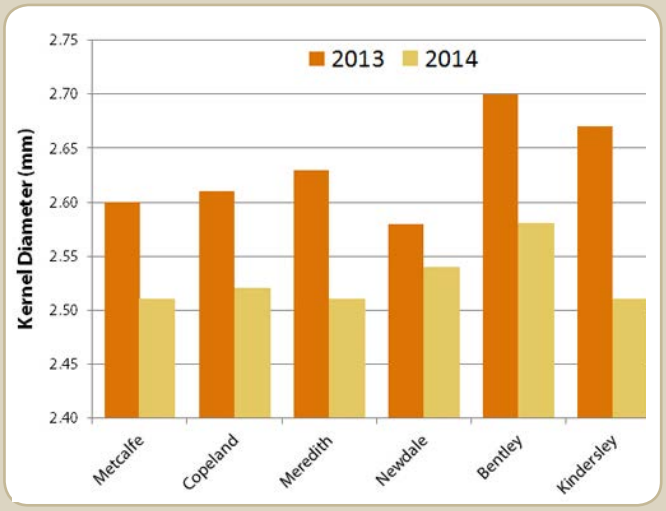


Figure 3.3 Average kernel diameter of barley varieties selected for malting in 2013 and 2014



Malting barley selected in 2014 was overall of average quality. Barley protein levels in 2014 (11.7%) were equal to the 10-year average, and substantially higher than in 2013 (11.2%) (Figure 3.1). Germination energy was adequate (Figure 3.2); however moderate water sensitivity was present in some samples. This year's barley had smaller diameter (Figure 3.3) and lower kernel weight (Figure 3.4) than in 2013. Kernel plumpness, which is a measure of kernels remaining on the 6/64" slotted screen, was slightly above the 10-year average (Figure 3.5).

Figure 3.4 Average kernel weight of malting barley selected from 2005-2014

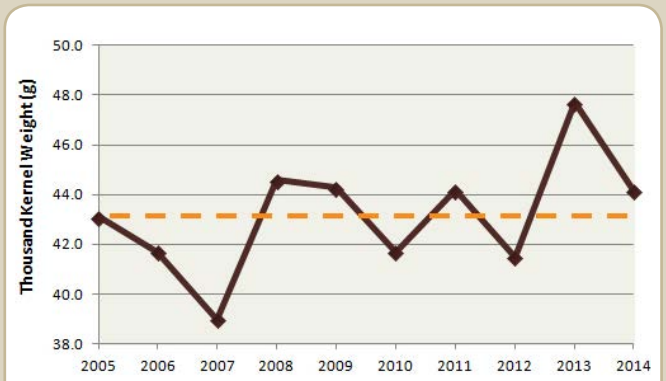
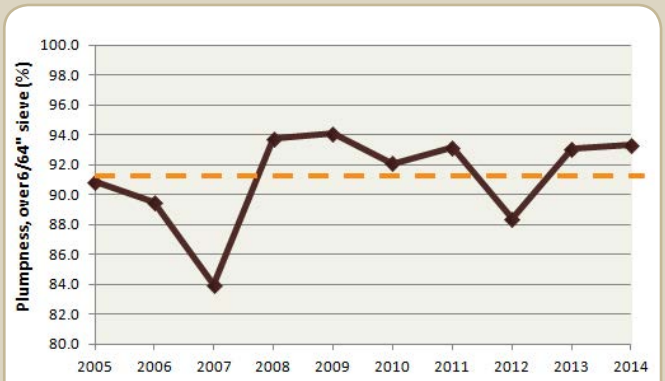


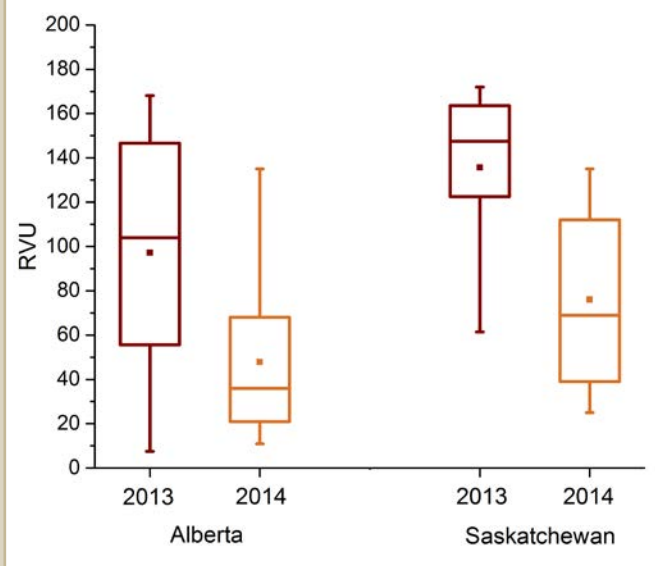
Figure 3.5 Average plumpness of barley selected for malting from 2005-2014



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; 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.

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 (T and RH) and the initial moisture content of the grain have to be taken into account.

Figure 3.6 RVA results for barley selected for malting in 2013 and 2014[1]



[1]The box 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.

Among the samples tested in 2014 survey only a few showed high RVA values (>120 RVU). This year's RVA results have reflected generally wet harvest conditions resulting in high incidence of substantial pre-germination (<50 RVU), a dramatic contrast to 2013 (Figure 3.6). The RVA results stress the need for identification of barley with low RVU that should be malted promptly. As indicated in the next sections of this report, pre-germinated barley malted soon after harvest can produce good quality malt.

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

3.3 GRL malting conditions and methodologies

Initial malting trials indicated that sufficient steep out moisture levels were achieved using two wet steep cycles. Despite slightly higher protein levels, the smaller kernels took up water easily; therefore, the total steep time was shortened from 18 hours (used in 2013) to 16 hours. 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 Phoenix Micromalting System in 2014

Steeping	**8 hours wet steep, 16 hours air rest, 8 hours wet steep, 12 hours air rest @ 13°C**
Germination	**96 hours @ 15°C**
Kilning	**12 hours @ 60°C, 6 hours@ 65°C, 2 hours @ 75°C, 4 hours @ 85°C**

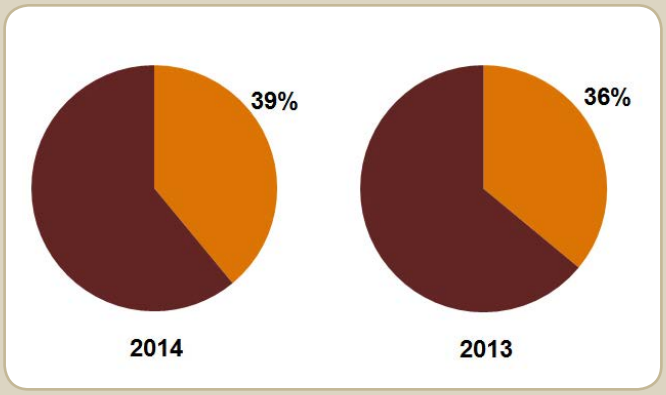
3.4 Malting Quality in 2014 - Highlights

This year's harvest resulted in malts with good quality:

- Well modified malt was easily obtained from 2014 barley; it showed good friability and after mashing it resulted in wort with average levels of β-glucan and increased levels of soluble protein, and free amino nitrogen (FAN).
- Slightly smaller kernels and higher protein levels in 2014 barley resulted in slightly lower malt extracts compared to the 5-year average values.
- This year's malts exhibited higher than average levels of diastatic enzymes.
- Good quality malt can be obtained from 2014 barley through careful selection and timely malting with the application of appropriate processing conditions.

AC Metcalfe

Figure 1. Percentage of the total malting barley acres in Western Canada seeded to AC Metcalfe in 2013 and 2014



AC Metcalfe continues to be the 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 2. Average protein content in AC Metcalfe selected for malting from 2010-2014

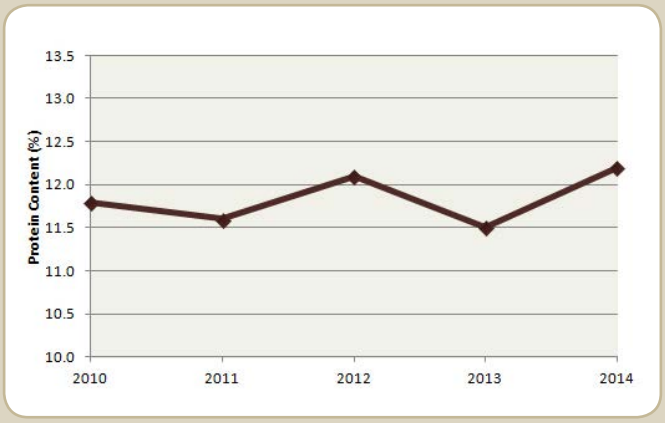


Figure 3. Average kernel weight of AC Metcalfe selected for malting from 2010-2014

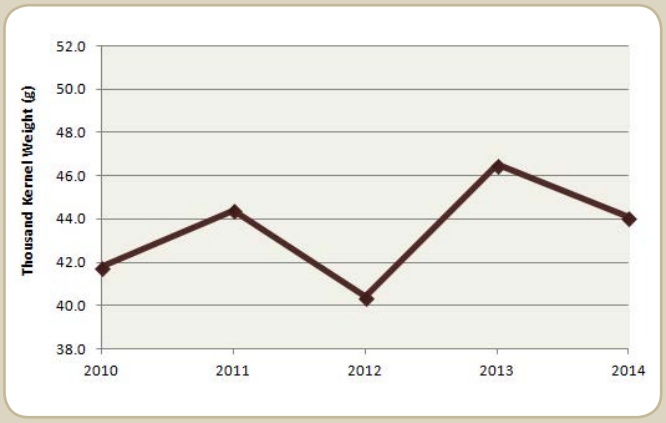


Figure 4. Comparison of average levels of extract by variety in 2014

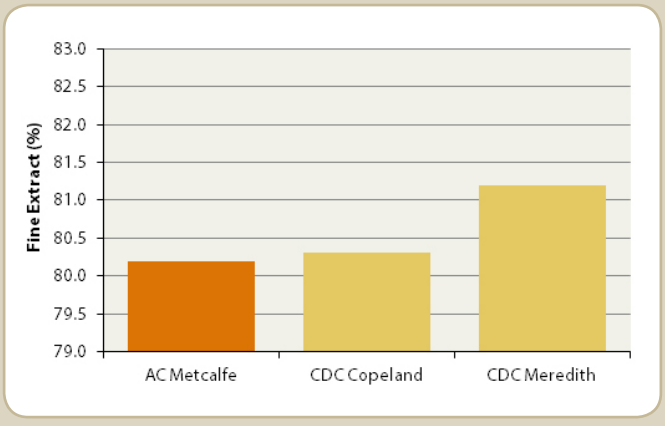


Figure 5. Comparison of average levels of diastatic power by variety in 2014

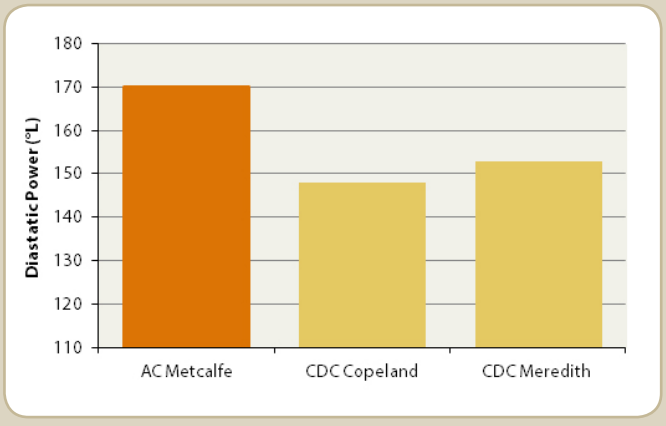


Table 3.2 Quality data for 2014 harvest survey composite samples of AC Metcalfe malting barley

Origin of selected samples	Alberta[1]		Saskatchewan[1]		Prairie Provinces		
Crop year	**2014**	2013	**2014**	2013	**2014**	2013	5 Year Avg
Thousands of tonnes[2]	**172**	187	**155**	175	**327**	369	319
Barley							
Test weight, kg/hL	**67.1**	69.5	**65.9**	68.8	**66.5**	69.2	67.1
1000 Kernel weight, g	**44.8**	46.7	**43.5**	46.2	**44.1**	46.5	43.4
Plump, over 6/64" sieve, %	**94.0**	93.8	**91.8**	93.6	**92.9**	93.7	91.9
Intermediate, over 5/64"sieve, %	**4.6**	4.8	**6.2**	4.9	**5.4**	4.8	6.1
Moisture, % [3]	**12.7**	11.4	**12.9**	11.5	**12.8**	11.5	11.7
Protein, %	**12.1**	11.5	**12.2**	11.5	**12.2**	11.5	11.8
Germination, 4 ml (3 day), %	**96**	98	**96**	99	**96**	98	98
Germination, 8 ml (3 day), %	**87**	89	**80**	90	**84**	90	86
Malt							
Yield, %	**90.7**	90.0	**90.3**	90.1	**90.5**	90.1	91.7
Steep-out moisture, %	**44.4**	44.9	**44.6**	44.8	**44.5**	44.8	45.4
Friability, %	**73.9**	77.4	**72.7**	77.8	**73.3**	77.6	70.8
Moisture, %	**4.8**	5.1	**4.9**	5.1	**4.9**	5.1	5.2
Diastatic power, °L	**168**	163	**171**	157	**170**	160	165
α-Amylase, D.U.	**78.9**	74.4	**79.0**	73.6	**79.0**	74.0	70.5
Wort							
Fine grind extract, %	**80.2**	81.9	**80.1**	81.8	**80.2**	81.9	80.6
Coarse grind extract, %	**79.4**	80.8	**79.5**	80.6	**79.4**	80.7	79.8
F/C difference, %	**0.7**	0.7	**0.7**	0.9	**0.7**	0.8	0.6
ß-Glucan, ppm	**77**	48	**70**	53	**73**	50	76
Viscosity, cps	**1.43**	1.44	**1.42**	1.44	**1.43**	1.44	1.43
Soluble protein, %	**5.02**	4.76	**5.35**	4.71	**5.18**	4.73	4.87
Ratio S/T, %	**41.5**	41.4	**44.0**	41.2	**42.7**	41.3	40.8
FAN, mg/L	**213**	212	**232**	211	**222**	212	206
Colour, ASBC units	**2.22**	2.00	**2.72**	2.00	**2.45**	2.00	2.10

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

[2] Does not necessarily 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 Copeland

CDC Copeland is the second major two-rowed malting variety grown on the Prairies. 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 acres in Western Canada seeded to CDC Copeland in 2013 and 2014

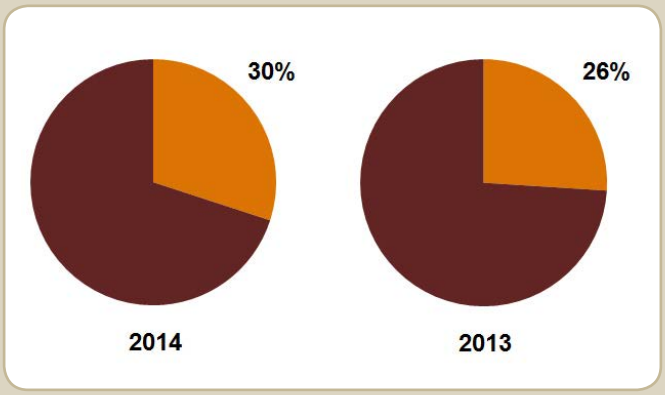


Figure 2. Average protein content in CDC Copeland selected for malting from 2010-2014

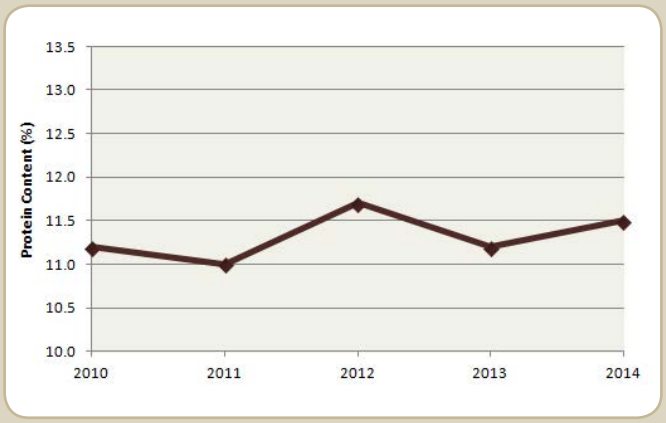


Figure 3. Average kernel weight of CDC Copeland selected for malting from 2010-2014

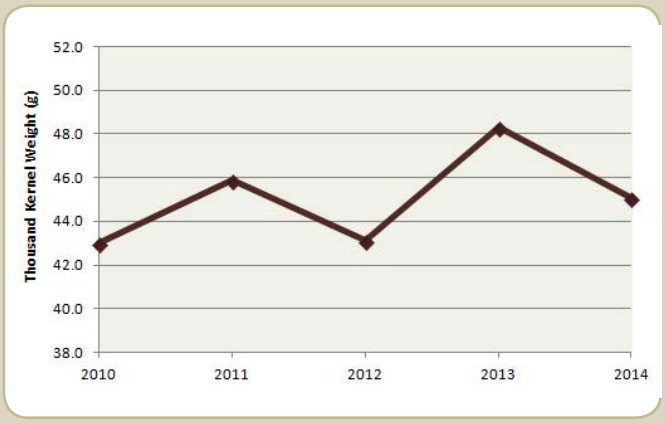


Figure 4. Comparison of average levels of extract by variety in 2014

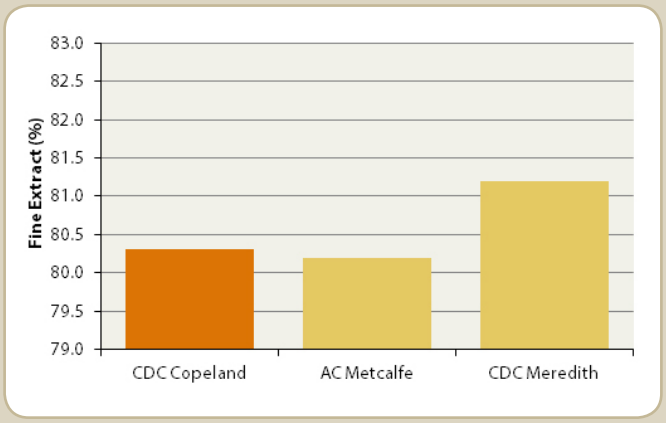


Figure 5. Comparison of average levels of diastatic power by variety in 2014

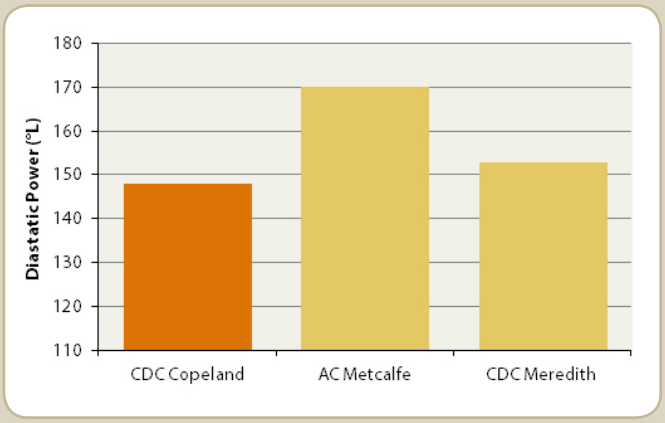


Table 3.3 Quality data for 2014 harvest survey composite samples of CDC Copeland malting barley

Origin of selected samples	Alberta[1]		Saskatchewan[1]		Prairie Provinces		
Crop year	**2014**	2013	**2014**	2013	**2014**	2013	5 Year Avg
Thousands of tonnes[2]	**152**	186	**182**	127	**334**	321	244
Barley							
Test weight, kg/hL	**65.6**	67.3	**64.3**	67.8	**65.0**	67.6	65.8
1000 Kernel weight, g	**45.8**	48.0	**44.1**	48.7	**45.1**	48.3	45.1
Plump, over 6/64" sieve, %	**93.7**	93.9	**92.6**	94.3	**93.2**	94.1	92.3
Intermediate, over 5/64"sieve, %	**4.6**	4.7	**5.3**	4.4	**4.9**	4.6	5.8
Moisture, % [3]	**12.8**	11.7	**13.4**	11.6	**13.1**	11.7	11.9
Protein, %	**11.5**	11.2	**11.5**	11.1	**11.5**	11.2	11.3
Germination, 4 ml (3 day), %	**96**	99	**93**	98	**94**	98	97
Germination, 8 ml (3 day), %	**88**	94	**83**	95	**85**	94	90
Malt							
Yield, %	**91.1**	90.7	**91.1**	91.1	**91.1**	90.9	92.2
Steep-out moisture, %	**44.6**	44.2	**45.0**	44.0	**44.8**	44.1	45.1
Friability, %	**79.8**	82.7	**81.0**	83.6	**80.3**	83.1	78.7
Moisture, %	**4.9**	5.0	**5.2**	4.9	**5.1**	4.9	5.1
Diastatic power, °L	**147**	138	**150**	135	**148**	137	141
α-Amylase, D.U.	**55.5**	54.1	**56.8**	55.3	**56.1**	54.6	52.2
Wort							
Fine grind extract, %	**80.2**	81.4	**80.4**	81.7	**80.3**	81.5	80.5
Coarse grind extract, %	**79.4**	80.2	**79.8**	80.2	**79.6**	80.2	79.6
F/C difference, %	**0.8**	0.8	**0.6**	0.9	**0.7**	0.9	0.8
ß-Glucan, ppm	**75**	56	**42**	49	**61**	53	75
Viscosity, cps	**1.43**	1.44	**1.41**	1.43	**1.42**	1.44	1.43
Soluble protein, %	**4.87**	4.62	**5.40**	4.64	**5.10**	4.63	4.86
Ratio S/T, %	**42.9**	41.3	**46.9**	41.8	**44.6**	41.5	42.4
FAN, mg/L	**200**	196	**238**	202	**216**	199	199
Colour, ASBC units	**2.22**	1.95	**3.04**	2.10	**2.58**	2.01	2.21

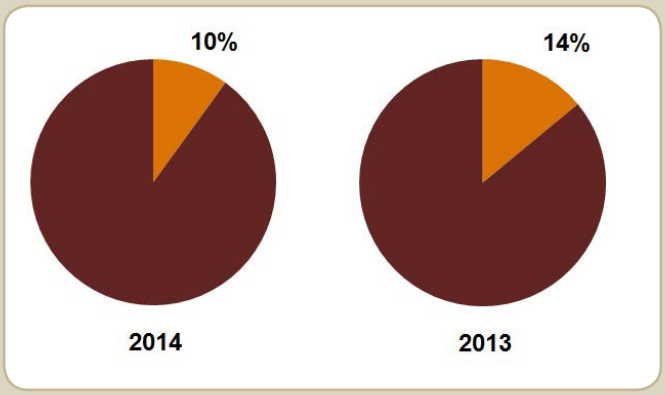
[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Does not necessarily 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 Meredith

Figure 1. Percentage of the total malting barley acres in Western Canada seeded to CDC Meredith in 2013 and 2014



With its good agronomics and disease resistance, CDC Meredith has the potential to produce superior yields making it an attractive choice for producers. Good malting characteristics such as consistently lower protein, higher extracts and moderate levels of enzymes, translate into good overall brewing potential.

Figure 2. Average protein content in CDC Meredith selected for malting from 2010-2014

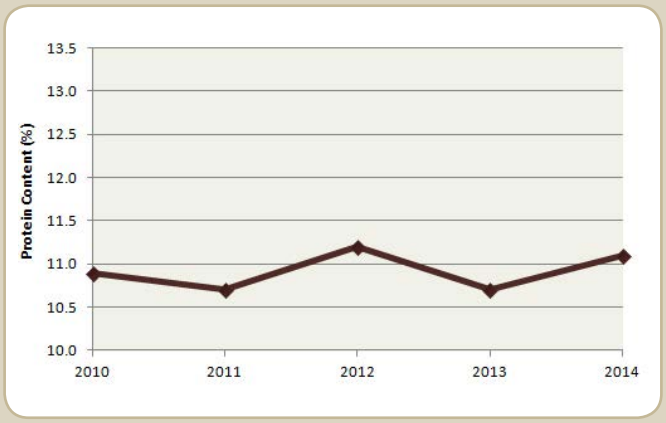


Figure 3. Average kernel weight of CDC Meredith selected for malting from 2010-2014

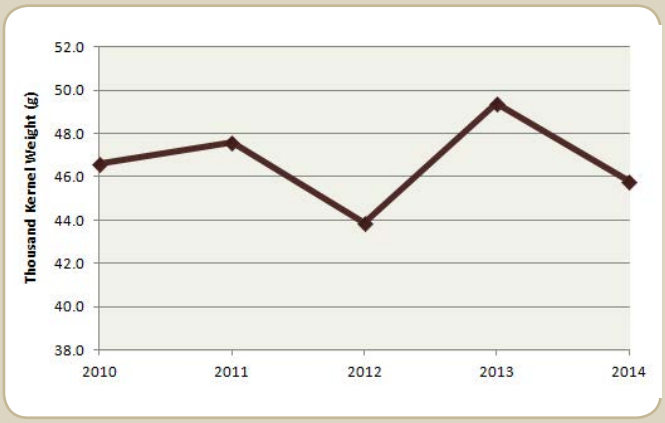


Figure 4. Comparison of average levels of extract by variety in 2014

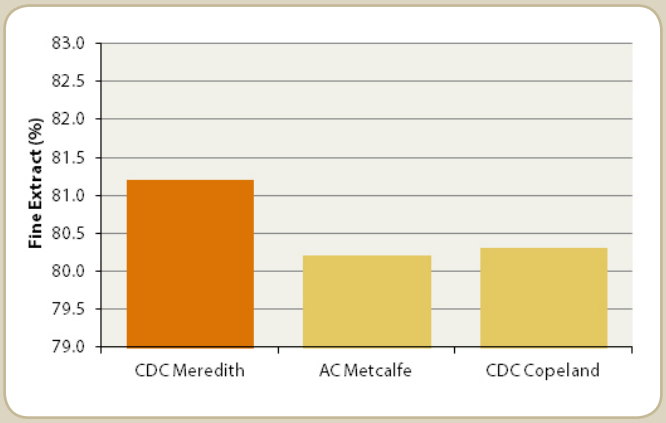


Figure 5. Comparison of average levels of diastatic power by variety in 2014

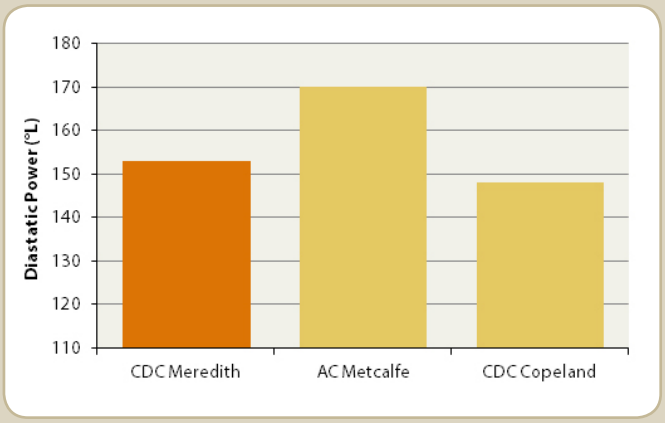


Table 3.4 Quality data for 2014 harvest survey composite samples of CDC Meredith malting barley

Origin of selected samples	Alberta[1]		Saskatchewan[1]		Prairie Provinces		
Crop year	**2014**	2013	**2014**	2013	**2014**	2013	5 Year Avg
Thousands of tonnes[2]	**45**	105	**4**	60	**49**	165	55.6
Barley							
Test weight, kg/hL	**64.1**	67.3	**68.8**	67.7	**64.6**	67.4	65.9
1000 Kernel weight, g	**45.7**	48.7	**47.2**	50.7	**45.8**	49.4	46.7
Plump, over 6/64" sieve, %	**95.2**	94.9	**94.8**	95.9	**95.2**	95.3	94.6
Intermediate, over 5/64"sieve, %	**3.4**	3.7	**3.5**	3.0	**3.4**	3.4	3.9
Moisture, % [3]	**12.5**	11.8	**9.9**	11.4	**12.2**	11.7	12.4
Protein, %	**11.2**	10.8	**10.5**	10.6	**11.1**	10.7	10.9
Germination, 4 ml (3 day), %	**89**	98	**98**	99	**90**	98	96
Germination, 8 ml (3 day), %	**76**	92	**87**	94	**77**	93	87
Malt							
Yield, %	**89.9**	89.4	**89.1**	89.5	**89.8**	89.4	91.1
Steep-out moisture, %	**46.5**	45.5	**44.1**	45.3	**46.3**	45.5	46.5
Friability, %	**83.4**	84.7	**82.0**	85.4	**83.2**	85.0	81.5
Moisture, %	**5.1**	4.9	**5.0**	4.8	**5.1**	4.9	5.1
Diastatic power, °L	**155**	152	**143**	142	**153**	149	153
α-Amylase, D.U.	**62.5**	64.3	**67.0**	63.6	**62.9**	64.0	59.8
Wort							
Fine grind extract, %	**81.0**	82.3	**82.8**	82.5	**81.2**	82.4	81.3
Coarse grind extract, %	**80.3**	81.3	**82.0**	81.1	**80.4**	81.2	80.4
F/C difference, %	**0.7**	0.7	**0.8**	0.8	**0.7**	0.8	0.8
ß-Glucan, ppm	**114**	54	**167**	65	**119**	58	99
Viscosity, cps	**1.43**	1.43	**1.46**	1.43	**1.44**	1.43	1.42
Soluble protein, %	**4.73**	4.74	**4.46**	4.76	**4.70**	4.75	4.78
Ratio S/T, %	**43.7**	44.1	**46.0**	45.1	**43.9**	44.5	43.9
FAN, mg/L	**209**	214	**198**	222	**208**	217	201
Colour, ASBC units	**2.56**	2.30	**2.37**	2.45	**2.54**	2.35	2.37

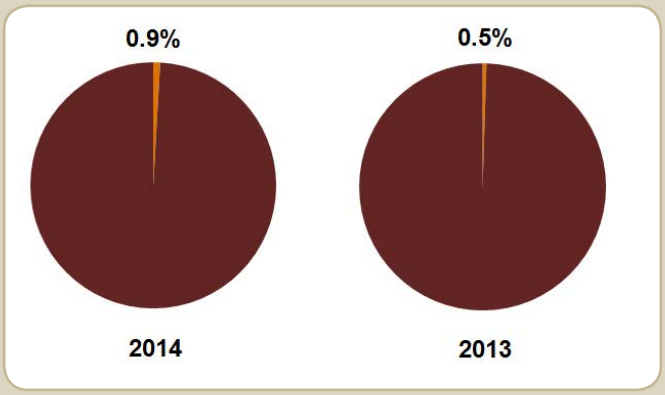
[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Does not necessarily 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 Kindersley

Figure 1. Percentage of the total malting barley acres in Western Canada seeded to CDC Kindersley in 2013 and 2014



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

Figure 2. Average protein content in CDC Kindersley selected for malting from 2010-2014

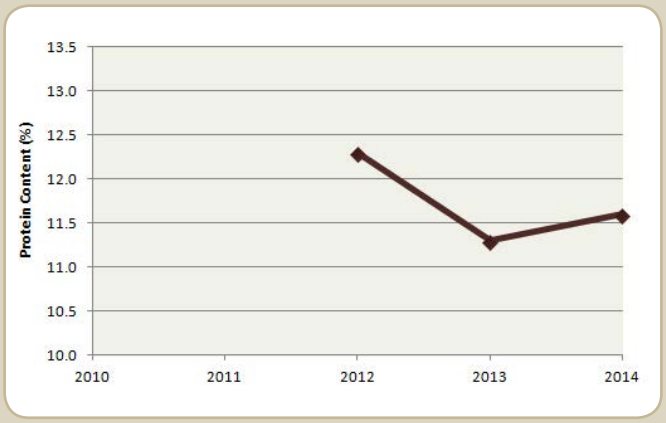


Figure 3. Average kernel weight of CDC Kindersley selected for malting from 2010-2014

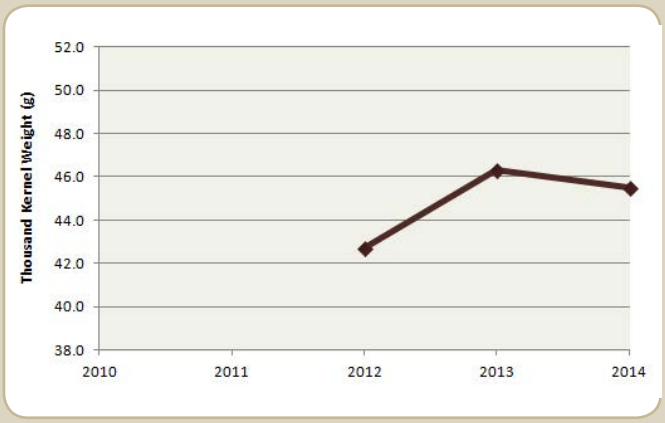


Figure 4. Comparison of average levels of extract by variety in 2014

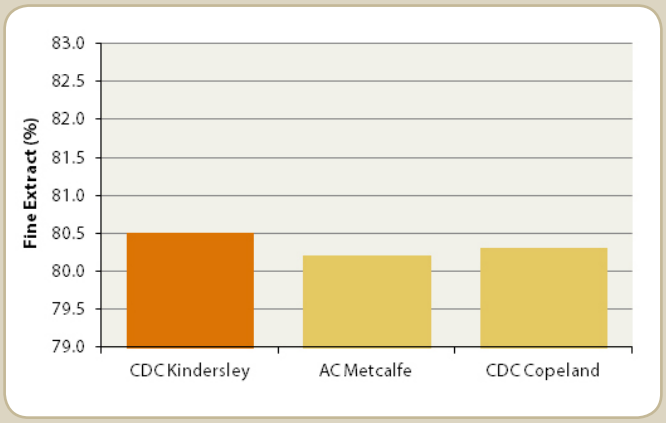


Figure 5. Comparison of average levels of diastatic power by variety in 2014

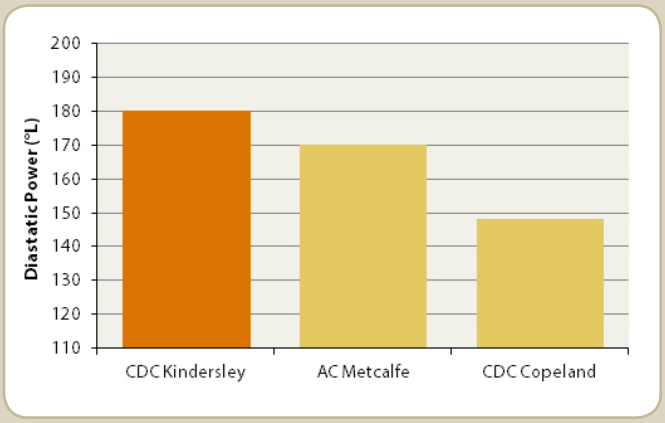


Table 3.5 Quality data for 2014 harvest survey composite samples of CDC Kindersley malting barley

Origin of selected samples	Alberta[1]		
Crop year	**2014**	2013	3 Year Avg
Thousands of tonnes[2]	**17**	5	9
Barley			
Test weight, kg/hL	**64.9**	70.2	67.1
1000 Kernel weight, g	**45.5**	46.3	44.8
Plump, over 6/64" sieve, %	**94.7**	94.5	92.8
Intermediate, over 5/64"sieve, %	**3.7**	3.7	5.1
Moisture, % [3]	**13.1**	12.5	12.5
Protein, %	**11.6**	11.3	11.7
Germination, 4 ml (3 day), %	**94**	98	97
Germination, 8 ml (3 day), %	**84**	98	91
Malt			
Yield, %	**89.7**	89.6	90.3
Steep-out moisture, %	**46.5**	44.8	45.7
Friability, %	**77.8**	81.2	76.5
Moisture, %	**5.4**	4.8	5.2
Diastatic power, °L	**180**	186	186
α-Amylase, D.U.	**68.7**	74.3	68.4
Wort			
Fine grind extract, %	**80.5**	81.6	80.6
Coarse grind extract, %	**79.7**	81.3	80.1
F/C difference, %	**0.8**	0.4	0.6
ß-Glucan, ppm	**59**	28	44
Viscosity, cps	**1.41**	1.41	1.40
Soluble protein, %	**4.93**	5.10	5.18
Ratio S/T, %	**43.3**	45.2	44.2
FAN, mg/L	**207**	226	217
Colour, ASBC units	**2.29**	2.24	2.33

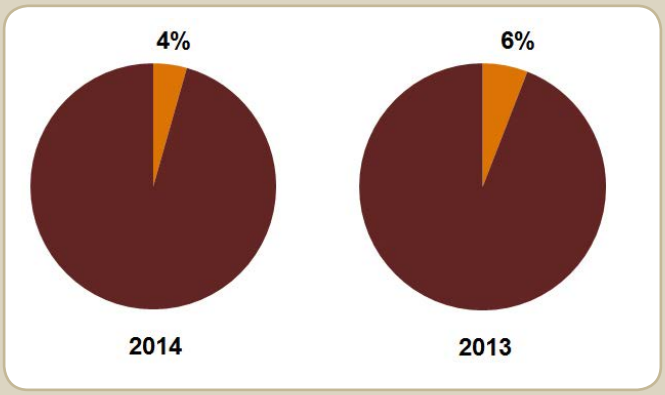
[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Does not necessarily represent amounts commercially selected

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

Legacy

Figure 1. Percentage of the total malting barley acres in Western Canada seeded to Legacy in 2013 and 2014



While acres planted to six-rowed malting barley are in decline, small amounts of Legacy barley continue to be grown and selected. Legacy's high enzyme package makes it ideal for high gravity or adjunct brewing.

Figure 2. Average protein content in Legacy selected for malting from 2010-2014

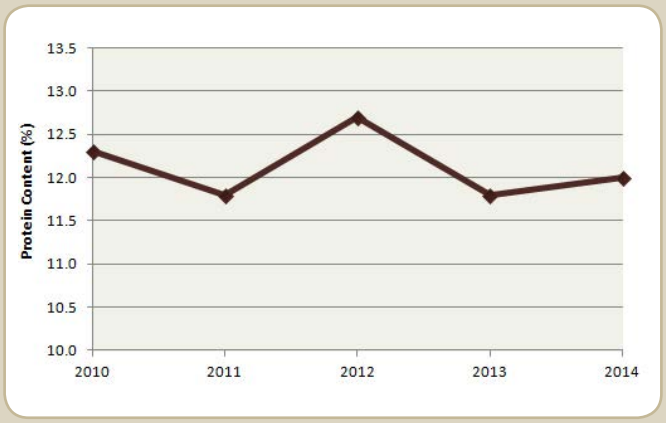


Figure 3. Average kernel weight of Legacy selected for malting from 2010-2014

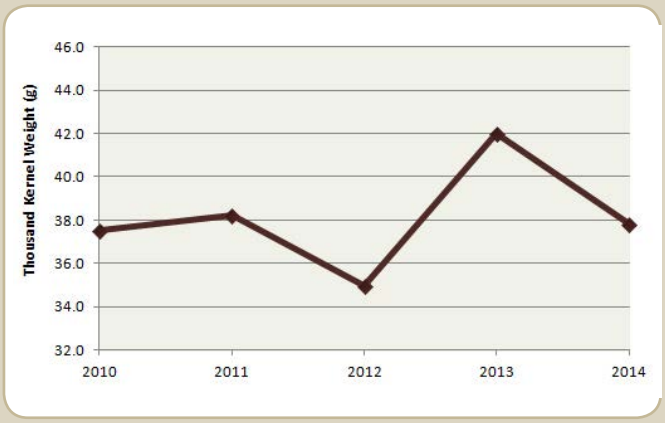


Figure 4. Comparison of average levels of extract by variety in 2014

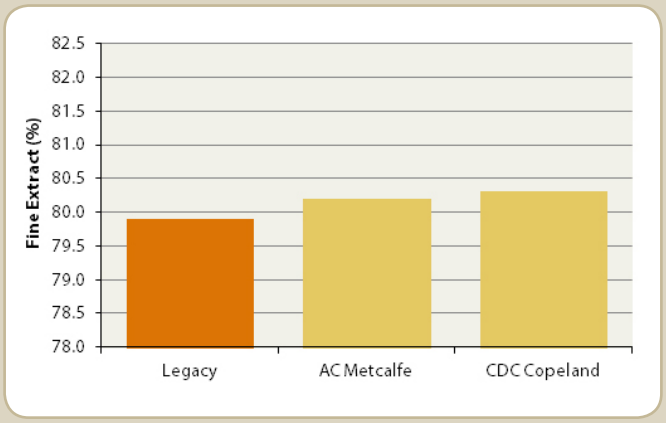


Figure 5. Comparison of average levels of diastatic power by variety in 2014

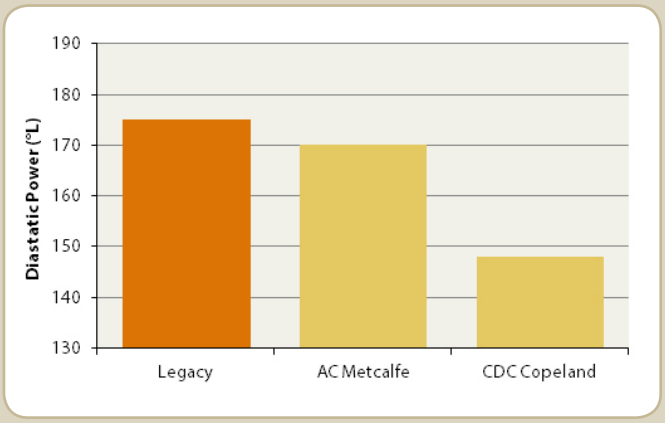


Table 3.6 Quality data for 2014 harvest survey composite samples of Legacy malting barley

Origin of selected samples	Saskatchewan / Alberta[1]		Prairie Provinces
Crop year	**2014**	2013	5 Year Avg
Thousands of tonnes[2]	**48**	3	40
Barley			
Test weight, kg/hL	**64.5**	67.3	64.7
1000 Kernel weight, g	**37.9**	42.0	38.4
Plump, over 6/64" sieve, %	**93.5**	95.9	92.5
Intermediate, over 5/64"sieve, %	**4.9**	2.6	5.4
Moisture, % [3]	**9.9**	12.5	11.5
Protein, %	**12.0**	11.8	11.9
Germination, 4 ml (3 day), %	**93**	96	97
Germination, 8 ml (3 day), %	**73**	91	79
Malt			
Yield, %	**91.1**	91.6	92.9
Steep-out moisture, %	**43.3**	44.3	45.5
Friability, %	**72.0**	72.3	72.0
Moisture, %	**5.1**	4.8	5.2
Diastatic power, °L	**173**	170	182
α-Amylase, D.U.	**69.8**	55.3	61.1
Wort			
Fine grind extract, %	**79.9**	80.2	79.2
Coarse grind extract, %	**78.8**	78.1	78.1
F/C difference, %	**1.1**	1.1	0.9
ß-Glucan, ppm	**296**	165	212
Viscosity, cps	**1.47**	1.48	1.45
Soluble protein, %	**5.49**	4.68	5.23
Ratio S/T, %	**47.9**	39.7	43.7
FAN, mg/L	**240**	213	221
Colour, ASBC units	**2.39**	2.62	2.33

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

[2] Does not necessarily represent amounts commercially selected

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

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 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 analyser calibrated by EDTA. Samples are ground on a UDY Cyclone Sample Mill fitted with a 1.0-mm screen. A 200-mg sample is analysed 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 gram sample of dockage-free barley is divided several times in a mechanical divider to obtain one representative 40g sub-sample. All foreign material and broken kernels are removed from one 40 gram 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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