



FCDC Malting Barley Breeding Program

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Freedom To Create. Spirit To Achieve.

Field Crop Development Centre



Government of Alberta ■
Agriculture and Rural Development

Breeding Methodology

Creating Variability



Breeding Methodology

Return to Homozygosity

- Modified bulk breeding program
 - Each year from the F_2 up to F_5 or F_7 several thousand plants are grown from each cross
- Pressure put on bulks to move them in desired direction
 - By head selections in F_3 California nursery
 - By screening over gravity table in other generations

Spreading Scald Infected Straw



Head selections in California

Breeding Methodology

Head Selection



- Head selections, 100 to 200 from each cross or population of about 8,000 plants OR a 2% selection rate.
 - Based on disease resistance, plant and head type only.

Breeding Methodology

Yield and quality evaluations



- Selected heads are grown out as F_6 - F_8 headrows
 - Approx. 5% selected
- Selected rows are advanced to yield tests
 - 1st year non-replicated
 - 2nd to 5th year multi-location replicated tests
 - Approx. 20% selected

Selection for malting quality in barley using NIRS

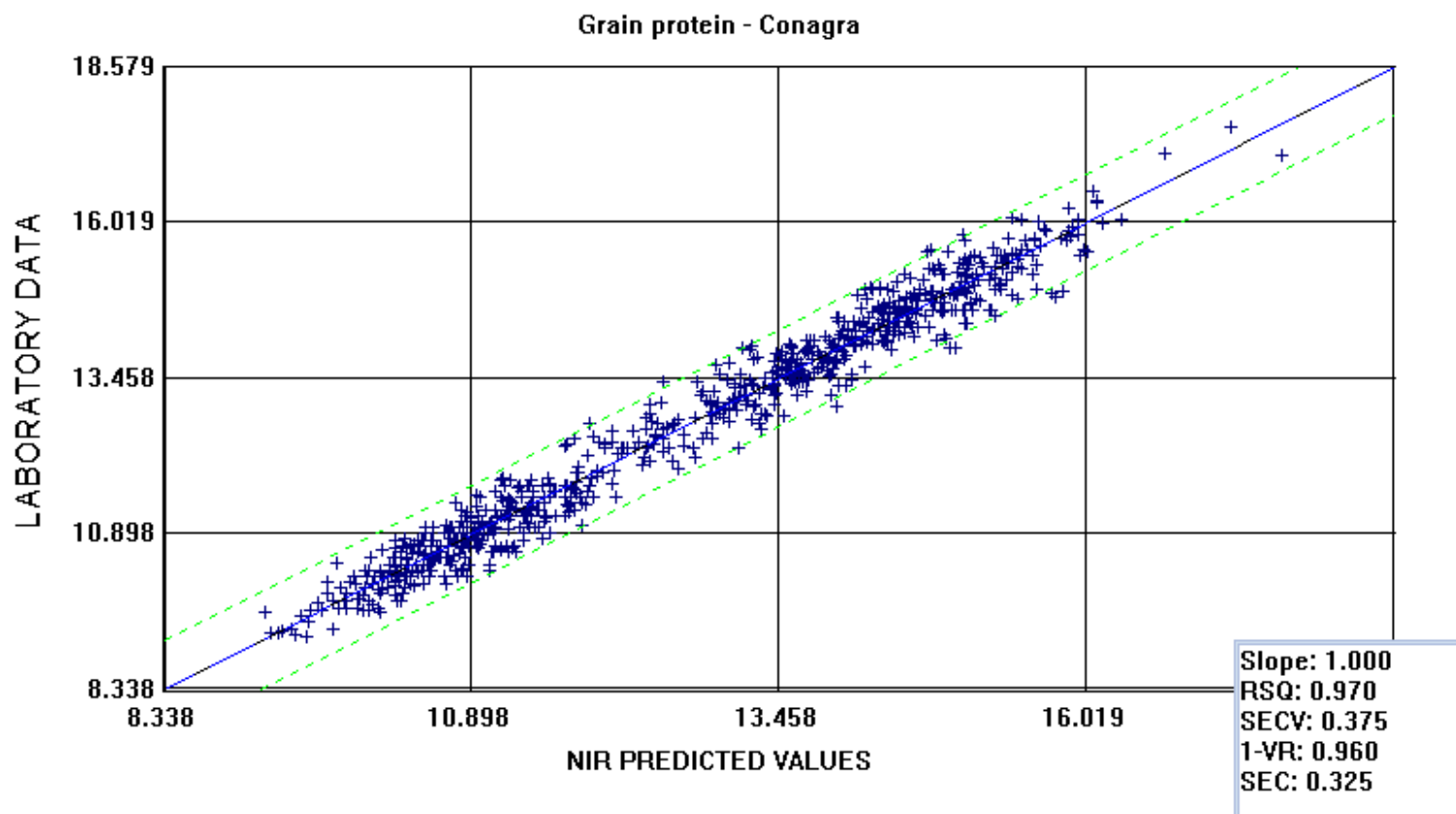


Quality Assessment using NIRS

Foss 6500



Barley Grain Protein – Canada Malting



Oatway, L. and J.H. Helm. 2007. Development of robust near infrared reflectance spectroscopy (NIRS) calibrations using genetic and environmental variation. 5th Canadian Barley Symposium. Winnipeg, MB.

Quality Assessment

- Food quality (grain)
 - Soluble fibre: pentosans, beta-glucans
- Feed quality (grain)
 - Protein
 - Starch
 - Protein digestibility (pig)
 - Energy content (pig)
- Malting quality
 - Malt extract
 - Malt protein: total, soluble
 - Enzyme activity: Diastatic Power, Alpha Amylase
 - Beta-glucan, viscosity
 - Friability, homogeneity, turbidity

Quality Assessment of Bentley and its sister lines in 2000 (non-replicated, one location)

Line	Protein	FE	DP	AA	Total Protein	Soluble Protein	S/T ratio	Beta-glucan	Friability	Homogeneity	Turbidity	Viscosity
H930103001	10.2	82.9	124	55.3	9.7	6.0	62	79	79	99	3.64	1.49
H930103002	10.7	82.9	118	53.3	10.1	5.6	55	113	75	96	4.26	1.50
H930103003	12.7	80.7	133	48.8	12.2	5.4	44	502	50	86	3.44	1.58
Bentley	12.5	81.5	124	49.6	12.0	6.1	51	258	58	88	2.59	1.53
H930103005	12.9	80.6	144	51.0	12.4	6.4	52	299	57	90	3.99	1.52
H930103006	11.5	81.2	116	49.3	11.2	6.0	54	200	63	92	4.04	1.46
H930103007	12.4	81.2	140	51.1	12.1	6.2	51	257	57	89	0.55	1.46
H930103008	12.6	80.9	141	52.7	12.2	6.4	52	397	49	86	0.46	1.53
H930103009	11.2	82.0	138	56.0	10.9	6.9	63	139	66	95	1.60	1.43
Harrington	13.0	79.5	134	54.3	12.5	6.7	54	541	50	85	1.71	1.52

NIRS predicted Malting Quality for Bentley and its sister lines from 2001 Lacombe and Trochu

NIRS Predicted Malting quality for H93103 sister lines from the 2001 Lacombe and Trochu

	Protein %	Fine Extract	DP	AA	Total Protein (Malt)	Soluble Protein (Malt)	ST ratio	B-Glucan (Malt)	Friability (Malt)	Viscosity	Homogeneity	Turbidity
Lacombe												
H93103002Y	12.6	79.9	161	52.8	12.1	4.6	38	376	49	1.55	84.1	3.6
H93103003Y	13.4	78.6	164	49.8	13.1	4.8	36	364	42	1.58	82.3	4.5
Bentley	13.0	78.7	165	52.4	12.7	4.6	36	383	42	1.58	84.0	4.1
AC Metcalfe	13.9	79.2	182	59.6	13.3	5.4	41	322	46	1.54	86.5	4.1
Harrington	13.4	79.0	172	61.7	13.1	5.6	43	428	48	1.57	83.7	3.8
Trochu												
H93103002Y	11.9	80.0	125	58.5	11.2	5.8	51	289	48	1.57	89.1	3.6
H93103003Y	12.7	78.6	138	52.1	12.3	5.2	43	308	43	1.63	86.5	3.6
Bentley	11.8	80.4	136	54.4	11.2	5.5	50	78	43	1.61	90.0	3.3
AC Metcalfe	11.9	81.1	156	57.6	11.3	5.5	48	162	50	1.60	93.3	2.9
Harrington	11.7	81.4	143	69.7	10.8	6.1	56	248	59	1.56	92.0	2.2

NIRS Predicted Quality for H93103 sister lines from 2002 Lacombe and Trochu

NIRS predicted quality for H93103 sister lines from the 2002 Lacombe and Trochu yield to

	Protein	Fine Extract	DP	AA	Total Protein	Soluble Protein	ST Ratio	B-Glucan	Friability	Viscosity	Homogeneity	Turbidity	Potential Skinning
Lacombe													
H93103002	12.6	78.9	169	33.6	15.2	4.9	32	342	53.3	1.50	81.9	5.44	55
Bentley	12.6	78.9	170	33.2	15.2	5.3	35	102	48.2	1.47	80.1	4.88	43
Harrington	13.3	78.4	169	37.3	16.1	5.4	34	241	49.9	1.53	80.5	4.97	50
AC Metcalfe	13.2	78.7	182	34.1	15.9	5.3	33	184	53.2	1.49	83.7	4.80	53
Trochu													
H93103002	11.4	79.0	148	32.2	13.4	3.1	23	418	60.5	1.52	83.8	4.88	63
Bentley	11.4	79.5	157	37.0	13.9	4.1	29	279	57.4	1.51	82.4	4.07	48
Harrington	12.7	78.7	161	41.9	15.5	5.3	34	284	49.6	1.54	80.1	3.71	50
AC Metcalfe	12.4	79.0	176	39.9	14.9	4.8	32	265	51.1	1.53	84.5	3.48	56

Wet chemistry for H9103 sister lines from Trochu and Calmar in 2003

Wet chemistry by Canada Malting Co. for H93103 sister lines from the Trochu and Calmar yield trials in 2003.

	%	As Is	Ext		Total	Sol.		Visc				Wort
Sample	Prot.	Extract	Db	Colour	Prot.	Prot.	S/T	osity	Friab.	DP	AA	B-Glu
<i>Trochu</i>												
H93103002	13.6	76.0	79.4	1.28	13.5	4.8	36	1.89	47.1	141	56.3	841
Bentley	12.7	76.9	80.6	1.11	13.0	4.8	37	1.71	51.8	135	52.8	651
Harrington	13.7	76.0	79.5	1.27	13.6	5.3	39	1.70	52.0	143	56.7	655
AC Metcalfe	13.4	76.6	80.3	1.28	13.5	4.8	35	1.62	44.1	144	59.7	478
<i>Calmar</i>												
H93103002	8.7	79.2	83.6	1.72	8.5	4.5	43	1.49	89.4	84	39.8	97
Bentley	9.2	80.3	83.3	1.32	9.0	4.0	45	1.53	86.9	76	43.5	256
Harrington	9.1	79.6	82.9	1.21	8.7	3.9	45	1.71	83.0	87	50.9	492
AC Metcalfe	9.3	79.8	83.4	1.51	8.8	4.3	49	1.49	91.9	96	54.1	101

Micro-malting quality for Bentley in 2005 and 2006 Coops

Malting quality data as presented in the 2005 and 2006 Western Cooperative Two Row Barley Registration Tables

		1000.0			Soluble	S/T	Diast.	Alpha-	Beta-			
	Plump	K. Wt.	Protein	F. Ext.	Protein	Ratio	Power	Amylase	Glucan	Viscos.	Friab	Peeled
	%	G.	%	%	%	%	°L	D.U.	ppm	cps	%	%
MEAN of Six Station Years												
Bentley	93.4	48.4	11.7	80.0	4.79	40.4	107	55.6	95	1.43	88.7	6.3
Harrington	89.2	42.9	11.9	79.7	4.92	41.3	115	56.8	111	1.45	90.0	9.4
AC Metcalfe	91.7	44.3	12.1	80.2	4.92	40.5	132	60.6	62	1.43	85.7	6.5
CDC Kendall	93.2	43.1	12.2	80.0	5.01	40.6	152	61.0	53	1.42	92.0	4.5

Micro-malting results from the 2006 and 2007 Collaborative tests

Malting quality data as presented in the 2007 Western Collaborative report.

	Plump	Protein	Barley P&B	Malt P&B	F. Ext.	Malt Protein	Soluble Protein	S/T Ratio	Diast. Power	Alpha- Amylase	Beta- Glucan	Viscosity	Friability
	%	%	%	%	%	%	%	%	°L	D.U.	ppm	%	%
2006-2007 Mean													
AC Metcalfe	94.8	12.3	3.2	7.7	80.8	11.8	5.04	43.0	153	65.9	175	1.47	79.6
Bentley	96.8	11.3	3.5	9.1	81.7	10.8	4.90	45.7	122	57.7	162	1.48	75.6
2006-2007 Standard Deviation													
AC Metcalfe	3.3	0.8	3.6	7.2	1.2	1.0	0.40	3.5	21	11.7	117	0.08	9.2
Bentley	1.3	1.0	2.9	8.7	0.8	0.9	0.46	4.3	19	14.2	96	0.12	11.9

H93103004 (TR05669) Registered as Bentley Two-Row Malting Barley



- Cross of a ND line (with Harrington and Bowman in its parentage) and TR229 (a Brandon line with AC Oxbow and Manley in its parentage) made in 1993
- Developed using traditional modified bulk breeding method
- Promoted due to malting quality combined with excellent yields and disease resistance

Summary

- NIRS can be used as an early generation screening tool to select for malting quality traits
- Our NIRS quality calibrations tend to predict high for malt beta-glucan, diastatic power and alpha-amylase, but are good for protein, extract, viscosity, homogeneity, turbidity
- Currently working on upgrading the malting quality calibrations with integration of Michael Edney's GRL malting quality from the John O'Donovan led project "Improvement of Malt Barley Quality and Seed Homogeneity through Optimization of Agronomic, Genetic, and Environmental Factors"

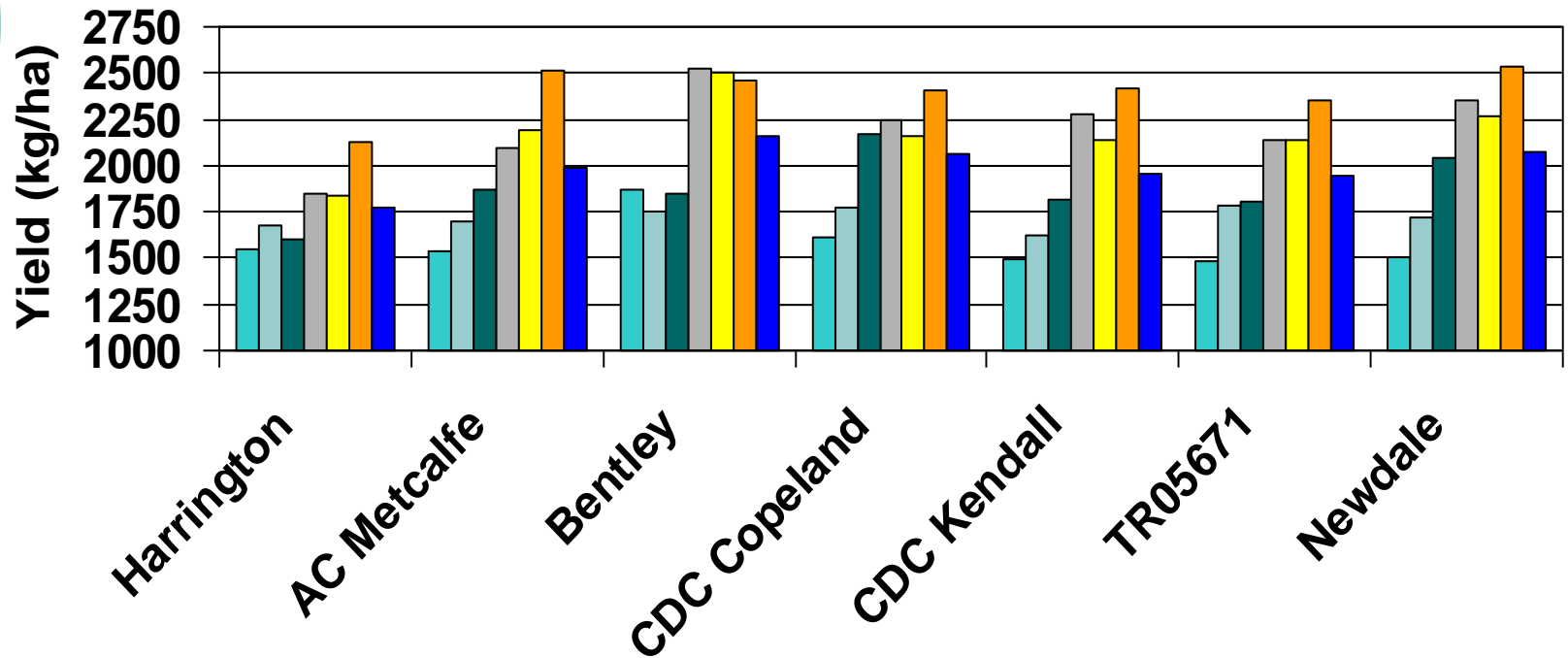
The Future

- Our needs:
 - to update calibrations
 - add new calibrations ie limit dextranase, FAN
 - Micro-Malting capacity for late generation material





2007 Yield data for malting varieties



Lacombe Low Fert

Morrin

Lacombe Late Seed

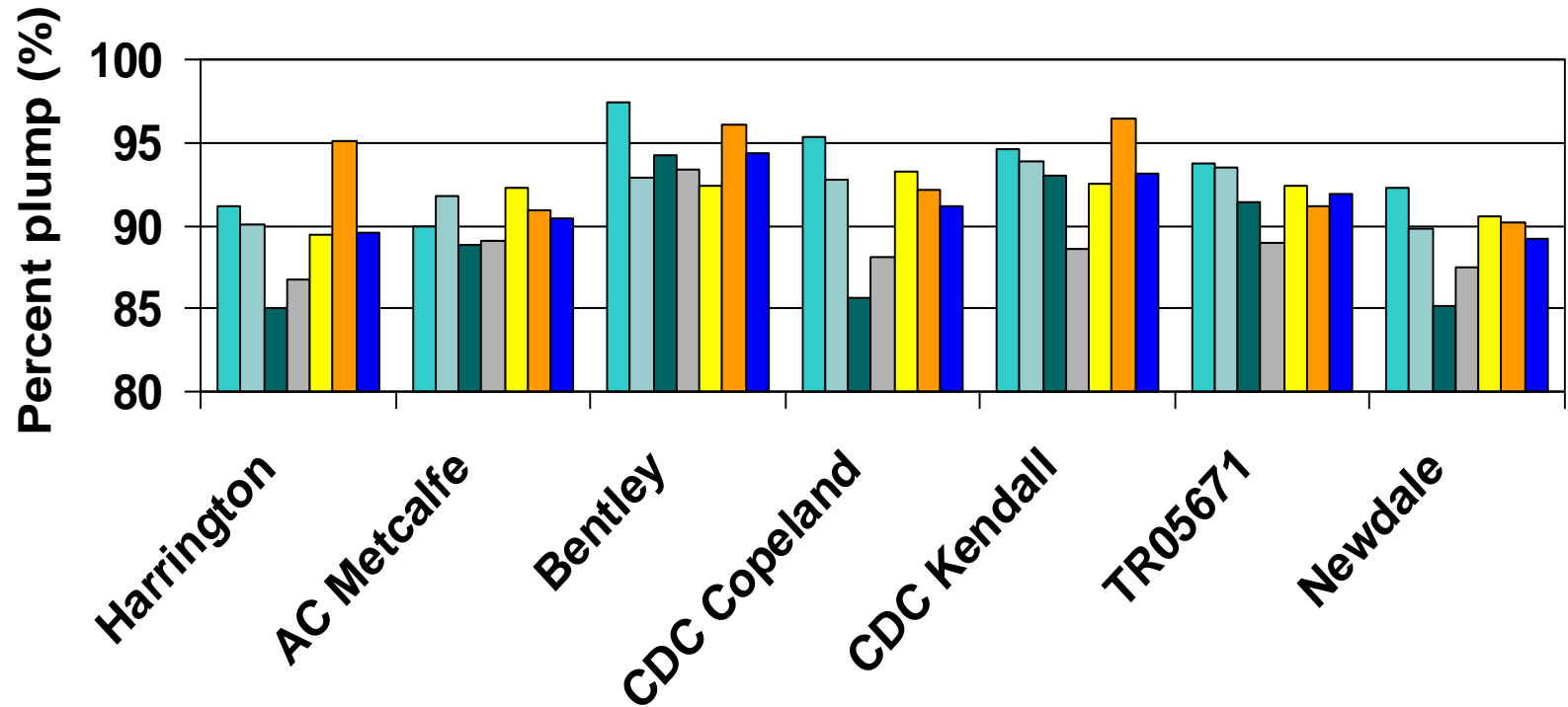
Lacombe Hi Fert

Calmar

Olds

Average

2007 Plump for malting varieties



Lacombe Low Fert

Morrin

Lacombe Late Seed

Lacombe Hi Fert

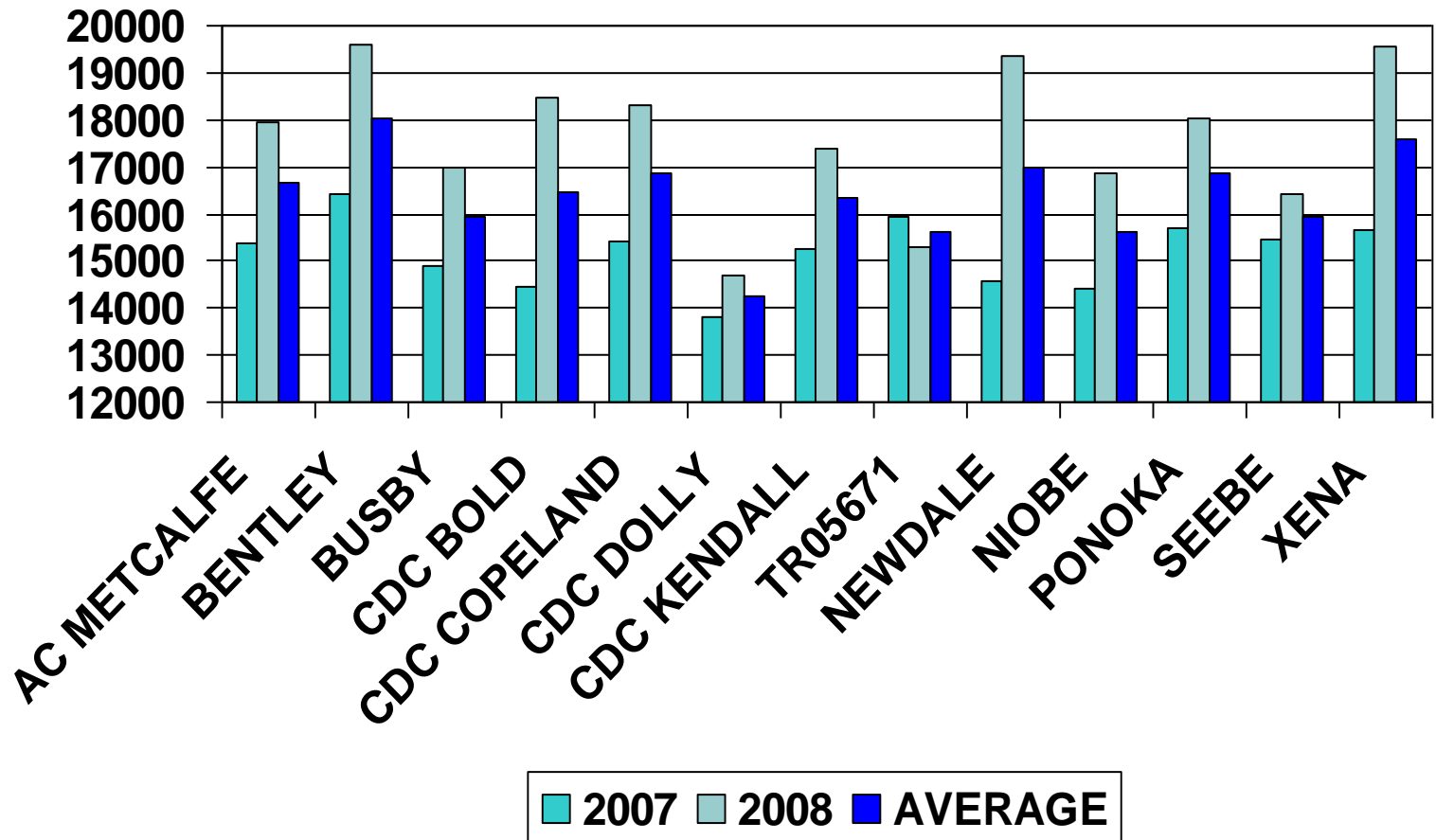
Calmar

Olds

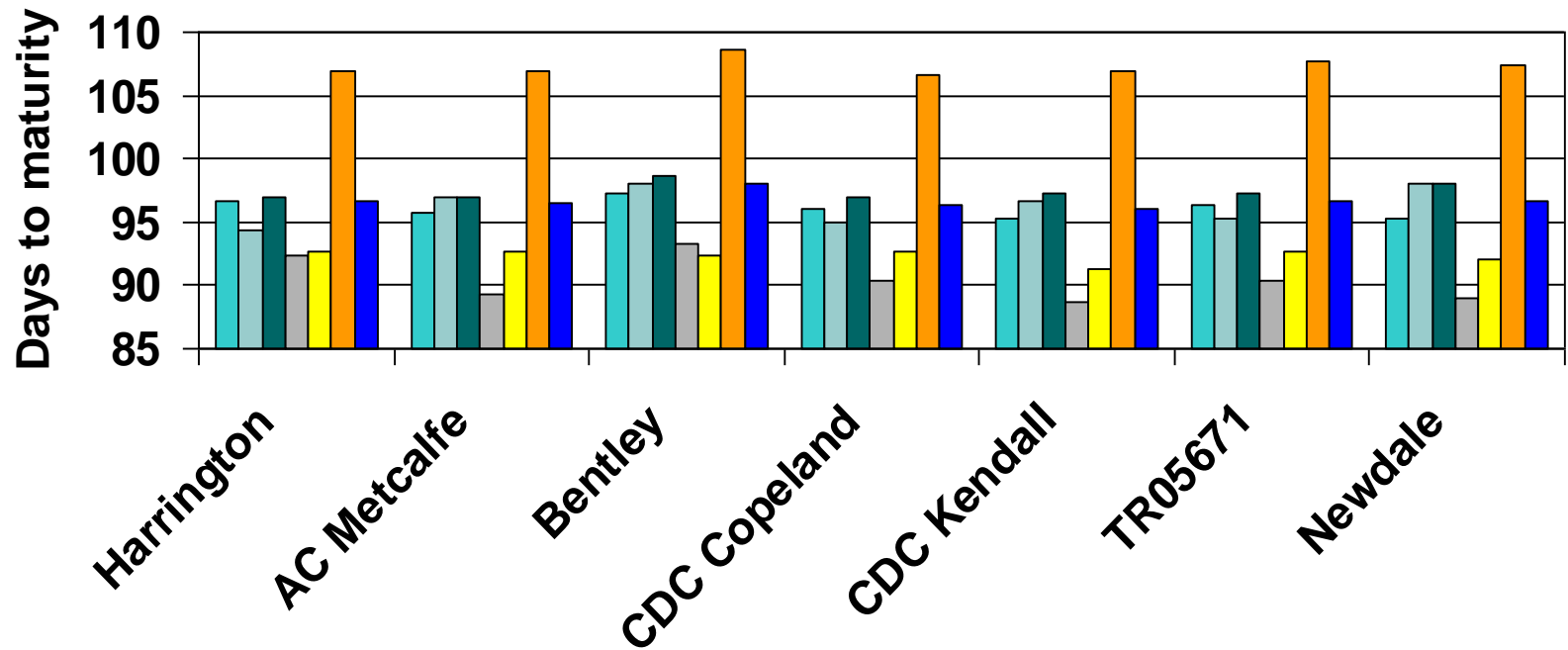
Average

Dry matter yields at Lacombe for 2007 and 2008

DM Biomass Yield (kg/ha)



2007 Maturity of malting varieties



Lacombe Low Fert

Morrin

Lacombe Late Seed

Lacombe Hi Fert

Calmar

Olds

Average



Bentley Two-Row Malting Barley

- 11% higher yielding than AC Metcalfe
- Similar maturity to Xena (1-2 days later than AC Metcalfe)
- Tall, but lodging resistance similar to Xena
- High test weight, kernel weight and percent plump
- 8% higher biomass yields than Virden, the six-row Coop check cultivar

Bentley Two-Row Malting Barley

- Disease resistance:
 - R to net blotch (spot), MR to spot blotch
 - MR to surface borne smuts, MS to loose smut
 - MR/MS to FHB, Stem rust, and common root rot
 - S to net blotch (net), scald, septoria, and BYD