High Moisture Canola in Bags
Final Report

Tom Boyle[1], Kim Stonehouse[1], Tiffany Martinka[2], Pat Flaten[3]
([1]Saskatchewan Ministry of Agriculture, [2]Canola Council of Canada, [3]Saskatchewan Canola Development Commission)

July, 2010

High Moisture Canola in Bags
Final Report

Tom Boyle[1], Kim Stonehouse[1], Tiffany Martinka[2], Pat Flaten[3]
([1]Saskatchewan Ministry of Agriculture, [2]Canola Council of Canada,
[3]Saskatchewan Canola Development Commission)

Problem:
Weather conditions during the cropping season of 2009 were such that Saskatchewan crops were delayed in development from establishment and through to fall. Fall harvest, particularly canola, was pushed into October and eventually November. Unusually snowy, wet and cool conditions in October resulted in pressure to harvest canola at much higher than usual moisture contents during that month. Moisture contents of canola were reported at 15-22%, much of which was not actually measureable by usual instruments. By November 1st, 80% of the canola remained in swath. Given that canola is considered 'dry' and therefore 'safe to store' at 10% or less moisture content, there was much concern about how to safely store Saskatchewan's record canola crop. By early November, unusually sunny, warm and dry weather allowed the harvest to restart and canola dried somewhat in the field, allowing most of the canola to be harvested, much still at greater than 10% but most at less than 13% moisture, so storage continued to be a concern.

Some producers were tempted to use bag storage given rumors that canola would store better there than in bins. Bag storage was also viewed to have advantages due to their portable nature and providing time and labor efficiencies during a high pressure season. No known data had been published to support the perceived effectiveness of bags. A group of interested individuals and organizations came together to take the opportunity to monitor some of the canola storage bags in north-central Saskatchewan. The goal was to gain knowledge as to the potential value of storing canola in bags.

Partnering Agencies
Staff of the Saskatchewan Ministry of Agriculture (Tom Boyle as project lead and Kim Stonehouse), SaskCanola (Pat Flaten), Prairie Agricultural Machinery Institute (Phil Leduc, Les Hill), Canola Council of Canada (Tiffany Martinka), and Bunge (Terry Slusar, Rick Cherepuschak) combined resources to devise a protocol, monitor temperatures and quality parameters and report results.

Method/protocol:
Provincial and Canola Council staff contacted potential producers within the Humboldt, Prince Albert, Kinistino and Tisdale areas with canola in bags and chose sites at which to monitor temperatures on an ongoing basis. Nineteen bags were targeted and complete information was obtained for 11 of those bags. On larger bags (12000 bu) more than one monitoring site was chosen as temperatures were thought to differ along the bag. Spots on the bag were chosen on the side but closer to the top, as there is less chance for the bag to split and less chance for canola to spill out. The chosen area was wiped down with

a rag to make sure that it was free from any moisture or dirt. Once clean, bag tape (or 'TUCT Tape') was applied to the sampling spots prior to puncturing with probe. Three strips of about 12 inch lengths ensured that the area was secured and would not split from the puncture hole. The probes used are essentially a thermocouple with multimeter (thermocouple reader) and a 5 foot rod with one foot markers and a sharp point on the end which can be used to puncture through the tape and bag. Slowly pushing and angling the probe through the middle of the taped area, and pointing towards the center of the bag meant that the middle of the bag was the sampling target, about four feet to centre. Probes were left in the bag for 2-3 minutes usually to allow the thermocouple temperature to equilibrate. After reading temperature, the probe was removed and more tape strips were applied over the original tape. Upon return for repeated monitoring, the second layer of tape was removed to access the original access hole.

Figures 1 & 2. Use of temperature probe.

As time permitted, bags were monitored twice per week, then less often as temperatures either stabilized or cooled. Canola samples were taken at or close to time of filling and emptying, then were tested by Bunge for moisture, dockage, green seeds and damage (See Appendix B). Green and damaged seed was not a significant issue for these samples, as seen in the canola quality data. Due to lengthy storage of canola samples prior to moisture testing, this data is not shown. Maximum air temperatures were gathered from Environment Canada for the days that bags were monitored.

Results and Interpretation:

Canola temperatures decreased relatively well, given elevated moisture contents (see Figures 3 and 4 below and Appendix A1-3 for detailed data). Given that all of these monitored bags were filled in November, air temperatures were relatively cool (2-16°C during November), which would have been helpful for maintaining or cooling the canola. At another time of the year, such as September or October, when air temperatures are normally much warmer, it may have been much more difficult to cool these bags down. In Figure 4, Bag 1 was monitored until spring and canola temperatures also rose with increasing air temperature.

Figure 3. Changes in Canola Temperature vs. Time for Five Storage Bags (Humboldt sites)

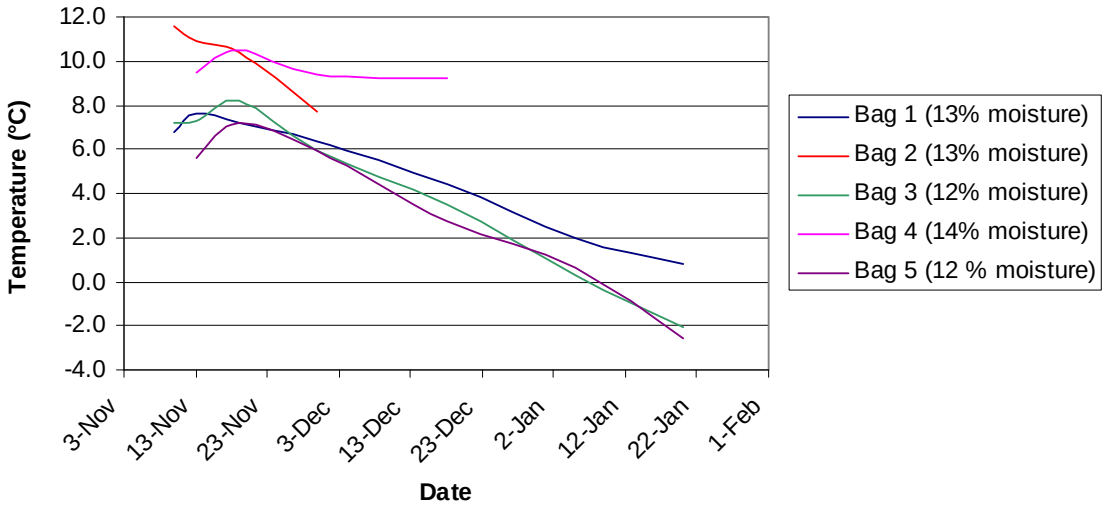
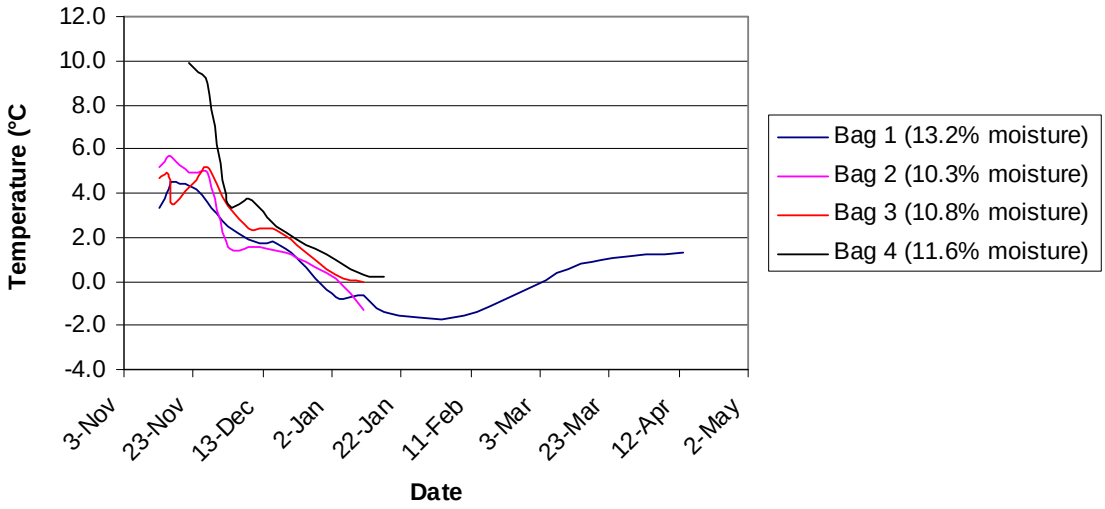
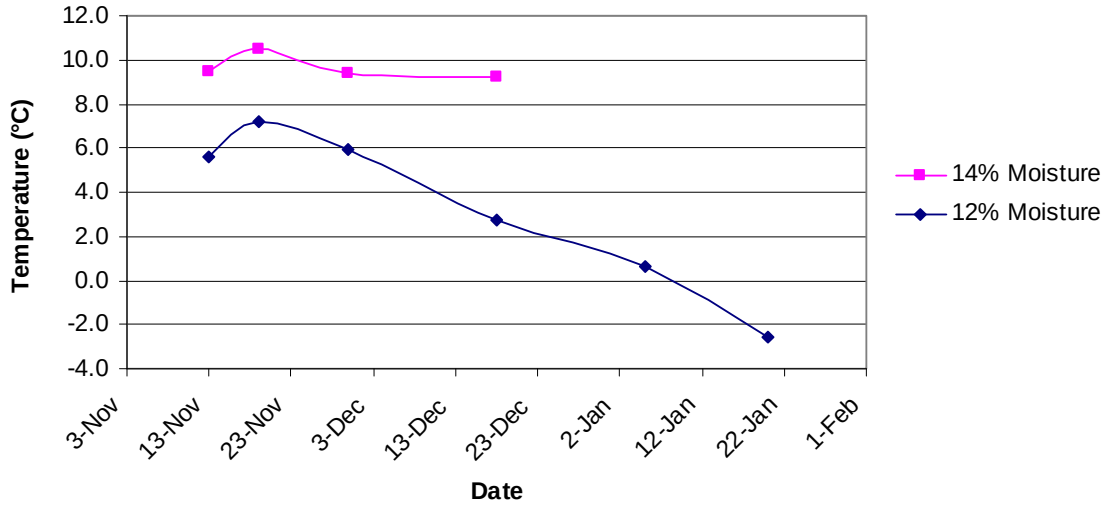


Figure 4. Changes in Canola Temperature vs. Time for Four Storage Bags (Prince Albert and Kinistino sites)



In all cases with this project, when canola temperatures were seen to either increase or remain constant, the producer moved the canola for sale or drying, so as to avoid spoilage. In particular, two side by side bags with 12 and 14% moisture contents provide an indication of the difference in behavior at the two moisture contents (Figure 5). The producer, in fact, separated the two quantities of canola because of the differences in moisture contents, a wise decision, given the higher moisture canola did not decrease in temperature to the same degree and therefore was moved before it became a problem.

Figure 5. Changes in Canola Temperature vs. Time for Two Storage Bags at Two Moisture Contents (Humboldt site)



It is well known that harvest conditions change dramatically within a single day. Therefore, storage conditions will reflect this and when heated pockets develop within any storage facility, it may be due to a number of factors, one of which may be moisture content differences.

In order to get more information about how moisture conditions change within a bag, data was taken from at least 2 points within any single bag. At the Humboldt sites, 2 points within a bag were monitored and that data was averaged for the graphs. However, Tisdale, Prince Albert and Kinistino data were taken at six to eight points along the bag, given different conditions at time of combining and filling the bag. The Tisdale data, shown in Figures 6 and 7, shows examples of data from two bags with 6-8 points along each bag. In one case, the temperature at one location along the bag was as much as 7°C warmer than other sites within the same bag (Figure 6) and the producer moved this canola shortly thereafter.

Figure 6. Changes in Canola Temperature vs. Location in Bag 1 (Tisdale site)

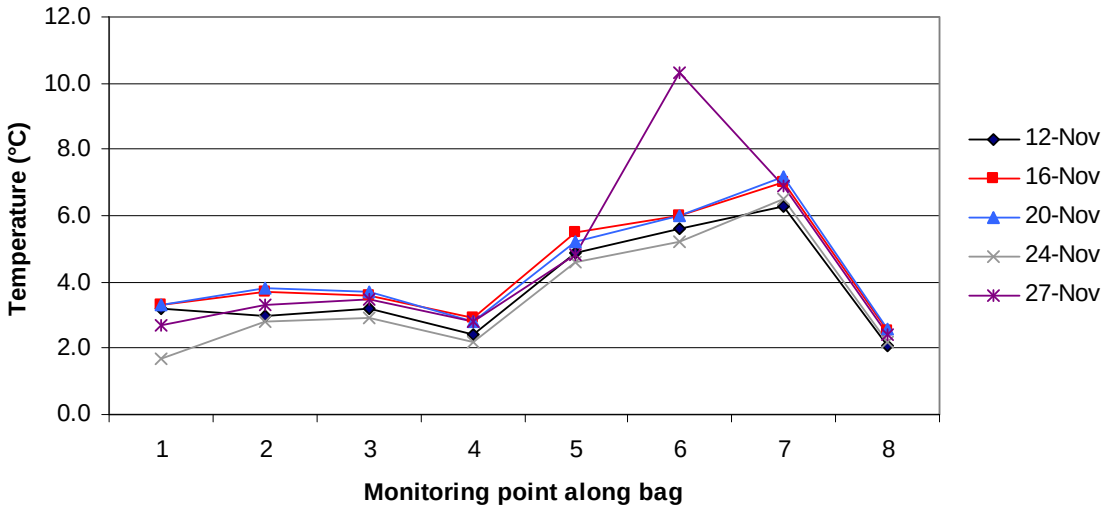
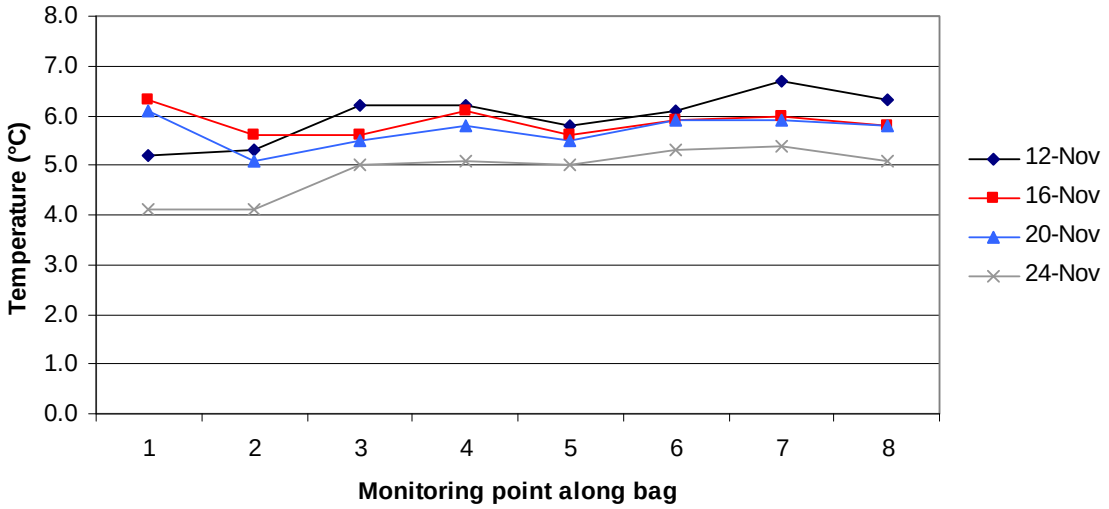


Figure 7. Changes in Canola Temperature vs. Location in Bag 2 (Tisdale site)



Of note, some bags were riddled with bird damage (especially ravens), often early in the storage period if there was one hole, there were often many holes. Other bags were not affected at all.

Recommendations:
Although the controls and monitoring in this project was not as intense as some of the upcoming research that will be done on canola storage, the project was useful for discovering more about the use of grain storage bags and confirming many previously known recommendations:

- All storage options require monitoring of temperatures, at least twice per week until temperatures stabilize or decrease to safe levels.
- Record-keeping: recording temperatures will offer some insight into the temperature trends and provide valuable information on which to base decisions for moving and drying all crops. When filling a bag, make notes, even on the bag itself, as to the field location, filling times, grain and air conditions. This may also guide monitoring points within the bag.
- All storage options require monitoring of several locations within the volume of grains or oilseeds, given the potential for differences in quality of grains or oilseeds within a given container. For storage bags, monitoring every 25 feet may be adequate. One might also consider monitoring conditions towards the bottom of the bag. One should not assume similar conditions among multiple bags nor for an entire single bag.
- Given the flexibility of volumes which can be contained in storage bags, there may be worthwhile advantages to separating grains or oilseeds based on qualities such as moisture content or dockage to reduce the risk of spoiling larger quantities of product in a large single container.
- Cool air temperatures at time of combining and storage are of tremendous value to prolonging safe storage of canola.

Future Needs:
There are needs for detailed research to provide further information to compare bin and bag storage of canola as well as revisit recommendations, given the increasing oil content of new canola varieties. Fortunately, within the past 12 months, funding for several canola storage research projects has been awarded by the Saskatchewan Ministry of Agriculture, Agriculture and Agri-Food Canada, SaskCanola, the Manitoba Canola Growers Association, Alberta Canola Producers Commission and the Canola Council of Canada.

Acknowledgments:
Thank you to all who participated in this project in all aspects:

- Canola producers who participated directly in the project by asking the questions and volunteering their canola bags for the project
- Saskatchewan Ministry of Agriculture for supporting staff participation in project leadership, field activity and reporting results
- Bunge for providing moisture and grading of canola samples
- Canola Council of Canada for supporting staff input and monitoring of bags
- PAMI for participating in the discussion of protocols and providing temperature probes
- SaskCanola for willingness to provide financial support, coordination and reporting

Appendix A1. Canola Temperatures in Bags, Humboldt sites.

			Temperature (°C)		
			Site within bag		
Bag #	Date	Ave % Moisture	1	2	Air Temp
1	6-Nov-09	13	Fill		16.0
	10-Nov-09		6.8		9.6
	13-Nov-09		7.6		3.0
	19-Nov-09		7.2		5.6
	30-Nov-09		6.4		2.2
	17-Dec-09		4.4		-7.0
	5-Jan-10		2.0		-11.5
	18-Jan-10		0.8		-1.0
	29-Jan-10		Empty		
2	6-Nov-09	13	Fill		16.0
	10-Nov-09		6.9	11.6	9.6
	13-Nov-09		6.1	10.9	3.0
	19-Nov-09		6.4	10.4	5.6
	30-Nov-09		5.3	7.7	2.2
	4-Dec-09		Empty		-12.5
3	9-Nov-09	12	Fill		7.0
	10-Nov-09		5.8	7.2	9.6
	13-Nov-09		4.8	7.3	3.0
	19-Nov-09		5.8	8.2	5.6
	30-Nov-09		4.1	5.9	2.2
	18-Dec-09		2.1	3.5	-7.0
	5-Jan-10		-0.5	0.3	-11.5
	21-Jan-10		-2.0	-2.1	-4.5
	19-Apr-10		Empty		
4	7-Nov-09	14	Fill		12.0
	13-Nov-09		9.5	2.0	3.0
	19-Nov-09		10.5	3.2	5.6
	30-Nov-09		9.4	3.5	2.2
	18-Dec-09		9.2	1.5	-7.0
	22-Dec-09		Empty		-9.0
5	7-Nov-09	12	Fill		12.0
	13-Nov-09		5.6	2.4	3.0
	19-Nov-09		7.2	3.6	5.6
	30-Nov-09		5.9	2.5	2.2
	18-Dec-09		2.7	-0.3	-7.0
	5-Jan-10		0.6	-1.4	-11.5
	20-Jan-10		-2.6	-3.6	-4.0
	1-Mar-10		Empty		

Appendix A2. Canola Temperatures in Bags, Prince Albert and Kinistino sites.

			Temperature (°C) Site within bag						
Bag #	**Date**	**Ave % Moisture**	**1**	**2**	**3**	**4**	**5**	**6**	**Air Temp**
1	11-Nov-09	13.2			Fill				
	13-Nov-09		2.7	3.2	2.9	2.8	4.2	4.2	2.9
	17-Nov-09		7.0	5.6	1.5	1.6	5.4	6.0	11.6
	24-Nov-09		6.6	5.8	1.6	0.3	5.3	5.3	2.2
	3-Dec-09		4.8	4.7	1.8	0.8	0.2	2.7	-9.0
	9-Dec-09		2.7	4.6	0.4	0.8	0.7	2.4	-20.0
	17-Dec-09		2.6	3.8	0.5	0.8	0.6	2.0	-9.0
	23-Dec-09		1.8	3.0	-0.8	0.7	0.0	1.8	-12.4
	3-Jan-10		-2.0	1.0	-3.3	1.0	-2.1	1.0	-11.4
	11-Jan-10		-1.7	0.8	-2.4	0.0	-1.2	0.8	0.4
	17-Jan-10		-2.4	-0.1	-2.8	-0.4	-2.2	-0.2	-3.7
	9-Feb-10		-2.2	-1.0	-2.6	-0.8	-2.4	-0.4	-14.4
	16-Feb-10	13			1/2 empty				
	11-Mar-10		1.0	0.8	0.0	0.5	0.2	0.8	2.7
	24-Mar-10		1.4	1.0	1.0	1.1	1.0	0.8	-6.4
	13-Apr-10		1.6	1.4	1.2	1.2	1.4	1.1	6.2
2		10.3			Fill				
	13-Nov-09		2.8	2.4	7.2	5.3	6.9	6.4	2.9
	16-Nov-09		4.4	3.4	8.7	4.0	7.7	5.7	9.5
	18-Nov-09		2.6	3.0	7.0	8.0	6.6	6.2	10.7
	22-Nov-09		1.6	2.8	6.1	6.8	6.0	6.1	3.5
	27-Nov-09		2.8	3.6	5.7	6.2	5.3	6.1	3.4
	3-Dec-09		1.6	1.1	0.5	2.5	1.4	2.0	-9.0
	9-Dec-09		2.9	1.4	1.5	1.9	0.3	1.4	-20.0
	17-Dec-09		2.3	1.2	0.5	2.2	0.2	2.0	-9.0
	23-Dec-09		2.0	1.0	-0.1	1.8	0.0	1.4	-12.4
	3-Jan-10		-0.7	1.1	-1.2	1.0	-0.4	1.1	-11.4
	11-Jan-10		-3.1	-0.4	-2.6	0.2	-1.9	-0.1	0.4
					Empty				
3		10.8			Fill				
	13-Nov-09		4.3	4.2	6.1	6.2	3.7	3.4	2.9
	16-Nov-09		4.7	3.8	6.8	5.6	4.6	3.4	9.5
	18-Nov-09		3.0	2.7	4.6	5.0	2.8	3.0	10.7
	22-Nov-09		5.7	4.6	4.6	5.1	2.4	3.0	3.5
	27-Nov-09		4.2	4.3	3.2	5.8	7.8	5.8	3.4
	3-Dec-09		4.6	4.7	3.8	5.2	1.1	1.0	-9.0
	9-Dec-09		1.0	2.2	1.6	3.6	2.8	3.1	-20.0
	17-Dec-09		1.1	2.4	1.4	3.6	2.5	2.8	-9.0
	23-Dec-09		0.1	2.0	0.9	3.0	1.4	2.4	-12.4
	3-Jan-10		-0.2	1.2	-0.9	1.7	-1.0	1.1	-11.4
	11-Jan-10		-1.4	2.2	-1.3	0.6	-1.2	0.7	0.4
					Empty				
4		11.6			Fill				
	22-Nov-09		13.3	11.6	9.6	8.7	8.6	7.4	3.5

27-Nov-09	13.8	11.4	7.9	7.3	7.2	6.3	3.4
3-Dec-09	6.0	5.7	2.5	2.3	1.6	3.0	-9.0
9-Dec-09	7.1	6.5	1.0	2.1	2.3	3.4	-20.0
12-Dec-09	6.5	6.0	2.1	1.8	2.0	1.4	-30.1
17-Dec-09	4.4	4.8	0.2	2.0	1.0	2.7	-9.0
11-Jan-10	0.9	1.5	-0.3	0.3	-1.4	0.6	0.4
17-Jan-10	1.7	2.6	-1.4	0.4	-2.1	-0.1	-3.7
			Empty				

Appendix A3. Canola Temperatures in Bags, Tisdale sites.

			Temperature (°C) Site within bag								
Bag #	**Date**	**Ave % Moisture**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Air Temp**
1	11-Nov-09	14.0					Fill				5.2
	12-Nov-09		3.2	3.0	3.2	2.4	4.9	5.6	6.3	2.1	3.1
	16-Nov-09		3.3	3.7	3.6	2.9	5.5	6.0	7.0	2.5	8.5
	20-Nov-09		3.3	3.8	3.7	2.8	5.2	6.0	7.2	2.6	6.7
	24-Nov-09		1.7	2.8	2.9	2.2	4.6	5.2	6.5	2.2	-0.8
	27-Nov-09		2.7	3.3	3.5	2.8	4.8	10.3	6.9	2.4	2.6
	4-Dec-09						Empty				-12.2
2	8-Nov-09	14.0					Fill				4.5
	12-Nov-09		5.2	5.3	6.2	6.2	5.8	6.1	6.7	6.3	3.1
	16-Nov-09		6.3	5.6	5.6	6.1	5.6	5.9	6.0	5.8	6.5
	20-Nov-09		6.1	5.1	5.5	5.8	5.5	5.9	5.9	5.8	6.5
	24-Nov-09		4.1	4.1	5.0	5.1	5.0	5.3	5.4	5.1	-0.2
	25-Nov-09						Empty				0.8
3	15-Nov-09	11.3					Fill				3.1
	11-Dec-09		0.9	1.5	1.7	1.5	0.5	0.5	4.1	2.3	-19.5
	22-Dec-09		0.3	1.3	0.9	0.8	-0.3	0.6	1.2	1.0	-12.2
	3-Feb-10						Empty				-11.9
4	15-Nov-09	12.3					Fill				3.1
	6-Dec-09		1.5	2.0	2.6	2.8	3.0	3.3			-13.2
	16-Dec-09		0.6	1.5	1.6	1.7	1.4	0.2			-11.7
	22-Dec-09		-2.3	-0.6	0.3	1.1	1.4	1.2			-12.2
	13-Jan-10						Empty				0.8
5	10-Nov-09	11.5					Fill				9.6
	6-Dec-09		-0.1	1.6	2.6	3.7	5.5	5.3			-13.2
	16-Dec-09		-0.2	1.2	2.2	3.0	3.9	3.8	3.9		-11.7
	23-Dec-09		1.0	1.7	2.5	2.8	3.3	3.8	3.7		-11.9
	9-Feb-10						Empty				-13.4
6	11-Nov-09	12.1					Fill				5.2
	6-Dec-09		0.6	1.8	2.0	1.8	1.3	0.6			-13.2
	16-Dec-09		2.3	2.5	2.2	2.4	1.9	0.6			-11.7
	22-Dec-09		-0.9	0.1	0.5	0.7	1.1	0.3			-12.2
	9-Feb-10						Empty				-13.4
7	12-Nov-09	12.7					Fill				3.9
	7-Dec-09		5.3	4.9	4.2	4.8	4.0	1.8			-18.1
	22-Dec-09		3.7	3.9	3.9	3.8	3.3	1.8			-12.2

	13-Jan-10					Empty					0.8
8	16-Nov-09	10.1				Fill					9.7
	11-Dec-09		5.5	5.2	4.0	4.2	4.8	5.6	6.4	8.8	-19.5
	23-Dec-09		2.7	2.8	1.7	1.9	2.0	1.9	0.8	0.7	-11.9
	3-Feb-10					Empty					-11.9
9	16-Nov-09	9.8				Fill					9.7
	11-Dec-09		6.0	6.7	8.3	6.1	5.5	4.4			-19.5
	23-Dec-09		3.8	4.7	4.8	5.3	5.5	2.2			-11.9
	3-Feb-10					Empty					-11.9
10	15-Nov-09	11.2				Fill					3.1
	11-Dec-09		1.3	0.1	2.5	1.5	1.2	0.5	0.6	0.6	-19.5
	22-Dec-09		-2.1	-2.1	0.3	0.7	0.3	0.0	-0.6	-0.6	-12.2
	3-Feb-10					Empty					-11.9

Appendix B. Canola quality data.

Area	Time of Sample	Bag #	Dockage (%)	Green (%)	Damaged (%)
Humboldt	Initial	1	1.2	0.2	0.2
Humboldt	Initial	2	1.5	0.2	0.2
Humboldt	End	2	1.5	0.2	0.2
Humboldt	Initial	3	1.8	0.2	0.2
Humboldt	End	3	2.4	0.2	0.2
Humboldt	Initial	4	0.8	0.2	0.2
Humboldt	End	4	1	0.2	0.2
PA, Kinistino	Initial	1	2.6	0.2	0.2
PA Kinistino	Initial	2	4.9	0.2	0.2
PA Kinistino	Initial	3	1.4	0.4	0.4
PA Kinistino	Initial	4	2.1	5	0.4
Tisdale	End	1	2.6	0.2	0.2
Tisdale	Initial	2	0.6	0.2	0.2
Tisdale	End	2	0.9	0.2	0.2
Tisdale	Initial	3	1.8	0.2	0.2
Tisdale	End	3	1.7	0.2	0.2
Tisdale	Initial	4	1.4	0.2	0.2
Tisdale	Initial	5	2.2	0.2	0.2
Tisdale	End	5	2.4	0.2	0.2
Tisdale	Initial	6	1.9	0.2	0.2
Tisdale	Initial	7	1.6	0.2	0.2
Tisdale	Initial	8	5.6	0.2	0.2
Tisdale	End	8	4.3	0.2	0.2
Tisdale	Initial	9	3.4	0.2	0.2
Tisdale	End	9	4	0.2	0.2
Tisdale	Initial	10	1.9	0.2	0.2
Tisdale	End	10	2	0.2	0.2