Irrigated Corn Production in Saskatchewan

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Abstract

Two hundred and twenty five site years of irrigated corn production experience, is analyzed here for the years 2000, 2001, 2002, 2003, 2004, and 2005. The leaf tissue nutrition and field agronomy of all sites are documented at anthesis. Cob development factors, yields, and grain quality was assessed by mid September. Whole plant silage and/or dry matter stover, for grazing was analyzed. Over twenty varieties of the newest corn genetics are also included in this study. A strong working relationship was established with Alberta and Manitoba during the course of this corn research. On the basis of the results from this study, it was concluded that a meaningful data base and foundation for agronomic recommendations, to irrigated corn producers has been established.

Discussion and Results

Corn (*Zea Mays L.*) is an "energy production" crop. The combination of superior feed energy, yield response and genetic traits makes corn a valuable crop to both Saskatchewan dairy and beef producers. For over thirty years Manitoba Corn Growers (Figure 1) have competed to demonstrate the progress in grain corn productivity. Through the 70's and early 80's a 140 bushel per acre corn crop could win the championship. Now in the late 1990's and twenty-first century, 200 bushels per acre is achieved. Most Manitoba growers will tell you that their corn yields have also increase about 50% in the same period. The highest yield ever recorded was in 1998 at 252.61 bushels per acre by Ken and Merley Wiebe of Morden, Manitoba. The Saskatchewan corn grain industry is very small in most years, however optimizing the grain fraction is essential in all successful corn silage or grazing enterprises. Saskatchewan corn production has stepped into the 21st Century based on this agronomic improvement.

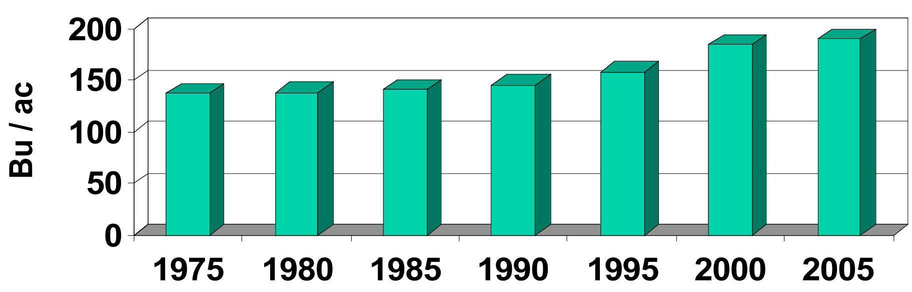

Figure 1. Manitoba Corn Winners median yield

The Irrigation Crop Diversification Corporation (ICDC) sponsored and annually reviewed the progress of this irrigated corn project. The corn project was partnered over six years with eight dairies, six ranchers and five beef feedlots. All were experienced irrigated corn growers and were collectively willing to invest 225 site years, to this research project.

The Saskatchewan Corn Day Planner (Appendix 1) focuses grower attention to the vegetative and reproductive stages of development. Assessment of corn grain maturity and bushel weight at September 10th (Figure 2) was of prime interest to our research. For example, the bushel weight minimum standard for the distilling industry is 56 pounds per bushel. The test weight concept accounts for the increasing density of the corn kernel during its development which is impacted by the environment and production practises. 2001 and 2003 were above average for bushel weight, while 2004 and 2005 were below average for most Saskatchewan corn growers, both at September 10th and their corn silage harvest.

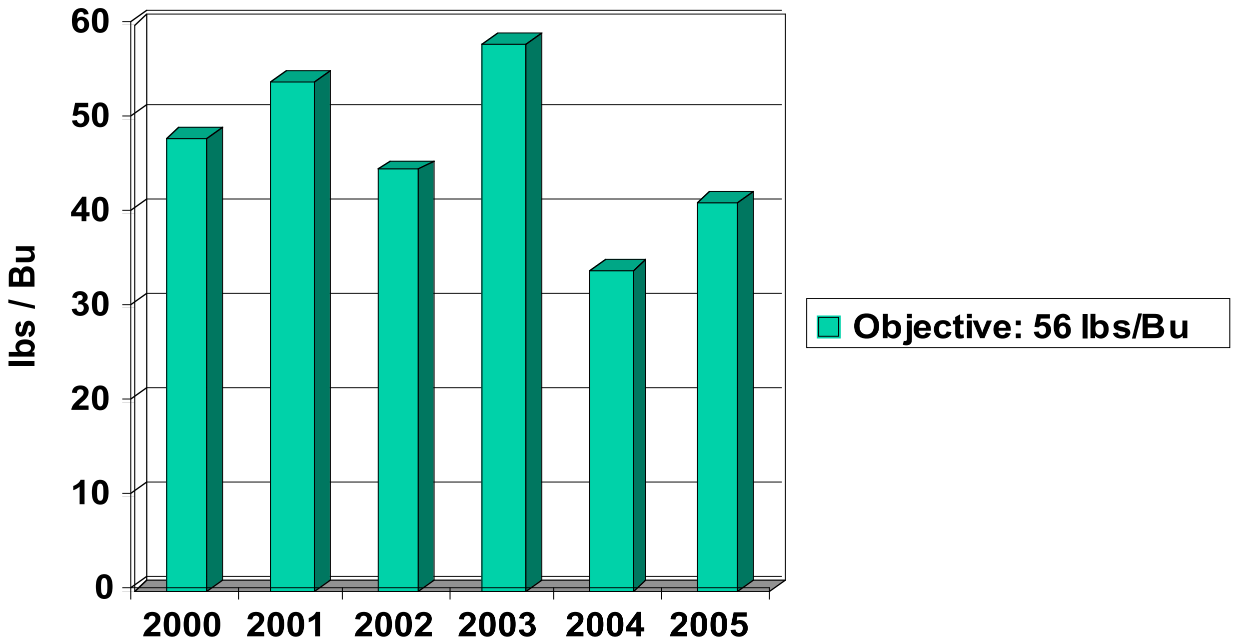

Figure 2. Saskatchewan Corn Bushel Weight on Sept. 10th.

Variability of average development (Figure 3) is essentially described by measuring the Acid Detergent Fibre (ADF) expressed as percent Total Digestible Nutrients (TDN). Our bushel weights were calculated from 225 samples ranging between 8 and 10% kernel moisture. TDN reached 85 to 87% at maturity, and through the dough and dent stage, the average increase was about a quarter percent TDN per one pound bushel weight and per calendar day of growth. This linear incremental yield/quality increase equation demonstrates an $R^2 = 0.8608$. Figure 3 demonstrates a higher confidence curve.

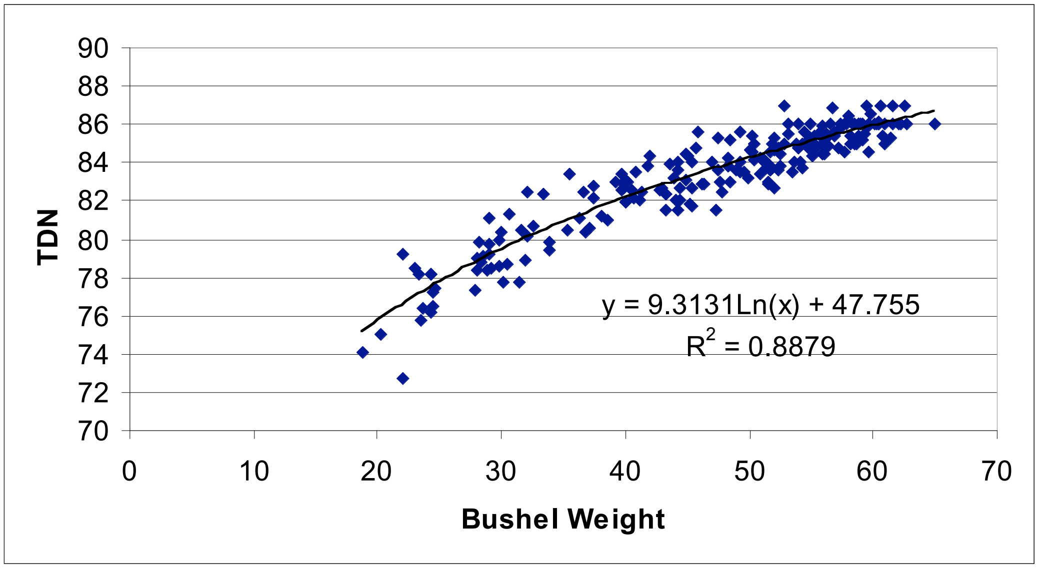

Figure 3. Corn Grain TDN (225 site years). For every pound of bushel weight increase, TDN increases about a quarter percent.

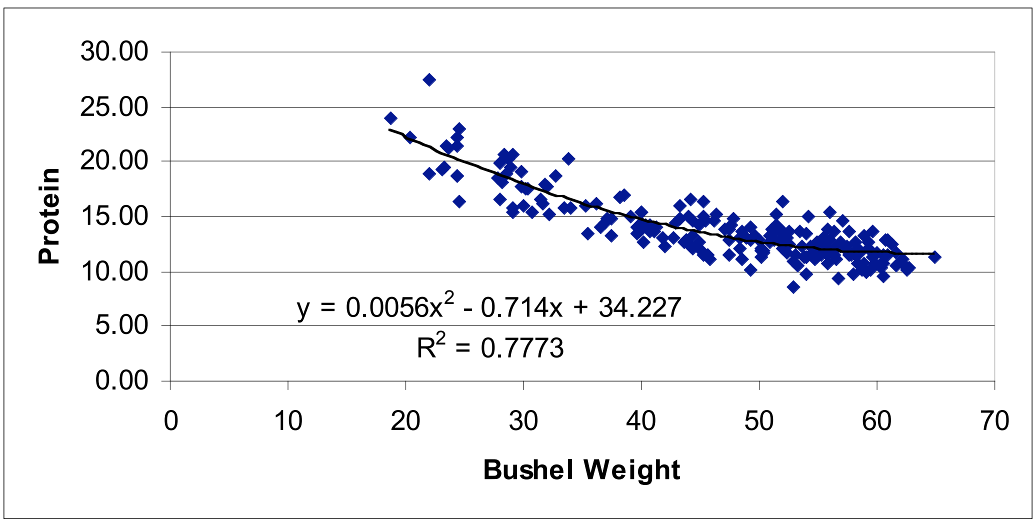

Figure 4. Corn Grain Protein (225 site years). For every pound of bushel weight increase the CP decreased about a quarter percent.

Mature corn grain is relatively low in crude protein (CP) content. A second development chart (Figure 4) shows the starch and sugar as it dilutes the existing protein fraction. CP decreases to 10 to 12% at maturity and through the dough and dent stage the average is about a quarter percent decrease per one pound bushel weight increase and per calendar day of growth. This near static presences of CP does reflect the incremental energy yield/quality increase. The linear CP to bushel weight equation demonstrates an $R^2 = 0.7252$. Figure 4 shows a higher confidence curve.

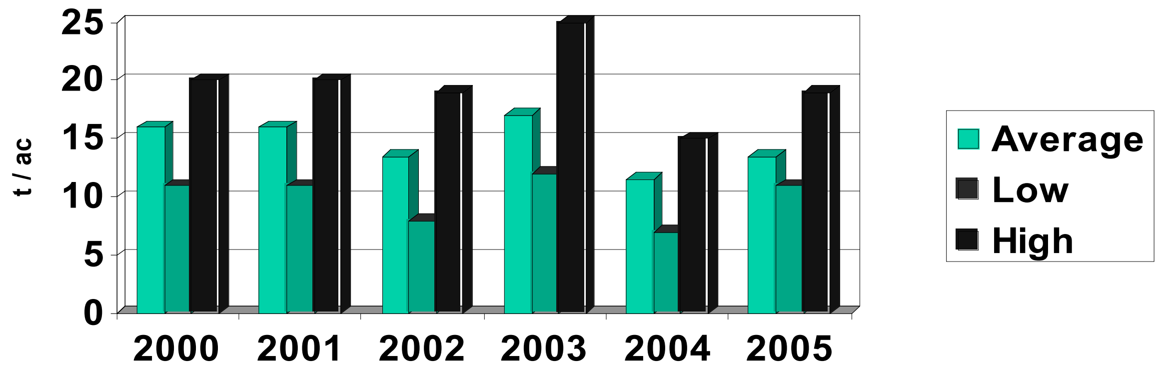

Figure 5. Corn Silage Yield (adjusted 65% moisture content)

Saskatchewan's irrigated corn silage dry matter yield (Figure 5) has an average of 5.25 t/ac as reported by irrigators. This is 17.5 t/ac at a field chopped at 70% moisture content (MC) or commonly adjusted in storage to 15 t/ac at 65%MC or if commercially traded may be adjusted to 13 t/ac at 60%MC. The difference is only water. The grain fraction in 5.25 t/ac corn dry matter equals 90 bushels per acre of kernel corn. The irrigators that regularly exceed 20 t/ac of corn silage on a portion of their corn produce 7.0 t/ac of dry matter containing a 120 bushel per acre grain fraction. The downside is adequate for delayed vegetative stands that never carried enough large cobs or lacked development of bushel weight.

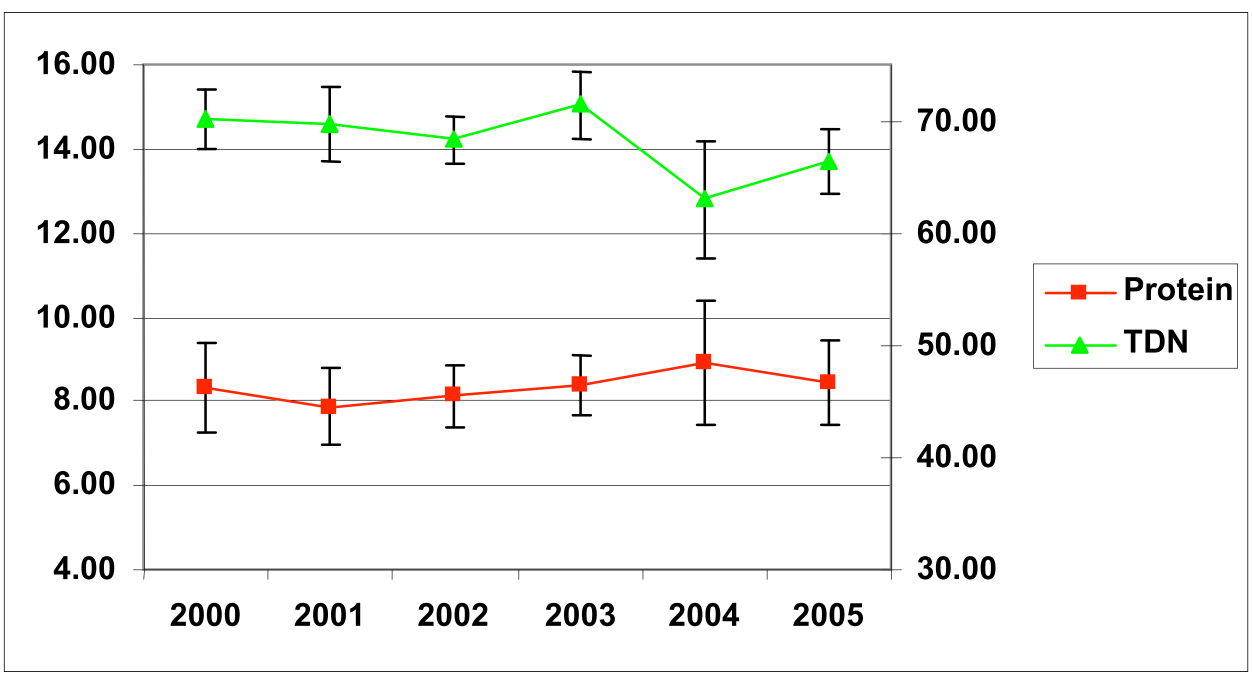

Figure 6. Corn Silage Quality (error bars of one StDev)

Corn silage quality (Figure 6) is termed "Making Good Corn Silage". Harvesting corn too wet (low dry matter content) results in silage nutrient seepage and reduced animal intake. The Kernel Stage system and the Corn Heat Unit system are not reliable guides for timing harvest. Whole plant moisture is the only definitive measurement. Corn silage preserved between 30 and 40% dry matter (60 to 70% MC) can provide good silage fermentation and animal performance. The optimal dry matter content varies with the type of silage storage structure. Kernel processing is essential to reduce the silage particles size and increase the starch digestibility were kernel development has reached or past the dent stage.

In this six year study, corn quality exceeded the normal barley quality range in every year, except 2004. Yes, 2004 was a great barley year even for corn. The error bars of one standard deviation show realistic objectives for Saskatchewan corn silage at 70% TDN and 8% CP.

Detailed analysis (Table 1) of the annual corn silage crop conveys the observed variability. Corn silage presents mineral nutrition challenges. The potassium level is low and the annual variability is high. Ensure adequate potassium is available in high corn silage rations. Calcium and magnesium are also low compared to common legumes and grasses. Phosphorous levels are highly responsive to the organic matter as well as the fertilizer and manure management on the host field. Sodium flags increased salinity and sodicity of the irrigation water or potential soil structural problems in some areas of the host field. Corn is responsive to higher levels of nitrogen availability in August and September. Nitrates are commonly observed in the green chopped corn silage. The ensiling process converts 30 to 50% of the nitrate to other nitrogen compounds including silo gas. The safe nitrate level (Table 1) of 0.12 is tested previous to fermentation. Over 200 nitrate tests in six years, 3% or 6 samples tested between 0.35 and 0.50% nitrate, and would be recommended for retests after the fermentation was complete.

Table 1. Typical Corn Silage from Saskatchewan Irrigation Farms

Corn Silage		Protein (%)	Energy TDN (%)	Nutrients (%)					Nitrate (%)	NDF (%)	ADF (%)	N
				Na	P	K	Ca	Mg				
2000	**Ave**	**8.31**	**70.18**	**0.02**	**0.21**	**1.27**	**0.22**	**0.20**	**0.11**	**47.53**	**26.69**	**20**
	StDev	1.07	2.70	0.01	0.06	0.32	0.07	0.04	0.10	4.74	2.63	
2001	**Ave**	**7.86**	**69.65**	**0.02**	**0.26**	**1.51**	**0.23**	**0.24**	**0.10**	**48.70**	**27.14**	**36**
	StDev	0.91	3.37	0.04	0.07	0.34	0.06	0.04	0.09	3.13	3.16	
2002	**Ave**	**8.12**	**68.33**	**0.02**	**0.21**	**1.00**	**0.15**	**0.18**	**0.16**	**52.08**	**28.36**	**45**
	StDev	0.73	2.11	0.02	0.04	0.18	0.05	0.03	0.10	2.76	1.95	
2003	**Ave**	**8.38**	**71.40**	**0.01**	**0.24**	**1.23**	**0.19**	**0.22**	**0.12**	**43.58**	**25.50**	**39**
	StDev	0.72	3.02	0.01	0.08	0.30	0.05	0.06	0.11	3.89	2.83	
2004	**Ave**	**8.92**	**62.96**	**0.01**	**0.25**	**1.53**	**0.19**	**0.22**	**0.10**	**56.94**	**33.40**	**34**
	StDev	1.48	5.21	0.01	0.06	0.52	0.07	0.04	0.11	6.42	4.87	
2005	**Ave**	**8.42**	**66.37**	**0.01**	**0.23**	**1.16**	**0.20**	**0.22**	**0.13**	**53.88**	**30.23**	**39**
	StDev	1.01	2.94	0.01	0.04	0.22	0.05	0.05	0.11	4.63	2.75	
Total	**Ave**	**8.34**	**68.15**	**0.02**	**0.23**	**1.29**	**0.20**	**0.21**	**0.12**	**50.45**	**28.55**	**6**
	StDev	0.35	3.07	0.00	0.02	0.20	0.03	0.02	0.03	4.80	2.87	

In Table 1, the TDN was calculated based on the ADF. This may not be the best way of estimating TDN since a large portion of the energy comes from the grain. Approximately 45% of the energy comes from the starch in the grain, 25% from the digestible portion of the Neutral Detergent Fibre (NDF), cellulose and hemicellulose, the remaining 30% comes from other sugars, pectin, organic acids, CP and fat. The grain has a small amount of ADF, so as the grain portion increases, it will dilute down the ADF which will increase the TDN in our table. This is a more indirect method of estimating TDN. The objective for Saskatchewan corn silage is to contain less than 28% ADF and less than 50% NDF.

Fall and winter corn grazing is the fastest growing crop use in Saskatchewan. Pregnant beef cows receive an adequately maintained diet and with good management, gain body condition throughout December and January. Cattle grazing on corn have the advantage of initially consuming moderately wet forage resembling corn silage. The kernels may still be at 20% MC but the rest of the plant parts can average over 50% MC in November. The actual dry down is highly variable, but can take till February for the whole plant to dry to 25% MC. Whole plant grazing starts on corn plants that have not been chopped and processed but contain 68% TDN and 8% CP. The cow's initial rumen efficiency can be low and should take a couple of weeks to improve. First the cows will immediately take all the cobs off the corn stalks. The cob material averages 80% TDN and 10.5% CP. What remains is stalks and stover that averages 54% TDN and less than 7% CP plus all the nitrate problems in that original plant. The period of time that cows remain grazing stalks and stover (past the first two days) becomes problematic. Modern electric fence systems favour smaller paddocks that can be grazed in two or three days. The Saskatchewan objective for corn winter grazing is 600 cow days per acre, costing $300.00 per acre and expressed as herd wintering at $0.50 per cow per day. Conventional herd wintering costs average $1.25 per cow per day.

Summary

Great corn crops are built one day at a time. Saskatchewan's irrigated corn is a one hundred and thirty day plus marathon (Appendix 1) from emergence (VE) to optimum. The first seventy days develops the factory. The warm environment plus the irrigator's precision planting, fertility placement, weed control and moisture management make every day count. From silk stage (R1) to the last sixty days deliver, through reproduction, the quality and quantity of grain energy. Much of the corn plant's nutritional requirement is still being imported during August and September. About two tonnes of dry matter or six tonnes per acre of corn silage yield is added in a frost free month of September. The new early varieties reported on **www.albertacorn.com** are the answer.

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Appendix 1

Saskatchewan Corn Day Planner

Day #	CHU	Date							Days to Maturity
			Seed at 8C Soil Temp						
		12 May	Seeding Complete, 12 days to Emergence						
134	Start	15 May			Competition Risk				139
143	175	24 May	VE	Emergence					130
					Drought Risk				
181	725	01 Jul	V6	6th Leaf					92
207	1400	27 Jul	VT	Tasseling	Frost Risk				66
212		01 Aug	R1	Silk					61
223		12 Aug	R2	Blister	>30% Loss				50
232		21 Aug	R3	Milk		Kernal Moisture			41
							Silage Moisture		
241	2000	30 Aug	R4	Dough		70	80		32
					>20%				
253		11 Sep	R5	Dent	Loss	52	75		20
263		21 Sep		Half Milk Line	>10% Loss	40	70	Silage	10
272	2300	30 Sep	R6	Black Layer		32	66	Kernel Processor	1
287		15 Oct				25	60		
300		28 Oct				22		Combine	

Assumptions: You receive 2300 CHUs on Sept 30 and seeded a 2300 CHU variety.
Where you expect less than 2300 CHUs, seed an appropriate earlier variety to match this planner. Delayed planting impacts your quality/yield risk and dictates switching to an earlier corn variety.
Protect the your downside with Crop Insurance. **Revised March 2006**