

A Demonstration of Corn Silage Yields Under High Fertility Conditions

Project Identification

1. **Project Title: A Demonstration of Corn Silage Yields Under High Fertility Conditions**
 2. **Project Number:**
 - 20190437
 3. **Producer Group Sponsoring the Project:**
 - Saskatchewan Forage Council
 4. **Project Location(s):**
 - Site 1 – Outlook, SK, RM of Rudy No. 284, LLD NW 11-31-7 W3, cooperating landowner was Dennis Fuglerud
 - Site 2 – Yorkton, SK, RM of Calder No. 241 LLD NE 8-26-30 W1, Cooperating landowner was Jason Becker.
 - Site 3 – Denzil, SK, RM of Grass Lake, LLD NW 36-38-26 W3. Cooperating landowner was Byron Clarke.
 5. **Project start and end dates (month & year):**
 - The project was started in April of 2020 and completed in October of 2020
 6. **Project contact person & contact details:**
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Objectives and Rationale

7. **Project objectives:**
 - The objective of this project was to demonstrate the yield potential of corn for silage when fertility levels are not limiting. Currently there are no provincial recommendations for corn fertility in Saskatchewan
 8. **Project Rationale:**
 - Availability of land is the number one issue restricting cattle producers from expanding in Saskatchewan. The idea behind this project was to demonstrate the yield potential corn has under a high fertility regime. Corn has the ability to far out yield other forage options if managed properly and therefore produce more feed than any other crop. Corn can assist in growing productivity of a cattle operation even when land base is held constant.
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Methodology and Results

9. **Methodology:**
 - This project took place at one irrigated site (Outlook) and two dryland sites (Yorkton, Kindersley). Each site had a soil test completed in the spring of 2020. Fertilizer application rates were based upon industry standards using a combination of current soil nutrient levels and crop removal rates. The following chart illustrates the nutrient removal of different yields of corn silage (source:AG phd nutrient removal app)

ton/acre	n	p	k	s
12	116.4	37.2	87.6	13.2
16	155.2	49.6	116.8	17.6
20	194	62	146	22
24	232.8	74.4	175.2	26.4
28	271.6	86.8	204	30.8

- Three treatments were setup at each location. Each treatment was 6 to 8 acres in size. At the dryland sites (Yorkton, Kindersley) the three treatments included a check (15 ton/acre yield goal) and two higher fertility treatments (18 and 21 ton/acre yield goals). At the Outlook (Irrigated) site the treatments included a check (20 ton/acre yield goal) and two higher fertility treatment (24 and 28 ton/acre yield goal). Fertilizer at the Outlook site was applied in split applications including a broadcast application incorporated prior to seeding and also fertigation during the growing season. Fertilizer at the Yorkton site was also applied in split applications including a deep banding application prior to seeding followed by liquid fertilizer applied by high clearance sprayer at the the 4-6 leaf stage. Fertilizer at the Denzil site was applied by deep banding prior to seeding.
- The Outlook site was seeded on May 18th. The variety used was Pioneer P7527am which is a 2150 crop heat unit variety. The following table illustrates the total fertility and cost per acre at the Outlook site.

Yield Goal tons/acre	Nitrogen lbs/acre	Phosphorous lbs/acre	Potassium lbs/acre	Sulphur lbs/acre	Cost/Acre
20	182.66	50	50	10	\$144.10
24	235	80	120	16	\$210.79
28	275	104.6	175	20.9	\$258.58

- The Yorkton site was seeded on May 11th. The variety used was Pioneer P7202am which is a 2050 crop heat unit variety. The following table illustrates the total fertility and cost per acre of the Yorkton site.

Yield Goal tons/acre	Nitrogen lbs/acre	Phosphorous lbs/acre	Potassium lbs/acre	Sulphur lbs/acre	Cost/Acre
15	151	50	60	0	\$156.66
18	185.54	50	60	0	\$178.40
21	218.6	50	60	0	\$199.360

- The Denzil site was seeded on May 15th. The variety used was Pioneer P7527am which is a 2150 crop heat unit variety. The following table illustrates the total fertility and cost per acre of the Denzil site.

Yield Goal tons/acre	Nitrogen lbs/acre	Phosphorous lbs/acre	Potassium lbs/acre	Sulphur lbs/acre	Cost/Acre
15	131	50	12	16	\$96.33
18	160	50	60	0	\$178.40
21	218.6	50	60	0	\$199.360

- Tissue sampling and satellite imagery were used during the growing season but both provided little value to the project. The tissue sampling showed minimal differences between treatments while the satellite imagery did not show any distinct difference between treatment areas.
- At the Outlook site the yield monitor on the forage harvester was used to determine yields. At the Yorkton site clippings were taken from each treatment to determine yields while the the Denzil site loads of silage from measured areas were used to determine yields. The Outlook site was harvested on October 1, the Yorkton site was harvested on September 22nd and the Denzil site was harvested on September 20th.

10. Results

- The parameters of this project that we collected were rainfall and crop heat units, forage yield and forage quality and an economic analysis was completed for each site.
- Outlook Site
 - i. Precipitation at the Outlook site was not limiting to corn growth. 12 inches of irrigation was applied during the growing season as well as the crop received 8.3 inches of rainfall. Crop heat units received during the 2020 growing season equalled 2260. This is below the long term average of 2381. The Yorkton site received 9.4 inches of rainfall and experienced hot dry weather in July. It is believed this negatively effected yield. Total crop heat units received during the 2020 growing season were 2168. This is slightly above the long term average of 2160. The Denzil site received 8.25 inches of rainfall and also experienced a severe hail storm which effected yield. Total crop heat units received during the 2020 growing season were 2048. This is below the long term average of 2211.
 - ii. Satellite imagery gathered throughout the growing season measured normalized difference vegetation index (NDVI). NDVI is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether or not the target being observed contains live green vegetation. Satellite imagery did not show any patterns consistent with treatment areas and was determined to have been of little value for this project. NDVI imagery tended to show soil deviations and topographical changes at all locations.
 - iii. Forage Yield and Quality – Outlook

Forage yield of the normal fertility treatment at the Outlook site yielded 18.52 tons per acre of wet silage. The mid fertility treatment yielded 19.4 tons per acre of wet silage with the high fertility treatment yielding 20.08 tons of wet silage. An early frost terminated the crop at Outlook on September 8th. At the time of the frost the corn had not started filling the kernels and this had a huge impact on potential yield of this trial. It was interesting to note we did see an increase in yield as we increased fertility but it is estimated that the frost cut final yield approximately 25%. The high fertility plots had the best nutrient profile with 67.68 % total digestible nutrients (TDN). Protein was also the highest at 9.11% while neutral detergent fibre (NDF) was the lowest at 46.76%. The low NDF indicates that the high fertility treatment had the most to gain if a longer growing season would have been the reality for 2020.

Treatment	Yield Tons/acre (adjusted to 65% moisture)	Total Digestible Nutrients	Protein %	Neutral Detergent Fibre
Normal Fertility (Check)	1	65.26	7.13	50.64
Mid Fertility (18 Ton Yield Goal)	19.40	64.42	7.97	52.12
High Fertility (21 ton Yield Goal)	20.08	67.68	9.11	46.76

Forage Yield and Quality – Yorkton

Forage yield of the normal fertility treatment at the Yorkton site yielded 18.3 tons per acre of wet silage. The mid fertility treatment yielded 12.45 tons per acre of wet silage with the high fertility treatment yielding 11.71 tons of wet silage. An early frost

terminated the crop at Yorkton on September 8th. At the Yorkton site the co-operator applied liquid nitrogen at the 4-6 leaf stage. This application burnt the crop and it is believed that is why are highest yielding treatment was the check. The higher rate applied to the mid and high fertility treatments damaged the crop and lack of rainfall prevented it from recovering. TDN ranged from 67.49% to 64.25% while protein ranged from 7.53% to 8.14%. The high fertility treatment had the lowest NDF value at 46.76% and likely would have benefited the most from a longer growing season.

Treatment	Yield Tons/acre (adjusted to 65% moisture)	Total Digestible Nutrients	Protein %	Neutral Detergent Fibre
Normal Fertility (Check)	18.3	67.49	7.53	50.64
Mid Fertility (18 Ton Yield Goal)	12.45	64.63	8.14	52.12
High Fertility (21 ton Yield Goal)	11.71	64.25	8.07	46.76

Forage Yield and Quality – Denzil

Forage yield of the normal fertility treatment at the Denzil site yielded 10.60 tons per acre of wet silage. The mid fertility treatment yielded 11.60 tons per acre of wet silage with the high fertility treatment yielding 8.50 tons of wet silage. An early frost terminated the crop at Denzil on September 8th. Lack of moisture, high heat and hail took its toll on the corn crop at Denzil. It is likely the rate of fertilizer applied to the high fertility plot led to burning resulting in the lowest yield. Nutrient Values of all treatments were very similar with TDN ranging from 66.32% for the high fertility to 67.03% for the mid fertility. Protein ranged from 10.15% for the check treatment to 10.93% for the mid fertility treatment.

Treatment	Yield Tons/acre (adjusted to 65% moisture)	Total Digestible Nutrients	Protein %	Neutral Detergent Fibre
Normal Fertility (Check)	10.60	66.29	10.15	48.95
Mid Fertility (18 Ton Yield Goal)	11.60	67.03	10.93	48.07
High Fertility (21 ton Yield Goal)	8.50	66.32	10.28	50.16

iv. Economics – Outlook

For the economic analysis, the Saskatchewan Agriculture Corn Silage Calculator was used. Although total cost per acre for Outlook site ranged from \$694.82 to \$826.26 the difference in cost of silage per wet ton was very small. The check had a cost of \$37.52/ton with the mid fertility having a cost of \$39.75/ton and the high fertility coming in at \$41.16/ton. An important thing to keep in mind about the Outlook site is that the high fertility treatment had the greatest nutrient value and depending on what type of animal is being fed, the extra cost could be justified in better feed quality. It is thought that if frost would not have shortened the growing season the economics of higher fertility would have been more advantageous at the Outlook site.

Silage Calculator - Outlook Site			
	Check	Mid-Fertility	High-Fertility
Yield (tons/acre)	18.52	19.40	20.08
Percent Moisture (%)	65.00	65.00	65.00
Dry Matter/acre(tons)	6.48	6.79	7.03
Dry Matter/acre(lbs)	12964	13580	14056
Expenses	\$/acre	\$/acre	\$/acre
Field preparation	\$ 10.00	\$ 10.00	\$ 10.00
Seed	\$ 100.00	\$ 100.00	\$ 100.00
Seeding	\$ 21.00	\$ 21.00	\$ 21.00
Fertilizer	\$ 144.10	\$ 210.79	\$ 258.58
Chemical and application	\$ 30.00	\$ 30.00	\$ 30.00
Crop insurance	\$ -	\$ -	\$ -
Harvest cost (\$/ton)(\$/acre \$ 11.00	\$ 203.72	\$11.00 \$ 213.40	\$11.00 \$ 220.88
Total variable expenses	\$ 508.82	\$ 585.19	\$ 640.46
Other expenses	\$/acre	\$/acre	\$/acre
Property taxes	\$ 6.00	\$ 6.00	\$ 6.00
Land cost	\$ 100.00	\$ 100.00	\$ 100.00
Irrigation Costs	\$ 80.00	\$ 80.00	\$ 80.00
Total expenses	\$ 694.82	\$ 771.19	\$ 826.46
Total Cost/wet ton	\$ 37.52	\$ 39.75	\$ 41.16
Total Cost/dry ton	\$ 107.19	\$ 113.58	\$ 117.60
total cost/dry lb	\$ 0.054	\$ 0.057	\$ 0.059

Economics – Yorkton

The total cost per acre at the Yorkton site ranged from a low of \$581.66 to a high of \$558.40. The most expensive treatment was the check as the total yield was highest and therefore resulted in the highest harvest costs. Total cost per wet ton was \$31.78 for the check, \$43.77 for the mid fertility treatment and \$47.46 for the high fertility treatment. High rates of nitrogen fertilizer applied as a liquid caused damage to the mid and high-

fertility treatments lowering yield potential.

Silage Calculator - Yorkton Site			
	Check	Mid-Fertility	High-Fertility
Yield (tons/acre)	18.30	12.45	11.71
Percent Moisture (%)	65.00	65.00	65.00
Dry Matter/acre(tons)	6.41	4.36	4.10
Dry Matter/acre(lbs)	12810	8715	8197
Expenses	\$/acre	\$/acre	\$/acre
Field preparation	\$ 15.00	\$ 15.00	\$ 15.00
Seed	\$ 105.00	\$ 105.00	\$ 105.00
Seeding	\$ 20.00	\$ 20.00	\$ 20.00
Fertilizer	\$ 156.66	\$ 178.40	\$ 199.30
Chemical and application	\$ 46.00	\$ 46.00	\$ 46.00
Crop insurance	\$ -	\$ -	\$ -
Harvest cost (\$/ton)(\$/acre \$ 10.00	\$ 183.00	\$10.00 \$ 124.50	\$10.00 \$ 117.10
Total variable expenses	\$ 525.66	\$ 488.90	\$ 502.40
Other expenses	\$/acre	\$/acre	\$/acre
Property taxes	\$ 6.00	\$ 6.00	\$ 6.00
Land cost	\$ 50.00	\$ 50.00	\$ 50.00
Total expenses	\$ 581.66	\$ 544.90	\$ 558.40
Total Cost/wet ton	\$ 31.78	\$ 43.77	\$ 47.69
Total Cost/dry ton	\$ 90.81	\$ 125.05	\$ 136.24
total cost/dry lb	\$ 0.045	\$ 0.063	\$ 0.068

Economics – Denzil

At the Denzil site the cost per acre ranged from \$451.33 to \$474.85. Total cost per wet/ton was \$42.58 for the check, \$41.68 for the mid-fertility treatment and \$55.86 for the high-fertility treatment. Higher fertility combined with lack of rain is thought to have caused a negative impact on yields at the Denzil site.

Silage Calculator - Denzil Site			
	Check	Mid-Fertility	High-Fertility
Yield (tons/acre)	10.60	11.60	8.50
Percent Moisture (%)	65.00	65.00	65.00
Dry Matter/acre(tons)	3.71	4.06	2.98
Dry Matter/acre(lbs)	7420	8120	5950
Expenses	\$/acre	\$/acre	\$/acre
Field preparation	\$ 15.00	\$ 15.00	\$ 15.00
Seed	\$ 82.00	\$ 82.00	\$ 82.00
Seeding	\$ 25.00	\$ 25.00	\$ 25.00
Fertilizer	\$ 118.33	\$ 140.47	\$ 162.85
Chemical and application	\$ 20.00	\$ 20.00	\$ 20.00
Crop insurance	\$ -	\$ -	\$ -
Harvest cost (\$/ton)(\$/acre \$ 10.00	\$ 106.00	\$10.00 \$ 116.00	\$10.00 \$ 85.00
Total variable expenses	\$ 366.33	\$ 398.47	\$ 389.85
Other expenses	\$/acre	\$/acre	\$/acre
Property taxes	\$ 5.00	\$ 5.00	\$ 5.00
Land cost	\$ 80.00	\$ 80.00	\$ 80.00
Total expenses	\$ 451.33	\$ 483.47	\$ 474.85
Total Cost/wet ton	\$ 42.58	\$ 41.68	\$ 55.86
Total Cost/dry ton	\$ 121.65	\$ 119.08	\$ 159.61
total cost/dry lb	\$ 0.061	\$ 0.060	\$ 0.080

- v. This information has been presented at the Saskatchewan Irrigation Conference on Dec. 9, 2020 to approximately 100 people. It was also presented at Ranch Management Forum on January 15, 2021. The webinar has been watched over 300 times. In July, there was a social media “ADOPT update” post that featured this project in the video.

11. Conclusions and Recommendations

- From this demonstration we were able to see that fertilizing corn at high rates involves too much risk under dryland conditions. Due to dry and hot conditions this past summer, the corn trials located at Denzil and Yorkton were not able to use the added fertility and, in some cases, resulted in reduced yields. On the irrigated site at Outlook we saw a definite trend to higher yields and increased forage quality with higher fertility. Unfortunately, an early frost had a massive effect on yields. More corn research would benefit producers in Saskatchewan.

Supporting Information

12. Acknowledgements

- We would like to acknowledge the Saskatchewan Forage Council, Shannon McArton and Chelsey Siemens, for their partnership on this project.

13. Abstract/Summary

Corn has become an important forage crop for cattle producers in Saskatchewan. Corn has the ability to yield more dry matter per acre than any other crop. It is high in energy and works well in both backgrounder and cow rations. This project aimed to demonstrate the yield and forage potential of corn when fertilizer was not a limiting factor. On dryland it is apparent that during hot, dry summers like what we had in 2020, it is too risky to apply heavy fertilizer rates. Without moisture the crop cannot use the extra fertility and can sometimes be negatively affected. On irrigation, where moisture isn't limiting, pushing fertility rates higher will provide more yield and increased forage quantity. It is important to always look at the economics of corn production to analyse the cost benefit of the extra fertilizer cost. This trial was only done one year so no concrete conclusions can be drawn as weather is so variable from one year to the next.
