 

Project Identification

1. **Project Title:** Demonstration of Suitable Forage Options for North Central Saskatchewan
2. **Project Number:** 20190377
3. **Producer Group Sponsoring the Project:** Saskatchewan Conservation Learning Centre
4. **Project Location(s):** Project was located at the Conservation Learning Centre located 18 km south of Prince Albert (SW 20 46 26 W2, RM 461). Coordinates of corners:
   N53°01.745' W105°45.369'
   N53°01.755' W105°45.376'
   N53°01.734' W105°45.420'
   N53°01.745' W105°45.427'
5. **Project start and end dates (month & year):** August 2019 to February 2022.
6. **Project contact person & contact details:**

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Objectives and Rationale

7. Project objectives:

This project provided an opportunity for producers to observe and compare different species of forages side by side. The objectives of this project were to test the suitability of perennial ryegrass for use in north-central Saskatchewan, which could help to reduce clubroot levels where present.

8. Project Rationale:

The Conservation Learning Centre had an older forage demonstration that had been seeded in 2016. This demonstration had been one of the most visited trials at the CLC from 2017-2019. Producers returned on multiple occasions to observe the species and varieties of forages in the demonstration to help make seeding decisions on their own operations. Due to the age of the demonstration, a new and updated forage trial would benefit local producers. The primary objective of the project would be to serve as a variety demonstration for forage and livestock producers in the area, it could also help canola producers select forages that would work on their farms for clubroot management if it were to be detected.

In western Canada, clubroot is usually first found near the right of the field's entrance (McDonald and Gossen, n.d,). In Saskatchewan, seeding grass forages, such as perennial ryegrass in field entranceways, and in clubroot-infested patches is recommended to help reduce the spread of clubroot. Perennial ryegrass is a non-host plant that has been shown to reduce the spore levels of the pathogen responsible for causing clubroot, *Plasmodiophora brassicae.* The root exudates of perennial ryegrass are believed to stimulate germination of clubroot-causing spores but do not allow for the multiplication or formation of new spores, effectively 'baiting' the spores and trapping them. Forage grasses could help decrease soil spore levels. Reducing soil spore levels is a significant benefit as spores can remain dormant in the soil for over 15 years without the presence of a host species (Ahmed et al., 2011 and Friberg et al., 2006). Spores resting in the soil can also build up to huge numbers in just one season in a heavily infested crop (McDonald and Grossen, n.d.). Perennial ryegrass has the potential to be a good forage to include in an integrated clubroot management program; it could be used to seed in entranceways and patches where clubroot has been present. The increasing spread of clubroot within the province has led to perennial ryegrass being especially of interest for producers in this demonstration.

References:

Ahmed, H.U., Hwang, S.F., Strelkov, S.E., Gossen, B.D., Peng, G., Howard, R.J., and G.D. Turnbull. 2011. Assessment of bait crops to reduce inoculum of clubroot (*Plasmodiophora brassicae*) of canola. Can J. Plant Sci. 91:545-551.

Friberg H., Largerlof, J., and B. Ramert. 2006. Usefulness of nonhost plants in managing *Plasmodiophora brassicae.* Plant Pathology, 55: 690-695.

McDonald, M. R., and B. D. Gossen. "Patch Management For Clubroot Control." *Canola Council* , Agriculture and Agri-Food Canada, https://www.canolacouncil.org/media/615345/7_maryruth_patchmgmt.pdf. Accessed 27 Jan. 2022.

Methodology and Results

9. Methodology:

This project provided an opportunity for producers to observe and compare different varieties of forage side by side. The trial originally demonstrated thirty varieties of perennial legume and grass forage options for north-central Saskatchewan and an additional three annual forages (Crimson Clover, Berseem Clover, and Beehappy Phacelia) were added to the demonstration. Three varieties of alfalfa that were originally proposed for this demonstration were swapped for new varieties (TRT 23, 24, 25). Instinct was swapped for Foothold, Assalt for AC Totem, and Able for Equinox. As well, treatment 5, Meadow Bromegrass (MBA) was removed. For ease of seeding and plot maintenance, the legume and grass forages were split into blocks and each treatment was replicated twice. The trial demonstrated fifteen species of grass and eighteen varieties of legumes. A full treatment list can be found in Table 1.

Table 1. Treatments in "Demonstration of Suitable Forage Options for North Central Saskatchewan"

Trt #	Grass Crops	Trt #	Legume Crops and Annuals
1	Perennial ryegrass - Tetrasweet	16	Alfalfa (Algonquin)
2	Perennial ryegrass - Toronto	17	Alfalfa (Vision)
3	Meadow Bromegrass (AAC Maximus)	18	Alfalfa (AC Grazeland)
4	Meadow Bromegrass (Common Meadow)	19	Alfalfa (Robust)
5	*Meadow Bromegrass (MBA) - removed*	20	Alfalfa (Perfection)
6	Hybrid Bromegrass (AC Knowles)	21	Alfalfa (Response WT)
7	Timothy (PS LMT)	22	Alfalfa (Rugged)
8	Hybrid Bromegrass (Succession Hybrid Brome)	23	Alfalfa (Instinct)
9	Timothy (Climax)	24	Alfalfa (Assalt)
10	Smooth Bromegrass (Carleton)	25	Alfalfa (Able)
11	2020 - Smooth Bromegrass (AC Rocket) *2021- Reseeded to Creeping Red Fescue*	26	Birdsfoot trefoil (Bull)
12	Crested wheatgrass (Kirk)	27	Cicer milkvetch (Oxley II)
13	Crested wheatgrass (common crested wheatgrass)	28	Alfalfa (VR Total)
14	2020 - Timothy (Barpenta) *2021 – Reseeded to Timothy (Comer)*	29	Sainfoin (Nova)
15	Tall fescue (Coutenay)	30	Sainfoin (AC Mountainview)
		31	Annual (Crimson clover)
		32	Annual (Berseem clover)
		33	Annual (Beehappy Phacelia)

In the fall of 2019, glyphosate was applied to prepare the site of the trial. The trial area was disced in the fall of 2019 and rototilled again prior to seeding select treatments in the spring of 2020. Composite soil samples were taken in the fall of 2019. The 2019 soil test results are available in Table 4 and 5.

All plots measured 10 meters long by 2 meters wide with seeding initially occurring on May 18th, 2020. On June 2nd, 2021, plots with poor emergence were rototilled and all plots were trimmed to control weeds on the edges of the plots. Establishment of many of the forages was difficult due to hot and dry growing conditions experienced in 2020 and 2021, intense weed pressure, and high salinity at the trial site. On June 3rd, 2021 all treatments except for 9 of 11 varieties of alfalfa were reseeded in rep one. In rep two, re-seeding occurred for all treatments except all alfalfa and sainfoin varieties. When reseeding treatments 11 and 14, there was not enough of the original seed remaining to re-seed so different forages were chosen in their place (Table 2). The plots had 10-inch row spacing and were seeded with the CLC's Fabro plot seeder. Seeding rates can be found in Table 2.

Data collection for this demonstration included forage percentage cover and biomass. Data collection methods are presented in the agronomic summary (Table 3).

Table 2. Seeding rates used in the Forage Demonstration

Trt #	Variety	Seeding Rate	Trt #	Variety	Seeding Rate
1**	Perennial ryegrass- Tetrasweet	8 kg/ha	**18**	Alfalfa (AC Grazeland)	9.6 kg/ha
2**	Perennial ryegrass- Toronto	8 kg/ha	**19**	Alfalfa (Robust)	9.6 kg/ha
3**	Meadow Bromegrass (AAC Maximus)	16.5 kg/ha	**20**	Alfalfa (Perfection)	9.6 kg/ha
4**	Meadow Bromegrass (Common Meadow)	16.5 kg/ha	**21**	Alfalfa (Response WT)	9.6 kg/ha
5	*Meadow Bromegrass (MBA) - removed*	N/A	**22**	Alfalfa (Rugged)	9.6 kg/ha
6**	Hybrid Bromegrass (AC Knowles)	14.5 kg/ha	**23**	Alfalfa (Instinct)	9.6 kg/ha
7**	Timothy (PS LMT)	3.3 kg/ha	**24**	Alfalfa (Assalt)	9.6 kg/ha
8**	Hybrid Bromegrass (Succession Hybrid Brome)	14.5 kg/ha	**25**	Alfalfa (Able)	9.6 kg/ha
9**	Timothy (Climax)	3.3 kg/ha	**26****	Birdsfoot Trefoil (Bull)	7.1 kg/ha
10**	Smooth Bromegrass (Carleton)	9.6 kg/ha	**27****	Cicer Milkvetch (Oxley II)	12.8 kg/ha
11**	2020 - Smooth Bromegrass (AC Rocket) *2021- Reseeded to Creeping Red Fescue*	9.6 kg/ha *9.6 kg/ha*	**28***	Alfalfa (VR Total)	9.6 kg/ha
12**	Crested Wheatgrass (Kirk)	4.5 kg/ha	**29***	Sainfoin (Nova)	33.9 kg/ha
13**	Crested Wheatgrass (Common Crested Wheatgrass)	4.5 kg/ha	**30***	Sainfoin (AC Mountainview)	33.9 kg/ha
14**	2020 - Timothy (Barpenta) *2021 – Reseeded to Timothy (Comer)*	3.3 kg/ha *3.3 kg/ha*	**31****	Annual Crimson Clover	14.0 kg/ha
15**	Tall Fescue (Coutenay)	8.0 kg/ha	**32****	Annual Berseem Clover	11.2 kg/ha
16	Alfalfa (Algonquin)	9.6 kg/ha	**33****	Annual Beehappy Phacelia	13.5 kg/ha
17*	Alfalfa (Vision)	9.6 kg/ha			

**Rep 1 plot was re-seeded in 2021*

***Rep 1 and 2 plots were re-seeded in 2021*

Table 3. Agronomics and additional information for forage demonstration

	2020	2021
Seeding Date:	May 18th, 2020	June 3rd, 2021
Seeding Method:	Fabro plot seeder with double disc openers and 10 in row spacing	
Seeding Rate:	*See Table 3.	
Soil Temp at Seeding:	8.4°C	17.4°C
Stubble	Rototilled soil, previously alfalfa/brome grass hay	
Seed Depth:	0.5-0.75 inches	0.8 inches
Weed Control:	Spot applications of glyphosate to control weeds between rows.	Infinity at 0.33 L/ac Applied to treatments 1-11, and 14 on June 29th
Crop Staging:	June 9th: broadleaf forages, tall fescue, hybrid bromegrass, perennial ryegrass, meadow bromegrass emerged.	Grassy forages: June 28th 2-4 lf. July 26th 2-6 tillers. Re-seeded alfalfa: June 28th emerged Sainfoin: June 28th flowering. July 26th 25% of seeds matured. Annual forages: June 28th emerged. Alfalfa: July 26th end of flowering.
Plant Percent Cover:	Using the transect line method in 2 x 1 m row per plot.	
	July 21st and August 14th	July 6th and July 28th
Biomass Date:	N/A	0.25m^2 quadrats from the front and back of each plot. Grass plots were not harvested as they were all reseeded and had not produced sufficient biomass for harvesting. August 16th, 2021
Soil Zone and Texture:	Black Clay loam	

10. Results

Soil Sample Results

Soil test results can be found in Table 4 and 5. In 2019, soil test results indicated N was medium, P was very low, and most micronutrients were adequate. Soil tests indicated that salinity was high. Based on these soil test results the decision was made not to apply any fertilizer to either

the legume or grassy forage block.

Table 4. Basic composite soil test results from Agvise Laboratories.

Year	Depth (in)	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)	OM (%)	pH	Salts (mmho/cm)
2019	**0 to 6**	20	4	227	120+	5.8	6.3	1.13
	6 to 12	16			120+		6.6	1.12

Table 5. September 9, 2019 micronutrient, cation exchange capacity (CEC) and calcium carbonate equivalent (CCE) soil analysis from Agvise Laboratories.

Cl	B	Fe	Mn	Cu	Mg	Ca	Na	CEC	Carbonate (CCE)
(lb/ac)				(ppm)				(meq)	(%)
4	0.7	66.1	4.6	0.37	791	3103	113	26.5	0.1

Weather

The 2020 growing season was cooler and drier than the long-term average (Table 6). The early September 8th frost in 2020 terminated many of the forages earlier than in 2021. The 2021 growing season at the CLC was very hot and even drier than 2020. The average temperature for the entire growing season was nearly 1˚C warmer than the long-term average. Total precipitation in 2021 was 97.1 mm lower than the long-term average. Precipitation was very low in May which resulted in the forages being seeded into a dry seedbed when some were re-seeded on June 3rd. Good precipitation in June likely prevented even more severe effects of the heat and drought on forage emergence. July was also exceptionally dry in 2021 (9.6 mm) when compared to the long-term average of 84.6 mm, and hot with 10 days above 30°C. In 2021, the first fall frost occurred on October 2 (-0.9˚C). The complete monthly weather summaries can be downloaded from src.sk.ca/download-weather-summaries.

Table 6. Weather conditions in 2020 and 2021 at the Saskatchewan Conservation Learning Centre from the onsite SRC weather station.

	May	June	July	August	September	October	Average/Total
				--- Mean Temperature (°C) ---			
2021	10.1	18.3	20.3	17.0	13.5	4.9	14.0
2020	9.2	13.4	17.6	16.1	10.9	1.0	11.4
2012-2020	11.4	15.9	18.5	17.1	11.4	2.9	12.9
				--- Precipitation (mm) ---			
2021	29.8	84.0	9.6	57.0	9.5	13.9	202.3
2020	68.4	91.4	32.2	33.2	31.6	10.1	266.9
2012-2020	40.4	79.6	84.6	42.9	31.2	20.7	299.4

Forage Establishment – 2020

Stand coverage was higher in the legume forages compared to the grass forages (Table 7). Emergence and growth in the grasses may have been impacted by weed pressure and cool spring temperatures. Stand coverage of many of the grassy forages decreased between July 21st and August 14th. Weed wiping glyphosate between the rows in the grassy forage block in an attempt to manage dandelion and thistle populations resulted in some crop death and reduced stand coverage. The legumes were more established at the time of weed wiping and were not as negatively impacted by the glyphosate.

Both perennial ryegrass varieties performed reasonably well in the first year of the demonstration (Table 7). Tetrasweet perennial ryegrass had the highest stand coverage of the grasses on July 21st. Toronto perennial ryegrass was among the highest percent cover in the grasses on July 21st and on August 14th. Coutenay tall fescue had the highest stand coverage of the grasses on August 14th. However, it is difficult to draw conclusions from the August 14th stand coverage assessment given the significant negative impact of the glyphosate weed wiping on the crops. Carleton smooth bromegrass and PS LMT timothy had the poorest coverage overall. All varieties of timothy and smooth bromegrass had poor establishment.

Overall, the legumes had fairly good stand coverage and the impact of the mid-season weed wiping was minimal (Table 7). The annual forages, crimson and berseem clover and beehappy phacelia, had high stand coverage. The clover varieties were the only forages with 100% coverage on August 14th. Several varieties of alfalfa also had high stand coverage, including perfection, response and assalt. Bull birdsfoot trefoil and Oxley III cicer milkvetch had the lowest coverage of the legumes.

Table 7. Stand coverage of forage crops demonstrated in 2020.

TRT #	Crop	Mean Forage Stands (% coverage)	
		July 21	Aug 14
1	Perennial ryegrass - Tetrasweet	100	60
2	Perennial ryegrass - Toronto	70	57.5
3	Meadow Bromegrass (AAC Maximus)	50	50
4	Meadow Bromegrass (Common Meadow)	70	47.5
6	Hybrid Bromegrass (AC Knowles)	75	35
7	Timothy (PS LMT)	23	12.5
8	Hybrid Bromegrass (Succession Hybrid Brome)	25	32.5
9	Timothy (Climax)	30	12.5
10	Smooth Bromegrass (Carleton)	23	5
11	Smooth Bromegrass (AC Rocket)	28	12.5
12	Crested wheatgrass (Kirk)	30	15
13	Crested wheatgrass (common crested wheatgrass)	40	25
14	Timothy (Barpenta)	30	22.5
15	Tall fescue (Coutenay)	68	65
16	Alfalfa (Algonquin)	80	87.5
17	Alfalfa (Vision)	70	72.5
18	Alfalfa (AC Grazeland)	70	75
19	Alfalfa (Robust)	78	80
20	Alfalfa (Perfection)	88	90
21	Alfalfa (Response WT)	85	87.5
22	Alfalfa (Rugged)	63	60
23	Alfalfa (instinct)	75	95
24	Alfalfa (Assalt)	75	97.5
25	Alfalfa (Able)	53	77.5
26	Birdsfoot trefoil (Bull)	30	37.5
27	Cicer milkvetch (Oxley II)	23	30
28	Alfalfa (VR Total)	73	87.5
29	Sainfoin (Nova)	60	62.5
30	Sainfoin (AC Mountainview)	73	77.5
31	Crimson clover	95	100
32	Berseem clover	85	100
33	Beehappy Phacelia	95	97.5

Forage Establishment – 2021

Percent coverage of the established forages was rated on July 6, 2021 and the re-seeded plots were assessed later on July 28, 2021 (Table 8). Establishment of the legume forages was mostly successful. Percent cover of the alfalfa varieties ranged between 68-100% in the established plots. VR Total alfalfa had the highest stand coverage of the alfalfa varieties. Algonquin and Response WT alfalfa performed very well in both 2020 and 2021, indicating these varieties are likely well suited to the region. The established sainfoin had adequate coverage, but establishment of the reseeded sainfoin was poor. Establishment of the bull birdsfoot trefoil and Oxley II cicer milkvetch was not very successful, averaging at 3% and 8% coverage, respectively. All annual forages had high stand coverage.

Forage stand coverage was much lower for most grassy forages after reseeding in 2021 compared to 2020 (Table 8, Table 7). Unfortunately, due to hot and dry conditions in 2021 and salinity issues at the trial site, reseeding the grassy forages did not help improve establishment as hoped. The hybrid, meadow and smooth bromegrass varieties had the highest percent cover of the grasses in 2021, ranging between 30-48% (Table 8). Establishment of timothy, tall fescue, crested wheatgrass and creeping red fescue was very poor.

Coverage of the Tetrasweet perennial ryegrass was among the highest of the reseeded grassy forages at 43%, suggesting that perennial ryegrass can be grown successfully in the region (Table 8). Establishment of the Toronto perennial ryegrass was less successful than Tetrasweet at only 13% coverage.

Biomass was only collected for the perennial legume and annual forages, as the grass forages were all reseeded in 2021 and had not accumulated enough biomass to harvest by the end of the growing season. Forage biomass was highest in alfalfa, with VR Total, Able and Assalt having the highest biomass (Table 8). The annual forages had lower biomass than most alfalfa varieties, but higher biomass than sainfoin, birdsfoot trefoil and cicer milkvetch.

Table 8. Stand coverage and biomass of forages in 2021.

#	Forage	Mean Forage Stands (% coverage)		Mean Biomass (kg/ha)
		July 6[†]	July 28[‡]	
1	Perennial ryegrass - Tetrasweet	-	43	-
2	Perennial ryegrass - Toronto	-	13	-
3	Meadow Bromegrass (AAC Maximus)	-	30	-
4	Meadow Bromegrass (Common Meadow)	-	35	-
6	Hybrid Bromegrass (AC Knowles)	-	48	-
7	Timothy (PS LMT)	-	3	-
8	Hybrid Bromegrass (Succession Hybrid Brome)	-	43	-
9	Timothy (Climax)	-	3	-
10	Smooth Bromegrass (Carleton)	-	33	-
11	Creeping Red Fescue	-	3	-
12	Crested wheatgrass (Kirk)	-	0	-
13	Crested wheatgrass (common crested wheatgrass)	-	15	-
14	Timothy (Comer)	-	0	-
15	Tall fescue (Coutenay)	-	5	-
16	Alfalfa (Algonquin)	93	-	6058
17	Alfalfa (Vision)	90[§]	50[§]	9824
18	Alfalfa (AC Grazeland)	88	-	10214
19	Alfalfa (Robust)	83	-	6131
20	Alfalfa (Perfection)	68	-	7465
21	Alfalfa (Response WT)	98	-	12996
22	Alfalfa (Rugged)	68	-	12921
23	Alfalfa (instinct)	93	-	11498
24	Alfalfa (Assalt)	85	-	13154
25	Alfalfa (Able)	90[§]	50[§]	14772
26	Birdsfoot trefoil (Bull)	-	3	0
27	Cicer milkvetch (Oxley II)	-	8	0
28	Alfalfa (VR Total)	100[§]	10[§]	16476
29	Sainfoin (Nova)	75[§]	5[§]	3610
30	Sainfoin (AC Mountainview)	85[§]	10[§]	2862
31	Crimson clover	90	100	6917
32	Berseem clover	50	75	3166
33	Beehappy Phacelia	85	90	5268

[†] On July 6, percent coverage was only rated for established plots that were not reseeded. Reseeded plots were slow to emerge and so percent coverage ratings for those treatments were delayed.

[‡] On July 28, percent coverage was rated in the reseeded plots and a second time for the annual forages.

[§] These ratings represent percent coverage of a single plot and not an average of replicates 1 and 2. The July 6 ratings correspond to the established plot of each treatment located in replicate 2, and the July 28 ratings correspond to the reseeded plot of each treatment located in replicate 1.

11. Conclusions and Recommendations

Due to dry conditions in both 2020 and 2021, as well as salinity exacerbated by dry conditions at the demonstration site, establishment of many of the forage varieties was difficult. Overall, establishment of the perennial legume and annual forages was more successful than the perennial grassy forages. Algonquin and Response WT alfalfa had high stand coverage in both 2020 and 2021. VR Total, Able and Assalt alfalfa produced the most biomass in 2021, indicating they are likely well suited to the region. Both varieties of sainfoin also had good coverage throughout the trial duration but produced less biomass than the annual forages. Establishment of the perennial ryegrass was successful, with the Tetrasweet variety out-performing Toronto in 2020 and 2021. Under exceptionally dry conditions, bromegrass species were the best performing of all grass species.

Forage establishment can be slow, especially in dry conditions or saline soil. It is likely than in the coming years and under wetter, more typical conditions, establishment of many of the forages will improve.

Supporting Information

12. Acknowledgements

The Conservation Learning Centre graciously acknowledged the Ministry's support through signage directly in field with the project, verbally during the Field Day and on the Field Day agenda handed out to all visitors. The CLC also thanks Northstar Seed and PickSeed for seed inputs.

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13. Abstract/Summary

This trial aimed to demonstrate different species of forages and assess the suitability of perennial ryegrass for use in north-central Saskatchewan. 15 varieties of perennial grass forages, 15 varieties of perennial legume forages, and 3 annual forages were seeded on May 18, 2020 at the Conservation Learning Centre located 18 km south of Prince Albert, SK. Due to difficulties with weed pressure, dry conditions and high salts in the first year of the demonstration, some forages were reseeded on June 3, 2021. Unfortunately, the 2021 growing season was unusually hot and even drier than 2020, so reseeding the forages did not help to improve establishment. Overall, establishment of the perennial legume and annual forages was more successful than the perennial grass forages. Several varieties of alfalfa performed well and seem well suited to the region. Algonquin and Response WT alfalfa had high stand coverage in both 2020 and 2021. VR Total, Able and Assalt alfalfa produced the most biomass in 2021. Both Nova and AC Mountainview sainfoin had good coverage throughout the trial duration but failed to produce more biomass than the annual forages. Establishment of the

perennial ryegrass was successful, with the Tetrasweet variety out-performing Toronto in 2020 and 2021. Under exceptionally dry conditions, bromegrass species were the best performing of all grass species. By 2021, AC Knowles and Succession hybrid bromegrass had the highest percent coverage of the grassy forages. Forage establishment can be slow, especially in dry conditions or saline soils. It is likely that in the coming years and under more typical, cooler and wetter conditions, establishment of the forages overall will improve.
