

Effect of sod-seeded legumes on forage composition, steer performance, methane emission and economics

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Background

- Old pasture stands need rejuvenation
 - Sod-seeding is a way to improve pasture productivity
- Alfalfa is one of the most important forage legumes grown in western Canada (McMahon et al. 1999)
 - Large concern with frothy bloat grazing monoculture or alfalfa dominant pastures (Majak et al. 2001, Popp et al. 2000, Wang 2012)



Non-Bloat Legumes



- **Sainfoin** (*Onobrychis vicifolia*)
 - Condensed tannins (CT) that bind to proteins
- **Cicer milkvetch** (*Astragalus cicer*)
 - Reticulate vein patterning of the leaves (Coulman et al. 2000; Williams et al. 2011)
- Unfortunately, research on using these these non-bloat legumes in pasture rejuvenation is negligible (Acharya et al. 2015)
 - Effectively introduce into existing stands
 - Ability to persist in existing stands with grazing

Study Objectives

- To determine forage yield, forage quality and botanical composition of sainfoin and cicer milkvetch when sod-seeded into mixed grass-legume stands
- To evaluate grazing performance, and rumen dynamics in cattle grazing pastures with sod-seeded non-bloat legumes
- To conduct an economic analysis of using non-bloat legume species for pasture rejuvenation

Materials and Methods

- Site Location

- Termuende Research Ranch,
Lanigan, Saskatchewan,
Canada
- Chernozemic Black Oxbow
Soil (Saskatchewan Soil Survey 1992)

- Timeline

- Seeded 2015
- 3-year grazing study
- (2016, 2017, 2018)



Study Site

- 30-ha meadow brome-grass-alfalfa (*Bromus riparius-Medicago sativa L.*) pasture
 - 15, 2-ha paddocks
- Paddocks randomly assigned to 1 of 3 replicated treatments sod-seeded
 1. Sainfoin (*Onobrychis viciaefolia*) (SAIN) (n=6)
 2. Cicer milkvetch (*Astragalus cicer*) (CMV) (n=6)
 3. No sod-seeded legume (CON) (n=3)



Site Establishment (2015)



- Two applications of 1.2 L/ha glyphosate to existing pasture
- Seeded at 19 mm depth
- Sainfoin seeded at 25 kg/ha
- Cicer milkvetch was seeded at 17 kg/ha
- Sod-seeded with an AgroPlow™



Animal Management

- Experimental animals
 - 2016: 60 steers
 - 2017: 45 steers
 - 15 ruminally cannulated cows
 - 2018: 45 steers
 - 15 ruminally cannulated cows



Data Collection

1. Pasture

- Forage yield & quality
- Pasture botanical composition (Daubenmire, 1959)

2. Steers

- Estimated dry matter intake (McCartney et al. 2004)
- Average daily gain

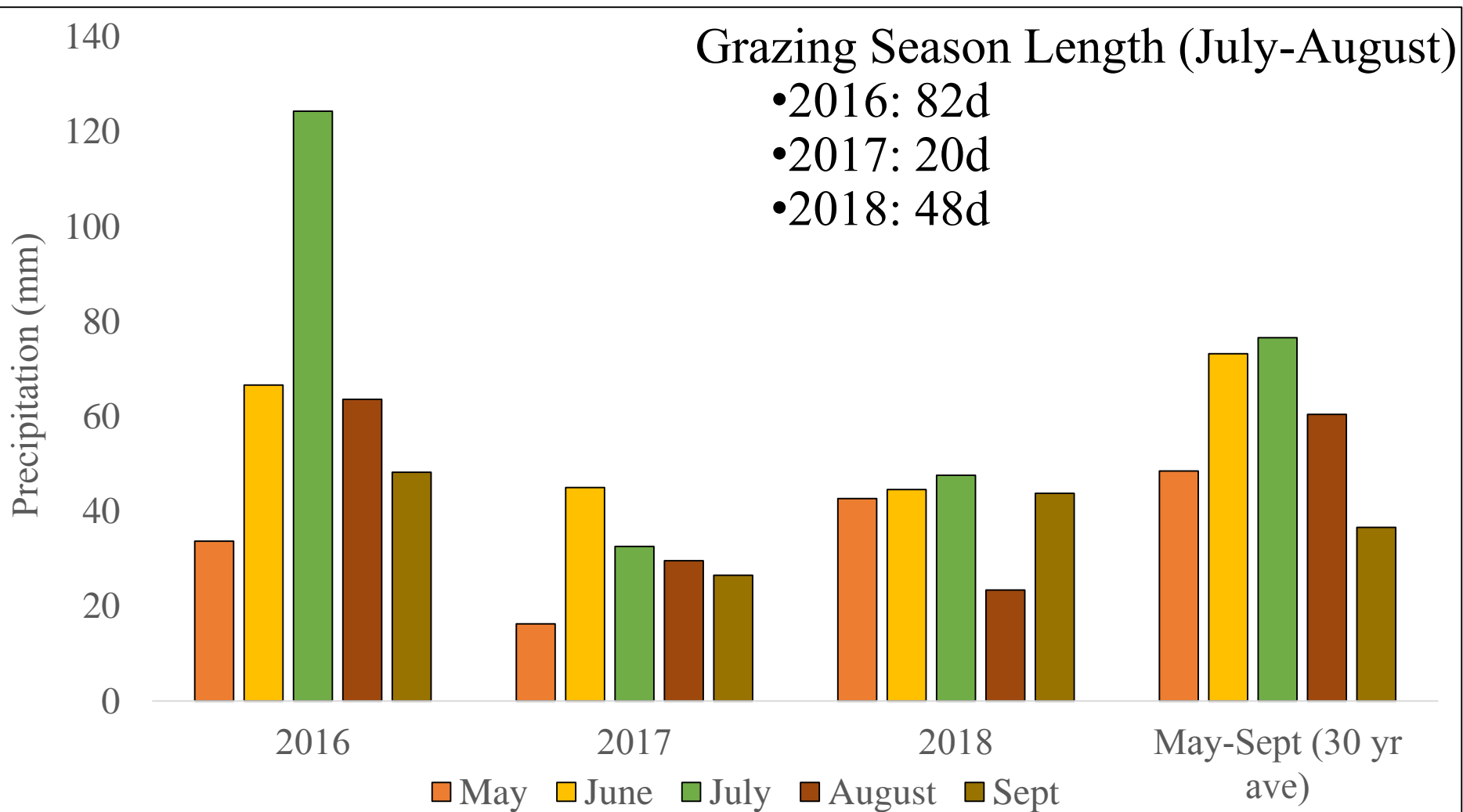
3. Ruminant cannulated cows

- Enteric methane emissions (SF_6 technique) (Johnson et al. 1994)
- Ruminant short chain fatty acid concentration and ammonia levels
- Blood plasma urea nitrogen

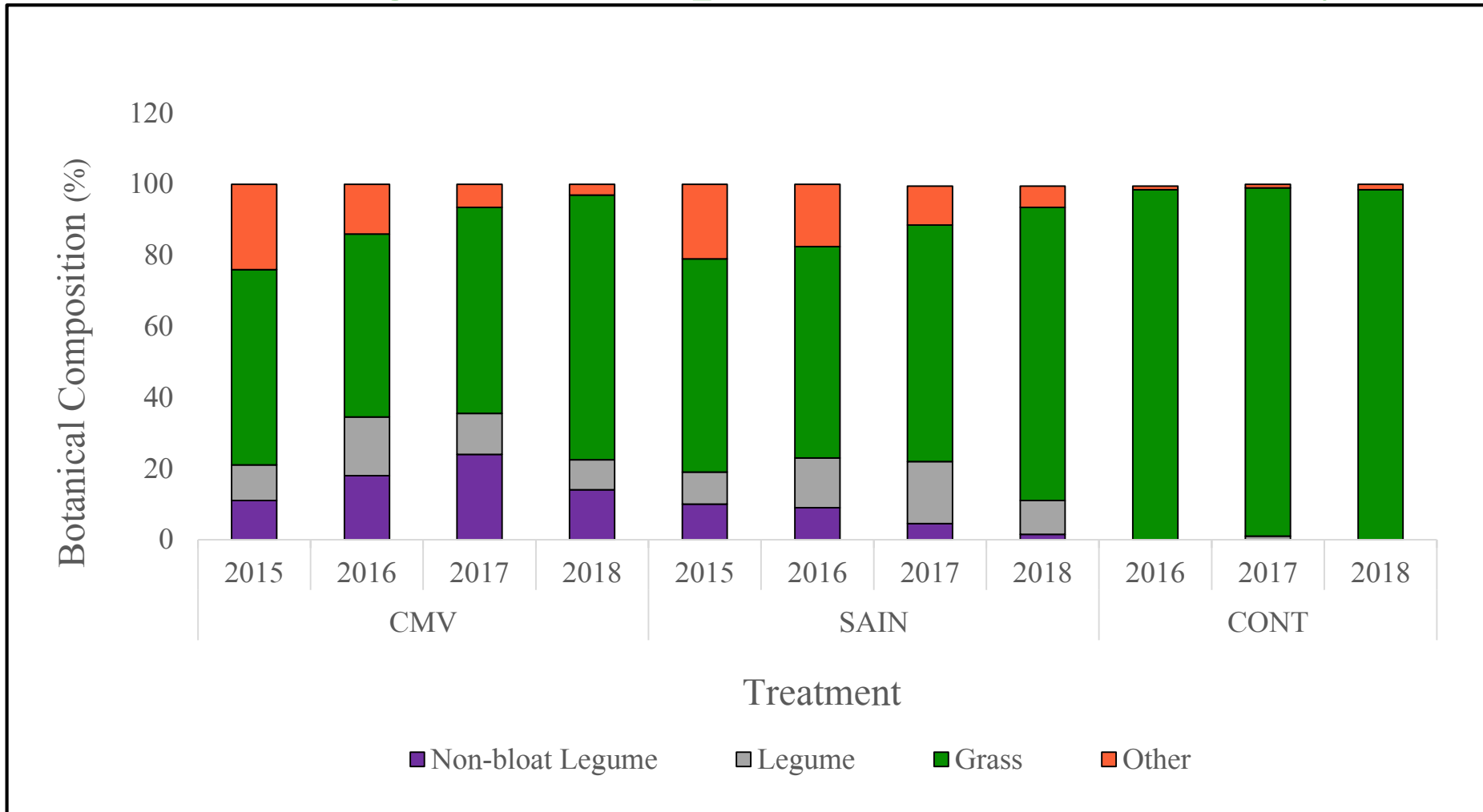
Statistical Analysis

- Completely randomized design (CRD)
- One way analysis of variance (ANOVA) of the Proc Mixed Model procedure of SAS
- Tukey's multiple range test
 - To determine if treatment means were different and differences were considered significant when $P < 0.05$ and trends considered when $P < 0.10$

Site Precipitation (mm)

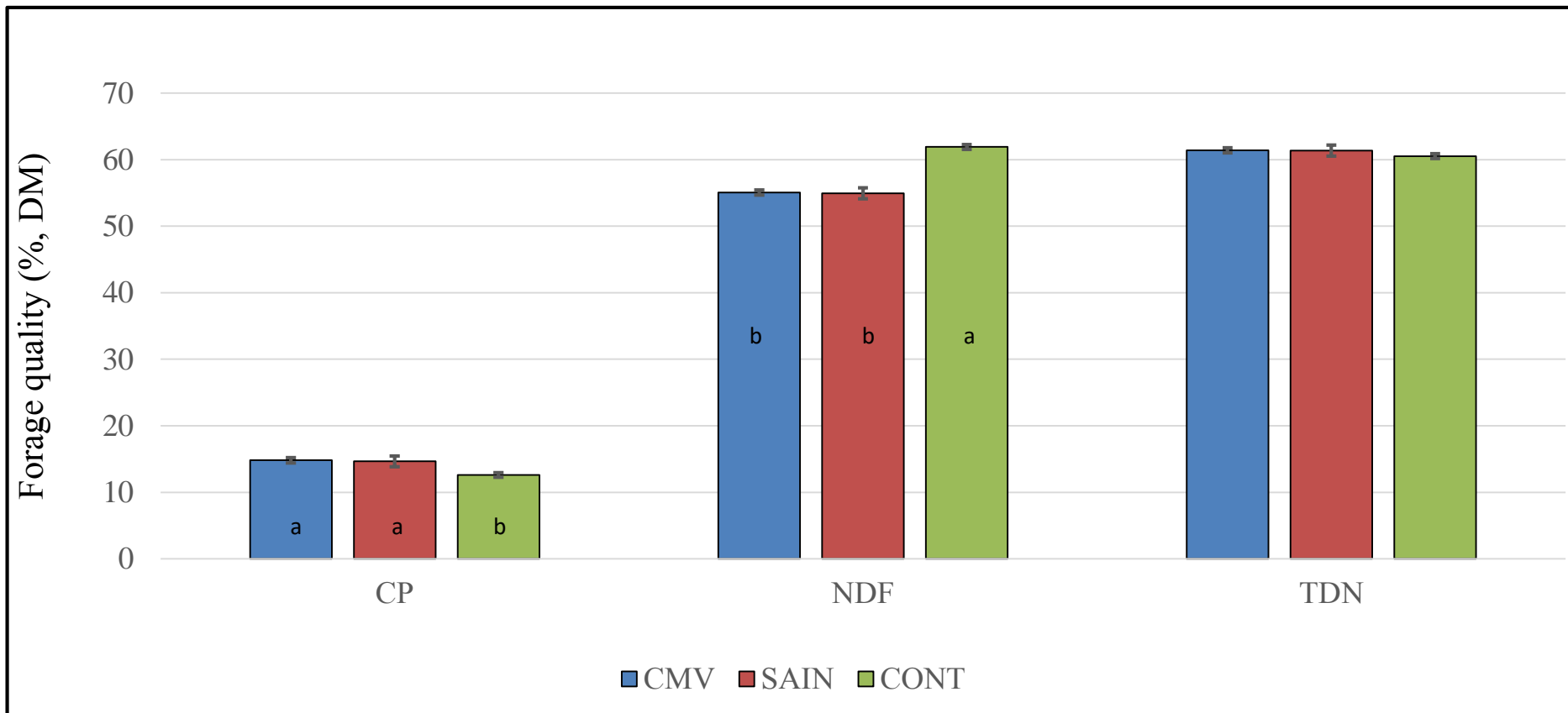


Effect of grazing on persistence of sod-seeded non-bloat legumes^z in pasture stand over 4 years



^zCMV = cicer milk vetch; SAIN = sainfoin; CONT = no sod-seeded legume

Forage quality of non-bloat legume^z pasture over 3 years



^zCMV = cicer milk vetch; SAIN = sainfoin; CONT = no sod-seeded legume

Effect of pasture type^z on forage production, forage quality and steer performance over 3 years

Item	CMV	SAIN	CONT	SEM	P-value
Length of grazing season (d)	50	50	50		
<i>Forage production (dry matter)</i>					
Available forage (kg/ha)	4367.40	4810.70	4055.19	723.320	0.74
Residual forage (kg/ha)	2702.20	2599.50	1850.00	390.160	0.39
Dry matter intake (kg/d)	14.40	13.53	11.79	1.665	0.62
<i>Steer performance</i>					
Starting animal weight (kg)	325.49	325.90	328.48	3.949	0.87
Ending animal weight (kg)	378.20	379.10	368.07	5.355	0.35
Average daily gain (kg/d)	1.04	1.04	0.84	0.077	0.16

^zCMV = cicer milk vetch; SAIN = sainfoin; CONT = no sod-seeded legume

a, b Means in the same row with different letters differ at the *P* value presented in the last column of this table.

Effect of pasture type on short chain fatty acid concentration, ammonia production, plasma urea nitrogen and enteric gas production

Item ^y	Experimental Treatments ^z				P value
	CMV	SAIN	CONT	SEM	
<i>Rumen fluid concentration</i>					
Total SCFA (mmol)	116.73	107.88	105.29	6.020	0.35
Acetate (A) (% ₂ , total)	68.77	69.23	69.53	0.970	0.86
Propionate (P) (% ₂ , total)	16.46 _a	15.56 _b	15.56 _b	0.207	<0.01
Butyrate (% ₂ , total)	9.48	9.89	9.74	0.178	0.20
A:P (% ₂ , total)	4.18 _b	4.46 _a	4.47 _{ab}	0.080	<0.05
NH ₃ -N (mg/dL)	9.07	9.82	9.49	1.210	0.88
<i>Blood concentration</i>					
PUN (mg/dL)	5.76 _a	4.22 _b	2.98 _c	0.460	<0.01
<i>Enteric gas production</i>					
Methane (L/d)	426.35	436.87	419.74	15.659	0.73
Methane (L/kg DMI)	28.16 _b	33.25 _a	36.59 _a	1.403	<0.05

^zCMV = cicer milkvetch; SAIN = sainfoin; CONT = control

^ySCFA = short chain fatty acid; NH₃-N = ammonia; PUN = plasma urea nitrogen

a, b Means in the same row with different letters differ (*P* < 0.05)

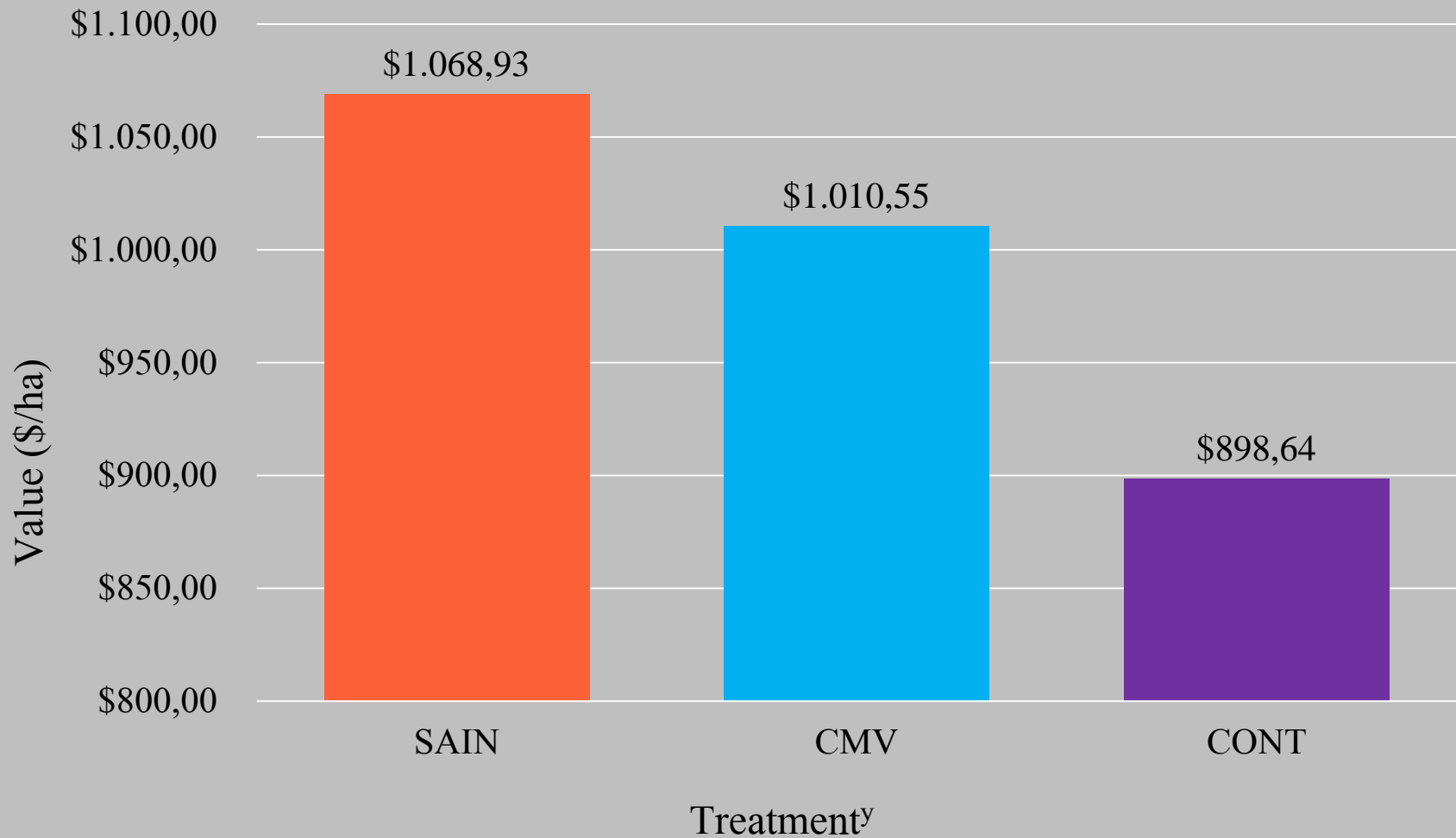
Comparison of pasture rejuvenation costs

	CMV	SAIN
	-----\$/hectare-----	
Pre-Seeding Glyphosate	7.68	7.68
Spraying	29.64	29.64
Seeding Equipment*	90.16	90.16
Land rolling	14.10	14.10
Seed	197.29	182.16
Total Costs	338.87	323.74
Expected Years of Use	10	10
Amortized Over Years of Use	33.89	32.37

*Agro-Plow (\$37.05/ha) and tractor (\$51.87/ha) rented for sod-seeding.



Net Present Value^z of DM Yield Valuation



^znet present value = estimated value over 10 years based on current standing dry hay price (\$0.04/kg).

^yCMV = cicer milkvetch; SAIN = sainfoin; CONT = control

Summary

- Forage quality of sod-seeded non-bloat legume pastures met requirements of growing steer calves
- Cicer milkvetch persisted in the stand better than Sainfoin
- Ruminal fermentation
 - Acetic to propionic ratio was lower ($P < 0.05$) for CMV (4.18 mM) compared to CON and SAIN (4.47 and 4.46 mM), respectively
 - Enteric methane emissions (L/kg DMI) were lowered for CMV treatment

Summary

- Net present value returns (\$/ha) were increased over 10 year estimate by using sod-seeded non-bloat legume as a rejuvenation strategy
- Study results suggest that sod-seeding non-bloat legumes into mixed pasture is an alternative pasture rejuvenation strategy
 - ✓ **Maintained animal performance**
 - ✓ **Reduced enteric methane emissions**
 - ✓ **Improved economic returns**

Acknowledgments

- Saskatchewan Agriculture Development Fund
- Alberta Beef Producers
- Saskatchewan Forage Council

A close-up photograph of green plants, possibly a grass or similar species, with a circular graphic overlay in the bottom right corner. The overlay is a dark semi-circle containing the text "THANK-YOU" in white, bold, uppercase letters. A small white horizontal line is positioned below the text. The background shows various green leaves and stems, some with small holes, suggesting they might be eaten by insects. The lighting is bright, creating shadows on the plants.

THANK-YOU