



EXTENDING WINTER GRAZING WITH SIMPLE AND COMPLEX POLYCROP MIXTURES FOR BEEF COWS IN WESTERN CANADA

By: Shelby Robinson MSc, Dr. Daalkhaijav Damiran, Kathy Larson MSc, Dr. Gabriel O. Ribeiro, and Dr. H. A. (Bart) Lardner

Introduction

Winter feed shortages and rising production costs have increased interest in alternative grazing systems for beef cattle in western Canada. Swath grazing annual forages can reduce winter feeding costs while maintaining cow performance. Recently, polycrop mixtures containing cereals, legumes, brassicas, and other forage species have gained attention because they may improve forage quality, soil health, biodiversity, and grazing flexibility compared with monoculture systems (Biligtu et al., 2014). However, limited research has evaluated how simple (4 species) and complex (8 species) polycrop mixtures compare with traditional oat monoculture under winter grazing conditions.

This study examined the effects of swath grazing oat monoculture, simple polycrop, and complex polycrop mixtures on forage yield and quality, beef cow performance, methane emissions, soil characteristics, and economic returns.

Site and Forage System Management

A 2-year grazing study (2022–2023) was conducted at the Forage & Cow-Calf Research & Teaching Unit of University of Saskatchewan. Three forage systems were compared: (i) a monoculture CDC Haymaker oat (100%) (**Mono**); (ii) Simple polycrop mixture of CDC Haymaker oat (45%), CDC Jasper pea (20%), Goliath brassica (17%), and hairy vetch (18%) (**Simple**); and (iii) a Complex polycrop mixture of CDC Haymaker oat (25%), CDC Maverick barley (20%), CDC Jasper pea (15%), Goliath brassica (10%), hairy vetch (10%), Red Proso millet (10%), Teff grass (5%), and Choice chicory (5%) (**Complex**).

Each system was established under standard agronomic practices with weed control, fertilization, seeding rates and depth-specific seeding for the Dark Brown soil zone (Government of Saskatchewan, 2021).

Animal and Feeding Management

Forage yield, plant composition, and feed quality were measured before and during grazing using systematic clipping and sampling protocols. Ninety (90) multiparous dry pregnant beef cows were randomly assigned to one of nine replicated paddocks



based on body weight and condition. Grazing occurred from mid-October to December, lasting 65 days in 2022 and 47 days in 2023.

Animals were provided windbreak shelters, water, bedding straw, and a free-choice mineral and salt supplement. Cow performance was monitored using body weight (**BW**) (adjusted for pregnancy) and body condition score (**BCS**). Forage allocation was adjusted every two weeks using nutrition models to maintain cow condition and match environmental demands. Pre- and post-grazing biomass yield was used to estimate forage dry matter intake (**DMI**).

Methane Emissions Measurement

Individual methane emissions were measured using an automated system that records and analyzes gases breathed out when an animal visits the system to consume small amounts of feed.

Soil, Root Biomass Analysis

Soil and root biomass were evaluated for all three treatments. Soil samples were collected from each paddock before seeding and after grazing to assess baseline conditions and treatment effects.

Samples were taken at multiple depths to evaluate soil physical and chemical properties.

System Cost Analysis

System economics compared costs to grow the forages, cost per kilogram of dry matter, as well as grazing costs per cow per day. Grazing costs included the swathed forage plus bedding, mineral, infrastructure depreciation, labour (to allocate swath and check cows) and equipment use (to bed). Costs were standardized per hectare, per kilogram of forage dry matter, and per animal unit to allow comparison among forage systems.

Results and Discussion

Forage Production and Composition

Both years of the study were drier than normal, with much less rainfall than the long-term average. All three forage systems produced similar amounts of forage (**Table 1**). Most of the plant material in the mixed systems still came from cereals like oat and barley,

Table 1. Forage yield, composition and utilization of forage systems

Item	Forage System ¹		
	Mono	Simple	Complex
Forage DM yield, lb/ac	4369.0	4052.5	4245.0
Botanical composition, %			
Seeded species	97.7	92.5	94.5
Other species ²	2.3	7.5	5.5
Chemical composition, %			
Crude protein	13.7	14.3	14.1
Total digestible nutrients	72.1	70.5	73.1
Utilization			
lb/ac	3584.1	3211.1	3494.9
% of total forage yield	81.9	79.1	82.3

¹Mono: CDC Haymaker oat; Simple: CDC Haymaker oat+Goliath brassica+hairy vetch+CDC Jasper pea; Complex: CDC Haymaker oat+Goliath brassica+hairy vetch+CDC Jasper pea+CDC Maverick barley+Red proso millet+Teff grass+Choice chicory.

²Other species include any non-seeded plants (weeds) such as redroot pigweed and foxtail barley.



which were the main drivers of growth (for details see Robinson et al., 2026). Weed levels stayed low in all treatments. In simple terms, adding more species did not increase forage yield under these dry conditions. All forage types met the nutritional needs of pregnant beef cows. Protein levels were good across all systems, and differences in total digestible nutrients and minerals were small. Overall, feed quality was similar among all forage systems.

Cow Performance and Methane Emissions

Cows performed the same through all three forage systems (**Table 2**). They maintained body weight, body condition, and fat levels throughout the winter grazing period. Even though forage intake was slightly below expected requirements, cows stayed in good condition without needing extra feed. This shows that all forage systems were able to support pregnant cows during winter.

Methane Emissions

Cows grazing oat monoculture produced lower methane emissions than cows grazing simple or complex polycrop mixtures (for details see Robinson et al., 2026). Differences in methane emissions among forage systems were likely related to forage quality, digestibility, and grazing selectivity rather than differences in feed intake. The results suggest that forage composition and animal grazing behavior can influence greenhouse gas emissions in winter grazing beef systems.

Soil, Root Biomass

Soil in this study was classified as loam throughout the 0–60 cm depth (for details see Robinson et al., 2026). Overall, different forage systems did not show strong differences in soil nutrient levels, although there were small trends suggesting slightly higher soil organic carbon and phosphorus in the more diverse (polycrop) system. Most soil nutrients were concentrated near the surface and gradually decreased with depth. In contrast, soil pH and bulk density increased in deeper layers. Compared with the first year, there was lower soil moisture and nitrate levels. These results suggest that depth and time had a stronger effect than forage system. Root growth was similar among forage systems, however, was decreased with deeper soil layers, which is a common pattern in annual forage crops.

Table 2. Effect of forage system on beef cow performance

Item	Forage System ¹		
	Mono	Simple	Complex
Grazing days	51	54	53
DMI, lb/d	30.9	30.4	30.9
Body weight ² , lb			
Initial	1332	1332	1330
Ending	1449	1433	1413
Change	117	101	84
ADG, lb/d	2.9	2.2	2.0
Body condition score ³			
Initial	2.8	2.8	2.9
Ending	3.1	3.0	3.0
Change	0.2	0.2	0.2

¹Mono: CDC Haymaker oat; Simple: CDC Haymaker oat+Goliath brassica+hairy vetch+CDC Jasper pea; Complex: CDC Haymaker oat+Goliath brassica+hairy vetch+CDC Jasper pea+CDC Maverick barley+Red proso millet+Teff grass+Choice chicory.
²Cow BW was adjusted for conceptus gain (NASEM, 2016).
³Body condition score (1 = emaciated; 5 = obese).



However, previous studies have found higher root growth in mixed crops than in barley, likely due to more diverse plants and weeds. More roots can help add carbon to soil over time.

System Cost

Crop production costs varied among the forage systems (**Table 3**). The oat monoculture had the lowest production cost, while the simple polycrop system had the highest cost, mainly due to seed cost despite having fewer species than the complex mixture. The complex polycrop system had intermediate costs. When costs were expressed per kilogram of forage, there was little difference between the monoculture and complex systems, although the simple system differed slightly from the monoculture.

Total daily feeding costs per cow were similar among all treatments, ranging from \$2.9 to \$3.33 per cow each day, meaning no system had a clear economic

disadvantage. Overall, swath grazing costs in this study were lower than typical winter feeding costs reported for western Canadian beef operations, showing it can be a competitive feeding

strategy. These results suggest polycrop systems can be economically viable while supporting grazing systems.

Table 3. Effects of forage systems on system economics

Item	Forage System ¹		
	Mono	Simple	Complex
Cost to grow, \$/ac	254.24	284.91	276.08
Cost to grow, \$/lb DM	0.33	0.39	0.36
Cost to feed, \$/hd/d	2.86	3.33	3.17
Swath cost, \$/hd/d	1.47	1.99	1.78
Mineral and Salt, \$/hd/d	0.05	0.05	0.05
Bedding, \$/hd/d	0.10	0.10	0.10
Machinery, \$/hd/d	0.12	0.12	0.12
Labour, \$/hd/d	0.12	0.14	0.12
Infrastructure, \$/hd/d	1.01	0.95	0.99
¹ Mono: CDC Haymaker oat; Simple: CDC Haymaker oat+Goliath brassica+hairy vetch+CDC Jasper pea; Complex: CDC Haymaker oat+Goliath brassica+hairy vetch+CDC Jasper pea+CDC Maverick barley+Red proso millet+Teff grass+Choice chicory.			

Implications

Swath grazing with simple or complex polycrop mixtures can support beef cow performance similar to oat monoculture in western Canada. Oat is more economical to grow, but polycrops remain cost competitive per cow day and may support diversity and soil goals.

References

- Biliget, B., P. G. Jefferson, R. Muri, and M. P. Schellenberg. 2014. Late summer forage yield, nutritive value, compatibility of warm- and cool-season grasses seeded with legumes in western Canada. *Can. J. Plant Sci.* 94:1139–1148.
- Government of Saskatchewan. 2021. Forage Crop Production Guide. [Online] Available: <https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/forage-production-annual-native-perennial/forage-crop-production>
- Robinson, S., D. Damiran, G. D. O. Ribeiro, K. Larson, and H. A. (Bart) Lardner. 2026. Effects of swath grazing either oat, simple or complex polycrop mixtures on forage quality and biomass, beef cow performance, enteric methane emissions, soil health characteristics, and system economics. *Appl. Anim. Sci.*