

Effect of Winter Feeding Systems on Beef Cow Performance and Feed Site Soil Nutrients

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Introduction

Beef cattle producers in Western Canada compete at an economic disadvantage relative to other regions in North America due to high winter feeding costs. Producers are seeking ways to effectively reduce these costs by managing manure nutrients more efficiently yet still maintain acceptable levels of beef cattle production. Producers are moving from drylot wintering systems where cattle are housed in pens and manure is hauled out, to systems where cattle are wintered on feeding sites and the manure nutrients are distributed over the site. However, beef cattle typically do not retain the majority of feed nutrients. Erickson and Klopfenstein (2001) reported that feedlot steers only retained 10 % of the nitrogen (N), excreting the remaining 90% in the urine and feces. In addition, most of the nitrogen excreted was then lost to volatilization. There is the potential to more efficiently utilize N if losses can be reduced. This study compared drylot versus field wintering systems, primarily evaluating cow performance, soil nutrients and feed system economics.

Site Description

The study was conducted at the Termuende Research Farm, Lanigan, SK, over two consecutive winters, 2003-2004 and 2004-2005. The study site was a Russian wild ryegrass (*Psathyrostachys juncea*) pasture situated on an Orthic Black soil (Saskatchewan Soil Survey, 1992). The cattle wintering site was 4, 2.5 acre replicate areas placed diagonally opposite each other with a winter watering system in the center. Animals were controlled access to feed using solar powered electric fencing. Portable wind shelters were used to provide protection from the wind. In addition, cows were also housed in drylot pens at the research farm.

Winter Feeding Systems

Ninety-six (96) crossbred pregnant beef cows were randomly allocated to 1 of 3 replicated (n=2) winter feeding systems. Feeding systems included (1) field bale grazing (BG), round straw + grass-legume hay bales fed *ad libitum* every 3 days; (2) field bale process feeding (BP), round straw + grass-legume hay bales processed and windrow fed *ad libitum* every 3 days; and (3) drylot feeding (DF), round straw + barley greenfeed bales processed bunk fed in drylot daily.

In the BG system, straw and hay bales were set out on the site in fall, in 18 rows of 8 bales each. Access to feed was controlled with electric fence allowing 1 hay and straw bale every three days. The BP system utilized a Highline 6800 bale processor to feed 1 hay and straw bale every 3 days, with feeding areas rotated throughout the paddock over the course of the trial. In the DL system, cows were fed daily with a feed wagon and tractor. In all systems the amount of feed was varied according to weather conditions. All feeds were sampled and analyzed for moisture, protein and energy to determine rations for each feeding system. Daily rations were based on

3% of body weight, consisting of 16 lbs of oat straw and 24 lbs grass/legume hay or greenfeed, calculated at 40 lbs per head per day. Salt and trace mineral was supplied free choice.

Soil Measurements

Soil samples (n=24) were collected from the site in the fall of 2003 to provide background levels of soil nutrients. Feeding areas were again sampled (n=36) in the spring of 2004 following winter feeding. All samples were taken to a 15 cm depth using a dutch auger with a 2.5 cm bit and analyzed for nitrate N, ammonia N, phosphorous (P) and potassium (K). For comparative purposes manure treatments from the drylot system were also mechanically applied to the research site. A replicated complete block design (RCBD) was marked out in the fall of 2003 in the same field. Treatments in the RCBD consisted of check (no manure), and fresh manure and compost applied at 67.2 and 22.4 tonnes per hectare, respectively. Treatment strips were 30m X 5m with 4 replicates per treatment.

Forage Production

Forage production was estimated the following summer from each of winter feeding sites and manure treatment areas. In 2004, dry matter yield (DMY) was estimated at two harvest dates, 19 July and 26 September and on 15 July in 2005. Forage estimates were collected using 0.25 m² quadrats, samples were then dried, weighed, ground, and analyzed for total crude protein.

Results

Feed ingredients and composition of rations from feeding systems are summarized in Table 1. Forage quality was adequate for beef cows in the 2nd trimester of pregnancy (Table 1). Beef cows in mid pregnancy require 54% TDN and 9% CP on a daily basis (NRC 1996).

Table 1. Ingredients and chemical composition of diets for beef cows.

<i>Ingredients, (% as fed)</i>	Drylot	Bale Process	Bale Graze
Grass-legume hay	-	60.8	60.8
Barley greenfeed	56.1	-	-
Oat Straw	43.8	39.1	39.1
Salt and trace minerals ^z	0.05	0.05	0.05

Chemical composition of diets (% DM)

Total digestible nutrients	52.7	52.4	52.4
Crude protein	8.9	9.7	9.7

^z1:1 mineral contained: 16.0% Ca, 16.0% P, 12,000 mg/kg Zn, 200 mg/kg I, 9000 mg/kg Mn, 70 mg/kg Co, 1,000,000 IU/kg vitamin A, 150,000 IU/kg vitamin D3, and 1,000 IU/kg vitamin E; fortified TM salt contained: 38.5% Na, 150 mg/kg I, 100 mg/kg Co

Throughout the trial, total amounts of feed, minerals and salt were recorded as well as labour and machinery costs.

Animal Performance

Cow performance is shown in Table 2. Ninety-six (96) cross bred pregnant cows, averaged 1367 and 1331 lbs at start of test, in 2003-04 and 2004-05, respectively. Average cow weight coming off the study was 1412 and 1428 lbs in 2003-04 and 2004-05, respectively.

Table 2. Effect of winter feeding system on cow performance

	ADG ^z		TG		ΔBCS	
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
DRYLOT	0.27	1.14	25	112	+0.08	-0.04
BALE GRAZE	0.33	0.57	44	76	+0.20	+0.26
BALE PROCESS	0.17	0.77	23	103	-0.03	+0.17

^zADG=average daily gain; TG=total gain; ΔBCS=change in body condition score

In the first year, cows were winter fed 105 days, 22 November 2003 to 5 March 2004 and in the second year cows were fed 112 days, 15 November 2004 to 7 March 2005. In 2003-04 cows fed in drylot, bale graze and bale process gained 0.27, 0.17 and 0.33 pounds per day, respectively. In 2004-05 animals fed in drylot, bale graze and bale process gained 1.10, 0.57 and 0.77 pounds per day, respectively. Body condition varied slightly between feeding systems in each year (Table 2). Total gain was greater in second year due to a longer feeding period. This would suggest the nutrient value of the diets not only met cow maintenance needs but also allowed the animals to put on body condition. There were minimal differences between systems for cow gain or cow condition. On average, cows entering the study and at the end maintained a body condition score of 3.0.

Soil Nutrients

Soil inorganic nitrogen levels are shown in Table 3. In fall 2003, soil N levels were low in all treatment areas prior to manure application or cattle wintering. Variation was small, showing an even distribution pattern of nutrients at the research site. However, following winter feeding of beef cows, soil nutrient patterns from the detailed sampling grids showed highly variable soil nutrient levels from feed sites, with inorganic soil N levels varying from 44 to 181 kg/ha (Table 3). Nitrogen levels were 2.5 to 3.0X greater on bale graze and bale process feeding sites compared to control. Levels were also significantly greater where cattle were wintered compared to treatment areas which received manure or compost. This would suggest these levels appeared to be due to capture of urine nutrients that had been lost when the cows were fed in the corral.

Table 3. Soil inorganic nitrogen (NO₃-N + NH₄-N) in the 0-15 cm depth.

	<i>Fall 2003</i>	<i>Spring 2004</i>
Bale Processing	35.2	181.0a
Bale Grazing	33.9	127.0a
Manure	36.4	44.9b
Compost	47.4	59.8b
Control	41.0	49.7b

Within a column means having the same letter do not differ significantly ($P < 0.05$)

Forage Yield

Forage production varied significantly between treatment areas (Table 4). Where cows were winter fed on either bale graze or bale process areas, DMY was 2.5 to 3.5 times greater compared to control areas. There was a similar trend observed for DMY in the second year after winter feeding. This would suggest the significant concentration of nutrients deposited by the animals had a carryover effect on subsequent pasture production.

Table 4. Forage dry matter yield (kg/ha).

	2004	2005
Bale Processing	4714a	4941a
Bale Grazing	3720b	3411a
Manure	2337c	1052c
Compost	2757c	1191c
Control	1585d	769d

Within a column means having the same letter do not differ significantly ($P < 0.05$)

Costs

Costs associated with the project include labor, equipment, feed and custom work. All costs were calculated in total then reported as cost per cow per day. Feed costs including trucking were hay at \$68.95 per bale, oat straw at \$23.00 per bale, and greenfeed at \$37.70 per bale. Labour for feeding was charged at \$15.00 per hour. Equipment costs were calculated using a guide to machinery rates (Saskatchewan Agriculture & Food, 2004). Therefore, in 2003-04 system costs of DL, BP and BG were \$1.42, \$1.04 and \$1.06 per cow, respectively. In 2004-05, costs for DL, BP and BG were \$1.53, \$0.96 and \$0.95 per cow, respectively.

Conclusions

Soil nitrogen levels measured in the spring averaged 2.5 to 3X higher where the cattle were fed on the pasture over winter compared to where an equivalent amount of manure was spread in the fall. Soil potassium levels were 1.5 to 2X higher. Nutrient distribution patterns were highly uneven following pasture feeding with levels of soil N ranging from 12 to 626 kg/ha and soil K ranging from 718 to 6326 kg/ha in the spring. Patterns following spread manure were more uniform, with soil N levels ranging from 10 to 60 kg/ha. Residue levels with their associated nutrients were also much heavier and more variable following pasture feeding.

Crossbred pregnant beef cows ($n = 96$) were allocated to one of three replicate ($n = 2$) wintering systems. Cow body weight and condition over 2 yr was not affected by feeding systems. Cattle condition and gain were similar whether they were fed in the yard or in the field, and were similar between the field feeding methods of bale processing and bale grazing. Forage growth where manure was spread increased 1.5 to 1.7X over the check treatment, and increased 2.2 to 2.7X where the cattle were fed on the pasture. Growth was most even on the spread manure treatments.

Economic calculations favoured infield feeding. Feed costs were similar between the systems but field feeding had savings in machinery use and manure handling costs, and gains in pasture productivity. Cow cost per day was lower for field feeding than wintering cows in drylot pens.

Finally, these results indicate that benefits from wintering cows on feeding sites can be managed to reduce daily costs with minimal impacts on cow performance.

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