The Effect of Winter Feeding Systems on Nutrients, Forages, Cattle and Economics

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Abstract

Extensive and intensive cattle feeding methods were compared for their effect on nutrient distribution, pasture growth, cattle parameters, and economics. In the extensive system cattle were fed on the pasture by either bale processing or bale grazing methods and the manure was deposited directly. In the intensive system cattle were fed in the yard and an equivalent amount of manure per acre was spread on the pasture in either a raw or composted state. Measurements were taken of soil nutrient levels, residue levels, pasture forage growth, cattle weight and condition, feed consumption, and economic factors.

Soil nitrogen levels measured in the spring averaged 2 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.

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.

Cattle condition and gain was similar whether they were fed in the yard or in the field, and was similar between the infield feeding methods of bale processing and bale grazing.

Economic calculations favoured infield feeding. Feed costs were similar between the systems but infield feeding had savings in machinery use and manure handling costs, and gains in pasture productivity

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. Our ability to compete with these regions may relate to how effectively we can reduce these costs by managing manure nutrients more efficiently yet still maintain acceptable levels of beef cattle production. Producers are moving from traditional wintering systems in which the cattle are kept in pens and manure is hauled out to those in which the cattle are fed in a field and the nutrients stay in place. This project compares confined versus in-field feeding systems, evaluating soil and forage response to manure hauled out and applied using a spreader versus manure accumulating in the field due to the presence of overwintering cows. Effect on the cattle herds and an economic analysis of the two systems was also conducted.

Cattle do not use a lot of the nutrients in their feed. Erickson and Klopfenstein (2001) found that feedlot yearlings only retained of 10 % of the nitrogen, excreting the remaining 90 %. Interestingly most of the nitrogen excreted was then lost to volatilization. There is huge potential to grow more feed if nitrogen losses can be reduced and N is returned to the forage stand.

Forage grasses have a great ability to utilize nutrients as they have a steady uptake throughout the season. Most grass crops used for pasture have less than optimal production due to shortfalls in one or more essential nutrients (Mahli et al, 2001). Manure applied on grass also has the advantages that it decreases the risk of surface water contamination by leached nutrients due to the reduced surface flow and greater infiltration that is typical in a grass stand. (van Vliet et al., 1998). Griffin (1998, 1997) found that forage yield where bales had been grazed on a pasture doubled after one year and increased by four times after two years. The additional increase was credited to a full recovery of the forage stand from heavy residue and the increased moisture retention that the residue then provided.

In the composting process raw manure is converted into a more stable form through decomposition (Larney et al, 1998). It results in a typical volume reduction of 60%, which saves money in transportation (Larney, 1999). It also can decrease concentrations of harmful E. coli bacteria to near undetectable amounts (Miller et al., 1998) as well as reducing weed seed viability.

The pattern of nutrients that cows leave on pasture is not well researched. Griffin (1998, 1997) found that over three years of study nitrogen levels on pasture averaged from five to six times higher where bales were grazed than where they were not.

Materials and Methods

Extensive Systems (in-field)

The in-field feeding systems were set out on a pasture of Russian Wild Rye grass at Termuende farm in the fall of 2003. Field records indicated that the field was an old stand that had not been fertilized in 2003 and had not been fertilized heavily in previous years. The plots were set out as two 220m X 90m (two hectare) parcels placed diagonally opposite each other with a winter watering system in the center. This strategy was intended to minimize problems keeping the cattle separated while allowing all equal access to water. Each plot was split into two replicates. The plot sites are laid out to minimize the effect of variation in the field, according to infra-red aerial photos, field inspection on the ground and exploratory soil sampling.

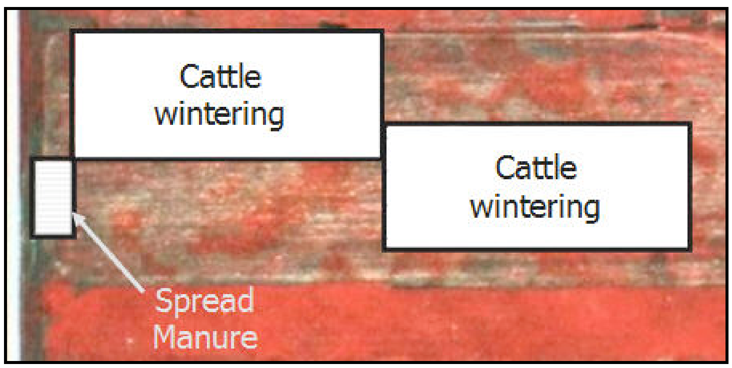

Figure 1. Site plan.

Once the plots are laid out solar powered electric fencing with permanent and temporary posts was used to keep the cattle in the required area. Solid fencing was used around the watering system at the separation point between the two plots, where pressure on the fence was the greatest. Portable wind shelters were used to provide protection from the elements.

The watering system was installed using a line dug in below the frost from a well on the next field, and was a relatively new system using geothermal energy to keep a watering trough free-flowing in cold winter conditions. Insulation in the trough sides, bottom and top, combined with special drinking tubes will be used to conserve the geothermal energy from the well water.

The plots were then soil sampled in a grid pattern. The pattern started 10 m from the edge of the outside fence and occurs at 25m intervals afterward. This resulted in thirty six points in each plot which were marked out with seven cm squares of coreplast, held down with fifteen cm nails so the cows did not pull them up when feeding during the winter. At each point a 15 cm soil sample was taken using a dutch auger with a 2.5 cm bit.

The soil samples were analyzed for nitrate N, ammonia N, P, K as well as pH, EC, total soil organic matter and light fraction organic matter.

The results from the fall of 2003 was used to create a map of nutrient availability and soil properties on the pasture paddock previous to the winter feeding using SURFER software.

On November 22nd thirty-two cows were placed in each of the two plots after being weighed and condition scored. Weights were taken twice initially to allow for gut fill. There were 16 cows in each replicate, based on the assumption each cow will produce 32 kg a day of manure[1]. When fed at the trial site for 130 days, this resulted in a manure application rate of 67.2 tonnes/ha. The cows were weighed once a month to monitor their progress and were condition scored as well at the end of the 130 days.

On two of the replicates the cows were fed by the bale processing method and on the other two by the bale grazing method. With each method the basic ration was 3% of body weight, 18.2 kg/day, which consisted of 7.3 kg of oat straw and 10.9 kg mixed grass/legume hay. For the bale processing method a Highline 6800 bale processor was used to feed one hay and one straw bale every three to four days, with the feeding being in different areas of the paddock each time.
For the bale grazing method all the straw and hay bales to be consumed in the winter were set out on the site at once, in 18 rows of 8 bales each. Access was controlled with electric wire so the cows of each replicate could access one hay and one straw bale every three to four days. In both feeding methods the amount of feed was varied as necessary according to weather conditions, with supplemental feed supplied as necessary. Salt and mineral was supplied free choice.

For both methods the amounts of feed, minerals and salt were recorded throughout the feeding season, and labour and machinery measurements were taken. The feed was sampled and analyzed for energy, protein, and minerals. Estimates made of the flexibility and ease of operation.

The cows were taken off the field on March 31st. Four intensive grids of 12 X 20 m size with 45 sample points per grid at 2.5 X 3 m spacing were marked out, one on each replicate. On May 19th to 27th soil samples were taken with 10 cm plastic tubes driven to a 15 cm depth. Testing was done for nitrate N, ammonia N, P, and K. Residue from the tube area was bagged separately, dried, weighed, and later tested for total nitrogen and total phosphorus.

Grass growth was also monitored. Cattle were kept off the field throughout the summer and clippings were taken at the same intensive grid points using quarter meter squares. A first cut was taken on July 16th to 17th and a second cut on Sept 26th to 27th. The samples were dried, ground and analyzed for total nitrogen and phosphorus.

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[1] p8, Manual for developing a Manure and Dead Animal Management plan, Sask. Agric. and Food.

Intensive Systems (confined)

For the intensive systems a replicated trial was marked out in the fall of 2003 in the same field. This trial consisted of check, raw manure, and composted treatments. The treatment strips were 30m long by 5m wide and were arranged side by side in a replicated complete block design with four replicates per treatment.

Soil sampling was done on each plot prior to the manure being applied, with four samples being taken in a zig-zag pattern down the center of each replicate and mixed together. These samples were analyzed in the same manner as those were for the extensive system.

A conventional rear spread manure spreader was loaded with raw manure from the corrals where cattle were fed the previous winter and was calibrated using a tarpaulin and scale to spread manure on the strips at a rate of 67.2 tonnes/ha, the same as the extensive system. The manure was then spread on all four replicates and the spreader was then emptied, cleaned, and loaded with cattle manure from the corrals which had been composted for the last 2 years. For the compost the rate was set at 22.4 tonnes/ha, which had the equivalent nitrogen content of the raw manure.

36 cows were fed intensively in drylot pens throughout the winter, using a tub ground ration of mixed straw and greenfeed from November to February 3rd, changing then to an alfalfa/grass hay, straw, and barley grain mix. Feeding was done once a day in bunk feeders with a Farm-Aid mix wagon. Salt and mineral were provided as needed. Amounts of feed, salt, and minerals fed during the feeding season were recorded, and labour and machinery measurements were taken. The feed was sampled and analyzed for energy, protein, and minerals. Estimates were made of the flexibility and ease of operation.

Soil samples were taken May 25th in a transect across the site, with five samples being taken per replicate. They were analyzed for nitrate N, ammonia N, P, and K.

Grass growth was monitored with a first cut taken July 19th and a second cut taken Sept 26th to 27th. These were taken using quarter meter squares taken in the same transect as the soil samples, with five samples also taken per replicate. The samples were dried, weighed, ground, and analyzed for total nitrogen and phosphorus.

Results and Discussion

Soil Nutrients

Soil nitrogen levels were low and even in all treatments in the fall prior to manure application or cattle wintering, averaging 36 kg N/ha. Spring levels, on the other hand were noted for large increases in soil N levels where the cattle were wintered and very small increases where manure or compost was spread. It should be noted that these levels do not include nutrients from surface residue or manure, which was moved away prior to sampling.

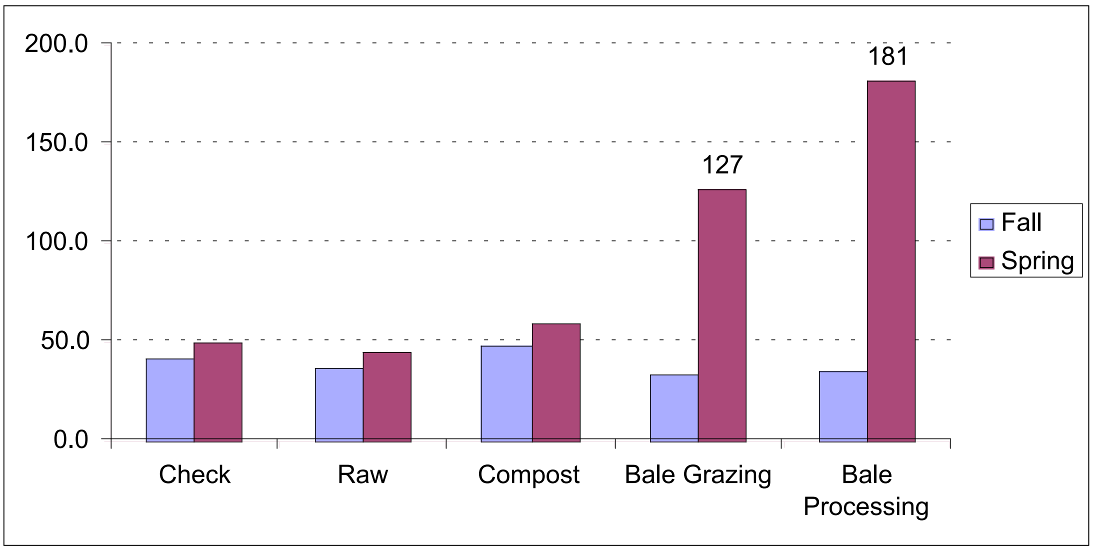

Figure 2. Soil inorganic nitrogen (nitrate + ammonium) in the 0-15 cm depth (kg N/ha).

Soil potassium levels followed the same trend, with little to no changes where manure or compost was spread and large increases where the cattle were fed over winter.

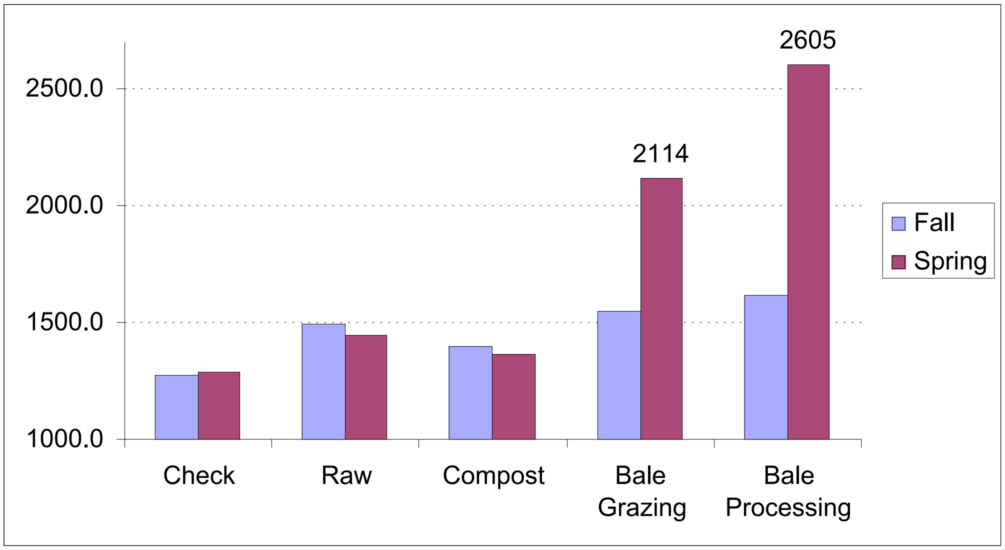

Figure 3. Soil potassium in the 0-15 cm depth (kg K/ha).

Soil nutrient patterns from the detailed sampling grids showed highly variable soil nutrient levels where the cattle were fed, with inorganic soil N levels varying from 12 to 626 kg/ha and soil K levels varying from 718 to 6326 kg/ha. Concentrations of nutrients followed bedding and feeding patterns, and appeared to be due to capture of urine nutrients that had been lost when the cows were fed in the corral. It was noted that the bale grazing was more uneven than bale processing, especially in the west sample site farthest away from the water. The cattle not only had their feed and bedding spread more evenly with the bale process feeding, but had access to the whole area of the site, whereas bale grazing cattle got access to the far areas of the pasture only at the very end of the trial. This concentration was accentuated in the last bale grazed areas by snow depth keeping the cows around the bales.

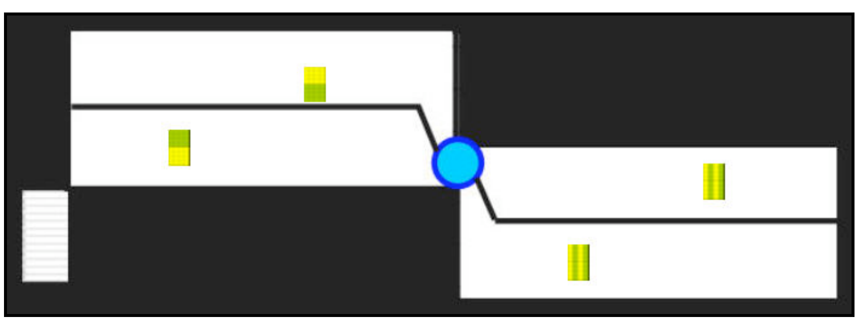

Figure 4. Location of detailed soil sampling grids, west is on the left.

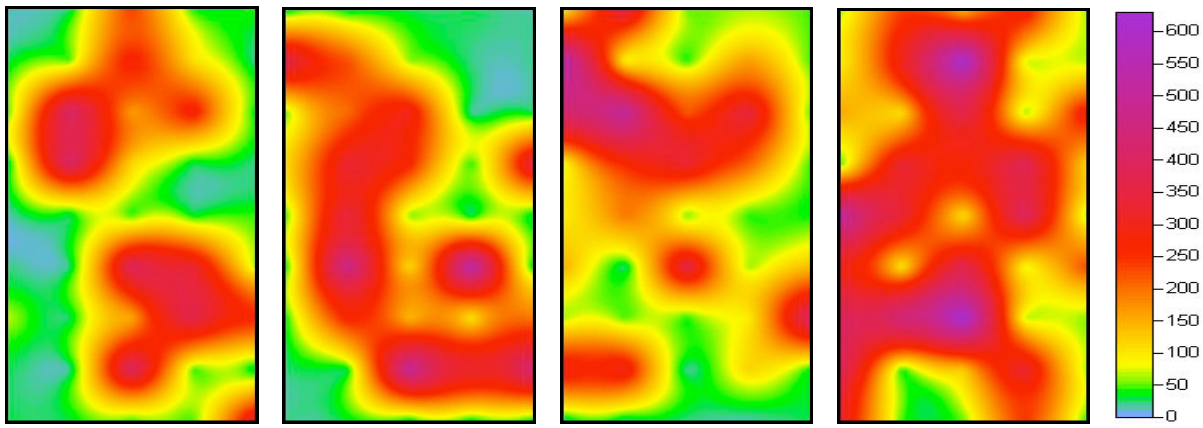

Figure 5. Soil inorganic nitrogen patterns: Bale Grazing west, Bale Grazing east, Bale Processing west, Bale Processing east. Nitrate + ammonium in the 0-15 cm depth (kg N/ha).

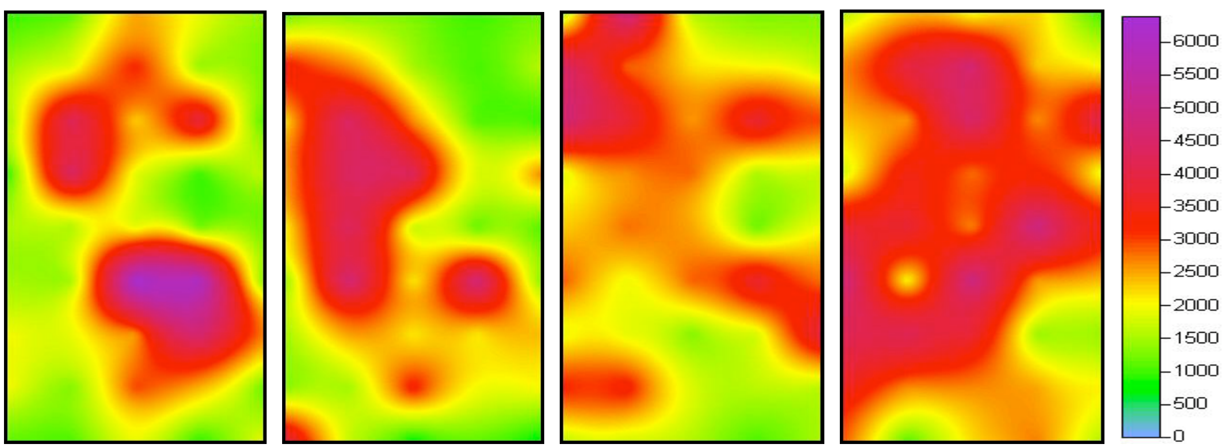

Figure 6. Soil potassium patterns: Bale Grazing west, Bale Grazing east, Bale Processing west, Bale Processing east. Potassium in the 0-15 cm depth (kg K/ha).

Forages

Grass growth was increased in all the manure treatments. Growth in the spread manure areas was early and even, with the composted manure giving a noticeable gain over the raw manure. Where the cattle was fed growth was later but stronger and held its quality much later in the year. There were gaps in grass growth where the cattle were fed, especially on the bale grazing from the straw. The forage on the pasture was Russian Wild Rye, a bunchgrass noted for holding its quality late into the fall. It appears to be not well suited to pasture feeding if residue levels are heavy as it is not as aggressive as a creeping rooted grass such as smooth brome.

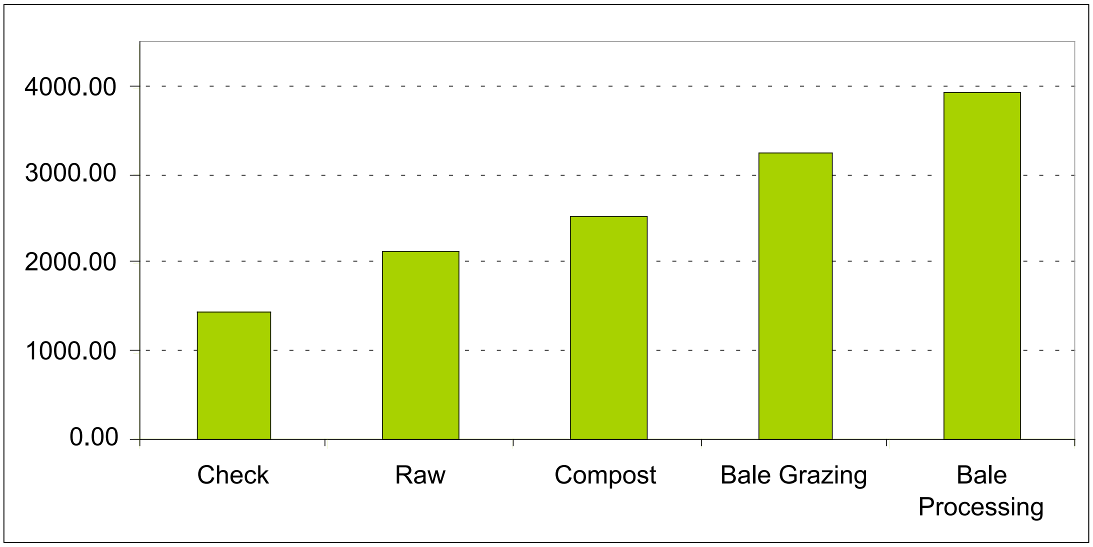

Figure 7. Total forage growth, kg dry matter/ha.

Cattle

Weight and condition changes were small and did not appear to be significant between the cattle in both pasture feeding treatments and those in the yard. It was noted that those fed in the pasture did appear to get better exercise.

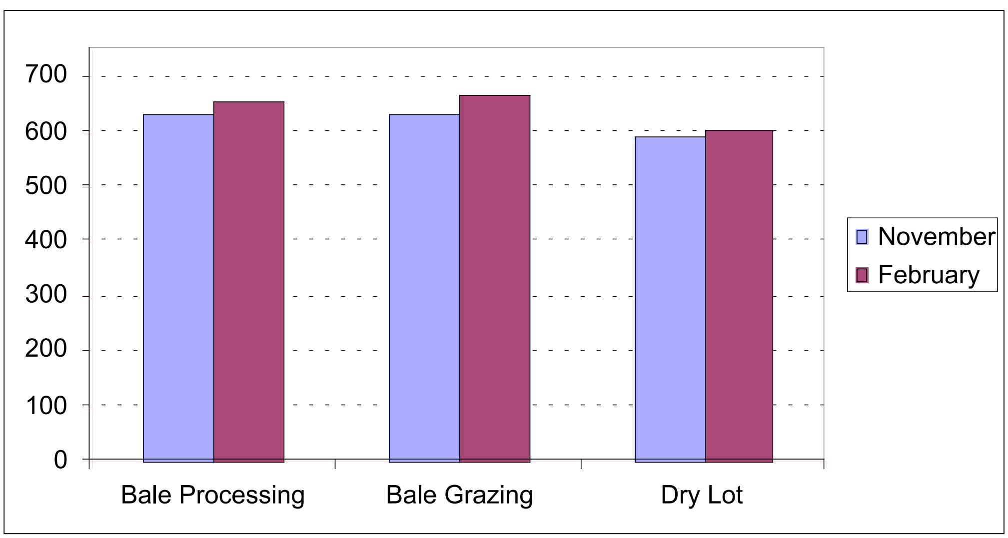

Figure 8. Weight change, kg.

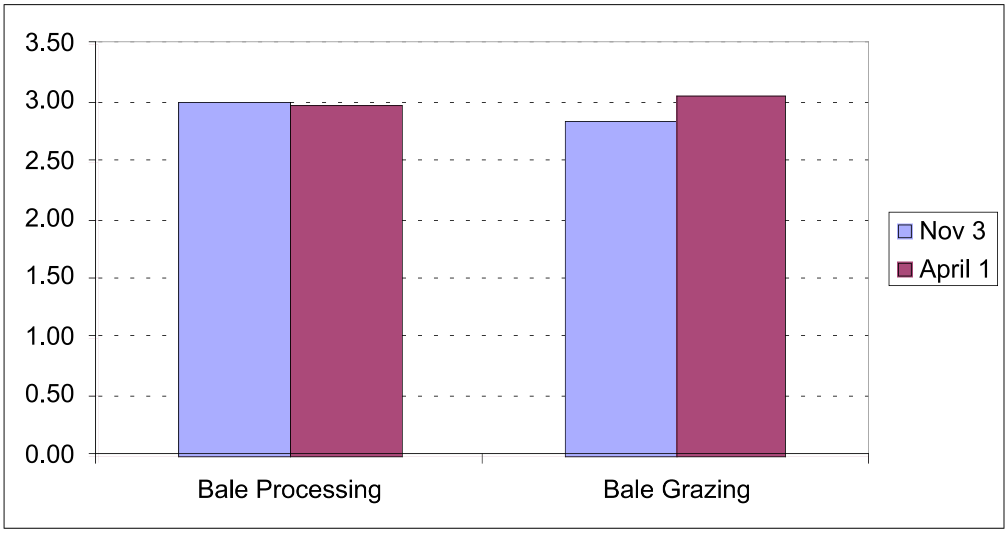

Figure 9. Condition change, scale of 0 to 5.

There was very little difference in feed consumed between the bale grazing and the bale processing, with the bale grazing consuming slightly more hay and the bale processing slightly more straw. Since the feeding was done with bale of slightly different weight and on an as needed basis the differences were not felt to be significant. Hay and straw left by the cows, s measured in the spring, was also similar between the treatment, with little hay left and considerable straw. It should be noted that estimating the exact amount of hay left was a very difficult and inexact process.

The yard fed animals did consume less feed, possibly due to being fed every day instead of every three to four days. However the fact they were fed a different ration and that it was tub ground makes it difficult to compare their feed consumption with that of the cows fed on pasture. Another complication is that they were bedded with chips instead of straw, so bedding amount and wastage was estimated only.

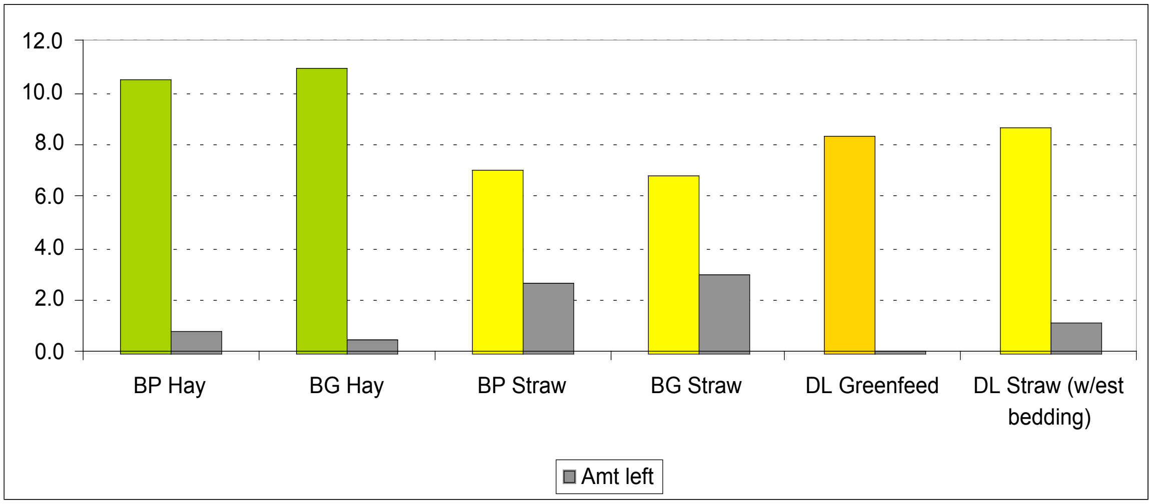

Figure 10. Feed and bedding, kg/cow/day.

Economics

Feed and bedding cost ended up being the same between the systems, with the savings from using a cheaper feed in the dry lot (yard fed) systems cancelled out by the extra cost of tub grinding. Machinery costs graduated sharply upwards from the bale grazing, in which a tractor was only needed to set out the bales, to dry lot compost, where manure needed to be composted by machine as well as hauled out to the field. Manpower, on the other hand was highest in the bale grazing system, mostly due to the difficulty of removing frozen on plastic twine by hand, one reason why many bale grazers prefer sisal twine, which only needs to be cut. When costs are added up at this point bale grazing still has an advantage in cost over the bale processing, and both pasture wintering methods have a considerable advantage over dry lot feeding. When an estimated value of additional pasture growth over the next three years is added to the list, pasture wintering gains considerably more.

Table 1. Cost breakdown of the different feeding systems, (Can $/cow/day).

	Bale Grazing	Bale Processing	Dry lot (raw)	Dry Lot (compost)
Feed and bedding	1.22	1.19	1.19	1.19
Machinery	.03	.08	.09	.09
		.04	.06	.06
			.04	.04
			.03	.03
Manure removal	0	0	.03	.13
Total	1.24	1.31	1.44	1.54
Manpower	.07	.04	.04	.04
Total	1.31	1.35	1.48	1.58
Pasture growth	.22	.31	.06	.09
Final total	1.09	1.04	1.42	1.49

Machinery differences are not as simple as portrayed in the cost figures given, derived from measures of running time multiplied by costs per hour from Sask Ag and Food. Number of cold starts during the winter show graphically how different the machinery use is.

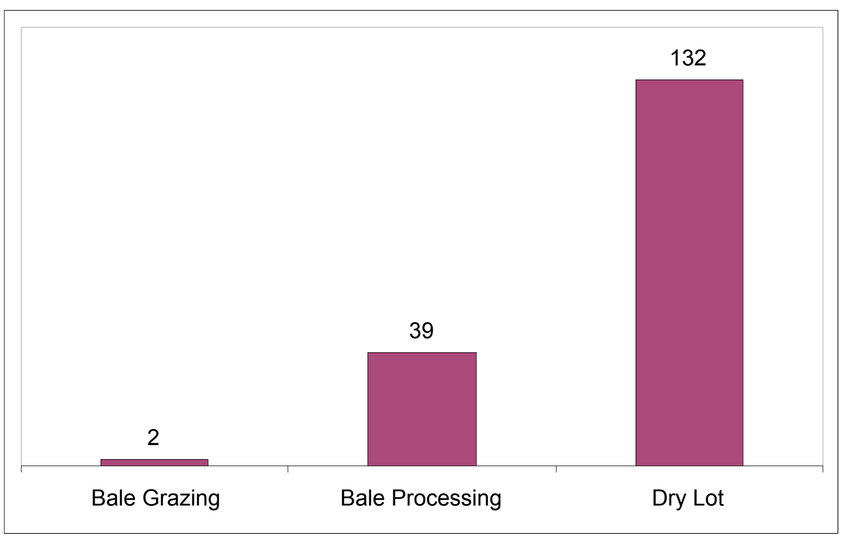

Figure 11. Tractor feeding cold starts, Nov 21 to March 31.

Conclusion

There was much better nutrient retention by the pasture when cattle were fed directly on the pasture versus being fed in the yard and having the manure spread afterwards. Distribution of nutrients after field feeding was directly related to feeding and nutrient patterns. Forage response was earlier and more even from spread manure but substantially greater in total from pasture feeding, despite the grass not being a species suited to high levels of residue cover. The cattle showed no significant differences in body condition or weight from any of the treatments. Economics favored infield feeding, especially when combined with the increased pasture growth.

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