Western Beef Development Centre
Division of PAMI

EFFECT OF WINTER FEEDING SYSTEMS ON SOIL NUTRIENTS, SOIL DISTRIBUTION & SOIL COMPACTION

By: Breeanna Kelln, Dept. Animal & Poultry Science;
Dr. Bart Lardner, WBDC; Dr. Jeff Schoenau, Dept. Soil Science;
& Tom King, Dept. Soil Science

Introduction

The winter feeding season represents 60-65% of the total cost of production for Western Canadian cow-calf producers (Kaliel and Kotowich 2002). Producers want to decrease production costs with feeding systems that utilize annual crops, such as swath grazing, bale grazing, and grazing crop residue. When using annual crops to winter cattle in a field, it is important to take into account how the feeding system impacts the soil. These extensive winter feeding systems can affect soil nutrient cycling and soil compaction, since the animals are applying nutrients from manure and urine throughout the winter feeding period. Traditionally, manure from a drylot pen is spread on land in spring, summer, or fall. This typically results in nitrogen (N) losses because the urine N gasses off to the atmosphere before the manure can be spread on the land (Ball et al. 1979). This N loss is inefficient in whole farm nutrient management and can lead to increased nutrient costs, reduced operational sustainability, and environmental problems. This study compared three field feeding systems, evaluating system effects on plant-available soil nutrients, soil nutrient distribution and soil compaction.

Study Site Description

A one-year study was conducted at the Western Beef Development Centre's Termuende Research Ranch, located at Lanigan, SK, over the 2005/06 winter period. The extensive wintering systems compared were swath grazing, bale grazing, and straw/chaff grazing, while the intensive system was a traditional drylot system. In June 2005, 100 acres of forage barley (cv. Ranger) was seeded at two bushels/acre, along with 50 lbs/acre actual nitrogen. The field was then divided into ten, 10-acre paddocks separated by electric fence. The barley was swathed at mid-dough stage for either greenfeed or swath grazing. Straw/chaff paddocks were left to mature and the grain was combined in late September. A whole-buncher (AJ Manufacturing, Calgary AB) was attached to the combine to collect piles of the straw/chaff residue.

Trial Management

One hundred and eighty cows were randomly allocated to one of four winter systems with three replicate groups per system. Each replicate group of cows (n=15) was confined in the 10 acre paddock and managed using electric fence to control access to feed. Drylot animals were housed in pens at the Termuende Research Ranch facilities. In each system feed was allocated to cows according to maintenance requirements. All cows were fed on a three-day feeding schedule along with free choice salt and mineral. Water was supplied in troughs every second day. Portable windbreaks were placed in each paddock and moved with the cows throughout the trial. The 2005/06 trial lasted 76 days from 17 November 2005 to 1 February 2006. In April 2006, core soil samples were taken from each of the replicate paddocks to determine available soil N and phosphorous (P). The soil samples were taken at the high, mid, and low slope positions to account for landscape effects. In addition, a 32-point grid (6.1m X 7.6m) was applied on each feeding site to create a map of soil nutrient distribution and availability throughout each paddock using digital analysis programming. Soil density measurements were taken at each grid point to determine the effect of winter feeding system on soil compaction.

Results

Soil extractable nitrate nitrogen (NO_3) levels were seen to increase at the low slope positions compared to the high slope positions. In all three systems, levels of NO_3 averaged 40 kg/ha at the high slope positions and increased to levels ranging from 35-72 kg/ha at the low slope positions demonstrating the influence of topography on the soil nutrient profile. Soil extractable ammonium nitrogen (NH_4) levels were similar for all three treatments with no differences seen with respect to slope position (Table 1).

Table 1. Effect of winter feed system on plant available soil nitrogen (kg ha^{-1})
Means within columns having the same letter do not differ significantly (P<0.05)

		Swath Graze	Straw/Chaff	Bale Graze
NO3	High slope	41.8b	42	38.3b
	Mid slope	29.6b	58.7	27.9b
	Low slope	71.8a	35.3	61.4a
NH4	High slope	8.3	6.8	7.4
	Mid slope	7.4	7.6	6.8
	Low slope	6.8	6.5	7.1

Patterns of manure distribution were seen to correlate with feeding site. Soil P distribution showed marked differences between treatments, with higher levels of P surrounding the feeding sites in each treatment, however, these results were not found to be significant (P>0.05). Straw/chaff grazing showed the greatest visual distribution of P with increased levels of P running horizontally through the feeding site correlating with feed site location (Figure 1). Landscape effects were also observed in the straw/chaff paddocks with increased P levels of 50 and 125 kg P ha^{-1}, in the mid and low slope areas. The lack of significant difference in amount of P could be due to a history of manure application on the current annual cropped field. Soil nutrients were not limiting in this trial, which is in contrast to a similar study by Jungnitsch et al. (2005) on which animals were winter fed on a Russian wildrye pasture. As well Jugnitsch et al. (2005) had higher stocking densities at 640 cow days ac^{-1}, whereas the current study had a stocking density of 114 cow days ac^{-1}. This difference in stocking density could have a significant impact on the amount of retained soil phosphorous.

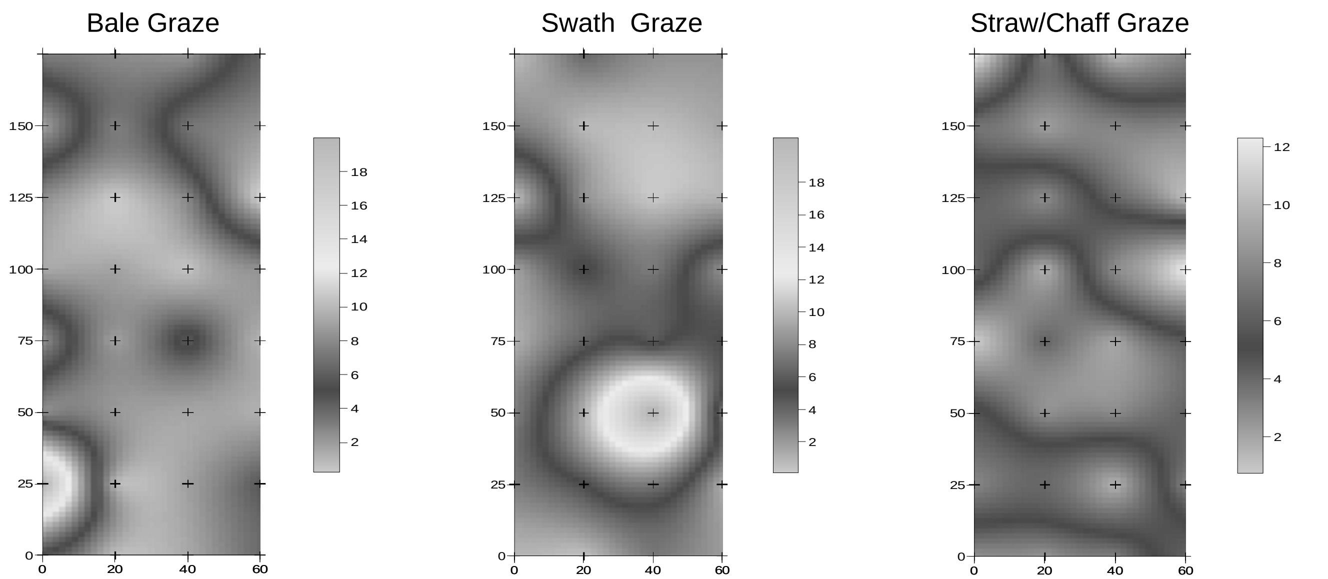

Figure 1. Effect of winter feed system on soil P distribution (μg cm^{-2})
(Units on axes are meters.)

The winter feed systems had a definite effect on soil density, with the bale-grazed treatment having the greatest effect and the straw/chaff-grazed treatment having the least effect on soil density at the 5 cm soil depth (Figure 2). However, these differences were not detrimental to soil hardness and adequate germination rates were observed the following crop year.

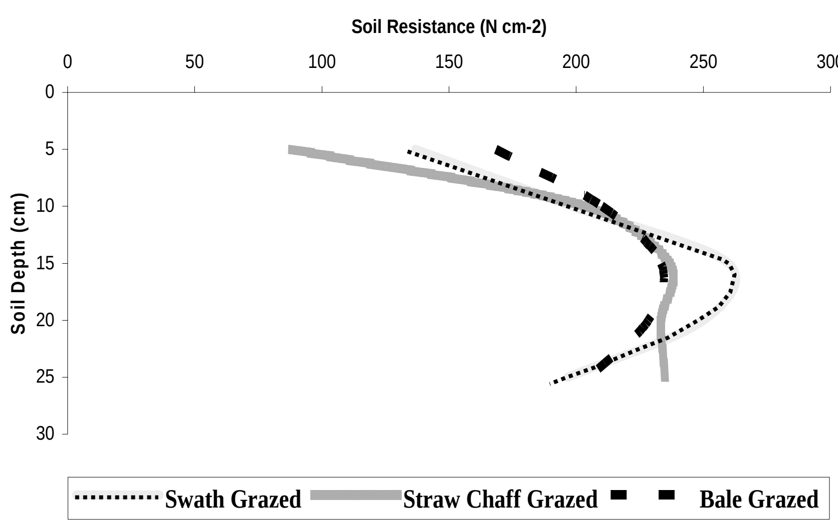

Figure 2. Effect of winter feeding system on soil compaction

Conclusions

From these results it can be concluded that feeding cattle in the field through the winter on annual forages allowed for increased capture of manure nutrients, along with a minimal impact on soil compaction. Depending on the resources and type of livestock operation, winter feeding beef cattle on crop residue or swath grazing or bale grazing can prove beneficial by depositing nutrients in the field for the subsequent crop the following year. With increased nutrient capture producers can decrease inputs needed the following growing season along with any associated production costs.

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For more information contact:
Western Beef Development Centre
Box 1150
Humboldt SK S0K 2A0
Phone (306) 682-3139 Fax (306) 682-5080
www.wbdc.sk.ca