Close the Loop, Cut Your Costs

At a time when soaring fertilizer and fuel costs gnaw at every beef producer's bottom line, free in-field nitrogen applications seem too good to be true.

by ***Ed Haag***

Not unlike their U.S. counterparts, Canadian beef producers have had to make major adjustments to their production systems in order to financially weather the rising costs associated with raising cattle.

Bart Lardner, research scientist from the Western Beef Development Centre in Humboldt, Sask., Canada, notes that producers in his province who continue to use drylot confinement to winter their cattle are operating at a major disadvantage.

"When fuel and fertilizer costs were low, it didn't make that much difference," he says. "Now it does."

He adds that, in response, a growing number of beef producers are shifting from the more traditional drylot approach to wintering their livestock (a system where all animals are housed in pens and manure is hauled to the fields) to systems where cattle are wintered on selected field feeding sites and the manure is deposited directly without the use of machinery.

Lardner notes that while the new system offers the obvious savings in fuel, machinery and labor costs, he and his associates believe that the return to the producer extends beyond those easily calculated cost reductions. He cites, as an example, a likely difference in nutrient quality between manure hauled to the field from the feedlot and the manure deposited directly on the field by the livestock.

"We know that manure that is deposited in a drylot feeding pen can be subject to volatilization losses," Lardner says. "If this loss could be minimized, there is the potential to improve soil nitrogen (N) levels in cropped fields and increase plant biomass."

He adds that a study conducted by University of Nebraska researchers in 2001 reported that feedlot yearlings retain approximately 10% of nitrogen, excreting the remaining 90%. And most of the nitrogen excreted is lost to volatilization.

Comparison data needed

While previous research and some in-field observations supported Lardner's suspicions that the quality of nutrients deposited in the field differed depending on the system used, no formal scientific study comparing the systems had actually been conducted.

"We needed to track the nutrient capture from each system so we could better understand what the actual benefits of each were to the next year's crops," he says. "Cattle drop a lot of manure every winter. It was important to determine how to best utilize it."

To better understand how each winter feeding system contributes to the nutrient levels of a pasture and the effect each one has on the following year's grass production, Lardner and his colleagues designed a set of comparative studies.

"By selecting certain winter feeding systems for the studies, [what] we were trying to do was mimic what was happening in the industry," Lardner says.

He notes that the drylot system featured in the study represents the traditional method of wintering cattle. Confining and feeding cattle in a drylot pen (DL) from October to April has been the prevailing feeding system for feeding cattle in the winter in western Canada from the 1940s through the 1990s, Lardner says, adding that the two other systems in the study — bale grazing (BG) and bale processing (BP) — are relative newcomers.

"We have seen producers adopting them over the last 10 to 15 years," he says, estimating that more than half the beef producers in Saskatchewan are now engaged in some type of in-field winter feeding.

Greg Lardy, North Dakota State University (NDSU) beef cattle specialist, has yet to see a significant shift from drylot winter feeding to in-field winter feeding in his region, but he is quick to point out that with soaring fuel, fertilizer and feed prices negatively affecting the producer's bottom line, any strategy that actually reduces the cost of production is likely to be embraced by the industry.

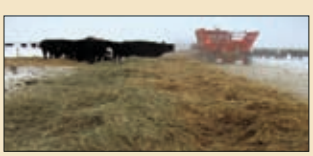
"Whatever you can do to improve pasture productivity is going to be increasingly important," he says. "This is especially true in relation to inputs and rising costs of nitrogen/phosphorous (P) fertilizers."

Lardy adds that escalating feed costs will also contribute to the adoption of more efficient winter feeding systems as beef producers strive to squeeze more forage out of the same pastures in order to survive in the business.

Fig. 1: Winter feeding systems

►Drylot
- — Cows fed daily in drylot pens
- — Nutrients accumulate in straw pack over winter
- — Cost to move manure (nutrients) in spring

►Bale processing
- — Feed one hay bale, one straw bale every three days
- — Distribution of nutrients in field
- — Eliminate cost of spreading manure



►Bale grazing
- — Feed set out in the fall; allocated on Day 3
- — Nutrient gradients as per bale site
- — Cost of moving feed to cows

Source: Bart Lardner, Western Beef Development Centre in Humboldt, Sask., Canada.

Evaluated head to head

The studies, designed by Lardner and his research colleagues to evaluate the most commonly used winter feeding systems, were conducted at Termuende Research Ranch, Lanigan, Sask., Canada, during two consecutive winters, 2003-2004 and 2004-2005. A long-established Russian wild ryegrass (*Psathyrostachys juncea*) pasture was divided into four 2.5-acre replicate areas located opposite each other with a centralized winter watering system. No fertilizer was applied to the study area in the previous two years; however, in 2000 and 2001 the site received 29.5 tons per acre of cattle manure and 49 pounds (lb.) per acre of nitrogen (46-0-0), respectively.

Lardner admits that he would have preferred conducting the study on a pasture populated by a more competitive perennial, such as smooth brome, but the advanced age of the ryegrass pasture added a desired dimension to the studies.

"We saw this also as an opportunity to demonstrate the use of these systems in rejuvenating an old perennial pasture," Lardner says, adding that with the high cost of ground preparation and seeding, more producers were looking to rehabilitation as a viable alternative to starting over.

For the studies, Lardner and his colleagues used 96 crossbred pregnant beef cows. These were randomly allocated to one of three replicated (n = 2) winter feeding systems.

Cattle in the drylot feeding system were confined in a single location and received round straw plus barley green-feed bales daily. These were processed and hauled by tractor and feed wagon and deposited in feedbunks for consumption.

In fall 2003, cattle manure and compost from the drylot pen system was applied with equipment to the study site in a replicated complete block design (RCBD) with four replicates per treatment. Treatment rates, manure at 30 tons per acre and compost at 10 tons per acre, were based on the amount of manure calculated to be deposited by study cows during the feeding period. The manure, compost (from a previous study) and check were applied in strips approximately 16 feet (ft.) by 100 ft.

In the bale-grazing system, straw and grass-legume hay bales were set out on the site in the fall, in 18 rows of eight bales each. Access to feed was controlled with electric fence, allowing one hay and one straw bale every three days.

"The cows were allowed to graze as much as they wanted off the bales available to them," Lardner says. "Then in three days we'd move the wire exposing two more fresh bales."

Fig. 2: Application of manure and compost from drylot feeding

►**Drylot manure treatments**
— 30 tons per acre raw manure
— 10 tons per acre compost
— No manure — control

► **RCBD design, 4 replicates per treatment**
►**100-ft. × 16-ft. strips**

Source: Bart Lardner, Western Beef Development Centre in Humboldt, Sask., Canada.

Lardner explains the animals in the bale-processing system were also fed one straw and one grass-legume hay bale every three days, but instead of allowing the cattle to graze directly off the bales, a bale processor was used to chop the forage, which was then deposited in 200-ft. windrows. Feeding locations were rotated across the study site during the 130-day period of the study.

All feeds used in the studies 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 lb. of oat straw and 23.5 lb. of grass-legume hay, calculated at 39.5 lb. per head per day. Salt and trace minerals were supplied free-choice.

Nutrient levels varied

In order to establish background levels of soil nutrients, soil samples were collected before beginning the studies in fall 2003. Feeding areas were again sampled (n = 45) in the spring of 2004 following winter feeding. All samples were taken to an approximate depth of 0.6 inches (in.) and analyzed for nitrate, ammonium, phosphorous and potassium (K).

For Lardner, one of the most striking aspects of the study was the difference in nitrogen distribution and concentration between the soil tests taken prior to winter feeding and the tests taken after winter feeding. He notes that in fall 2003, soil nitrogen levels were equivalent 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. In contrast, Lardner says, tests taken after winter feeding of beef cows showed soil nutrients on research plots were highly variable.

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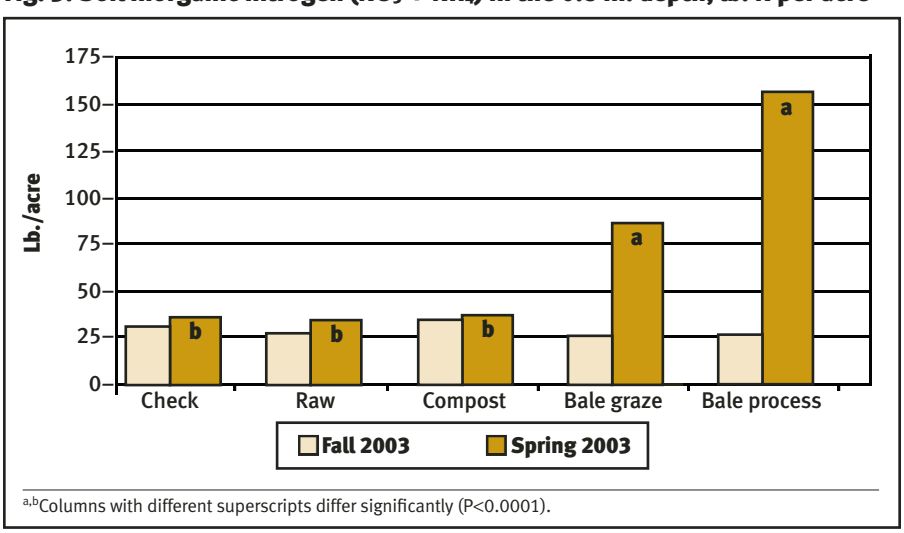
Fig. 3: Soil inorganic nitrogen (NO_3 + NH_4) in the 0.6 in. depth, lb. N per acre



[a,b]Columns with different superscripts differ significantly (P<0.0001).

Source: Bart Lardner, Western Beef Development Centre in Humboldt, Sask., Canada.

Nutrient levels from feed sites showed inorganic soil nitrogen levels varying from 39 lb. to 142 lb. per acre. "Nitrogen levels were 2.5 to 3.0 times greater on BG and BP feeding sites compared to control," he says. "They were also significantly greater where cattle were wintered compared to treatment areas [that] received manure or compost applied with equipment."

Lardner and his colleagues suggest the increased nitrogen levels from cattle wintering sites may be due to capture of urine nutrients that had been lost when the cows were fed in the corral. This hypothesis is supported by the types of nitrogen identified in the different systems and nitrogen uptake by plants the following year.

"Most of the nitrogen in the manure from the drylot was tied up in organic nitrogen and wasn't immediately available for plant uptake," Lardner says, adding that the inverse was true when the nutrients from the bale-processing and bale-grazing sites were analyzed. This discrepancy was most dramatically demonstrated the following year when plant uptake from the different sites was calculated.

"On the locations where the cattle were actually wintered, between 37% and 40% of the nutrients were used by the growing crop the next year," Lardner says. "Where the manure was put on with machinery, it was only 7%."

Levels reflected in production

One key component in Lardner's study was measuring and comparing forage production from each feeding system. Biomass samples were collected from each winter feeding site and manure treatment area using quadrants 0.25 square meters (m^2) in size. The material was then dried, weighed and presented on a dry-matter (DM) basis. In 2004, DM yield was estimated at two harvest dates, July 19 and Sept. 26. In 2005, samples were collected July 15.

Like the nutrient levels measured in the soil after the winter feeding, forage production varied significantly between treatment areas. In general, increased DM yield was observed on all treatment areas compared to the control site.

"Pasture growth was significantly greater where cattle were wintered compared to sites receiving manure and compost spread with equipment," Lardner says, adding that while production was 1.7 and 1.5 times greater on the applied manure and the applied compost sites than on the control sites, respectively, it was 2.3 and 3 times greater on bale-grazing and bale-processing sites than on the control sites, respectively.

For Lardner and others who participated in the two-year study, the evidence is conclusive. "Significant benefits can result from winter feeding beef cows on preselected sites due to increased capture and utilization of manure nutrients," he says. "With the price of inputs going through the roof, that is saying a lot."