1. What are the economic effects of incorporating alfalfa and fertilizer into grass-based pastures?


Objective
The objective of this project was to evaluate the effect of including alfalfa and/or fertilizer (N, P, K, and S) on the profitability of different pasture management strategies.

Method
A ten-year grazing study was conducted at the Agriculture and Agri-Food Canada Brandon Research Centre from 1994-2004. In the spring of 1994, pastures were established on a Souris fine sandy loam. The study used rotational grazing on four combinations of pasture type and fertilizer management. There were two different pasture types (100% grass or mixed alfalfa-grass) and two different fertilizer treatments (no fertilizer, or spring fertilization to full soil test recommendation levels). This resulted in a total of four treatments, shown in Table 1.

Table 1: Pasture types and fertilizer treatments used in the study.

<table>
<thead>
<tr>
<th>1) Meadow bromegrass</th>
<th>3) Meadow bromegrass</th>
</tr>
</thead>
<tbody>
<tr>
<td>No added fertilizer</td>
<td>+ Alfalfa</td>
</tr>
<tr>
<td></td>
<td>No added fertilizer</td>
</tr>
<tr>
<td>2) Meadow bromegrass</td>
<td>4) Meadow bromegrass</td>
</tr>
<tr>
<td>+ Fertilizer</td>
<td>+ Alfalfa</td>
</tr>
<tr>
<td></td>
<td>+ Fertilizer</td>
</tr>
</tbody>
</table>

The grass-only pastures were seeded with 10 lb/acre ‘Paddock’ meadow bromegrass. The mixed alfalfa-grass pastures were seeded with 7 lb/acre ‘Paddock’ meadow bromegrass and 3 lb/acre ‘Spredor II’ alfalfa. Starting in 1995, fertilizer was surface-applied as a dry blend prior to grazing each spring. The concentration of each nutrient in the blend was based on soil samples collected the previous fall.

The economic performance of the four different pastures was compared based on annual net revenue. Net revenue was calculated by subtracting all production and input expenses from gross revenue. Gross revenue was assumed to be $0.43 per pound of animal gain, which was the typical revenue for custom grazing during the last few years of the study.
Production and input expenses included: labour, variable costs (i.e., seed, fertilizer, chemical, fuel and oil, repairs, land taxes, interest cost on variable inputs, and miscellaneous), and fixed costs for machinery and livestock handling systems (depreciation, interest on investment, insurance and housing). Annual input expenses included the cost of pre-planting activities, fertilization, planting, harvesting, and transportation. Farm-level machinery and equipment were used to estimate costs. The labour cost and lifespan of machinery for farm operations was calculated according to the machinery work rate per acre (Saskatchewan Agriculture, Food and Rural Revitalization 2004 & 2007). The lifespan of infrastructure, determined from published values and other sources, was used to calculate infrastructure depreciation and interest on investment. No allowance was made for interest costs associated with land equity.

**Observations**

*Forage Yield and Animal Gain*

Adding fertilizer and/or alfalfa to grass-based pastures improved pasture productivity. Table 2 shows that the highest forage yield and animal gain were achieved in the fertilized alfalfa-grass pastures.

**Table 2: Forage yield and animal gain averaged over the 10-year study.**

<table>
<thead>
<tr>
<th>Pasture management strategy</th>
<th>Forage yield (tons/ac)</th>
<th>Animal gain (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilized alfalfa-grass</td>
<td>2.4</td>
<td>224</td>
</tr>
<tr>
<td>Fertilized grass-only</td>
<td>2.2</td>
<td>217</td>
</tr>
<tr>
<td>Unfertilized alfalfa-grass</td>
<td>1.7</td>
<td>156</td>
</tr>
<tr>
<td>Unfertilized grass-only</td>
<td>1.1</td>
<td>99</td>
</tr>
</tbody>
</table>

**Economic analysis based on 2007 fertilizer prices**

Table 3 shows the annual fertilizer cost for the four pastures, based on spring 2007 fertilizer prices ($0.50/lb N, $0.38/lb P, $0.22/lb K, $0.34/lb S). Fertilizing either grass-only or alfalfa-grass pastures at least doubled the forage yield compared to unfertilized grass-only pastures. However, the yield increase in alfalfa-grass pastures was achieved with less than half the cost required to fertilize grass-only pastures.

**Table 3: Fertilizer cost for the different pastures, based on 2007 fertilizer prices.**

<table>
<thead>
<tr>
<th>Pasture management</th>
<th>Fertilizer cost (10-year average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfertilized grass only</td>
<td>$0</td>
</tr>
<tr>
<td>Fertilized grass only</td>
<td>$65</td>
</tr>
<tr>
<td>Unfertilized alfalfa grass</td>
<td>$0</td>
</tr>
<tr>
<td>Fertilized alfalfa grass</td>
<td>$31</td>
</tr>
</tbody>
</table>

Figure 1 shows the net revenue for the four pastures based on spring 2007 fertilizer and input prices. The bars above the horizontal line show a net profit, while the bars below the line show a net loss. Averaged over the 10 years of the study, the only pasture improvement strategy with a
net profit was the unfertilized alfalfa-grass pastures, which had a profit of $11.75/acre. The other three pasture improvement strategies resulted in a net loss. It should be noted that all the pastures had fairly similar fixed costs. While the unfertilized grass-only pasture was the lowest-cost grazing system, it was not the most profitable because the fixed costs were high, relative to the low level of productivity.

The highest net loss ($40.06/ac) was for the fertilized grass-only pastures, even though adding fertilizer doubled the forage yield compared to unfertilized grass-only pastures. Therefore, fertilizing grass-only pastures to full soil test recommendations is not advised. Fertilizing alfalfa-grass pastures to full soil test recommendations resulted in a yield increase of 0.7 tons/acre each year compared to unfertilized alfalfa-grass pastures. Despite this yield increase, fertilizing alfalfa-grass pastures to full soil test recommendations resulted in a net loss of $3.24/ac.

Based on 2007 fertilizer prices, every pasture management strategy resulted in a net loss for at least two years of the ten-year study. Even the most profitable strategy, the unfertilized alfalfa-grass pastures, had a net loss in two out of ten years. In comparison, a net loss was seen in fertilized alfalfa-grass pastures for five out of ten years, in unfertilized grass-only pastures for six out of ten years, and in fertilized grass-only pastures for nine out of ten years.

![Figure 1: Net income of four pasture systems calculated using 2004 and 2007 fertilizer prices, 10-year average ±SEM](image)

**Figure 1: Net income of four pasture systems calculated using 2004 and 2007 fertilizer prices, 10-year average ±SEM**

**Economic analysis based on 2004 fertilizer prices**

The results of the economic analysis depend heavily on fertilizer price. As a comparison to 2007 costs, calculations were done using 2004 fertilizer prices ($0.33/lb N, $0.12/lb P, $0.12/lb K, $0.26/lb S), which were lower than in 2007. The year 2004 was chosen because it was the last year of the study. Figure 1 shows that with 2004 fertilizer and input prices, both of the alfalfa-containing pastures generated a net profit. The unfertilized alfalfa-grass pasture was still
economically the best choice ($11.75/ac profit). However, under this scenario, the fertilized alfalfa-grass pasture also produced a net profit ($9.11/ac).

Precipitation strongly affected net revenue. Between 1998 and 2000, most of the pastures showed a net profit. Figure 2 shows that during these years, higher precipitation tended to result in higher forage yield.

![Figure 2. Effect of Precipitation on Forage Yield (tons/ac)](image)

Both of the grass-only pasture pastures resulted in a net loss. Fertilizing grass-only pastures was still economically the worst option, followed by unfertilized grass-only pastures. Therefore, while actual numbers for profitability may be heavily influenced by variable costs, especially fertilizer costs, the relative profitability of the pastures did not change.

**Conclusion**

While converting poorer soils from cropland to perennial forage grasses may improve soil health and reduce erosion, it is not always profitable unless pasture improvements are made. These improvements include adding nutrients as either commercial fertilizer or supplemental feed, or simply by adding alfalfa or other nitrogen-fixing legumes at the time of seeding.

Pasture improvements can increase forage yield, but superior yields do not necessarily translate into increased profits. Fertilizing grass-only or alfalfa-grass pastures to full soil test recommendations improved pasture productivity, but did not improve profitability compared to unfertilized pastures. Fertilizing grass-only pastures resulted in the highest net loss of any pasture management strategy in this study. Adding alfalfa at the time of seeding, with no added fertilizer, was economically the best pasture improvement strategy in this study.

Because of moisture limitations, adding commercial fertilizer to full soil test recommendations is probably not economically justifiable in most years, especially with the rising cost of fertilizer. However, improved productivity could probably be achieved with much lower rates of fertilizer. Further research is needed to determine what level of fertilization would be optimal.
**Research Team**
Dr. Mohammad Khakbazan, Dr. Shannon L. Scott, Mr. Clayton Robins, Dr. Hushton Block, and Dr. Paul McCaughey.

For more information contact Dr. Mohammad Khakbazan, (204) 578-3555, mkhakbazan@agr.gc.ca

**Acknowledgements**
- The technical assistance of Mr. Clayton Robins, Ms. Tanya Lewandoski-Duncan, Mr. Dean Sykes, Mr. Ron Kristjansson, Mr. Jay Ahntholz, Mr. Jeff Bieganski, Mr. Jason Lamb, Mr. John Rempel, and Mr. Brett Stewart
- Factsheet development by Ms. Orla Nazarko, Greenstem Communications, and Ms. Corie Arbuckle, Manitoba Forage Council Communications
- Funding from the Greencover Canada Technical Assistance Program and the Manitoba Agriculture Food and Rural Initiatives Covering New Ground Program
2. What is the energy use efficiency of incorporating alfalfa and fertilizer into grass-based pastures?


Objective
The objective of this project was to evaluate the efficiency of non-renewable energy use on four different pasture systems.

Method
The study used rotational grazing on four combinations of pasture type and fertilizer management. There were two different pasture types (100% grass or mixed alfalfa-grass) and two different fertilizer treatments (no fertilizer, or spring fertilization to full soil test recommendation levels). (See presentation entitled, “What are the economic effects of incorporating alfalfa and fertilizer into grass-based pastures?” for more details).

In order to evaluate the efficiency of non-renewable energy use of beef production in these four different pasture systems, both energy inputs and energy outputs were calculated. Energy inputs were determined from the non-renewable energy inputs into the grazing systems. All direct and indirect non-renewable energy inputs used in the manufacturing, formulation, packaging, transportation, maintenance and application of all purchased inputs were included.

Direct energy inputs are those that can be easily converted into energy units; for example, the diesel fuel used to seed a pasture. Amounts of fuel and lubricants used by machinery were determined from the Saskatchewan Agriculture, Food and Rural Revitalization Farm Machinery Custom and Rental Rate Guide (2004 & 2007).

Indirect energy inputs are not as easily measured. For example, the energy required to manufacture the metal frame and rubber tires of the tractor used to seed the pasture is an indirect energy input. The amounts of both the direct and indirect energy inputs used were calculated in Megajoules per acre (MJ/acre). As a comparison, burning one litre of gasoline produces approximately 40 MJ of energy. Table 1 shows the energy inputs that were included in the study as well as those that were not.

Energy outputs were determined from the energy retained in the beef produced by the cattle grazing the different pasture types.
Table 1: Energy inputs included and not included in the study.

<table>
<thead>
<tr>
<th>Energy inputs included</th>
<th>Energy inputs not included</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fuel &amp; lubricants</td>
<td>• Human labour (it accounts for less than 0.2% of the energy input in most cropping systems)</td>
</tr>
<tr>
<td>• Machinery</td>
<td>• Plant nutrients removed from soil</td>
</tr>
<tr>
<td>• Fertilizer</td>
<td>• Increases or decreases in soil organic matter</td>
</tr>
<tr>
<td>• Pesticides</td>
<td>• Energy captured directly from the sun by growing plants</td>
</tr>
<tr>
<td>• Infrastructure (fencing, corrals, water, etc.)</td>
<td>• Transportation and processing of crops beyond the farm</td>
</tr>
</tbody>
</table>

The use of non-renewable energy was measured in two different ways:
1. Total energy inputs per acre (MJ/acre)
2. Efficiency of non-renewable energy use. This is the energy output per MJ of non-renewable energy input used.

Observations

Fertilizer Inputs
The average amount of fertilizer applied each spring to each pasture type is shown in Table 2. The amount of nitrogen (N) applied on fertilized grass-only pastures was three times higher than that applied on fertilized mixed alfalfa-grass pastures.

Table 2: Fertilizer applied annually to each pasture type, 10-year average.

<table>
<thead>
<tr>
<th>Pasture management</th>
<th>N (lb/ac)</th>
<th>P (lb/ac)</th>
<th>K (lb/ac)</th>
<th>S (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfertilized grass-only</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unfertilized alfalfa-grass</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fertilized grass-only</td>
<td>99</td>
<td>26</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Fertilized alfalfa-grass</td>
<td>32</td>
<td>30</td>
<td>20</td>
<td>11</td>
</tr>
</tbody>
</table>

Total Non-renewable Energy Inputs per Acre
Fertilizer, especially N fertilizer, accounts for a large amount of the total non-renewable energy input. Fertilizer was responsible for 93% of the total energy input for fertilized grass only pastures and 75% for fertilized alfalfa-grass pastures.

Figure 1 shows that the energy input per acre was highest for fertilized grass-only pastures, requiring more than 3700 MJ/acre. This is approximately equivalent to burning 96 litres of gasoline per acre (see Table 3). In comparison, the total energy input for both unfertilized pastures was very low, requiring about 200 MJ/acre, approximately equivalent to burning 5 litres of gasoline per acre.
Table 3: Energy input and output in equivalent litres of gasoline/acre (10-year average).

<table>
<thead>
<tr>
<th>Pasture management</th>
<th>Energy input (Litres of gasoline/acre*)</th>
<th>Energy output – beef production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfertilized grass-only</td>
<td>4.7</td>
<td>14.7</td>
</tr>
<tr>
<td>Unfertilized alfalfa-grass</td>
<td>5.2</td>
<td>23.7</td>
</tr>
<tr>
<td>Fertilized grass-only</td>
<td>95.6</td>
<td>33.7</td>
</tr>
<tr>
<td>Fertilized alfalfa-grass</td>
<td>37.0</td>
<td>35.0</td>
</tr>
</tbody>
</table>

*Gasoline contains approximately 39.6 MJ per litre.

Figure 2 shows the forage yield of the different pasture management strategies. Although fertilizing grass-only pastures doubled the forage yield compared with unfertilized grass-only pastures, it also required more than 20 times the energy input. Similar yield increases were also achieved in fertilized alfalfa-grass pastures; however, this required less than half the energy input required in fertilized grass-only pastures. Adding alfalfa without applying fertilizer also increased forage yield (by 55%), although the yield increase was less than that achieved by adding fertilizer to either grass-only or alfalfa-grass pastures. However, the unfertilized alfalfa-grass pastures required only a small increase in energy input (11%) compared to unfertilized grass-only pastures.
Efficiency of Non-renewable Energy Use

Another way of measuring non-renewable energy use is to calculate the ratio of energy output to energy input. This ratio shows how much energy is produced for every MJ of energy input. Higher ratios mean more energy is produced per MJ of energy input, resulting in a more efficient use of non-renewable energy. Figure 3 shows the efficiency of energy use for the four pasture systems. The highest efficiency of energy use was calculated for unfertilized alfalfa-grass pastures, with 4.6 MJ of energy produced for every MJ of non-renewable energy input. The fertilized pastures had the lowest efficiency of energy use. Again, this is due to the high energy cost associated with the manufacturing of chemical fertilizers.

Conclusion

The unfertilized grass-only pasture used the least amount of non-renewable energy. Improving grass-only pastures by adding fertilizer and/or alfalfa required additional non-renewable energy inputs; however, the additional energy required for unfertilized alfalfa-grass pastures was minimal compared to the fertilized pastures. In the fertilized pastures, N fertilizer accounted for most of the total energy input. Since there was no fertilizer applied to the unfertilized pastures, they required much less energy.

Of the four pasture management strategies, adding alfalfa to grass pastures without adding fertilizer had the highest efficiency of energy use. The unfertilized alfalfa-grass pasture was also the best choice in terms of net revenue (see presentation entitled, “What are the economic effects of incorporating alfalfa and fertilizer into grass-based pastures?” for more details). Based on energy use and economic performance, the unfertilized alfalfa-grass pasture was the most efficient pasture system.
Research Team
Dr. Mohammad Khakbazan, Dr. Shannon L. Scott, Mr. Clayton Robins, Dr. Hushton Block, and Dr. Paul McCaughey.

For more information contact Dr. Mohammad Khakbazan, (204) 578-3555, mkhakbazan@agr.gc.ca

Acknowledgements
• The technical assistance of Mr. Clayton Robins, Ms. Tanya Lewandoski-Duncan, Mr. Dean Sykes, Mr. Ron Kristjansson, Mr. Jay Ahntholz, Mr. Jeff Bieganski, Mr. Jason Lamb, Mr. John Rempel, and Mr. Brett Stewart
• Factsheet development by Ms. Orla Nazarko, Greenstem Communications, and Ms. Corie Arbuckle, Manitoba Forage Council Communications
• Funding from the Greencover Canada Technical Assistance Program and the Manitoba Agriculture Food and Rural Initiatives Covering New Ground Program
3. Can resting pastures during the critical late-season period affect productivity and alfalfa persistence?


Objective

To determine the effect of resting perennial pastures during the critical period on productivity, alfalfa persistence and water use efficiency.

Methods

This grazing system uses 8 paddocks of perennial meadow brome grass-only pasture (approximately 10 ha each), 8 paddocks of alfalfa/meadow brome grass pasture (approximately 10 ha each), and 4 paddocks seeded to annual forages for swath-grazing (approximately 10 ha each) (see map). The perennial pastures were established as paired grass only and grass/alfalfa paddocks over a period of eight years. Of the 4 paddocks seeded to annual forages for swath-grazing, two are seeded as early as possible in May, and two are seeded late, in mid-June. Both the early- and late-seeded annual forages are swathed at the soft dough stage for swath-grazing (see Figure 1). This trial will run for four years, and oats and barley will alternate as the annual forage.

The grazing trial is set up as a replicated trial, with 4 grass-only paddocks, 4 alfalfa-grass and 2 swath-grazing paddocks assigned to each of two replicates. Separate cow-calf herds graze the Replicate 1 – grass only paddocks, the Replicate 1 – grass/alfalfa paddocks, the Replicate 2 – grass only paddocks, and the Replicate 2 – grass/alfalfa paddocks. The cows in each of the four separate cow-calf groups will continue together for the four years of the trial. For this trial, the summer grazing season is divided into three phases (see Figure 2):

Figure 1: Early-seeded oats for swath-grazing

Figure 2: Three phases of the grazing trial (one replicate shown)
In Phase 1, cow-calf pairs rotationally graze their respective perennial pastures from the beginning of June until the end of July. Twenty 0.25-m² quadrat samples are clipped at pre-determined GPS coordinates within each pasture before and after grazing to estimate daily intake, forage yield, and botanical composition. During Phase 1, cow-calf pairs graze each pasture once for 10-12 days. The perennial pastures are grazed in the same sequence each year, although a different set of pastures is grazed first over the four years of the trial. This grazing schedule ensures that all pastures are grazed at differing periods throughout the growing season and the dormant season, so that the impact from grazing will be as uniform as possible. Water use efficiency in the perennial and annual pastures is calculated from soil water content determined using a neutron moisture gauge (see Figure 3).

In Phase 2, the perennial pastures are divided in half lengthwise at the beginning of August (see Figure 4). One half is not rested and one half is rested. In the half that is not rested, cow-calf pairs continue to rotationally graze through their respective paddocks. The cow-calf pairs from the rested halves are moved off the perennial pastures and onto the early-seeded annual forages for swath-grazing (see Figures 5 and 6). In order to maximise use of swathed material and minimise residual material, access to
the swathed annual forages is restricted using electric cross-fences. Cattle are moved daily to fresh material. Phase 2 ends when either the swathed forage or the non-rested perennial pasture runs out. At the end of Phase 2, the calves are weaned from the cows in all treatment groups, and the cows are housed in pens and/or additional available pasture until such a time as the perennial forages in the Rested Grazing Trial have entered fall dormancy. The calves are fed in separate pens prior to being allocated to winter feeding trials.

In Phase 3, the cows that had been swath-grazing the early-seeded annual forages prior to weaning move back to graze the rested halves of their respective perennial pastures. At the same time, the cows that had been grazing the non-rested halves of the perennial pastures move onto the late-seeded annual forages for swath-grazing. Phase 3 ends for the late-seeded cereals when the swathed foraged is completely utilized and for the rested perennial pastures when they have been grazed to the same residue as the corresponding non-rested portion.

During all three phases of this trial, perennial pasture productivity is determined from clippings taken at specific locations in each paddock pre-determined by GPS. These clippings are hand separated into forage species in order to determine percentage of alfalfa in the pasture on a dry matter basis. Clippings are also used to determine the nutritional quality and the yield of the forage available. For the annual forages, clippings taken prior to swathing are used to determine their yield. Grab samples are taken from the swath as the swath-grazing progresses to determine the nutritional quality of the swathed material. Clipped samples of the cereal regrowth, should regrowth occur, are also collected near the same points as the grab samples to assess yield and quality. At the end of swath-grazing in each paddock, the mass of the residual material is measured to estimate intake. Cow and calf weights and cow body condition scores are determined at the beginning and end of each phase in order to determine impact of treatments on animal performance.

Observations in 2006 and 2007

Due to the extremely dry conditions in the summer of 2006, there was a significant improvement in forage yield of the early-seeded over the late-seeded oats on the lighter soils in the experimental paddocks. Early-seeded oats yielded 8660 kg ha\(^{-1}\) total forage yield, while late-seeded oats yielded only 3200 kg ha\(^{-1}\). In 2007, early-seeded barley yielded 9800 kg ha\(^{-1}\) total forage yield, while late-seeded barley yielded 6360 kg ha\(^{-1}\). This translates to a 1.5-fold increase in carrying capacity when comparing the two systems. All input costs were identical for the early and the late-seeded crops. These differences in forage production translate into a 1.5-fold increase in carrying capacity for the rested grazing system compared with the normal grazing system (Table 1). It should be noted that all input costs were identical for the early and the late-seeded crops.

An additional benefit to the early-seeded cereal grazing system is the opportunity for fall weed control options due to the earlier timing of the grazing and complete utilization of the forages much prior to normal timing of late-season herbicide applications.
Table 1: Estimated Animal Unit Days (AUD) of grazing per hectare at AAFC-BRC

<table>
<thead>
<tr>
<th>Management Stage</th>
<th>Normal Grazing</th>
<th></th>
<th>Rested Grazing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
<td>2007</td>
<td>2006</td>
<td>2007</td>
</tr>
<tr>
<td>Phase I</td>
<td>114</td>
<td>137</td>
<td>112</td>
<td>134</td>
</tr>
<tr>
<td>Phase II</td>
<td>67 (perennial pastures)</td>
<td>99 (perennial pastures)</td>
<td>360 (swathgrazing early-seeded oats)</td>
<td>510 (swathgrazing early-seeded barley)</td>
</tr>
<tr>
<td>Phase III</td>
<td>152 (swathgrazing late-seeded oats)</td>
<td>315 (swathgrazing late-seeded barley)</td>
<td>100 (stockpiled perennial pastures)</td>
<td>167 (stockpiled perennial pastures)</td>
</tr>
<tr>
<td>TOTAL AUD ha⁻¹</td>
<td>333</td>
<td>551</td>
<td>574</td>
<td>811</td>
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</table>

Research Team

Dr. Shannon L. Scott, Dr. Hushton Block and Mr. Clayton Robins, AAFC-BRC
Dr. Martin Entz and Mr. Simon Neufeld, University of Manitoba

For more information contact Dr. Shannon Scott, (204) 578-3605, sscott@agr.gc.ca

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- Funding from the Beef Cattle Research Council is greatly appreciated.
### Pasture Map for Rested Pasture Grazing Project

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4. Which barley variety is the best for early season swath grazing?

Researchers: Mario Therrien, Ph.D., Hushton Block, Ph.D., and Clayton Robins, B.S.A.

Background
Extended swath grazing using annual crops has shown benefits to cattle producers wanting to manage costs by allowing cattle to graze one to three additional months beyond the normal grazing period. The newest barley varieties, including AC Ranger (6-row, smooth-awned, forage variety) and Desperado (6-row, smooth-awned, forage variety), have very high dry matter yield potential, along with high forage quality, making them an excellent choice for swath grazing. However, when barley is used for swath grazing, it often begins to deteriorate from weathering more rapidly than such crops as millet. This can result in reductions in both quality and palatability, increasing forage refusal and waste, and often negating any gains from increased yield. To overcome this deficiency, the Brandon Research Centre forage barley program has developed a new form of forage barley with a coat of heavy wax similar to that found in the common millets. The idea is to produce barley that has the potential to maintain forage quality in the swath as long as millet, but which provides the higher forage yields and quality that are typical of barley.

Objectives
The objectives of these trials are to evaluate the potential advantage of this new heavy wax barley for use with early season swath grazing relative to other annual crops. This involves an *in situ* trial for evaluation of rumen degradability and a field-scale extended swath grazing experiment with cattle. The trials will assess how well the different varieties of annual crops maintain forage quality when used for early-season swath grazing from the degradability and palatability or preference that cattle exhibit for different crop varieties.

Preliminary Observations – 2007
To see if the heavy wax barley variety would maintain quality in a swath, it was grown alongside conventional barley [AC Metcalfe (2-row, rough awned, malting variety)], swathed at the end of July, and left in the field until the middle of October. The conventional barley displayed considerable evidence of deterioration (growth of mildew and loss of colour in the stems), whereas the heavy wax cultivar appeared to be comparatively less weathered after two months of exposure to the elements. Samples collected during this period were prepared for evaluation of *in situ* rumen degradability in a trial this autumn. Additionally, there was some evidence that the local white-tailed deer population preferred the heavy wax barley. Based on these observations, we decided to conduct the current evaluation of grazing preference.

Methods
*In situ* trial:
The stem and leaf fractions were separated from the samples collected from the swaths left in the field until mid-October of 2007 of the experimental variety of heavy wax barley and the control variety of barley, AC Metcalfe. They were ground and will be used for a nylon bag *in situ* incubation trial. Only
the stem and leaf fractions will be evaluated since there was extensive removal of the heads from the later samples of the heavy wax barley by the white-tailed deer population inhabiting the Brandon Research Centre.

Samples of each type of barley will be incubated in the rumen of ruminally cannulated steers for varying lengths of time. The amount of material removed from the bags by microbial fermentation will allow determination of rate and extent of rumen degradation of the stem and leaf fraction of the swathed material. These parameters are related to the total digestibility of fibrous plant material. Results of this comparison will provide information on how the digestibility of the leaf and stem portions of the heavy wax barley compares to that of the AC Metcalfe control, and how this relationship changes over time with increased weathering.

**Preference Trial**
Three varieties of barley, AC Ranger, Desperado and EX733 (heavy wax experimental variety), and one spring triticale, AC Ultima, were sown in long strips, in three replicates (Figure 1). AC Ranger and Desperado are two smooth-awned, high-yielding forage barley varieties; EX733 is the experimental heavy wax barley, and AC Ultima spring triticale is very resistant to stem rust, leaf rust, and common bunt and is used for comparative purposes. Each strip was swathed at approximately the late milk stage in July and left in the swath until mid-September before grazing started.

Forage samples were collected at the time of swathing for yield and quality. Further samples were collected at the original sample sites for quality determination on days 7, 28, and 56 (just prior to the start of grazing). As grazing progresses, another set of samples will be collected for quality determination and any regrowth present at the same site will also be collected for yield and quality measurements. After grazing, residue samples will be collected at the same original sample sites post-grazing in order to estimate refusal or waste for each cultivar.

Four mature, non-lactating cows are grazing each replicate of the four crop varieties (12 cows total). Grazing is expect to last ca. one month and should be complete by late October. Electric fencing restricts access to feed to reduce wastage, but cows have access in excess of what they can consume. Mature cows were selected as they typically demonstrate the most developed feeding preferences.

Samples collected during the grazing period determine the yield, nutrient content, and the relative amount of each feed that the cows are consuming. Data will be analyzed to determine the best crop variety for early season swath grazing with regard to yield, nutrient content and grazing preference.

**Preference trial preliminary results:**

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<tr>
<th>Variety</th>
<th>Initial Yield</th>
<th>Regrowth</th>
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<tr>
<td>AC Ranger</td>
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<td>ca. 3000 kg/ha</td>
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<td>AC Ultima</td>
<td>ca. 9400 kg/ha</td>
<td>ca. 2000 kg/ha</td>
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<tr>
<td>Desperado</td>
<td>ca. 6700 kg/ha</td>
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<tr>
<td>EX733</td>
<td>ca. 7000 kg/ha</td>
<td>ca. 3000 kg/ha</td>
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**Research Team**
Dr. Mario Therrien, Dr. Hushton Block, Mr. Clayton Robins
Acknowledgements:

- The technical assistance of Mr. Clayton Robins, Mr. Rudy Von Hertzberg, and Mr. Everett Smith is gratefully acknowledged.

- Funding from the Western Grains Research Foundation and Agriculture and Agri-Food Canada is greatly appreciated.

Figure 1. Preference trial plot plan.
Figure 2. Cows swath grazing annual forage.
5. What are the annual forage options for extending the grazing season?

Researchers: Byron Irvine, Shannon Scott, Hushton Block and Clayton Robins

Background
In Western Canada, use of annual forages and, in particular, cereal grains, has been a tradition. However, choosing an appropriate combination of annual species to complement perennial forages is not always apparent. Species choice will depend to some degree on the age and growth rate of the animals being fed. There have been a large number of species evaluated, including cereal grains, brassica species and various legumes. All of these species have one thing in common, which is that they mature later in the growing season. This means they are complementary to the perennial species, which tend to have a peak production earlier in the growing season. Traditional uses of annual forages have been for greenfeed and silage, but more recently they have been used for swath grazing in the fall or winter.

Objective
We are currently conducting a trial in which seeding dates of annual cereal grains are varied in order to determine their relative yield and quality during the early August to early September growing period. In addition, we are evaluating corn, hairy vetch, brassicas and millets for use in the late September to early October period. It is critical that the species chosen do not have to stay in the field and be stored for extended periods of time, as this could lead to quality loss. Using annual forages in this way allows us to rest the perennial forages during the period when they are preparing for winter, and thereby increase the longevity of the stand. Barley, triticale and oat were underseeded with either pea or winter triticale at four seeding dates. As expected, the earliest seeding date had the highest yields. However, these yields were only about 10% greater than those for later seeding dates, which were good due to a later season rainfall pattern in 2008. Winter triticale yields at the first cut were only 940 kg ha$^{-1}$, with pea yields being 2309 kg ha$^{-1}$. Yields of barley, oat and triticale were reduced by 18-25% when planted with pea, but the total biomass produced by the pea-cereal mixture was slightly greater than that produced by the same cereal underseeded to winter triticale. However, it is likely that the regrowth of the winter triticale will be greater than that of the other annuals.

Previous research results have indicated that annual cereal grains are at their peak of yield and quality during the late-July to mid-August time frame. Golden German millet and some of the other millet species appear to have a good fit in fall. However, the protein levels and relative feed value (RFV) of cereals and millet are low. Potential species with higher protein and RFV’s include many annual clovers, hairy vetch, dry pea, fababean and forage brassicas (Table 1). In general, the annual grass crops have an RFV of 80 - 120, which is fine for dry cows. Crops such as fababean, dry pea, hairy vetch and forage brassicas can have RFV’s equal to or greater than high quality alfalfa. Kale had somewhat lower yields than other species. While the RFV of barley or corn were in the range of 90 – 130, kale had an RFV of over 300. This means that it should be possible to add barley straw bales to the field in which kale is being swathgrazed and...
still maintain adequate performance on the cattle. We have less data on crops such as hairy vetch. Since it fixes its own nitrogen, it may be a cost-effective crop, even though its seed costs are relatively high. Species such as hairy vetch and forage brassicas maintain quality well into late fall since they do not produce seed in our environment.

Most of the species being tested are grown on limited acreage at this time and thus most have no registered herbicides. This makes their production somewhat problematic due to weed management issues. These weed management issues can be further compounded if no fall weed management is conducted and weeds are allowed to reseed, thus increasing the numbers in the seed bank. In addition, the small seeded species such as the clovers and forage brassicas are not competitive during the early part of their development and can be easily out-competed by weeds, which may not be palatable to beef cattle.

Table 1: Yields of non-traditional forage species in kg ha⁻¹

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<td>Hairy vetch common</td>
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<td>2728</td>
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<tr>
<td>Winter canola</td>
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</tbody>
</table>

| Grass                |              |              |              |              |              |
| Crown / Proso millet | 4685         |              |              |              |              |
| Forage triticale     | 6172         |              |              |              |              |
| German Golden millet | 8354         | 2478        | 10192        | 7869         | 4212         |
| Mil Hy 500           | 12394        | 2043        | 9649         |              |              |
| Sorghum/Sudangrass   | 8731         | 7188        | 8515         |              |              |
| Barley               | 13208        | 7852        | 9555         |              |              |

Corn                      Millet                      Forage Soybean
Research Team
Dr. Byron Irvine, Dr. Shannon Scott, Dr. Hushton Block and Mr. Clayton Robins, AAFC-BRC
Dr. Vern Baron, AAFC-Lacombe, AB

For more information contact Dr. Byron Irvine, (204) 578-3572, birvine@agr.gc.ca

Acknowledgements

• The technical assistance of Ms. Tanya Lewandoski-Duncan, Mr. Justin Cleaver, Mr. Brent Kirkup, Ms. Julie Badiou, and Ms. Abby Horner is gratefully acknowledged.

• Funding from the Greencover Canada Technical Assistance Program is greatly appreciated.
6. Does grass cover affect ammonia volatilization on grazed pasture?

Researchers: Katherine Buckley, Ph.D., Shannon Scott, Ph.D., Clayton Robins, B.S.A., and Rhonda Thiessen

Objective
Develop emission factors for NH$_3$ loss in native and tame pastures under different canopy heights and simulated stocking densities.

Background
On average, volatilization losses of ammonia are 25% of the total nitrogen excreted as feces and urine and may be as high as 50% depending on characteristics of the beef production unit. Under an actively growing leaf canopy, potential ammonia losses are thought to be much lower, due to capture and absorption by the foliage. There is very little reliable data in grazing systems on which to base this hypothesis.

Methods
Native and tame grassed areas for the ammonia volatilization study will be established in 2008/09 and measurements will commence in 2009. Ammonia volatilization will be measured using 12 wind tunnels, each tunnel consisting of an inverted U-shaped transparent polycarbonate tunnel (thickness = 3.15 mm) with a height of 0.45 m (maximum height), covering an area of 1 m$^2$ (0.5 m x 2 m) connected to a steel duct housing an electrically powered fan (Fig. 1). Air temperature and velocity will be measured using a total air temperature sensor immediately down flow from a flange reducing the internal diameter of the steel duct. Three wind tunnels will be used for each treatment arranged as a randomized complete block design. The 12 tunnels will be aligned side by side, at least 2 m apart from each other, and their opening perpendicular to major wind directions to avoid cross-contamination among tunnels emitting NH$_3$ at different intensities. Independent air inlets will also be installed in front of the tunnel openings to measure background NH$_3$ content of incoming air. There are three main components of the ammonia emission measurement system; the wind tunnel, acid trap and lab analysis. Air flow rates and pump sampling rates will be carefully monitored and controlled (Fig. 2).

The effect of altering canopy height and simulation of grazing intensity by the application of urine and fecal pats on NH$_3$ volatilization will be assessed during seasonal periods that coincide with normal pasture grazing seasons in the moist black and the dry brown soil zones using the wind tunnel technique. As a general procedure, the treatments will be applied on plots within the perimeter of the wind tunnel (approximately 0.5 m x 2 m). Tunnels will be placed immediately over treated areas, airflow will be established at a preset speed and air will be drawn through acid traps continuously. The acid trapping solution will be replaced two times on day 1 (3 collections), once on day 2 (2 collections) and the trapping solution will be replaced...
once on days 3, 4, 5, 6, 7, 8, 10, 12, 14, 17, 21, and 28. The NH₃ in the acid samples will be analyzed by Flow Injection Analysis using the Ammonia (Phenate) method on a Lachat QuikChem 8500. This method is based on the Berthelot reaction. Ammonia in solution reacts with alkaline phenol, then with sodium hypochlorite to form indophenol blue. Sodium nitroprusside (nitroferricyanide) is added to enhance sensitivity. The absorbance of the reaction product is measured at 630 nm, and is directly proportional to the original NH₃ concentration. Ammonia emission factors will be calculated on the basis of kg of NH₃ per kg of applied TAN (total ammoniacal nitrogen). Several trials will be conducted to measure ammonia emissions from urine and feces application (separately) on: bare ground, native and tame forage, on pasture under simulated grazing (different forage heights and densities) and on pasture under different simulated stocking densities.

**Research Team**

Dr. Katherine Buckley, Dr. Shannon Scott, Mr. Clayton Robins, and Ms. Rhonda Thiessen, AAFC-BRC
Dr. Alan Iwassa, AAFC-SPARC, Swift Current, SK

Acknowledgements

- The technical assistance of Mr. Randy Westwood is gratefully acknowledged.
7. What is the impact of early (March/April) versus late (May/June) calving under western Canadian conditions on the economics, labour requirements, and energy use efficiency of cow-calf production?

Researchers: Lynne Girardin (Graduate Student - University of Saskatchewan), Tanis Sirski (Graduate Student – University of Manitoba), Dr. Shannon Scott and Dr. Hushton Block (Research Scientists at AAFC-BRC), Dr. Bart Lardner (Research Scientist at WBDC), Dr. Alan Iwaasa (Research Scientist at AAFC-SPARC)

Overview
- June calving systems are shown to reduce production costs for the cow-calf pair from birth to weaning.
- Major costs for a raising a weaned calf are those necessary to support the cow. By integrating extended grazing practices winter feeding costs can be diminished.
- Net returns are assumed to be higher for June born calves if retained as yearlings and finished as compared to when they are sold as weanlings.

Objectives
- To measure calf performance between 2 different calving systems (March vs. June) at three locations in western Canada. Locations are Brandon, MB, Swift Current, SK, and Lanigan, SK.
- To determine the system effects on cow and calf performance, reproductive efficiency, winter and summer feeding practices and on the environment.
- To determine profitability of the two production systems and compare the risks associated with each.
- To determine whether there is an increase in revenue because of off-peak calf sales for retaining and finishing June-born calves.

Calf Performance
Calf average daily gain (ADG) was significantly less for the June calving system compared to the March calving system (Figure 1 and 2).
Calving System Economics
Preliminary cost analysis was calculated for all three locations. These calculations comprise all expenses from birth to weaning for the 2007 year and include feeding costs for the cow and calf, vaccination and treatment costs and varying yardage costs for the different feeding management practices.

Total production costs from calving to weaning were $461.21 and $296.23 for the March and June calving systems, respectively. This is a difference of $164.98 (Table 1). Brandon and Swift Current locations had higher costs for the June calving system because of increased drylot feeding or days on feed. This resulted in less time spent grazing pasture systems which had
lower daily costs. System costs are consistently higher for March calving at the Lanigan location (Table 1). This resulted in increased feeding and treatment costs which contribute to higher cost per pound to raise a March-born calf as compared to a June-born calf.

Table 1. Cow production costs from calving to weaning for 2007 production year.

<table>
<thead>
<tr>
<th>Summary Economics</th>
<th>BRANDON</th>
<th>SWIFT CURRENT</th>
<th>LANIGAN</th>
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<tr>
<td></td>
<td>March</td>
<td>June</td>
<td>March</td>
</tr>
<tr>
<td>A. Total Feed Costs 1,a</td>
<td>$172.05</td>
<td>$152.70</td>
<td>$192.85</td>
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<td>B. Other Direct Costs 2,a</td>
<td>$89.41</td>
<td>$65.60</td>
<td>$88.51</td>
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<tr>
<td>C. Yardage Costs 3,a</td>
<td>$190.98</td>
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<tr>
<td>Total Production Costs</td>
<td>$452.44</td>
<td>$319.70</td>
<td>$452.06</td>
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1 Total feed costs include: hay in drylot rate $1.20/head/day; grazing pasture rate $0.75/head/day; swath grazing annuals rate $0.35/head/day; bale grazing rate $0.80/head/day.
2 Direct Costs consist of bedding ($0.50/head/day) and Vet & Med costs (March Calving System: $0.47/head/day; June Calving System: $0.24/head/day)
3 Yardage costs: drylot rate: $1.15/head/day; on pasture: $0.78/head/day; swath grazing rate: $0.78/head/day
4 Costs references: Saskatchewan Ministry of Agriculture and Cost of Production studies done at WBDC.

Figure 3. Comparing cost to raise a calf ($/lb) from birth to weaning between the March and June calving systems (note: cost does not include sale price of weaned calf).

Take Home Message
The amount of purchased and harvested feeds required by a cow herd is strongly related to calving date. Delaying the calving season into the summer may be an efficient way of reducing winter feed costs:

- The calving season starts when the quality of grass can meet the requirements during the last third of gestation and of a lactating cow.
Extended grazing practices such as stockpiled forages, swath grazing of annual crops, and bale grazing are utilized throughout the winter months. Adequate pasture resources are available to manage the cow/calf pair throughout the production year on varied grazing practices.

For more updated information: Lynne Girardin at (306) 966-4150 or lgirardin@sasktel.net

Research Team
Lynne Girardin (Graduate Student - University of Saskatchewan), Tanis Sirski (Graduate Student – University of Manitoba), Dr. Shannon Scott and Dr. Hushton Block (Research Scientists at AAFC-BRC), Dr. Bart Lardner (Research Scientist at WBDC), Dr. Alan Iwaasa (Research Scientist at AAFC-SPARC)

Acknowledgments
The funding assistance from:
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- Viterra/Proven Seed
- Cattle Marketing Deductions Fund
- Horned Cattle Purchases Fund
- Saskatchewan Agriculture Development Fund
- Southwest Forage Association

The technical assistance of:
- BRC Staff: Clayton Robins, Ron Kristjansson, Dean Sykes, Jay Ahntholz, Jeff Bieganski, Jason Lamb, John Rempel, and Brett Stewart
- WBDC Staff: Leah Froehlich, George Widdifield, and Jonathan Pearce
- SPARC Staff: Ed Birkedal, Dale Sandau, Curtis Letkeman, and Lindsay Kohl
What is the impact of backgrounding and finishing system on meat quality and profitability in early-born (March/April) and late-born (May/June) steers?

Researchers: Shannon L. Scott, Ph.D., and Hushton Block, Ph.D.

Objective
To evaluate effects of calving system and backgrounding/finishing regime on calf post-weaning performance (growth, health, and feed efficiency) and on carcass composition and quality at slaughter.

Method
A multi-site research study is currently evaluating the production performance and economics of early (March-April) vs. late (May-June) calving under western Canadian conditions. There are 50 cows at the AAFC-SPARC, Swift Current, SK; Western Beef Development Centre [WBDC] Lanigan, SK; Brandon, MB) SPARC, 100 cows at the WBDC, and 100 cows at BRC on trial. The 250 cows have been divided into two calving dates. The early group is calving in March-April and the late group is calving in May-June. Approximately 125 steers from the 2007 calf crop have been assembled at one feeding site in Brandon and divided into one of two feeding backgrounding and finishing programs: 1) Short backgrounding: wean at 180 d of age – background for 84 days (1.00+ kg/d ADG) – then feedlot feeding period (1.35+ kg/d ADG for 200 d), or 2) Long backgrounding: wean at 180 d – background for approximately 200 days (0.70 kg/d ADG) – graze on spring and summer pastures for 120 days – then feedlot feeding period (1.35+ lb/d ADG for 60 to 90 d). The timelines for each group are shown in Tables 1 and 2 below. Steer feed intake and gain in the backgrounding phase (including backgrounding on pasture for certain treatments) and finishing phase will be determined.

For the early-calved, short backgrounding steers, the backgrounding diet was 30.0% barley silage, 40.0% alfalfa/grass hay, and 30% rolled barley (DM basis), and the finishing diet was 77.8% rolled barley, 20.0% barley silage, and 2.2% supplement pellet with rumensin (DM basis). For the late-calved, short backgrounding steers, the backgrounding diet was 45.0% barley silage, 40.0% alfalfa/grass hay, and 15% rolled barley (DM basis) and the finishing diet was 87.8% rolled barley, 10.0% hay, and 2.2% supplement pellet with rumensin (DM basis). For both the early-calved and late-calved steers in the long backgrounding treatment, the backgrounding diet was a 50:50 blend of pounded 1st and 2nd cut alfalfa/grass hay.

At slaughter, carcass blue tag data (fat colour, fat texture, meat colour, meat texture, marbling texture) will be collected by a certified grader. Following slaughter, ribeye steaks will be analysed for content of moisture, protein and fat. Separate steaks will be evaluated for meat quality (taste, tenderness, etc.) by a trained taste panel at the Agriculture and Agri-Food Canada Lacombe Research Centre in Alberta.
### Table 1: Early calving system with one weaning date and two post-weaning feeding strategies.

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<td>Wean &amp; background (84 d)</td>
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### Table 2: Late calving system with one weaning date and two post-weaning feeding strategies.

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### Observations to date for 2007-2008 (Year 1)

**Early-calved steers:**

For the early-calved steers on the short backgrounding program, the average daily gain (ADG) of 0.81 kg/d during the 84-day backgrounding period was slightly under the target value of 1.00 kg/d (Fig. 1). The ADG of 1.66 kg/d observed from the beginning of the feeding period up until the first group of cattle went for slaughter (196 days on feed) exceeded the target of 1.35 kg/d. It can be seen from Fig. 1 that after the first group went for slaughter, there was a drop in the average weights of the remaining group. Between 196 d and 224 d of feeding, this last group gained 1.69 kg/d. For the early-calved steers on the long backgrounding program, the ADG during the 224-d backgrounding period was on-target at 0.77 kg/d (Fig. 1). In the first 30 days on pasture, the ADG dropped to 0.25 kg/d (Fig. 1).
Late-calved steers:

For the late-calved steers on the short backgrounding program, the ADG of 1.10 kg/d during the 84-day backgrounding period was slightly over the target value of 1.00 kg/d (Fig. 2). During the first 140 d of the feeding period, their gain of 1.66 kg/d exceeded the target of 1.35 kg/d. For the late-calved steers on the long backgrounding program, the ADG of 0.85 kg/d during the 124-day backgrounding period from weaning until they went on pasture on June 10th slightly exceeded the target of 0.70 kg/d (Fig. 2). During the first 30d on pasture, the ADG was 0.66 kg/d (Fig. 2).

Figure 2: Weight gains of late-calved steers.
Research Team

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Winter bale grazing: does bale residue management influence soil nutrient distribution and subsequent forage production?

Objectives
- To measure the impact of bale grazing on nutrient movement in the soil profile.
- To determine the effect of redistribution of manure and bale residues on forage production, and grass species population dynamics.

Methods
A 2.5 ha (approximately) site was selected for overwintering beef cows in the fall of 2007. A detailed site survey was conducted at a survey intensity level (SIL) 1 and portrayed at a map scale of 1:5,000. Site inspections were made along five north-south foot traverses across the field at a density of 10-12 inspections per traverse or one site per 130 m and along three east-west foot traverses at a density of 9 inspections per traverse. The transect locations were determined based on general surface patterns identified using stereo interpretation of the air photos for the section. The watering site was located west of the feeding area at the end of a narrow ally which discouraged congregation of the cattle in that area. The feeding site was split into two replicates using electric fencing. Moveable wind shelters were used to provide protection from the elements. The wind shelters were 5 m long × 3 m high, made from 10 cm × 2.5 cm boards on a steel frame. Following site inspection electric fencing with permanent and temporary posts were installed to keep the cattle in the required area (Fig. 1).

Soil sampling grids for pre-trial and post-trial sampling were identified prior to placement of the bales (Fig. 2). Soil samples were taken at 15 points in a 10 x 20 m grid area at 24 sites in the feeding area (indicated by 3 horizontal strips in Fig. 2). Soil samples were taken at depths of 0-15, 15-30, 30-60, 60-90, and 90-120 cm, the maximum depth taken depended on the presence of gravel lenses. The soil samples will be analyzed for ammonium-N, nitrate-N, extractable P, extractable K, EC and pH. Point frame plant counts were also performed to determine plant density and dominant species. The 48 bales in the soil sampling grid were sampled and weighed prior to placement. A hot wire was placed to control access to the bales and advanced every 2 to 3 days (depending on climatic conditions) allowing access to new bales. When all the bales were consumed, the cattle were removed and when conditions allowed, alternate strips were harrowed in the feeding area (as shown by blue and green stripes in Fig. 2). In the fall of 2008, the soil profile will be resampled at a more intensive level (45 sampling point in the grid) to determine the concentration of residual nutrients. Forage yield, forage nutrient concentration and plant population densities will also be determined.

Bale grazing can reduce labour and fuel costs for feed and manure handling as well as reduce wear and tear on machinery. There may be greater potential for increased nitrogen capture in soil compared to intensive feeding in a feedlot where ammonia losses can reduce the nutrient value of the excrement to be spread on fields in the spring. A thorough
understanding of the feeding and resting behaviour of the cattle coupled with proper bale density and quality will ensure the nutrients from manure, urine and leftover material are uniformly deposited at a rate which will enhance forage growth and minimize environmental impacts. Data from this trial will be forthcoming in 2009.

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Figure 1. Electric fencing is used to control access to bales (top). Harrowing the residue from bales and manure to redistribute nutrients (bottom).
Figure 2. Layout of the bale grazing site showing soil sampling sites (horizontal stripes) and harrowing treatment (green – no harrow, blue – harrow).