The Impact of Forage Use and Quality on Economic Returns of Canadian Dairy Farms

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Take Home Messages

- Reducing forage cost of production does not imply a decrease in quality, but demands that the cost in machinery is kept low.
- High milk from forage is positively linked with economic returns.
- In order to increase milk from forage, good quality forages must be ingested in large quantities and used with the proper type of concentrates.

Introduction

Forage cost of production can vary greatly among farms. When the cost of production is kept low, forages can be an economic asset for a farm. Producing low-cost but high-quality forages decreases the dependence on concentrate feeds and their fluctuating prices. In order to make good decisions on forages, different aspects of forage production and utilisation must be considered. Forage quality, the impact of high forage utilisation on the herd's performance and how to maximize forage utilisation are topics that need to be addressed in order to increase profitability.

Forage Production

Forage production is a crucial sector in dairy management that directly influences production costs in many ways. There are costs associated with production and harvest of the forages, but as well the impact of forage quality on feed costs for the herd needs to be considered.

Impact of Forage Cost of Production on Forage Quality

It is often thought that in order to have good quality forages farms need to invest in technology which increases the cost of production. However, higher cost of production for forages does not necessarily result in more forages of good quality being produced. In fact, the data from eastern Canada suggest the opposite; producers with higher cost of production have lower yields and quality is not affected (Table 1). Their forages cost them more than double those with lower cost, mainly due to the high cost of machinery, with a difference of 44 $/T between both groups. Results from analysis of the previous year were similar (Valiquette, 2000; Roy et al., 2008).

Table 1. Impact of the cost of production on forage quality for mixed grass and legume hay and silage.

	Average	Comparison[3]	
		Higher 20% cost of production	Low 20% cost of production
Number of observations	570	112	112
Cost of production ($/T DM)	208	293[a]	140[b]
Yield (TDM/Ha)	6.3	5.4[b]	7.3[a]
NE_L[1] (Mcal/Kg DM)	1.28	1.30[a]	1.27[b]
Crude protein[2] (% DM)	15.7	15.9	15.7
Machinery cost ($/T DM)	55	79[a]	35[b]

[1] number of observations : Average = 252; comparison groups = 52 each.
[2] number of observations : Average = 259; comparison groups = 52 each.
[3 a,b] Means for the comparison within a row with different superscripts differ (P<0.001).
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Impact of Forage Quality on Concentrate Costs

It has been shown that variations in forage quality have direct impacts on costs of concentrates to produce the same amount of milk (Shaver, 2010). In the US, costs of concentrates increased from $3.60 to $4.35/cow/day for an increase of 10% in the level of NDF of forages fed at the same level in the diet.

Considering both the cost of production and the impact of forage quality on farm revenue, it is clear that decisions on forage production and utilisation have a major impact on farm profitability. To decrease the expenses of the farm it is important to produce low-cost forages of high quality. It is evident that some producers are able to do this because data from commercial dairies show that lower cost of production does not necessarily decrease forage quality.

Strategies to Adopt Considering an Increase in the Cost of Fuel

Generally, forage yield and quality are negatively correlated. If the fossil energy price increases, should we continue to produce high quality forage? Or, should we push for higher yields to decrease the cost of production?

Using a whole-farm model (N-CyCLES; **http://dairynutrient.wisc.edu/N-CyCLE/page.php?id=517**), we were able to simulate the economic impact of decreasing the number of cuttings in order to increase the yield by harvest date for an average farm in one region of Quebec (70 cows, 117 ha; Charbonneau et al., 2009). This analysis took into account both the impact on the fields and for the herd. Results from these simulations showed that increasing quality of forages is the best option since decreasing the number of cuttings had a negative impact of $0.29/hL (-$1578) on net income. Decreasing the number of cuttings lowered the cost of production of forages (-$0.23/hL; -$1264) but clearly increased the cost of concentrates needed to maintain similar milk production (+$0.66/hL; +$3639). In this simulation, only the impact of cutting frequency was considered and it did not take into account the impact of fuel cost on the price of concentrates. These results are important if the variation in the price of concentrates is considered as well.

■ Forage Utilization

Once we have high quality forages produced at low cost, it is important to maximise their utilisation. An indicator of forage utilisation was developed by our team in order to estimate this utilisation.

Milk from Forage

Milk from forage (**MF**) is an estimate of the amount of milk produced from the forage portion of the diet; the estimated amount of milk allowed from concentrates is subtracted from the actual amount of milk produced (Charbonneau et al., 2006). This calculation assumes that the animal's maintenance requirements are being met through the forage portion of the diet. Since MF is an estimation of forage utilization, it can be used with any mixture of forages. With this calculation, the data used are easier to gather on the farm than if we were to use forage intake. It also gives us a better idea on the efficiency of forage utilisation by the cows, not just its quality and intake. When forages are used with the appropriate concentrate feeds, higher milk from forages is to be expected.

Milk from Forage Calculation

Milk from forage is calculated using simple equations that were adapted from the NRC (2001) (Charbonneau et al., 2002; Charbonneau et al., 2006):

$MF_{average} = (MF_{energy} + MF_{protein}) / 2$

$$MF_{energy} = ECM - \frac{[\text{Conc } NE_L \text{ (Mcal)} - NE_L \text{ for growth (Mcal)}]}{0.75 \text{ (Mcal/kg milk)}}$$

Where

ECM (energy corrected milk, 4% fat, 3.4% protein) =

Milk * (0.124 %Fat + 0.073 %Protein + 0.256)

(Adapted from Tyrell and Reid 1965)

NE_L concentrate (Mcal) = Σ(DMI of concentrate$_i$ * NE_L of concentrate$_i$)

NE_L growth (Mcal) = Mature BW (kg)*herd size*culling rate (%) * 0.67

$$MF_{protein} = PCM - \frac{[\text{Conc CP (kg)} - \text{CP for growth (kg)}]}{0.088 \text{ (kg CP/kg of milk)}}$$

Where

PCM (protein corrected milk, 3.4% protein) = Milk * 0.296 %protein

CP concentrate (kg) = Σ(DMI of concentrate$_i$ * CP of concentrate$_i$)

CP growth (kg) = Mature BW (kg) * herd size* culling rate (%) * 0.11

Performance of Farms with High Milk from Forage

Since the time that “milk from forages” was originally proposed in the seventies by Agri-Gestion Laval, a link between this indicator and farm revenue has been clear. When comparing the results of the 20% of farms with the highest MF to the lowest 20% (Table 2), we can conclude that farms with high MF clearly have better economic returns (higher net income; higher Standardized work income/ Full time equivalent; higher margin/cow). These results are mostly due to the 10% lower feeding cost for the group with high MF. Farms with high MF also produce the same amount of milk, but with fewer cows.

Table 2. Financial impacts of different levels of milk from forages

	Average	Comparison[2]	
		High 20% for MF	Low 20% for MF
Number of observations	570	114	114
Milk from forage (kg/cow/yr)	2071	3660[a]	248[b]
Net income ($/cow)	35	337[a]	-379[b]
SWI/FTE[1] ($)	76 306	87 478[a]	64 323[b]
Margin/cow (std)	3420	3789[a]	3028[b]
Feeding cost ($/cow)	2324	2207[b]	2453[a]
Total milk produced (hL)	5445	5221	6245
Number of cows	68	62[b]	82[a]

[1] SWI/FTE = Standardized work income/ Full time equivalent.
[2 a,b] Means for the comparison within a row with different superscripts differ (P<0.001).
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MF = milk from forage

Data on animal performance also indicate additional strengths of farms with high MF (Table 3). As expected from previous results, farms with high MF had greater milk production per cow. The milk composition was only slightly different with a 0.05% difference for protein content. The body weight of cows did not differ between both groups. Farms with high MF were able to produce 1.35 kg of milk per kg of concentrates more using forages that were similar in quality. Their feed efficiency was higher as well. Farms with high milk from forage did not differ in culling rate, and had slightly lower calving interval than farms with low MF, meaning that better use of forage may improve health and reproductive performance.

Table 3. Impact of forage level on dairy cow perfomance

	Average	Comparison[3]	
		High 20% for MF	Low 20% for MF
No. of observations	570	114	114
Milk yield (kg/cow/yr)	8139	8527[a]	7682[b]
Fat content (%)	4.04	4.05	4.05
Protein content (%)	3.37	3.34[b]	3.39[a]
Forage EN_L[1] (Mcal)	1.28	1.30	1.29
Forage CP[2] (%)	15.7	15.9	16.2
Feed efficiency	1.08	1.16[a]	0.97[b]
Average body weight	632	624	631
Milk/kg of concentrate	2.70	3.42[a]	2.07[b]
Calving interval (d)	423	421[b]	428[a]
Culling rate (%)	29	29	31

[1] number of observations : Average = 252; comparison groups = 52 each.
[2] number of observations : Average = 259; comparison groups = 52 each.
[3 a,b] Means for the comparison within a row with different superscripts differ ($P<0.05$).
Agritel Web 2008
MF = milk from forage

Milk from Forage In Comparison With Feed Efficiency

Other indicators of efficiency are considered when the profitability of farm operations is evaluated. One of the main nutritive indicators used at the moment in the US is feed efficiency (kg of milk/ kg of feed). When comparing the results of farms with high MF or high feed efficiency (Table 4), we can see that both groups have better economic results (net income and Standardized work income/ Full time equivalent) than the average, but don't differ one from the other. While the economic returns are similar, the way they are achieved is very different. Even if lower than for the group with high feed efficiency, the farms with high MF had above-average feed efficiency as well. The opposite is not true; 2172 kg of MF for the high feed efficiency group is near the average (2071 kg) but lower than the high MF group by 1488 kg of MF. The farms with the higher feed efficiency favor the use of concentrate feed, whereas the high MF group favors forage utilisation as seen by the results for milk per kg concentrates which differ by 0.70 kg of milk/kg of concentrates.

Table 4. Comparisons of producers with high MF and high feed efficiency

	Average	Comparison[2]	
		High 20% for MF	High 20% for Feed efficiency
Number of producers	570	114	113
Milk from forage (kg/cow/yr)	2071	3660[a]	2172[b]
Feed efficiency	1.08	1.17[b]	1.25[a]
Net income ($/cow)	35	337	280
SWI/FTE[1] ($)	76 306	90 893	87 478
Milk yield (kg/cow/yr)	8139	8527	8675
Mil/kg of concentrates	2.70	3.42[a]	2.72[b]

1 SWI/FTE = Standardized work income/ Full time equivalent.
[2 a,b] Means for the comparison within a row with different superscripts differ (P<0.001).
Agritel Web 2008
MF = milk from forage

As long as concentrate costs are not too expensive, both models are as efficient to achieve high economic returns. The main difference is that producers that favour forage utilisation are in control of their cost of production for forages, whereas the cost of concentrates is often beyond their control. For this reason, achieving high milk from forage should be a goal for all dairy producers.

Data from the field clearly demonstrate the impact of increasing milk from forage. It is now important to understand how to increase it.

How to Increase Milk from Forage

Different experiments have been conducted to better understand how to increase milk from forages. The main important areas to increase MF are the quality and the quantity of forage fed, as well as the type of concentrates used.

Forage Quality and Digestibility

We have previously seen from the results of Shaver (2010) and Charbonneau (2009) that quality of forage has direct impacts on concentrate costs and farm net income. The impact of the quality of forage on MF was also estimated by the simulation performed by Charbonneau (2009). The decrease in number of cuttings, and in quality, resulted in a decrease of 485 kg of MF per cow per year.

Data from an experiment that evaluated barley silage varieties in Alberta (Oba, unpublished data) showed that, for the same amount in milk production, MF was higher by 2.30 kg per cow per day when a variety of barley silage with greater fibre digestibility was used instead of silage with lower fibre digestibility. This experiment did not directly measure milk from forage, so the difference between treatments could not be verified statistically, but the results do point toward a positive impact of forage fibre digestibility on MF.

Quantity of Concentrates

In order to see the impact of the quantity of concentrates used, a study was performed during 2 years where cows with similar production were assigned to high or low-concentrate diets (Pellerin et al., 2000). Cows fed the low-concentrate diets ate 1000 kg less concentrate per lactation and increased their forage intake by 24%. There was no difference in milk production or composition between the groups, but milk per kg of concentrates was higher by 70% for the low-concentrate group (5.0 vs. 2.95 kg of milk/kg of concentrates). When treatments of this experiment were planned, it was expected that the low-concentrate group would produce less milk compared with cows in the high-concentrate group, but that was not the case. These results suggest that not only the amount of concentrates, but also their type, had an impact on MF.

Type of Concentrates

Two experiments were subsequently performed to determine which type of concentrate is best suited for legume silage or for a mixture of legume and corn silage.

Legume silage

When forages high in degradable protein, such as alfalfa silage, are used for early lactation cows the most suitable concentrates have high energy availability in the rumen (Charbonneau et al., 2006). This is demonstrated in an experiment shown in Figure 1 and Table 5, where MF production was increased by 3 kg per cow per day when ground corn was used instead of cracked corn. Cows fed ground corn also had higher milk production but decreased milk fat percentage. The DMI of cows was increased when fed ground corn in comparison to cracked corn. The replacement of part of the ground corn with more degradable carbohydrates, such as wheat starch, did not result in better performance than ground corn alone. When dried whey permeate was fed in replacement of part of the ground corn, DMI was increased but milk production was intermediate between cracked and ground corn.

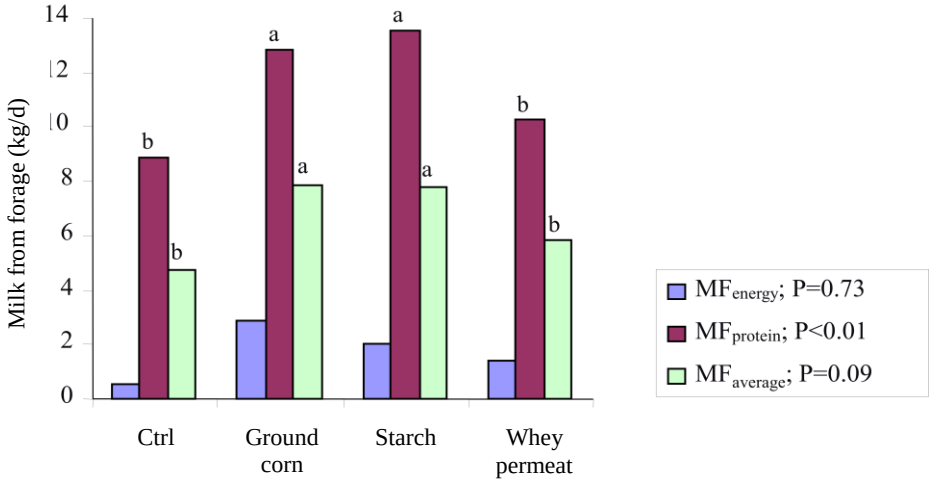

Figure 1. Milk from forage (MF) energy, protein and average for cows in early lactation fed alfalfa silage with cracked corn (Ctrl), ground corn (GC), wheat starch or dry whey permeate.

These results are mostly due to the better use of forage nitrogen by providing more energy available in the rumen. Both milk urea nitrogen (MUN) and rumen fermentation analyses confirmed better nitrogen utilisation (Table 5).

Table 5. Dry matter intake, milk production and milk composition for cows fed alfalfa-based diets supplemented with concentrates with different ruminal carbohydrate degradabilities.

	Ctrl	Ground Corn	Starch	Whey permeate
DMI (kg/d)	22.7 ^{c}	24.3 ^{b}	24.4 ^{b}	25.7^{a}
Milk (kg/d)	34.0^{c}	37.4^{ab}	37.6^{a}	35.8^{b}
Fat (%)	3.82^{ab}	3.55^{ab}	3.49^{b}	3.88^{a}
Protein (%)	3.22	3.33	3.33	3.35
MUN (mg/dl)	13.4^{a}	10.7^{b}	9.9^{b}	9.8^{b}

^{a,b,c} Means within a row with different superscripts differ.

Forages high in energy

With high energy forages, our hypothesis was that increasing rumen degradable protein would have a positive impact on MF. An experiment was conducted using corn- and alfalfa-silage based diets (Charbonneau et al., 2007). The hypothesis was that higher levels of rumen degradable protein

supplied from concentrates would increase MF since energy from the forage would be better used. However, our findings were contrary to the hypothesis. Milk from forage was higher with the lower RDP level, which met RDP requirements from NRC (2001). Replacing cracked corn with ground corn in high RDP diets increased MF. Based on these observations, it was concluded that to increase MF when forages are complementary, energy and protein concentrates should present similar degrees of availability in the rumen.

Conclusion

Forage utilisation is of economic interest for dairy farmers. Farmers who favour higher usage of forages decrease their dependency on concentrate feeds. Considering the current price of concentrates, producers using higher forage diets achieve similar economic results compared with producers maximising milk production by increasing concentrate in the diet. Also, some producers are able to obtain high-quality forages at low cost mainly because they kept machinery costs low. Once low-cost forages are produced, it is important to maximise their utilisation. Not only is it important to feed high quality forages in large amounts to increase MF, but also the utilisation of the right concentrates is necessary. Being able to feed low-cost but high quality forage in the appropriate amount and with the right concentrate feeds is a sure step toward high profitability of the farm.

References

Charbonneau, E., G. Allard, D. Lefebvre, R. Daigle, N. St-Pierre and D. Pellerin. 2002. Calcul du lait fourrager: quoi de neuf depuis le NRC 2001? Le Producteur de lait québécois, vol. 22, no 9: 34-37.

Charbonneau, E., P. Y. Chouinard, G. Allard, H. Lapierre and D. Pellerin. 2006. Milk from forage as affected by rumen carbohydrate degradability with alfalfa silage-based diets. J. Dairy Sci. 89:283-293.

Charbonneau, E., P. Y. Chouinard, G. Allard, H. Lapierre and D. Pellerin. 2007. Milk from forage as affected by rumen degradable protein and corn grinding when feeding corn- and alfalfa silage-based diets. J. Dairy Sci. 90: 823-832.

Charbonneau, E. and D. Pellerin. 2009. Toujours économiques les fourrages? Journée à foin, CQPF, 16th september, Saint-Albert-de Warwick, Québec. N-CyCLES

National Research Council. 2001. Nutrient Requirements of Dairy Cattle. 7th ed. Natl. Acad. Press, Washington, DC. 381 pp.

Pellerin, D.G., K. Valiquette, G. Allard, D. Lefebvre, L.P. Vézina, P. Paquin and D. Pellerin. 1999. Producing milk with less concentrates and more forages. J. Dairy Sci. 82 (Suppl. 1): 90. (Abstr.)

Roy, R., J. Brisson and D. Pellerin. 2008. Tirer parti de ses fourrages pour rester dans le coût. Symposium sur les bovins laitiers, 30 novembre, Drummondville, Québec.

Shaver, R. D. 2010. Using high quality forages to optimize production. WCDS Advances in Dairy Technology 22: 13-22.

Valiquette, K. 2000. Comparaison des fermes laitières québécoises selon leur niveau de lait fourrager. Master thesis. Université Laval. 69 p.