CREATING PROFITABILITY AND LOWERING GREENHOUSE GASES: A STUDY OF SELECTED MANITOBA COW-CALF FARMS

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Abstract

Agricultural greenhouse gas (GHG) emissions account for 31% of all emissions in Manitoba in 2012. With the rising trend in Canada (and in Manitoba) in these emissions, efforts are now aimed at finding ways to reduce them. Effort is being placed on cultural practices followed by producers. This study is based on an investigation of four cow-calf farms from Manitoba, using details on their operations through a 2012 survey, in order to determine whether profitability could coincide with lower GHG emissions. Due to its use of tame pasturelands, its handling of perennial cropland, and its economical provision of feed, one of the farms, from Cluster Four, was able to achieve both measures. The farm that was able to sequester GHG emissions without profitability grew too much feed for its purposes, and maintained more land than necessary. The two remaining farms gained profits, though without sequestering GHG emissions. They would have benefitted from tame pastureland, and more legume crops.

Keywords: greenhouse gas emissions, cow-calf operations, Manitoba, profitability

1. Introduction

While the role of cattle with regards to greenhouse gas (GHG) production has been discussed for decades, the release of a “Livestock’s Long Shadow” report by the United Nations’ Food and Agriculture Organization’s (FAO) has proved to be a catalyst (Steinfeld et al. 2006). The report has drawn worldwide attention, resulting in research intended to mitigate GHGs emissions from the livestock sectors.

The Canadian beef cattle sector contributed about 43% of the national agricultural emissions and 72% of the livestock emissions (Environment Canada 2014). Agricultural GHG emissions in Manitoba in 2012 accounted for 30% of the total provincial GHG emissions (Eco- Network 2014). Emissions from beef cattle occur primarily in the cow-calf stage, as animals are predominately fed forage diets (Beauchemin et al. 2010). Several management practices to minimize GHG emissions have been developed and implemented including feed management, breed stock management, and land use management (Beauchemin et al. 2011).

Policies to reduce GHG emission from livestock depend on cattle management practices utilized by producers within the state’s jurisdiction. Difficulties arise when a country as vast and diversified as Canada lends itself to a variety of different management practices. Beyond differences, such as mixed farms, organic farms, and conventional farms, other changes such as soil type, feeding practices, and risk tendencies can affect both profitability and GHG emissions. Knowledge of such variability among cow-calf operation could be of assistance in formulating comprehensive GHG mitigation policies.

While there are methods to reduce GHG emissions from livestock, it is necessary to find methods to do so in a cost-effective manner. The Manitoba Beef Producers have indicated that initiatives to increase the public’s good are critical, though that they should be voluntary, controlled and delivered by producers (Manitoba Beef Producers 2011). Therefore, gaining a partnership with the industry will require information regarding present financial and production characteristics of beef farms in Manitoba.

2. Method

In order to understand existing practices utilized by beef producers in Manitoba, and the impact of these practices on their profitability and GHG emissions, a survey was developed for Canada with the support of the Beef Cattle Research Council. This survey contained eight sections to collect data from 1009 farms across Canada regarding general farm operations, feed management, grazing throughout the year, feeding areas, barn and feedlot operations, manure management, shelterbelts, and farmer information and preferences (Alemu et al. 2015; Sheppard et al. 2015).

2.1. Cluster Farms

Based on the data collected under the purview of the above survey, Alemu et al (2015) developed eight clusters using the principal component and cluster analysis procedures. Selected variables were related to farm production, land use and management, farm inputs, manure handling and storage, farm income, as well as risk attitude. The principal component analysis resulted sixteen principal components used for cluster analysis. The farm closest to the cluster seed was chosen as a representative of the entire cluster. Although conceptually eight clusters were planned, only six were found in Manitoba. Even within these six clusters, only four of them had more than one member. Due to privacy concerns, only these four were investigated. These clusters focused mainly on cow-calf production (Alemu et al. 2015).

2.2. Estimation of GHG Emissions

For each of the four farms, GHG emissions were estimated using the Holos model[1]. This model is based on the methodology recommended by the Intergovernmental Panel on Climate Change (IPCC), modified for Canadian conditions. In order to compare various farms, emissions are calculated by dividing the profit by the total weight of weaned calves and culled cows sold, as shown in equation (1).

$$Emissions\ per\ lb_k = \frac{LUC+CS+B}{TW} \qquad (k=1,\ldots 4) \qquad (1)$$

Where, *LUC* is the GHG emissions resulting from land use changes (cropped area added from previously perennial crops, tillage, fallow, and seeded/broken grasslands), *CS* is emissions from crops/soils (for annual crops, perennial forages, and land applied manure), *B* is the sum of all emissions from cattle (enteric methane, manure methane, plus direct and indirect nitrous oxide from manure storage), and *TW* is the total weight of weaned calves and culled cows sold by the farm. These calculations were completed for each of the *k* farms.

2.3. Profit Model

In order to find a relationship between greenhouse gas emissions and profitability for all four farms, gross farm revenues and costs were used to determine profit level using equation (2). This was then expressed on per pound of beef produced. In order to find a relationship between greenhouse gas emissions and profitability for all four farms, revenues and costs will then determine gross farm revenue.

$$Profit\ per\ lb_k = \frac{\left[\sum[PC_{sa}*(AW_{sa})]+[RGF_y*PF_y]\right]_k-[F+I+D]_k}{TW_k} \qquad (2)$$

[1] Holos is a whole-farm model and software program that estimates greenhouse gas (GHG) emissions based on information entered for individual farms. More details can be found in Agriculture and Agri-Food Canada (www.agr.gc.ca/holos-ghg).

In equation (2), the first section of the numerator represents revenue generated on the farm, where *PC* is the price of each animal in 2011 based on weight, *AW* is the average weight of each animal in kg, while *s* is the sex of the animal, and *a* is the age of the animal, denoting whether the animal is sold as a culled cow. Furthermore, *RGF* is the remaining grown feed, in metric tonnes, leftover after the producers have fed their cattle multiplied by the average market price of the feed, *PF*, and *y* denotes the type of feed. The second section of the equation in the numerator refers to the cost, where *F* is the cost of purchased feed, *I* is the cost of investments, and *D* is the depreciation of buildings and machinery. These costs vary depending on the type of feed utilized, amount of pasture tended, the overall size of land farmed, and the type of machinery used. In order to compare GHG emissions to profits, this equation was also divided by the total pounds of beef sold by each farm.

Based on a study of beef farms in Illinois and Iowa, Miller et al. (2001) have reported that hired labor was not a significant factor in determining productive farm management. Furthermore, few cow-calf farms use hired labor. Thus, the measure of profitability on the farm resulting profit in equation (2) is the income paid to the owner(s) of the farm. Estimation of the amount of feed necessary to maintain each herd was based on the dry matter and protein requirement recommendations from the National Research Council (2000), optimized using linear programming model for each cow, bull, and replacement heifer.

2.4. Deterministic Factors

The body weight of weaned calves has been theorized as an important factor affecting profitability and level of GHG emissions. On average, Miller et al. (2001) reported a gain of US$1.18 for each additional kg of a weaned calf's body weight. They also noted that feed costs can range dramatically from farm to farm, and can account for 50% of the variation of profitability from beef herds, and comprising 63% of the total annual cost for cows.

Investments in machinery and other equipment could provide benefits or a costs to a farm. Since larger investments in machinery also result in repair and depreciation costs, purchasing equipment that is too large for a given piece of land, or purchasing other equipment that is inappropriate or inefficient can lead to greater costs and burdens (Ramsey et al. 2005).

3. Data

Farm level variability in cow-calf operations is a reality. This was noted for the four cluster farms in this study. The differences between the farms from the four clusters are summarized in Table 1.

Table 1. Comparison of Cluster Study Farms

	Cluster 1	Cluster 4	Cluster 6	Cluster 7
	Percentage Income			
Beef	100	70	100	30
Crops	0	25	0	70
Forage Sales	0	5	0	0
	Herds			
Cows	26	120	145	55
Bulls	1	5	8	3
Replacement Heifers	3	30	17	7
Average weight: At birth	32 kg	41 kg	41 kg	41 kg

Average weight: At weaning	227 kg	295 kg	272 kg	272 kg
Land (ha)				
Grain	6.88	12.14	263.05	-
Hay	133.55 (1 cut)	145.69 (3 cuts)	263.05 (1 cut)	68.80 (1 cut)
Native Pasture	60.70	80.94	-	259.00
Tame Pasture	-	335.89	-	-
Feeding Area	30.35	6.07	-	6.07
Non Feed Grain	-	64.75	-	259.00
Total	231.48	645.48	526.10	592.87
Stocking Rate				
Animal Unit Month per ha	4.47	2.02	n/a	2.14

Source: Possberg (2015).

Notably, the Cluster Four farm was the only farm that cut its hay more than once. This increased its hay production by 2.37 times the amount other farms would have reported, on average.

Farms which reported less than 162 hectares per farm were assumed to have rented their equipment, rather than purchasing it. Equipment used for transportation or day-to-day activities, such as a 150 hp tractor or a truck, were excluded from this assumption.

Neither the weaning rate nor the calving rate was considered in the survey. In order to account for all possible costs, both were considered to be 100%. However, a death rate of 2.37% was subtracted from the revenue generated by cattle.

4. Results

When all of the figures above are considered, only one farm was able to generate positive profits along with a negative change in GHG emissions. As seen in the figure 1, the Cluster Four farm was able to gain the most profit at $1.88 per kg sold, while sequestering 3.25 kg CO_2e per kg sold. The Cluster One farm was also able to sequester GHG emissions, at 13.69 kg CO_2e per kg sold. However, it was unable to generate a profit as it grew more feed than necessary. Farms from Clusters Six and Seven were able to generate a profit, though they also emitted more GHGs than they sequestered in the process.

4.1. Emissions from Cattle

Greenhouse gas emissions including methane and nitrous oxide varied greatly between farms. The variations depend on time spent in a pasture, the quality of diet provided to the animal, on-farm feed production (type and amount), and type of manure storage, among other factors.

The Cluster Four farm emitted the largest amount of GHG emissions from cattle per kg sold, at 25.01 kg CO_2e. This is a result of the four months on pasture during the summer, in addition to a relatively poor quality diet containing majorly forage (70 - 90%) with minimal amounts of grain (~10%) during the colder months. The hay contained moderate amount of alfalfa ranging between 25 – 49%. Furthermore, Cluster Seven farm had the second largest contribution of emissions from enteric fermentation from their cattle. Similar to that of Cluster Four, the farm in Cluster Seven's depended on a diet heavy in hay during the cold season, supplementing with some cereal grains, and pastures during the warm season.

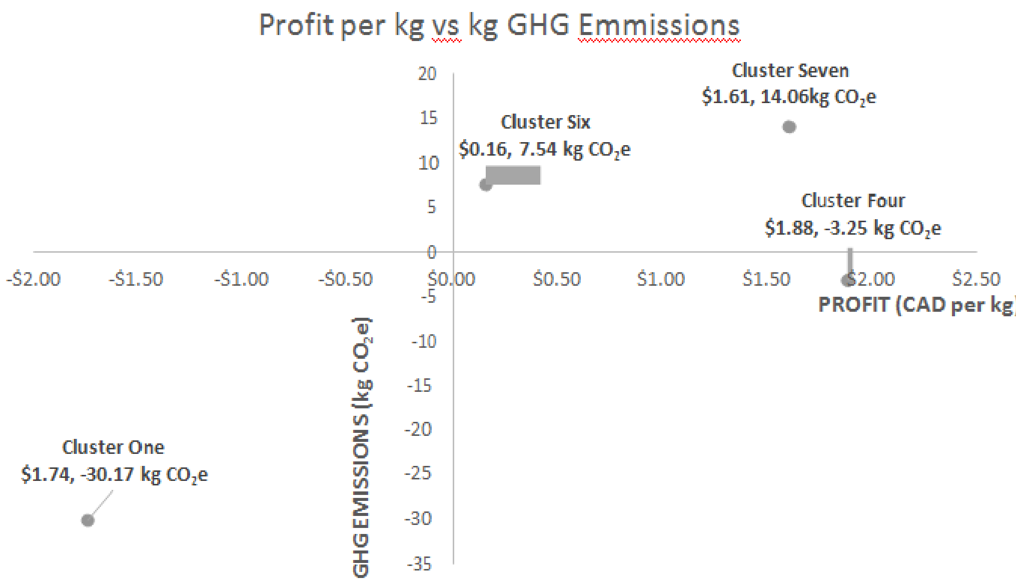
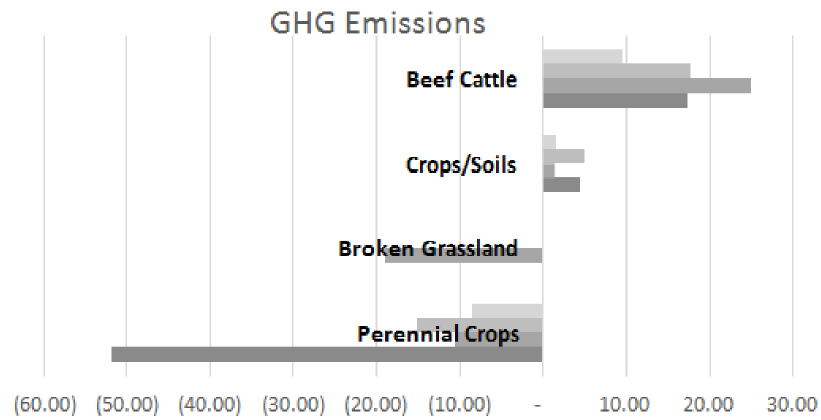


Figure 1. Assessment of profits and GHG emissions
Source: Possberg (2015).

There were several other areas responsible for increasing GHG emissions on each farm. Stored and applied manure, hay and oat production, as well as non-feed barley production added to each farm's emissions. None of these emissions were as great as those from emitted through enteric fermentation from cattle.

4.2. Greenhouse Gas Sequestrations

Soil carbon change depends on percentage of perennial crop, area of permanent grassland, changes in tillage practice and use of fallow in the farm. Practices that increase carbon in the soil including planting perennial crops, growing legumes, reducing tillage, restoring grasslands and eliminating fallow can sequester carbon in the farm (McConkey 2012). Out of the four farms, Cluster One farm sequestered the most. Even though only 30% of its perennial crop seed was alfalfa, it still sequestered far more per kg (51.91 kg CO2e per kg) than any other farm. It also had more ha per pound sold than any other farm, in conjunction with a low weaning weight of only 227 kg. The Cluster Six farm was able to sequester the next highest amount from the use of perennial crops, at 15.23 kg CO2e per kg sold, which is attributed to the large percentage of alfalfa. Cluster Four farm was able to sequester 10.60 kg CO2e per kg sold, though it was able to sequester even more due to its tame grassland. While this pasture land was not as productive as most farms' perennial crops in terms of sequestration, it did add an additional 19.01 kg CO2e per kg sold. The lowest amount sequestered, from Cluster Seven farm, is due to low amount of alfalfa within hay crop. Only 20% of the crop was alfalfa, which then sequestered less GHGs per acre than the tame pastureland from Cluster Four. It also used four times less land for perennial crops than Cluster One farm.



	Perennial Crops	Broken Grassland	Crops/Soils	Beef Cattle
Cluster 7	(8.52)	-	1.46	9.58
Cluster 6	(15.23)		5.07	17.71
Cluster 4	(10.60)	(19.01)	1.35	25.01
Cluster 1	(51.91)		4.39	17.35

Cluster 7 Cluster 6 Cluster 4 Cluster 1

Figure 2. Detailed sources of GHG emissions on cluster farms in kg CO2e per kg
Source: Possberg (2015).

4.3. Revenue

Since the farms studied are largely cow-calf farms, each should be expected to find profitability through the sale of weaned calves and culled cows. However, not all of these farms were able to do so, when comparing the operating costs of managing a herd to the revenues gained though calf and culled cow sales.

The Cluster One farm was unable to reach profitability even when fixed costs (depreciation and investments) were excluded. The difference between operating costs and revenue from cattle reached $18,986.76. The Cluster Six farm was able to produce a small positive profits over all costs of $1,257.92 per annum. Both mixed farms were able to sustain profitability from their cow-calf operation on its own merits. Cluster Four farm was able to achieve a profit of $13,658.51 when considering operating costs and cattle revenues, whereas Cluster Seven farm generated profits at $1,988.58 per annum.

These differences are only partially explained by weaning weights. The Cluster One farm had the lowest weaning weight, at only 227 kg. If average weaning weights were increased to 295 kg, profitability would have increased by $2,826.75. However, this weight increase still leaves the farm at a significant loss. The Cluster Six farm, however, would have decreased its revenue from cattle by $24,369.13 if it had increased its weights from 272 kg to 295 kg. As weights increase, the average prices for feeder calves decreased in 2011 (Agriculture and AgriFoods Canada 2008).

These four farms generated their revenue through different methods. Though revenues from cattle were low, the Cluster Seven farm generated more revenue ($8.62 per kg sold) than any other farm, through its sale of non-feed barley. The Cluster Four farm grew considerably less, and therefore increased revenue through barley production by $0.97 per kg sold. The Cluster One farm was able to generate most of its revenue from hay production, though this feed was likely saved for future years. Since it produced 80% more hay than necessary, this result is expected. Cluster Four farm only generated 29% of its revenue from hay production, though it produced 58% more hay than necessary. The remaining two farms only generated 2% of their revenue from hay production.

As the Cluster Six farm used more acres than any other farm to produce oat greenfeed, it was expected that a larger portion of its revenue would originate from the sale of this crop. However, it constituted only 28% of total revenue, while the majority of its income arose from the sale of cattle. This was the farm that generated most of its income from the sale of cattle. The only other farm to rely less on feed to produce revenue was the Cluster Seven farm.

4.4. Costs

The farms from Clusters One and Seven had significant revenue, though they also had significant costs as well. The farm with the most amount of acres per pound sold is the Cluster One farm, followed by the Cluster Seven farm. While Cluster One farm had a higher stocking rate, it grew significantly more feed than necessary for its animals. This resulted in higher costs overall for the farm. The cost to provide pastureland, however, was considerably smaller, as these investments consisted of 20 year investments on fencing and troughs for native pastures, while tame pastures had an additional cost of seeding every ten years.

Economies of scale were not evident in this study. Instead, greater efficiency led to higher profitability. Cluster Four farm had the lowest investment and depreciation costs overall. It used its perennial land more efficiently, through three hay cuts in a year, as against one. By doing so, Cluster Four farm spent $12,443.50 on rental rates, but spent $24,666.53 less on machinery and equipment, even when accounting for a manure composter.

5. Discussion and Conclusion

Linear programming methods enable researchers to maximize profits or minimize costs, though assumptions made in their models might be unrealistic expectations as to what is actually accomplished in the cattle industry. The activities of the farms studied vary greatly in terms of emissions and profitability, even though they all produce calves exclusively, rather than choosing to background or finish their animals. Cluster One farm might not have sequestered as much GHG emissions had it produced its feed more efficiently. It might also have created more profitability. Cluster Seven farm might have sequestered GHG emissions had it relied on tame pastureland, rather than native pastureland. It could have done so without increasing its costs. If each farm had produced its hay more efficiently through additional cuttings of hay throughout the year, as Cluster Four farm practiced, it might have saved costs on its land in terms of land taxes and seeding. In order to understand the full ramifications of these results, studies of beneficial management practices that result in higher profitability and lower GHG emissions are needed.

6. Acknowledgements

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