Influence of Management on Ontario Beef Operation Margins

by

Maury E. Bredahl and Leonie A. Marks

Bredahl is Professor of Agricultural Economics at the University of Guelph and Director of the Centre for Agribusiness Research and Management. Marks is form Research Associate there.

Selected Paper prepared for presentation at the Agricultural and Applied Economics Association 2012 Annual Meeting, Seattle, Washington

August 12-14, 2012

Influence of Management on Ontario Beef Operation Margins
Selected Paper 2012 AAEA Meeting

Maury E. Bredahl and Leonie A. Marks

Abstract

The long term prospects for cattle farmers in the province of Ontario will depend on their ability to stay competitive in a changing business environment: managing the returns to farm operations will be critical to their long run viability. Focusing on good management practices that reduce operational inefficiencies and that increase gross margins may be the best strategy available to producers for reducing costs and increasing output (Kalirajan, 1981). Such short run management decision making should translate into long run business viability. Groth (1992, p.3) argues that businesses operate under an "operating cycle." An operating cycle includes the assets, cash, raw materials, work-in-process, finished goods and accounts receivable of the business – with each component varying by type of business. Managed properly the operating cycle is the origin of economic returns to the business operation. Operating cycles are important because: (1) managers can affect the cycle over short time periods – hence, management decisions and actions can yield immediate results; (2) the manager often has the authority to make changes and implement them right away; and (3) greater levels of economic returns can be achieved through effective management which reduce operating risk and lower the cost of capital over the long run. We use contribution margin to measure operational performance of Ontario cow-calf farms for these reasons. We focus on how Ontario beef farmers can improve their operational efficiency by (1) benchmarking their performance against competitors using key performance indicators (KPIs) of effective enterprise management; and (2) understanding the management practices of high margin farms in order to improve industry performance.

Three key performance indicators of biological efficiency were used to explain contribution margins of the cow enterprise: the calf-loss rate, birth rate, and weaning rate. Our initial results indicate that two of three biological KPIs significantly explain the observed variation in contribution margins, that is, the calf-loss and birth rates. Weaning rates are not significant. We find that a unit (1%) increase in the calf-loss rate on average leads to a loss of $2,851 in contribution margin; while a unit (1%) increase in the birth rate adds $1,669 to the contribution margin from these cow enterprises. These magnitudes suggest that if the least efficient farms can reduce their calf losses throughout the production year and increase their calving rates this would have a large significant impact on the bottom line. We conclude that these biological KPIs are straightforward indicators that farmers can monitor, investigate and take corrective managerial action on in the short run. Our initial results also indicate that the larger operations – in terms of the average herd size – enjoyed higher contribution margins from their cow operations. However, while herd size is highly significant each additional unit (cow) adds only $1.85 to the overall contribution margin from the cow operation. Hence, significant potential gains from implementing sound management practices that reduce calf-losses and increase calving rates are likely to be more effective and within reach of the smaller operations.

Introduction

The beef industry in Ontario faces a number of challenges. Increased biofuel production (Elobeid *et al*., 2006) and rising crude prices (Saha and Mitura, 2009) have increased feed costs. Increased crude prices also translate into rising fuel (diesel and heating) costs for beef producers. Feed, fertilizer, and fuel costs make up one-third of total farm operating expenses for livestock producers (*ibid*., p.7). Changes in food safety regulations are also expected to increase costs of beef production (Antle, 2000). .

The long term prospects for cattle farmers in the province of Ontario will depend on their ability to stay competitive in this changing business environment. In this context, managing the returns of farm operations will be critical to the long run viability of Ontario beef operations. Focusing on good management practices that reduce operational inefficiencies and increase gross margins (or returns) may be the best strategy available to producers for reducing costs and increasing output (Kalirajan, 1981). Such short run management decision making, if optimal, should translate into long run business viability.

In this paper, we focus on how Ontario beef farmers can improve operational efficiency by (1) benchmarking their performance against competitors using key performance indicators of effective enterprise management; and (2) understanding the management practices of high margin farms in order to improve their overall operational efficiency and profitability.

Literature Review

Benchmarking is established as a tool to improve an organization's performance and competitiveness in business (Kyro, 2003, p.210). Increasingly it has been extended from initial studies of the operation of large firms to small businesses including farm operations and public as well as semi-public sectors. Yet the "concept of benchmarking is viewed as an evolving and dynamic phenomenon" (*ibid*. p.212). Watson (1993) suggests that benchmarking has evolved since the 1940s towards its more sophisticated form today. The initial focus of benchmarking was on reverse engineering techniques, or comparing product characteristics with those of competitors. "Competitive benchmarking" broadened the comparison to business processes of industry competitors; while "process benchmarking" focused on learning from companies outside of one's industry. In the 1990s, "strategic benchmarking" implemented systematic performance improvement through understanding successful external partner business strategies. The goal was to generate continuous and long run improvements in processes. More recently, competence or "learning benchmarking" advances process efficiencies by changing the actions and behaviors of individuals and teams within the organization.

In summary, benchmarking compares business performance with that of others engaged in a similar (or alternative) activity and learning from the comparisons that follow (Ashworth, 2002 as cited in Hansen et al. 2005). It is not an act of imitation but rather should lead to process innovation (Thompson and Cox, 1997) – particularly if looking outside of one's immediate industry (Francis and Holloway, 2007, p.176). Benchmarking is therefore not just about an understanding of how exemplary performers achieve desirable outcomes in one's own industry but also how dissimilar organizations perform similar processes. By examining the actions of dissimilar organizations, Francis and Holloway (2007) argue that process improvements can outstrip incremental change found within a single organization or industry. The goal of benchmarking is also to enable profit maximization by optimizing the use of inputs and outputs in the production process. An outcome of benchmarking is better innovative practices over time which, in turn, leads to improved profits (Ashworth, 2002 as cited in Hansen et al. 2005).

Benchmarking requires the measurement of different aspects of the production process. These chosen measures are then used to derive quantitative key performance indicators (KPIs). Key performance indicators measure the productivity of a specific resource in physical units (e.g., in the case of beef production: number of live births, number of calf deaths) or in financial terms ($/cow). Key performance indicators are tools used to understand the competitive performance and the production process achieved and used by the best (most profitable or efficient) operations (Hansen et al. 2005, p.2).

The quality of the resulting management recommendations is dependent on the relevance of the indicators used.

In the case of agricultural production the task of benchmarking is to find key performance indicators that (1) easily measure the level of achievement from a specific input; (2) reflect the economic and biological basis of production; (3) contain information about the farm's strengths and weaknesses relative to its competitors. They should reflect the use of those inputs that most constrain farm performance; and (4) describe the production process achieved and used by the best operations. Hansen et al. (p.2) argue that in order for benchmarking to work one must compare similar enterprises, facing similar market opportunities, and of a similar size.

Although benchmarking has evolved out of industrial management, it is also being used extensively to improve agricultural production practices in both developed and developing economies. A number of studies use management accounting measures, such as gross margins, to account for farm performance while other studies have used parametric or non-parametric approaches, such as data envelopment analysis, to derive farm efficiency scores. For example, Hansen et al. (2005) used KPIs to assess which factors might be important in obtaining higher gross margins among Norwegian dairy farms. They used "extended gross margin" to measure farm performance which includes all subsidies to milk operations deducting fixed costs of roughage production. They argue this measure allows for a more critical examination of the efficiency of milk production in relation to the main variable costs over which farmers have managerial control. Hence, extended gross margin is a measure of short run profitability. They found that gross roughage cost is an important KPI in explaining the relative performance of Norwegian dairy production. Gross roughage cost consists of depreciation, maintenance of machinery and roughage storage, and other fixed costs related to roughage production such as electricity, fuel, machinery insurance and hired labor. They also found that good quality roughage in sufficient amounts appeared to be an important strategy to maintain efficient milk production.

Similarly, United Kingdom (UK) farmers across a broad array of commodities have adopted benchmarking as a tool for reducing operating costs and increasing farm efficiency. Gross margins, or other similar management accounting measures, are being used to benchmark UK farm profitability. According to the Food Chain Center (Farmers Weekly, 2007, p.89) almost one-third of UK farmers benchmarked their business on a regular basis compared with just 8% in 2002. Sixty-nine percent of these farmers reported gaining a better understanding of costs, while 45% gained a better insight into what drives business profitability. Thirty-four percent increased their financial returns, while 27% increased the quality of their products. In Cornwall, three joint Milk Development Council (MDC) / Dairy Crest Direct (DCD) business groups are using benchmarking to improve dairy production. Participating farmers supply on an identical contract making such comparisons straightforward (Dairy Farmer, 2006, p.20). The participating groups identified potential cost-savings in supplementary overheads, such as veterinary and medical expenses, and large input costs such as bought-in feed. There was not a significant difference between producers in terms of veterinary charges, but there were significant differences in areas such as bought-in feeds, heifer replacement costs, and machinery and labor. They also examined management factors that would maximize contract value. They found that they were able to implement processes that improved the quality of their milk products, allowing them to better fulfill contract specifications by providing the right mix of protein, fat, and low cell count. This resulted in increases in revenues of two to four pence per liter milk.

In the case of arable farming, a UK farm management company, Sentry, compared establishment costs across its arable units using benchmarking. It found that the number of passes had little effect on yield (tons/hectare) despite different soil conditions across farming units. It was able to adjust its number of passes to gain efficiencies in establishing crops and cost savings from using less fuel and machinery

(Ashbridge, 2006, p.41). In 2006, Brown and Company surveyed UK sugar beet farmers to determine gross farm margins and total costs of production. They found that total costs of production varied by nearly 90% between the lowest and highest cost producers. Brown and Company proposed using benchmarking for those growing sugar beet in similar conditions to reduce costs and increase efficiencies (Hughes, 2006).

Australia has a long tradition of benchmarking agricultural production systems (McGregor and English, 2010, p.573). Recently, the Grains Research and Development Corporation (Lukacs, 2011) benchmarked physical and financial performance indicators for grain-producing agroecological zones, providing insights into the top performing farms' success. Financial performance was measured by rate of return on capital. The study found that superior financial performance of the top performing grain producing farms differed between the specialist and mixed-enterprise farms within each zone as well as between zones. In general, however, the top performing farms were more intensively managed, realized higher efficiency and productivity over time, were more effective at converting rainfall into output, and responded more rapidly to market signals, seasonal conditions, and the development of new crop cultivars (Lukacs, 2011,p.1).

Similarly, McGregor and English (2010) benchmarked 23 Australian mohair enterprises and 30 wool enterprises across 2004-2007 financial years on the basis of gross margin per dry sheep equivalent (DSE). They surveyed farmers on their farm practices, physical resources, inputs (e.g., animal health, pasture costs, supplementary feeding) and outputs (e.g., kid/lamb numbers, fibre production, etc.), livestock trading, and details of labor (contract, casual, operator input), capital and overhead costs (e.g., fuel, vehicle expenses, insurance, rates and rents). Given their limited sample size, they used simple regression analyses on pooled data across the three years to examine the relationship between production, physical parameters, and financial variables in mohair and wool production. They found considerable variation in KPIs for both wool and mohair enterprises in the sample indicating substantial scope for some producers to increase profit (ibid., p.575). The most significant costs in mohair production were supplementary feed (particularly during drought) and selling costs. They found that the most important factor determining gross margins was that the price/kg of mohair declined as the number of does increased indicating that mohair quality declined as the proportion of does in the flock increased. In comparing mohair with wool production they found that mohair enterprises grazed their goats less intensively, that is, the stocking rates were lower than similar sized wool enterprises. They also used less phosphate fertilizer than wool enterprises suggesting pasture productivity would be lower in mohair enterprises. These differences were counterbalanced by much higher prices for mohair compared to fine wool, resulting in higher gross margins.

Several studies have investigated factors driving agricultural production efficiency in developing countries (Dhungana, Nutall and Nartea, 2004). For example, Chauhan et al. (2006) examined efficiencies of rice production activities in West Bengal, India using non-parametric data envelopment analysis. They used benchmarking to segregate efficient farmers from inefficient ones and identified wasteful uses of energy from the inefficient farmers in the sample. They found that efficient farmers used a more balanced mix of fertilizers, used less human energy (labor) in the weeding and threshing operations, and used better quality seed. Similarly, Malana and Malano (2006) benchmarked the efficiency of wheat production in selected areas of Pakistan and India using DEA. Wheat productivity had shown significant declines and variation in these regions. They ranked the productivity performance (output) of different wheat growing areas in both countries based on three inputs: irrigation, seed and fertilizer use. They found that the overuse of irrigation and fertilizers was a major source of inefficiency among the decision making units at regional and inter-regional levels.

Benchmarking Beef Production

There are a limited number of studies that have used benchmarking to investigate best management practices in beef production systems (Featherstone, Langemeier, and Ismet, 1997; Gillespie and Rakipova, 2000; Iraizoz, Bardaji, and Rapun, 2005; Kim et al., 2005; Trestini, 2006; Samarajeewa, 2007; Ghorbani, Mirmahdavi, and Rahimabadi, 2009; Nelson and Robinson 2009; Villano et al. 2009; Best et al., 2010; Lisson et al., 2010; Weber, 2010; Banaeian, 2011). Parametric (Iraizoz, Bardaji, and Rapun, 2005; Kim et al., 2005; Trestini, 2006; Samarajeewa, 2007), non-parametric data envelopment analysis (Featherstone, Langemeier, and Ismet, 1997; Gillespie and Rakipova, 2000; Ghorbani, Mirmahdavi, and Rahimabadi, 2010; Weber, 2010; Banaeian, 2011) and management accounting approaches (Nelson and Robinson, 2009; Best et al., 2010; Hughes, 2010; Lisson et al., 2010) are all currently being utilized in the literature.

For example, Iraizoz, Bardaji, and Rapun (2005) employ a stochastic translog production function to estimate beef farm efficiency. They estimated efficiency for 1,022 different livestock holdings over an 11 year sample period. Output was specified as the output from all farm activities without net current subsidies (in Euros). Inputs were land, number of livestock units, labor, depreciation (in Euros), feed (in Euros) and the value of other intermediate inputs. They found that the mean value obtained for technical efficiency was 84%. That is, livestock holdings attained on average only 84% of their maximum potential output during the 1990s. Trestini (2006) and Samarajeewa (2007) both use stochastic Cobb-Douglas production frontiers to estimate beef farm efficiency. Samarajeewa examined the production efficiency (technical, allocative, and economic) of 333 Alberta cow-calf farms from 1995 to 2002. He used the value of weaned calves as the output variable, and labor, capital, feed, utilities, and veterinary, medical and breeding expenses as inputs. He found that average technical efficiency was 83%, while allocative efficiency was 78% and economic efficiency was 67% respectively among Alberta beef herds. Kim et al. (2005), on the other hand, examined factors affecting cattle producers' adoption of best management practices (BMP) using probit analysis. They found that beef farmers most likely to adopt best management practices managed farms with more enterprises, of which the percentage of income from beef production was higher; had contact with Natural Resources Conservation Service personnel; held a college bachelor's degree; and managed farms which included hilly land.

Featherstone, Langemeier, and Ismet, (1997), Gillespie and Rakipova (2000), Ghorbani, Mirmahdavi, and Rahimabadi (2009), Weber (2010) and Banaeian (2011) employ data envelopment analysis to estimate efficiency scores as indicators of best practice among beef and cattle operations. For example, Featherstone, Langemeier, and Ismet (1997) estimated technical, allocative, and scale-efficiency measures to examine the competitiveness of Kansas beef farms. They used six inputs: feed, labor (unpaid and paid), capital, utilities and fuel, veterinary costs, and miscellaneous costs. Accrual gross income, measured on a value-added basis, was used to measure output. As pricing information in the sample was not collected they assumed the law of one price, that is, all farmers face the same input price in the sample. They found that on average the farms in the sample were 78% technically efficient, 81% allocatively efficient, and 95% scale efficient. Given their findings they argue that farmers should focus on using their capital, labor and feed more efficiently rather than focusing on increasing their size.

Banaeian (2011) investigated the efficiency of Iranian cattle (dairy and beef) farms using nonparametric DEA. The mean technical efficiency score was 79% indicating, similar to Featherstone et al., that there was potential for more efficient input utilization in cattle farming in Iran. His study uses aggregate data from 18,830 industrial cattle farms (herds) across 28 provinces of Iran. The analysis was based on three inputs: payment of water; electricity and fuel; and feed and other expenditures; while the output was expressed as three revenues from milk, farmyard manure and other revenues (measured in hundred dollars per farm). He found that dairy farms were more efficient than beef farms and that the Holstein breed of cattle was positively associated with efficiency scores.

Villano et al. (2009) argue that single enterprise studies may miss potential efficiencies that can be achieved when taking a systems approach and investigating the efficiency of the whole farm operation. They have investigated synergies in mixed-enterprise (sheep, beef, and crop) farming systems among a benchmarking group in the Wheat-Sheep Zone in New South Wales, Australia. They used a stochastic input distance function to calculate the degree of synergies among the three different enterprises. They found complementary synergies between all enterprises, as measured by positive second cross-partial derivatives of pairwise enterprise outputs. They found strong complementarities between sheep and cereal production and between beef and sheep production. They also found that the average technical efficiency of the farmers in the benchmarking group over an 8 year period was 0.784 with a range of 0.214 to 0.963. These figures suggest that there was considerable opportunity for many beef farmers to expand farm output with the current input mix (*ibid*., p.150).

Hughes (2010), on the other hand, uses management accounting measures as a practical way for ranchers in Nebraska and Wyoming to identify their high-cost components against those of a set of benchmark herds. Costs are compared on the basis of a unit cost of producing a hundredweight of calf (UCOP) rather technical efficiency scores. He argues that this measure takes into account the production process -- a low UCOP indicates a high production rate per cow. His approach requires ranchers to quantify their individual cost components and then select a high-cost component (relative to available benchmarks) to analyze and change over time. Nelson and Robinson (2009) report on a “Research to Reality Project” which assisted beef producers in Australia in developing practical responses to a range of production and grazing challenges, using extension techniques such as economic benchmarking and management accounting measures. They found a link between better land management and profitability for many producers and uptake of recommended grazing practices as a result of the project.

In addition to determining the overall level of efficiency in the beef industry, a number of these studies have identified technical and management factors that account for best management practice. Several of these studies have found that herd size is positively related to beef farm efficiency (Featherstone, Langemeier, and Ismet, 1997; Gillespie and Rakipova, 2000; Iraizoz, Bardaji, and Rapun, 2005; Trestini, 2006; Samarajeewa, 2007; Banaeian, 2011). The relationship between demographic variables (such as producer age, education and off-farm income) and operational efficiency is more mixed, however. For example, Featherstone et al. (1997) found that age and efficiency are negatively related, while Gillespie and Rakipova (2000) found that age was positively related to efficiency, and Gillespie et al. (2009) found that education and off-farm work were positively related to efficiency. Iraizoz, Bardaji, and Rapun (2005), on the other hand, found that age had no impact on farm efficiency; and some studies have excluded socioeconomic variables altogether from their approach (see for example Ghorbani, Mirmahdavi, and Rahimabadi, 2009).

Samarajeewa (2007), in his study of Alberta cow-calf operations, found that biological efficiency; namely, higher conception, weaning, and calving rates have a positive effect on technical efficiency, while government support programs were negatively related. Weber (2010) also found that the weaning rate was an important variable in explaining technical efficiency of cow-calf operations in Ontario. Best et al. (2007) developed technical production, market, and economic information common to extensive beef production systems in Central Queensland, Australia. Rather than benchmarking against actual operations they used representative property models to generate best-practice farm enterprise estimates. Cost structure and market price information was used to establish representative gross margin profitability estimates for selected beef production systems across different land types in Central

Queensland. They defined gross margin as gross income received less the variable costs incurred. They found that gross margins were sensitive to assumptions about the weaning rate (higher weaning rates led to higher gross margins), weaning price and breeder mortality rates (higher mortality rates led to lower gross margins). Hence, these results are consistent with those of Samarajeewa (2007) and Weber (2010) using parametric and non-parametric efficiency analyses.

Other management factors that positively explain the technical efficiency of beef operations include having purebred bulls, percentage of land rented, weaning weight and the percentage of pasture that is improved (Gillespie et al., 2009). On the other hand, the authors found a strong negative relationship between efficiency and management practices, such as whether the farm had a designated hay field. Similarly, Trestini (2006) found that beef operations that used more hired labor and had higher building values were less efficient. Gillespie and Rakipova (2000) investigated the link between efficiency and pregnancy checking, vaccination programs and the presence of pure-bred cows, among other variables. No significant relationship was established between these variables and technical efficiency in their study.

In summary, there are a number of approaches that have been used to determine what constitute relevant performance metrics in farm benchmarking studies. Non-parametric approaches, such as data envelopment analysis, are advocated because they allow benchmarkers to examine what constitutes best practice, namely, economic efficiency and its components, over many variables. Unlike with parametric approaches, data envelopment analysis places no restrictions on the functional form of the production relationships between inputs and outputs. Researchers are able to capture complex economic relationships between several inputs and outputs (enterprises) that often characterize agricultural production systems. Such scores are particularly useful when farm inputs are not monotonic and where both substitute and complementary relationships exist between them (Fleming et al., 2006).

On the other hand, as Greene (1993 as cited in Samarajeewa, 2007) notes, the deterministic approach effectively attributes any deviation from the production frontier solely to inefficiency. Any measurement error or any source of stochastic variation in the dependent variable is embedded in the one-sided error component. As a result, outliers can have profound effects on the estimates and any shortcoming in the specification of the model could translate into increased inefficiency measures. Another drawback of data envelopment analysis is its potential sensitivity to the number of observations used as well as to the number of outputs and inputs (Bravo-Ureta and Rieger, 1991) specified in the model. Moreover, as the foregoing discussion illustrates – in empirical applications the choice of inputs and outputs varies and is often determined by data availability.

The use of alternative parametric approaches; namely, stochastic production frontiers, explicitly model inefficiency while allowing for noise, measurement error, and exogenous shocks that characterize agricultural production (Samarajeewa, 2007, p.26). Hence, stochastic production frontiers address the noise problem associated with deterministic approaches, while permitting the estimation of standard errors and hypotheses testing. As well, stochastic frontiers offer flexibility in modeling various aspects of production, such as production risk and marketing risk (Samarajeewa, 2007, p.25). Kalirajan and Shand (1999, as cited in Samarajeewa, 2007) argue that modeling a production function with a stochastic frontier also conforms to production theory. However, drawbacks of the approach include the fact that there is no a priori distributional assumption for the inefficiency · error term. Furthermore, the need for specification of a particular functional form, which is common to all parametric frontiers, is another drawback.

A more accessible approach that has been employed in the literature is to rely on management accounting measures as indicators of farm performance. These have the advantage of being readily accessible to farmers who can utilize their own farm budgets in order to make decisions. Accounting measures also have the advantage of linking financial outcomes to management decision making. By using profitability as an indicator of farm performance, for example, farmers can take immediate action to alter their bottom line. Outputs and costs are usually calculated for comparative or benchmark analysis on per acre/hectare or per cow/calf bases (Fleming et al. 2006, p.2). Calculations incorporate adjustments for opening and closing values and the addition of non-cash items of receipts and payments. Net output figures are used to account for internal transfers between activities, such as feed produced from crops used in livestock production (Barnard and Nix 1979, p. 527 as cited in Fleming et al., 2006).

There have been a number of criticisms of using management accounting measures for "comparative" or benchmarking analysis. Malcolm (2004, as cited in Fleming et al. 2006) argues that sound economic principles of optimal resource allocation (an advantage of using efficiency scores) have often been ignored. Partial measures of performance, such as yield or stocking rate, were initially used to measure farm performance. More comprehensive measures, such as net operating profit or gross margin, have been developed and are being used which do attempt to measure whole-farm performance. However, such measures do not account for the size of the farm operation. Small-scale farmers may appear to be less profitable and, hence, performing less well than their larger counterparts when that might not be the case.

Contribution Margin as a Means of Measuring Farm Performance

In this paper, we use contribution margin of the cow enterprise to measure operational performance of Ontario cow-calf farms. As we have comprehensive detailed farm budgets available to us we are able to utilize this approach. Groth (1992, p.3). argues that businesses operate under an "operating cycle." An operating cycle includes the assets, cash, raw materials, work-in-process, finished goods and accounts receivable of the business – with each component varying by type of business. Managed properly the operating cycle is the origin of economic returns to the business operation (ibid.). Managed ineffectively it is the source of economic losses and, in the long run, exit from the industry. Operating cycles are important for a number of reasons: (1) managers can affect the cycle over short time periods – hence, management decisions and actions can yield results in the short run; and (2) the manager often has the authority to make such changes and implement them right away. Moreover, Groth argues that by effectively managing the operating cycle greater levels of economic returns from operations are achieved, which reduces operating risk. This, in turn, this leads to less capital invested and at a lower risk which lowers the cost of capital over the long run.

The intent of starting a business is to realize an attractive economic return to capital employed – the money invested in the business. The decision then is to take cash and invest it in both fixed and operating assets in the cycle. Hence, a firm has the total invested capital in the operating cycle and the variable costs or direct costs of materials and dedicated labor associated with making the finished product. In the short run, fixed costs are set for the period in terms of investment decisions concerning finished goods, and only variable costs are relevant to decision making. Contribution margin measures the difference between the sales price (revenues) and variable costs to produce the finished product sold. Contribution margin then, measures performance of day-to-day operational decision making – what we are concerned with here. The contribution margin must cover the fixed costs for the period. If it does that, the firm is at break-even, if not, it operates at a loss. On the other hand, if the contribution margin exceeds total period fixed costs the firm makes a profit (ibid., p.5). Contribution margin as a measure of firm performance can also aid in decision making where there are multiple outputs and inputs, such as, in restaurant menu selection (LeBruto et al., 1997). LeBruto et al. demonstrate how competing menu groupings can effectively be compared and managed on the basis of their respective popularity (sales) and contribution margins.

In the case of this paper, we measure contribution margin on a per cow basis (as defined in the farm budgets of participating cow-calf operations). Contribution margin of the cow enterprise essentially embodies key day-to-day cow-calf operational decisions: revenues achieved through cow-calf sales minus feed costs (purchased and/or produced on farm); animal health and breeding costs; hired labor expenses; and any other variable costs. Management decisions that reduce variable costs (increase contribution margins) reduce the amount of capital at risk; lower the break-even point of the operation; have favorable compounding effects, e.g., an increase in the productivity of labor may reduce material usage through increased quality control; allow greater pricing flexibility (e.g., positive cash flow allows the farmer to wait to sell at higher prices); and allows a farm to grow with less incremental capital investment per dollar of incremental sales.

Data Description

Data for this study is taken from an Ontario benchmarking survey conducted in 2007 and 2008, for the production years 2006 and 2007, respectively. The benchmarking study was a partnership between the University of Guelph, the Ontario Ministry of Agriculture, Food and Rural Affairs, and the Ontario Cattlemen's Association. This study was intended to provide benchmarks for Ontario's cow-calf producers, in order to reduce their cost of production and increase the competitiveness of the industry.

Data was collected in the fall of 2007 and 2008 by the Ontario Ministry of Agriculture, Food and Rural Affairs staff, Ontario Cattlemen's Association staff, and by independent contractors. Two surveys were administered to each participant: a financial (budget) survey and management survey. The financial data was collected using the Ontario Ministry of Agriculture, Food and Rural Affairs' Ontario Farm Management Analysis Program (OFMAP). Under OFMAP's data collection framework, the cow-calf enterprise is separated out from other farm activities, if applicable. The management survey implemented in 2007 included forty-two multi-part questions addressing the demographic and management characteristics of the participating producers. Information, such as, education level, age, off -farm income, feeding management and breeding practices and marketing activities were collected in this survey. A modified management survey with a reduced number of questions was implemented in 2008. Not all producers participated in both the management and financial surveys. Only data from participants who completed both the management and financial surveys for at least one year are utilized in the analysis and regressions done in this study. In 2007, 38 farmers completed the financial and management surveys. Similarly, 40 farmers are included in the sample for 2008[1].

Farm budgets collected as part of the financial survey include data on whole-farm revenues and costs as well as for individual cow, calf, and crop enterprise budgets. Moreover, production data, such as, average number cows, number of calves weaned, number of calves born, and number calves died as well as number acres in pasture, hay, forages and crops are also available. Tables 1 and 2 below provide summary statistics for the performance measure that we are using in this study – contribution margin ($/cow) of the cow enterprise.

[1] Note that some farmers completed budgets and the management surveys in both years, while some farmers completed them in either year.

Table 1: Summary Statistics for 2006 Production Year

Variable Name	Mean	Standard Deviation	Minimum	Maximum
Average Number Cows	95	69	18	290
Farm Size (acres)	575	730	47	3600
Pasture Land (acres)	443	471	38	2600
Contribution Margin Cow Enterprise ($/cow)	$-124	$226	$-696	$424
Contribution Margin Total Farm ($)	$42,835	$82,051	$-232,128	$280,916
Calf Loss Rate	0.075	0.063	0.000	0.273
Birth Rate	0.987	0.087	0.703	1.148
Weaning Rate	0.920	0.097	0.500	1.123

Table 2: Summary Statistics for 2007 Production Year

Variable Name	Mean	Standard Deviation	Minimum	Maximum
Average Number Cows	85	63	22	319
Farm Size (acres)	503	646	62	3600
Pasture Land (acres)	373	299	52	1438
Contribution Margin Cow Enterprise ($/cow)	$-269	$306	$-1,166	$286
Contribution Margin Total Farm ($)	$20,449	$57,056	$-107,193	$264,805
Calf Loss Rate	0.069	0.061	0.000	0.243
Birth Rate	0.970	0.075	0.777	1.185
Weaning Rate	0.903	0.067	0.738	1.111

Contribution margin for the total farm operation is also included in tables 1 and 2. As can be seen from the positive mean total farm contribution margin of $42,835 and $20,449 in 2006 and 2007, respectively, – a majority of farms are covering their total variable costs in the short run. However, the mean contribution margin from the cow enterprise is -$124 per cow in 2006 and -$269 per cow in 2007, respectively. Such a finding – that the Ontario beef farmers sampled are on average making negative returns on the cow enterprise – is not unexpected. For example, Featherstone, Langemeier, and Ismet (1997) also document mean negative net income per cow for Kansas beef farms during 1992. However, it does indicate that a majority of the farmers sampled are making losses on the cow enterprise in the short run. Moreover, these losses increased during the 2007 production year. Figures 1 and 2 below order the beef farm operations by contribution margin for the 2006 and 2007 years, respectively. Approximately, 20% of the sample is making short run positive contribution margins from their cow operations.

In addition to the contribution margin metrics, different measures of farm size and three key performance indicators of biological efficiency: calf-loss rate, birth rate, and weaning rate were used.

The birth rate is defined as the number calves born divided by the average number of cows in the herd. The weaning rate is similarly defined: number of calves weaned divided by average number of cows. The calf-loss rate is the number of calves that died in a given production year divided by the number of cows in the herd.

The mean herd size declined from 95 to 85 between 2006 and 2007 – a 10.5% decrease. While the mix of farmers in the sample changed over this period – this number also reflects the broader decline in cattle production and farm profitability in Ontario during 2007. The summary statistics for herd size (ranging from 18 to 319 over the period of analysis) reflect sample heterogeneity. Farm size statistics based on total acreage and acreage in pastureland also reflect the heterogeneity of the two samples. This will be taken into account in subsequent analysis. Note that the mean calf-loss rate is 7.5% in 2006 but ranges from 0 to 27% for the most efficient to least efficient producers. Could these key performance indicators of biological efficiency explain some of the short run losses in the cow operation by less efficient farms? We investigate the degree to which these underperforming farms can improve their operational performance by utilizing these key performance indicators as benchmarks to modify their production and management practices.

Figure 1: Contribution Margin Cow Enterprise: 2006 Production Year

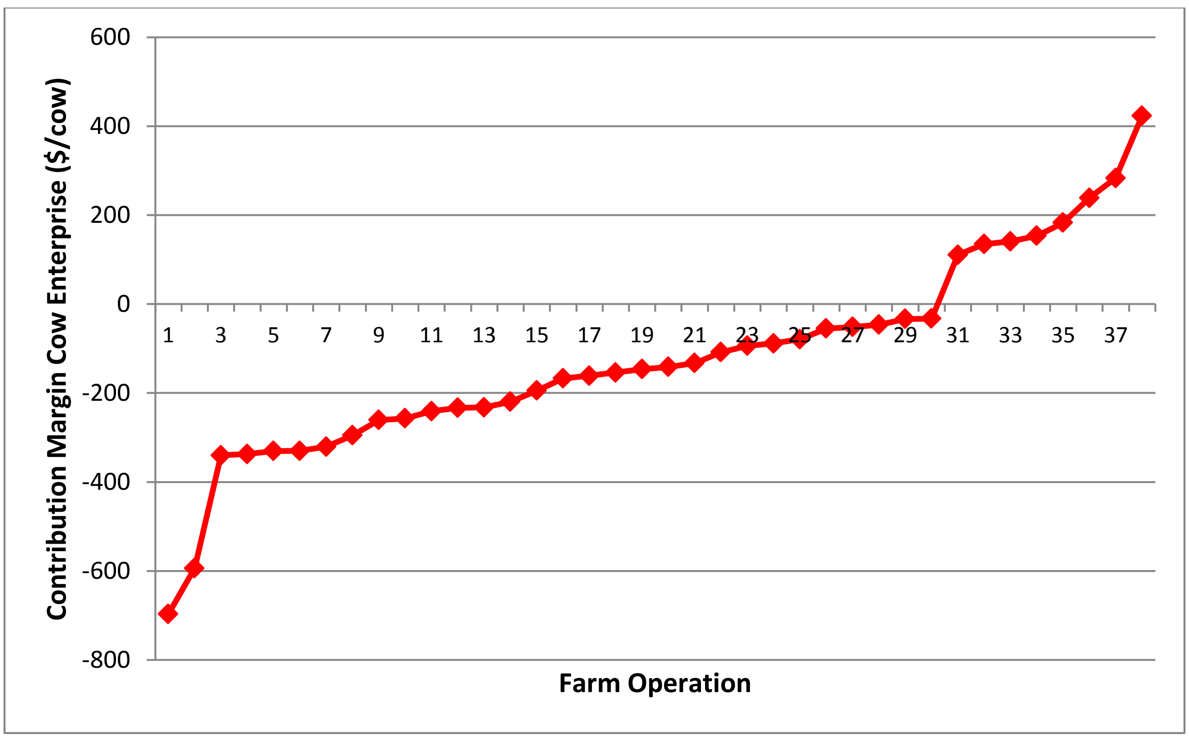
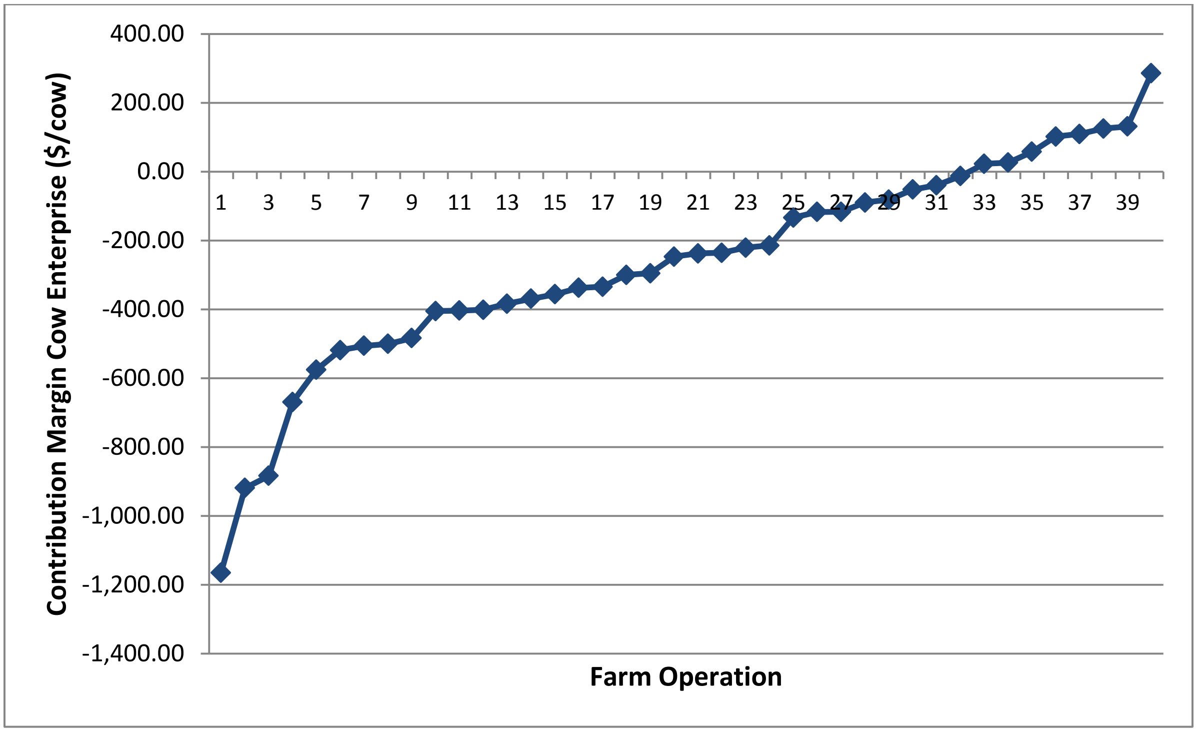


Figure 2: Contribution Margin Cow Enterprise: 2007 Production Year



Model Specification and Data Validation for Pooled Sample

As our data set has a small number of farm operations in each sample year, for our initial set of results we pool the data into a combined set which includes 78 initial observations. Our combined sample is unbalanced – some operations might be included in either year or both years. Hence, we include a YEAR dummy variable to capture any qualitative differences in cow-calf production between the two years. Our initial empirical model is specified as follows:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + u_i \quad (1)$$

where Y_i = is the cow enterprise contribution margin of the i^{th} farm in the 2006 or 2007 production years;

X_{1i} = 1 if production year equals 2007
= 0 otherwise
X_{2i} = birth rate
X_{3i} = weaning rate
X_{4i} = calf-loss rate
X_{5i} = average number of cows
X_{6i} = acres of land in pasture
$i = 1, \ldots, 78; j = 1, \ldots, 6$

Tests for Sample Outliers

From visual inspection of the contribution margin data there are some farm operations that might be potential outliers. The ROBUSTREG Procedure in SAS is utilized to check for normality and test for potential outliers and leverage points. Outliers can be problematic in the y-direction (or the response variable) as well as in the x-space (or leverage points). The main purpose of robust regression is to detect potential outliers and provide resistant (stable) results in the presence of them (SAS Institute Inc, 2003).

We use high-break down estimation to detect potential outliers in both the y-direction and x-spaces. The MM estimation is a high breakdown value method introduced by Yohai (1987) that builds on the approach of Rousseeuw (1984) and others (SAS Institute Inc. 2003). The breakdown value is a measure of the proportion of contamination that an estimation method can withstand and still maintain its robustness. The breakdown value of an estimator is defined as the smallest fraction of contamination that can cause the estimator to take on values arbitrarily far from its value on the uncontaminated data. Hence, the breakdown value of an estimator can be used as a measure of the robustness of the estimator. The MM procedure is as follows: (1) compute an initial (consistent) high breakdown value estimate$\widehat{\theta'}$. The breakdown value of the final MM estimate is decided by the breakdown value of an initial least trimmed squares estimate (see SAS Institute Inc. 2003) and the constant $k_0$in the χfunction. Hence, find $\widehat{\theta'}$ such that

$$\frac{1}{n-p}\sum_{i=1}^{n}\chi\left(\frac{y_i-x_i^T\widehat{\theta\prime}}{\hat{\sigma}\prime}\right) = \beta \qquad (2)$$

$$\text{where, } \beta = \int \chi\,(s)d\Phi(s) \qquad (3)$$

$$\text{and where } \chi_{k_0}(s) = \begin{cases} 3\left(\frac{s}{k_0}\right)^2 - 3\left(\frac{s}{k_0}\right)^4 + \left(\frac{s}{k_0}\right)^6, \textbf{if}|\mathbf{s}| \le k_0 \\ 1 \qquad\qquad\qquad\qquad \textbf{otherwise} \end{cases} \qquad (4)$$

Then (2) find a local minimum $\hat{\theta}_{MM}$ of

$$Q_{MM} = \sum_{i=1}^{n}\rho\left(\frac{y_i-x_i^T\theta}{\widehat{\sigma'}}\right) \qquad (5)$$

such that $Q_{MM}\left(\hat{\theta}_{MM}\right) \le \hat{\theta}_{MM}(\widehat{\theta'})$.

We report two sets of estimates for completeness: those from the MM estimation on the full set of observations (i.e., n = 78) and those using OLS regression on a reduced set where the outliers (if any) identified in the MM estimation have been excluded from the analysis.

Tests for Heteroscedasticity and Multicollinearity

As our data is cross-sectional, characterized by some degree of heterogeneity in farm operation it is important to test that the assumption of homoscedasticity holds. Standard estimation methods, such as ordinary least squares, are inefficient when errors are heteroscedastic or non-constant. Hence, after testing for any potential outliers and excluding them from the subsequent regression analyses, we conducted two tests for homoscedasticity -- White's test and the Breusch-Pagan test. White's statistic tests the null hypothesis,

$$H_0: \sigma_i^2 = \sigma^2 \, \forall \, i \quad (6)$$

White's test is general because it makes no assumptions about the possible form of the heteroscedasticity (White 1980 as cited in SAS Institute Inc. 2003). Because of its generality it may identify specification errors other than heteroscedasticity (Thursby 1982 as cited in SAS Institute Inc. 2003). Thus, White's test may be significant when the errors are homoscedastic but the model is misspecified in other ways. We also use the modified Breusch-Pagan test where the null hypothesis of homoscedasticity is tested against the alternate that the error variance varies with a set of regressors included in the model. Define the matrix *Z* to be composed of the values of the variables specified in the model, such that $z_{,ij}$ is the value of the *j*th variable in the model specification for the *i*th observation. The null hypothesis of the Breusch-Pagan test is

$$\sigma_i^2 = \sigma^2(\alpha_0 + \boldsymbol{\alpha}'\boldsymbol{z_i}) \quad (7)$$

$$H_o : \boldsymbol{\alpha} = \mathbf{0} \quad (8)$$

where σ_i^2 is the error variance for the *i*th observation, and $\alpha_0$and $\boldsymbol{\alpha}$ are regression coefficients.

The statistic for the Breusch-Pagan test is

$$bp = \frac{1}{v}\,(\mathbf{u} - \bar{u}\mathbf{i})'Z(Z'Z)^{-1}\mathrm{Z}'(\mathbf{u} - \bar{u}\mathbf{i}) \quad (9)$$

where $\mathbf{u} = (e_1^2, e_2^2, \ldots, e_n^2)$, $\mathbf{i}$ is a $n \times 1$ vector of ones, and $v = \frac{1}{n}\sum_{i=1}^{n}(e_i^2 - \frac{\mathbf{e}'\mathbf{e}}{n})^2$.

Another assumption of OLS regression is that there is no multicollinearity among the explanatory variables. Multicollinearity makes it difficult to obtain estimates with small standard errors, and can result in insignificant t-ratios and larger confidence intervals. Therefore, we explicitly test for multicollinearity using variance inflation factors (VIFs): the VIF measures the strength of inter-relationships among the explanatory variables in the model. A VIF = 0 indicates no multicollinearity; as a rule of thumb a variance inflation factor > 10 indicates potentially serious multicollinearity although caution is warranted in interpreting this statistic in light of other modeling considerations (O'Brien, 2007).

Empirical Results for Pooled Data

Table 3 details the results of the empirical MM and OLS estimations. The MM estimation identified two outliers in the y-space (no leverage points) based on the 78 observations combined across the two production years. These outliers were excluded from the subsequent OLS estimation. As expected, the two sets of results and parameter estimates are similar implying robustness in the OLS estimates when the outliers are excluded from the analysis. The adjusted R^2 for the OLS estimation was 0.37, or 37% of the variation in the dependent variable is explained by the KPIs and the other explanatory variables included in the model. This is acceptable for cross-sectional data. The model estimated using OLS with a reduced set of observations (n = 76) was also tested for heteroscedasticity. White's test statistic is χ^2 = 17.77, $p > 0.884$ and the Breusch-Pagan test statistic is χ^2 = 4.63, $p > 0.592$ confirming the null hypothesis that the errors are homoscedastic and lending further validity to the OLS estimation. And although some collinearity exists between the birth and weaning rates (with VIFs ranging from 6 to 7.5) this is considered acceptable based on a cut-off VIF $\geq$ 10.

Importantly, two of the three biological KPIs significantly explain the observed variation in contribution margins, that is, the calf-loss and birth rates. Weaning rates are not significant. These variables are also consistent with *a priori* expectations – hence, one would expect an increase in the calf-loss rate to lead to a reduction in the contribution margin per cow; similarly an increase in observed birth rates should lead to an increase in the contribution margin of the cow enterprise. Indeed, a unit (1%) increase in the calf-loss rate on average leads to a loss of $2,850.50 in contribution margin; while a unit (1%) increase in the birth rate adds $1,668.64 to the contribution margin from the cow enterprise. These magnitudes suggest that if the least efficient farms can reduce their calf losses throughout the production year and increase their calving rates this would have a large significant impact on the bottom line. These biological KPIs are straightforward indicators that farmers can monitor, investigate and take corrective managerial action on in the short run.

We also found that the larger operations – in terms of the average herd size – enjoyed higher contribution margins from their cow operations. This result is consistent with other studies (e.g., Weber, 2010; Featherstone et al., 1997) who also found that larger operations are more efficient. While herd size is highly significant ($p > 0.001$) each additional unit (cow) adds only $1.85 to the overall contribution margin from the cow operation. Hence, significant potential gains from implementing sound management practices that reduce calf-losses and increase calving rates are likely to be more effective and within reach of smaller operations. Interestingly, the amount of pasture land owned or rented is negatively related to contribution margins from the cow enterprise – although the losses are miniscule. Our dummy variable YEAR is significant ($p > 0.03$) and implies that, on average, contribution margins declined by $105.09 between the 2006 and 2007 production years. This is consistent with 2007 being a poor production year with drier conditions.

Model Specification and Data Validation for Individual Samples

In order to utilize the data collected from the management surveys implemented during 2007 and 2008 – the samples were unpooled. As already indicated in 2007, 38 farmers completed the financial and management surveys. Similarly, 40 farmers are included in the sample for 2008[2]. We specified two separate empirical models for each production year – a "demographic variables" model and a "management factors" model. Our empirical <u>demographic variables</u> model for 2007 is specified as follows:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + u_i \qquad (10)$$

where Y_i = is the cow enterprise contribution margin of the i^{th} farm in 2007;

X_{1i} = education
X_{2i} = age
X_{3i} = continuing education
X_{4i} = off-farm income level

[2] As already noted some farmers completed budgets and the management surveys in both years, while some farmers completed them in either year.

$i = 1, \ldots, 40; j = 1, \ldots, 4$

Education is measured as an ordinal variable ranging from 1 through 5 where 1 = less than high school and 5 = attended university graduate school. Continuing education is defined as 1 if they attended a continuing local education program, 0 otherwise; and off-farm income is defined as an ordinal variable where 0 = no off-farm family income, 1 = off-farm family income is in the range 0-10K, 2 = off-farm family income is in the range 10K – 40K, and 3 = off-farm family income is greater than 40K.

Our preferred empirical management factors model is specified as follows:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} \ldots \beta_k X_{ki} + u_i \quad (11)$$

where Y_i = is the cow enterprise contribution margin of the i^{th} farm;

X_{1i} = importance of calving ease
X_{2i} = percentage herd artificially inseminated
X_{3i} = synchronization of herd for breeding
X_{4i} = vaccination of herd (cows) for scours
X_{5i} = vaccination of herd (calves) for scours
X_{ki} = value chain member
$i = 1, \ldots, n; \quad j = 1, \ldots, k$

Importance of calving ease – measures the degree of importance that a farm manager places on ease of calving with 1 = most important and 4 equal to least important. Percentage herd artificially inseminated measures the degree to which the farm manager utilizes artificial insemination in the fertility of the herd. Synchronization of the herd measures whether the farm manager synchronized the herd for breeding – with 1 = yes, 0 otherwise. Percentage of herd bred to pure females or bulls measures the degree of pure breeding in the herd. The vaccination for scours variables are also binary with 1 = the herd was vaccinated, 0 otherwise. Number of calvings per year measures the number of calving windows that the farm manager employs and varies from 1 to 4. Stocking density measures the number of cow-calf pairs per acre. Stocking days is the average number of days that cow/calf pairs are in pasture. The marketing variables: hedging and forward-selling are binary and measure whether the farm manager uses hedging/options/futures and forward selling contracts to manage returns. Followup performance measures the number of times in a given year that a farm manager follows up with sales, and whether the farm manager is a member of a value chain is also included. These models were also tested for outliers and leverage points using the ROBUSTREG procedure in SAS, along with tests for heteroscedasticity and multicollinearity. Final models were determined based on the basis of the F-statistic and overall adjusted R^2. For brevity, only the results of the preferred models are reported.

Empirical Results for Unpooled Data

Results for the demographic variable models are reported in table 4; while results for the management factor models are reported in table 5. For the 2006 production year none of the demographic variables explained the variation in contribution margins for the cow enterprise. Results are reported in table 4 for completeness. Both AGE and OFF-FARM INCOME were significant for 2007. Age is a proxy for management experience and is positively related to farm returns, as is the degree to which the farm operation enjoys higher off-farm income sources. However, White's test statistic is χ^2 = 24.56, *p* > 0.026 and the Breusch-Pagan test statistic is χ^2 = 11.40, *p* > 0.022 rejecting the null hypothesis that the errors are homoscedastic. Hence, there is some heteroscedasticity present in the non-pooled 2007 sample. No collinearity was detected with variance inflation factors close to 1.

Several management factors were significant in explaining the variation in contribution margins, although results vary by production year. All models were tested for heteroscedasticity and collinearity. No multicollinearity was detected in either year. Similarly, White's test statistic is χ^2 = 34.00, *p* > 0.419 and the Breusch-Pagan test statistic is χ^2 = 4.61, *p* > 0.948 for the 2006 model and White's test statistic is χ^2 = 10.61 *p* > 0.643 and the Breusch-Pagan test statistic is χ^2 = 3.78, *p* > 0.581 for 2007. Hence, errors are homoscedastic

In both 2006 and 2007, importance of calving ease is positively related to contribution margins. However, as lower values of the ordinal variable indicate a higher degree of importance placed on calving ease by the farm manager -- the results indicate that farmers who placed less emphasis on this variable had higher overall returns. This would seem to be opposite to *a priori* expectations. Percentage herd artificially inseminated is positive and significant in both years – however, the magnitude of the effect is quite small. Number of calvings per year is positive and significant for the 2006 production year only. Moreover, the magnitude is quite large – indicating that farm managers that employ more calving windows throughout the production years enjoy higher returns. Stocking density was significant and negatively related to returns implying diminishing returns to that those farms that are more intensively managed. In 2006, those farm managers that engaged in the use of hedging, options and futures contracts lost revenues over those that did not. Finally, the use of scours vaccinations during the 2006 and 2007 production years had a significant negative effect on farm returns from the cow enterprise. It is important to note that these results should be used as directions for further research given the relatively small size of the data sample in each production year.

Table 3: MM and OLS Parameter Estimates for Contribution Margin (Pooled Data)

	MM Estimates *N*= 78	**OLS Estimates** *N*= 76
Variable	**Contribution Margin**	
Intercept	-513.67[a] (338.39)	-588.71[b] (334.78)* VIF = 0
Birth Rate	1510.11 (744.19)**	1668.64 (750.78)** VIF = 6.08
Weaning Rate	-1102.27 (773.75)	-1182.16 (778.18) VIF = 7.47
Calf-Loss Rate	-2701.94 (713.79)***	-2850.50 (717.19)*** VIF = 3.42
Average Number of Cows	1.58 (0.51)***	1.85 (0.51)*** VIF =2.05
Land in Pasture	-0.15 (0.08)*	-0.17 (0.08)** VIF =2.02
Year	-90.35 (48.47)*	-105.09 (47.30)** VIF = 1.02
F-Statistic **Adj. R^2**	___	8.25*** 0.37

Note: [a] significance reported for chi-square statistic; [b] significance reported for t-statistic; * = significance at the 10% level, ** = 5% level, *** = 1% level.

Table 4: Parameter Estimates for Demographics Variables Models

	OLS Estimates 2007 N = 37[a]	**OLS Estimates 2006** N = 38
Variable	**Contribution Margin**	
Intercept	-1062.45[b] (365.05)*** VIF = 0	-229.25 (340.52) VIF=0
Education	16.33 (70.62) VIF=1.58	3.42 (64.53) VIF=1.41
Age	12.38 (4.45)*** VIF=1.31	2.62 (4.69) VIF= 1.14
Continuing Education (Local)	50.56 (105.34) VIF=1.30	-44.82 (112.62) VIF=1.43
Off-Farm Income Level	62.81(36.62)* VIF=1.05	0.98 (34.14) VIF=1.16
F-Statistic **Adj. R^2**	2.69** 0.16	0.15 -0.10

Note: [a] Number of observations reported for model with any identified outliers excluded. [b] significance reported for t-statistic; * = significance at the 10% level, ** = 5% level, *** = 1% level.

Table 5: Parameter Estimates for Management Factor Models

	2007 OLS Estimates N = 37[a]	2006 OLS Estimates N =34
Variable	**Contribution Margin**	
Intercept	-390.76 [b] (75.45)***	-717.85 (188.39)
Number Calvings Per Year	—	86.81 (34.13)**
Importance of Calving Ease	133.88*** (37.29)	208.66*** (36.85)
Percentage Herd Artificially Inseminated	5.71*** (1.62)	2.95*** (0.92)
Synchronization of Herd	-520.53*** (121.83)	—
Percent Bulls from Purebred Breeders	—	-0.78 (0.73)
Percent Females from Purebred Breeders	—	0.86 (1.12)
Stock Density	—	-148.35** (71.47)
Stock Days	—	1.41 (0.87)
Use of Hedging/Options/Futures	—	-265.23** (118.31)
Use of Forward Selling	—	61.54 (71.99)
Number Times Follow up Performance	—	6.25 (22.66)
Value Chain Member	—	86.10 (76.04)
Vaccination for Scours (Cows)	-163.79 (79.26)**	—
Vaccination for Scours (Calves)	-393.16 (130.65)***	—
F-Statistic	10.16***	5.75***
Adj. R^2	0.56	0.61

Note: [a] Number of observations reported for model with identified outliers excluded. [b] significance reported for t-statistic; * = significance at the 10% level, ** = 5% level, *** = 1% level.

References

Antle, J. M., 2000. No Such Thing as a Free Safe Lunch: the Cost of Food Safety Regulation in the Meat Industry. *American Journal of Agricultural Economics,* 82, 310 – 322.

Ashbridge, I. 2006. Information Sharing Proves Beneficial. *Crops*, May 6, 2006, p.41.

Ashworth, S. 2002. Should we be benchmarking? *The Scottish Agricultural College, Sheep and Beef Notes*, November 2002.

Banaeian, N. (2011). Do the Cattle Farms of Iran Produce Economically Efficient or Not? *Asian Journal of Agricultural Sciences* 3(2): 142-149.

Best, M., J. Aisthorpe, T. Beutel, F. Chudleigh, R. Dodt, P. Donaghy, B. Holmes, K. McKeller, K. Murphy, V. O'Keefe, and S. Robinson. (2007). The Economics of Beef in Central Queensland: Gross Margins and Production Notes, *Department of Primary Industries and Fisheries, the State of Queensland*.

Canfax Research. (2008). *http://www.canfax.ca/general/StatBrf.pdf*. Accessed March 2008.

Chauhan, N.S., Mohapatra, P.K.J., and Pandey, K.P. (2006). Improving Energy Productivity in Paddy Production through Benchmarking—An Application of Data Envelopment Analysis. *Energy Conservation and Management*, 47:1063-1085.

Dairy Farmer. Business and Finance: Benchmarking – Will it give you Essential Guide? *Dairy Farmer*, August 14 2006, p.20.

Elobeid, A., Tokgoz, S., Hayes, D. J., Babcock, B. A., Hart, C. E., 2006. The Long-Run Impact of Corn-Based Ethanol on the Grain, Oilseed, and Livestock Sectors: A Preliminary Assessment. *CARD Briefing Paper*. 06-BP 49.

Benchmarking Reaps Benefits of Efficiency, *Farmers Weekly*, March 23, 2007, p.89.

Featherstone, A., Langemeier, M., and Ismet, M., 1997. A Nonparametric Analysis of Efficiency for a Sample of Kansas Beef Cow Farms. *Journal of Agricultural and Applied Economics*. 29, 175 – 184.

Fleming, E., Farrell, T., Villano, R. and Fleming, P. (2006). Is Farm Benchmarking the New Acceptable Face of Comparative Analysis? *Australasian Agribusiness Review*, 14 (12): 1-12.

Frances, G. and J. Holloway. (2007). What Have we Learned? Themes from the literature on best-practice Benchmarking. *International Journal of Management Reviews*, 9(3): 171-189.

Ghorbani, A., Mirmahdavi. S., Rahimabadi, E., 2010. Economic Efficiency of Caspian Cattle Feedlot Farms. *Asian Journal of Animal Sciences*. 4(4), 221 - 228.

Gillespie, J., Rakipova, A., 2000. Efficiency of Louisiana Beef Cattle Producers. *LSU Ag Center Research & Extension.* Department of Agricultural Economics and Agribusiness.

Grier, K., 2002. Beef Demand and Health and Food Safety Risks. *George Morris Centre.*

Groth, J.C. (1992). The Operating Cycle: Risk, Return and Opportunities, *Management Decision* 30(4): 3 – 11.

Hansen, B.G., G. Stokstad, A. Hegrenes, E. Sehested, and S. Larsen. 2005. Key Performance Indicators on Dairy Farms, *Journal of International Farm Management*, 3(1): 1-15.

Hughes, H. (2010). Maximize Profits. *Beef*. 46(9), May.

Hughes, R. (2006). Meticulous Management Brings Profit Back to Beet. *Crops*, December 16, 2006, p.30-31.

Iraizoz, B., I. Bardaji, and M. Rapun. (2005). The Spanish Beef Sector in the 1990s: Impact of the BSE Crisis on Efficiency and Profitability, *Applied Economics,* 37: 473 – 484.

Kalirajan, K. P. (1981). An Econometric Analysis of Yield Variability in Paddy Production. *Canadian Journal of Agricultural Economics*, 29: 283 – 294.

Kim, S-A, J.M. Gillespie, K.P. Krishna, The Effect of Socioeconomic Factors on the Adoption of Best Management Practices in Beef Cattle Production. *Journal of Soil and Water Conservation* 60(3): 111-120.

Kyro, P. (2003). Revising the Concept and Forms of Benchmarking. *Benchmarking an International Journal*, 10 (3): 210-225.

Lisson, S., N. Macleod, C. McDonald, J. Corfield, B. Pengelly, et al. A Participatory, Farming Systems Approach to Improving Bali Cattle Production in the Smallholder Crop-Livestock Systems of Eastern Indonesia, *Agricultural Systems* 103: 486-497.

Lukacs, Z. (2011, 27 April). How is my Farm Performing? Benchmarking Data Available for Australian Grain Growers. *States News Service*, April 27 2011.

Malana, N.M. and H.M. Malano. (2006). Benchmarking Productive Efficiency of Selected Wheat Areas in Pakistan and India Using Data Envelopment Analysis. *Irrigation and Drainage*, 55: 383-394.

McGregor, B.A. and W.D. English. (2010). Gross Margins in Australian Mohair Enterprises and Relationships with Farm Inputs, Productivity, and Mohair Quality. *Animal Production Science*, 50: 573-580.

LeBruto, S.M., Ashley, R.A. and Quain, W. (1997). Using the Contribution Margin Aspect of Menu Engineering to Enhance Financial Results, *International Journal of Contemporary Hospitality Management*, 9(4): 161-167.

Nelson, B.S. and E. Robinson. 2009. Critical Success Factors of a Whole Business Extension Approach for Increased Capacity of Beef Producers and Improved Enterprise Profit and Sustainability. *Rangeland Journal*, 31(1): 61-68.

O'Brien, R.M. (2007). A Caution Regarding Rules of Thumb for Variance Inflation Factors, *Quality & Quantity*, 41: 673–690.

Rousseeuw, P.J. (1984), "Least Median of Squares Regression," *Journal of the American Statistical Association*, 79, 871-880, as cited in SAS Institute Inc. 2003.

Rousseeuw, P.J. and Van Driessen, K. (2000), "An Algorithm for Positive-Breakdown Regression Based on Concentration Steps," *Data Analysis: Scientific Modeling and Practical Application*, ed. W. Gaul, O. Opitz, and M. Schader. New York: Springer-Verlag, 335--346 as cited in SAS Institute Inc. 2003.

Saha, B. and Mitura, V. (2009). *Canadian Agriculture in 2008: An Overview of Key Events*. *Catalogue no. 21-004-X*, November 2009.

Samarajeewa, S., 2007. An Analysis of Production Efficiency of Cow-Calf Operations in Alberta. MSc. Thesis. University of Guelph.

SAS Institute Inc. (2003). *ROBUSTREG Procedure Overview*. SAS Institute Inc.,: Cary NC, USA.

Statistics Canada. (2011). Farm Cash Receipts. *Agriculture Economic Statistics.* Catalogue no. 21-011-X, vol. 10, no. 1, May 2011.

Thompson, I. and Cox, A. (1997). Don't Imitate, innovate. *Supply Management*, pp.40-43.

Trestini, S., 2006. Technical Efficiency of Italian Beef Cattle Production Under a Heteroscedastic Non-Neutral Production Frontier Approach. *Presented at the 10th Joint Conference on Food, Agriculture and the Environment*. 26 – 30. August 2006. Duluth, Minnesota, USA.

Thursby, J. (1982 as cited in SAS Institute Inc. 2003), "Misspecification, Heteroscedasticity, and the Chow and Goldfield-Quandt Test" *Review of Economics and Statistics*, 64, 314--321.

Watson, G.H. (1993). *Strategic Benchmarking: How to Rate your Company's Performance against the World's Best*, John Wiley & Sons, Inc., New York, NY.

Weber, M.J.J. (2010). The Influence of Management on the Technical Efficiency of Ontario Cow-Calf Operations, MA Thesis, University of Guelph, Ontario, Canada.

White, H. (1980 as cited in SAS Institute Inc. 2003). "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," *Econometrica*, 48 (4), 817-- 838.