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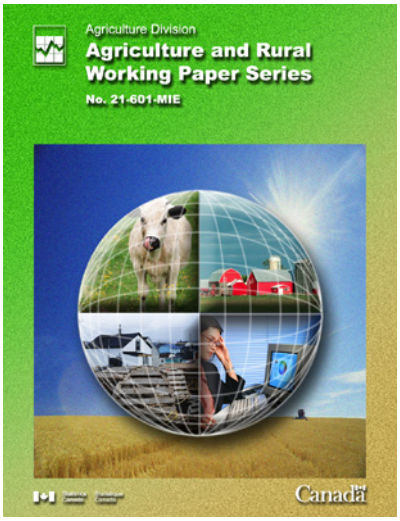
Impact of Characteristics of the Farmers and their Business on Profitability in the Canadian Hog Industry



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Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
…	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
A	excellent
B	very good
C	good
D	acceptable
^{E}	use with caution
F	too unreliable to be published

This paper was presented during the annual meeting of the Canadian Agricultural Economics Society (CAES) held in Montreal on May 27, 2006.

Executive summary

The purpose of this study is to identify the characteristics of Canadian hog farms and their operators that significantly influence their financial success and how it is influenced. An ordinary least squares (OLS) regression model was estimated using 828 observations to represent 5,234 Canadian hog producers. The results show that techno-economic efficiency, the share of the farm's receipts generated by hog sales and being located in the Prairie Region are positively related to financial success. Conversely, the debt ratio negatively influences financial success, and this relationship diminishes as the debt ratio increases. Farm size would appear to be proportional to operating income and negatively related to the profitability ratio.

Introduction and background

Hog production has an important place in the Canadian agricultural industry. In 2004, hog production generated 25% of national cash receipts from livestock sales. Canadian producers had 14.9 million hogs in inventory, equivalent to half of Canada's population.

Hog production has grown substantially in recent years. In fact, from 1997 to 2004, the number of heads produced increased 69%. This is essentially related to the growth of live hog exports, which rose 168% during the same period. The increase in production was especially pronounced in the Prairie provinces, where production grew by 90% from 1997 to 2004. The magnitude of the growth was particularly marked in Manitoba. Hog production in that province grew by 161% during this period while Saskatchewan and Alberta registered an increase of 92% and 40%, respectively. The start of this growth coincides with the 1995 repeal of the W*estern Grain Transportation Act* (which replaced in 1983 the Crow's Nest Pass Act enacted in 1897) which established a permanent preferential rate for the movement of Western grain. The fact that these two events coincided suggests that the increase in transportation costs for grain and oilseed crops encouraged Western farmers to raise livestock in order to increase the value added of their production.

For the past few years, the profit margins of this sector have come under various pressures. The introduction of new environmental rules, vertical integration and rising energy prices are a few of the underlying causes. This would lead to pressure on costs and in turn on profit margins. Hence, an understanding of the factors associated with financial success is relevant information for individual farmers and the industry as a whole.

Earlier studies on the financial success of farms have focused on the impact that a farm's characteristics have on its financial performance. These studies generally find that farm size, the relative share of household income derived from the farm, the share of farm

receipts generated by hog sales and the region where the farm is located[1] significantly affect financial results (Adhikari et al. 2004; McBride and Key, 2003; Morgan and Langemeier, 2003; Mishra and Morehart, 2001). In contrast, although there is some evidence that the characteristics of the operator influence his/her ability to maximize the financial performance of the farm, the findings in the existing literature are mixed. Moreover, the above-cited studies are based on U.S. data as there is very little literature on this subject concerning hog farms in Canada.

This analysis provides some empirical evidence on the impact that the characteristics of a farm and of its operator have on its financial success. The results of such an analysis will enable hog producers to make more informed decisions. They may also give policy makers some indications as to the actions to be taken in order to maximize the effectiveness of government support programs for hog production. In accordance with the commitments made by the government at the signing of international commercial agreements, the goal is to apply support not on a product unit basis, but rather on the overall income of farms. In that policy context, studying the parameters that influence overall income becomes a necessary tool. This study also seeks to propose useful avenues for future analyses.

Methodology

Empirical studies on farm financial results have often relied on OLS regression models (Stark et al., 2002; Dunn and Williams, 2000; Lawrence et al., 1999; Haden et al., 1989). This is the approach that was taken in this study as well. The analysis assumes that the financial success of hog farms depends on certain characteristics of the operator (e.g., age and education level) and of the farm (e.g., number of managers, operating arrangement, share of household income generated by hog sales, farm size, geographic location, techno-economic efficiency, debt-to-asset ratio, and percentage of income derived from government payments).

The analysis aims to verify whether these variables are related to financial performance and whether this relationship is positive or negative. To do so, an OLS regression model[2] is used (Greene, 2003). Such a model is designed to estimate the linear relationships between various independent variables and a dependent variable. The model specification can be summarize as follows:

$$FINP_i = \beta_0 + \beta_1 HC_i + \beta_2 FRM_i + \beta_i OTHER + \varepsilon_i \quad (i = 1, 2, \ldots, n; n \geq k + 1)$$

Where $FINP_i$ is a measure of financial performance, HC_i represent a vector of variables measuring human capital characteristics of the operator, FRM_i represents a vector of variables measuring the farm characteristics, and OTHER indicates additional control variables; β_i are the estimated coefficients, that is the expected change in response (positive or negative) to a unit change in the explanatory variable holding constant other

1. Insofar as the location of the farm affects the cost of feed.
2. For more on the OLS regression model, see Greene (2003).

variables, and ε_i corresponds to the residuals of the model. This summary description of the model shows the main grouping of variables; the computation of each variable and the rationale for its use as is further discussed in the following section.

Data and variables selection

This analysis will use data on hog operations from the Farm Financial Survey conducted by Statistics Canada in 2005. The 828 survey respondents who identified themselves as being mainly hog producers represent 5,234 Canadian hog farmers. Respondents who stated that they did not fit into any subcategory of hog production were removed from the sample analysed because of the lack of information concerning them. Thus, observations representing 194 farms were excluded.

Dependent variables

The measurement of financial success is a subject that generates considerable interest among both economists and accountants. In several earlier studies, operating income is often used as a proxy for financial performance (Mishra and Morehart, 2001). Operating income corresponds to total receipts from agricultural product sales less total operating expenses. This excludes capital investment, capital sales, custom work, support programs, depreciation, and adjustments for tax purposes. One reason for the use of this variable is that it serves for accounting and taxation purposes. However, this accounting measure does not account for the opportunity cost of the resources invested in the farm. To measure the capacity of the farm to compensate the various capital inputs, the profitability ratio will also be used as a proxy for financial success. This indicator is computed as: (operating income before interest expense and tax)/total value of assets.

Independent variables

The choice of independent variables to be included in the logistic regression is based on the existing literature, the availability of data, and to avoid strong multicollinearity[3].

1. Age of main operator

Empirical models have shown that a farm operator's efficiency tends to increase with age up to a point where it subsequently declines. This decline in later years would appear to be due primarily to the fact that older producers have a shorter planning horizon. Therefore, they are less likely to adopt technologies and practices that may reduce unit costs and increase farm productivity (McBride and Key, 2003; Tauer and Lordkipanidze, 2000; Tauer, 1995). However, since age is strongly correlated with the number of years of experience in the management of a farm, it is likely that an older and more experienced farmer will be better able to make decisions that will maximize the performance of the farm. The net effect of this variable is therefore difficult to predict. To evaluate separately the effect of being a younger producer and that of being an older producer, two binary

3. The Pearson correlation coefficients matrix is available in the appendix.

variables coding age are used. One variable will be equal to one if the main operator is under 35 years of age and the other will identify producers over 55 years of age.

2. Education

According to the literature, the link between education and financial returns appears weak. It has been shown that more educated hog producers obtain a lower price for their product (Baumann and Kinsey, 1984). This correlation may be explained by the fact that these producers have a higher opportunity cost for their time and reach more quickly the point where the marginal value of information obtained equals its marginal cost. Specifically regarding financial knowledge, it has been shown that such knowledge is conducive to financial success, but the correlation between the two becomes non-significant when confidence in one's decision-making ability and exposure to management training programs are taken into account (Jackson-Smith et al., 2004). To assess the impact of various levels of formal education, three binary variables will be used. One will identify operators who have completed high school, another will identify those who have some post-secondary education and the third will identify those with a college or university certificate or diploma below bachelor level. The use of these variables is necessary because the database used contains no data on technical training in agriculture or management.

3. Number of operators

This is a binary variable equal to one if only one operator is responsible for the farm. Having more than one operator may indicate that someone could take over in the future. It seems reasonable to postulate that the managers would therefore be more likely to maintain investments to ensure that the farm is viable in the long run and to maximize income for a time so that the farm can meet the needs of more people. Also, the presence of more than one operator may mean that decision-making will benefit from both experience and knowledge. Consequently, the financial results of the farm may be better. However, the fact that the farm must meet the needs of more people may increase its wage costs and exert pressure on its operating income.

4. Operating arrangement

This analysis will determine the impact of incorporation on a farm's financial success. Since this operating arrangement may make the acquisition of capital more efficient, affords greater flexibility with respect to taxation and facilitates the transfer of the business, it seems likely that corporations tend to experience greater financial success. Also, since incorporation is a complex task, owners who choose to incorporate probably give more attention to the management of their business.

5. Share of off-farm income

This variable consists of the ratio of income from non-farm sources[4] to all income earned by the farm household. McBride and Key (2003) found that a larger proportion of farm operators producing at a lower cost identified farming as their main source of income. This may be explained by the fact that farmers who have income from outside the farm have a higher opportunity cost for their time. Therefore, the point where the marginal income becomes equal to the marginal cost of the resources invested is reached more quickly in their farming business.

6. Concentration on hog production

This indicator reveals the economies of specializing in hog production. It consists of the ratio of receipts from hog sales to total farm receipts. Diversification may achieve a better distribution of the risk faced by the farm, increase the manager's control over the quality of inputs and maximize the use of these resources (e.g., land, labour). On the other hand, specialization may allow the development of greater expertise in hog production and maximize the profitability of the operation.

The literature tends to show that the degree of specialization goes hand in hand with financial success. The economies of specialization would therefore appear to outweigh the economies of diversification. Thus, the hog farms with relatively low costs are those with the highest level of investment per head (Lawrence et al., 1999). Other studies analysing the performance of farms of varying sizes have also found that there is a positive correlation between farm size and specialization (Mishra and Morehart, 2001; Purdy et al., 1997).

7. Farm size

In the literature, the proxies commonly used for farm size are the number of production units (herd size or cultivated area), farm receipts and the value of farm assets (Morgan and Langemeier, 2003; Purdy et al., 1997). Because of the variability of soil quality, yields and product prices, these measures can be problematic. Correlation analysis was performed indicating that these variables are highly correlated. It therefore seems preferable to retain only one indicator for estimating the model. The proxy variable used for this study is the value of assets, which is less affected by the above-mentioned sources of bias.

Previous studies showed that the performance of a hog farm is positively related to its size (Purdy et al., 1997; Stark et al., 2002) and that small farms find it hard to compete with large ones on the basis of production costs (Adhikari et al., 2004). In their study of

4. Includes gross wages from non-farm sources, withdrawals from farm income stabilization accounts and annuities from various retirement plans. These income sources may be those of the farmer, the spouse or the farmer's never-married children who live with him/her. Withdrawals from NISA (Net Income Stabilization Account) and the CAIS program (Canadian Agricultural Income Stabilization) are excluded from farm income.

Kansas farms with different production mixes, Morgan and Langemeier (2003) observed that large farms are relatively more efficient and profitable and that they even realize an economic profit, unlike smaller ones. Stark et al. (2002) demonstrated that larger farms are more likely to opt for a low-prices strategy to differentiate themselves on the market and that farms adopting such a strategy in this sector are more likely to succeed. On the other hand, using cross-sectional data on hog farms in the Midwest, Lawrence et al. (1999) did not find that economies of scale existed. McBride and Key (2003) stressed that cost variations between hog operations are notable and that only a portion of these variations may be explained by size differences.

8. Subsector of specialization

In the past few years, hog production in Canada has been characterized by a tendency toward greater specialization. To determine whether specialized farms tend to perform better financially, a binary variable will be incorporated into the model. This variable will be equal to zero if it is specialized in particular stage(s) of production and equal to one if the hog farm is a farrow-to-finish. The farrow-to-finish operations are those on which hogs are farrowed and then finished to a slaughter weight around 125 kg. If it is more profitable to specialize in one or more stages of production, the estimated coefficient will be negative.

9. Prairies

This is a binary variable equal to one if the farm is located in the Prairies. Since the supply of livestock feed products is greater in this region, the expectation is that farms located there will have greater financial success. Along these lines, Adhikari et al. (2004) found that the region where a farm is located could significantly affect the financial outcomes of American hog farms insofar as geographic location influences feed costs. However, McBride and Key (2003) concluded that technological and organizational advances have surpassed the regional advantage.

10. Debt ratio

This is the ratio of the farm's liabilities to the total value of its assets. Since indebtedness leads to larger interest expenses, it seems plausible to expect that the debt ratio will be negatively correlated with financial success. However, McBride and Key (2003) showed that producers with the lowest production costs have a significantly higher debt ratio. In their longitudinal study, Kauffman and Tauer (1986) found that the most successful dairy producers see quick changes in their debt ratio. Flexibility in the management of a farm thus appears to be a crucial factor in financial success. Several studies have shown that a farm's debt ratio is negatively related to income performance (Stark et al., 2002, Mishra et al., 1999 and Purdy et al., 1997). In this study, it is expected that the relationship between the debt ratio and financial success will be negative. To allow for non linearity in this relationship, a quadratic term for this variable is included.

11. Expense ratio

A number of studies on hog farm costs stress the importance of technical efficiency (Adhikari et al., 2004; Lawrence et al., 1999; McBride and Key, 2003). For this study, since no technical data are available on farm efficiency (e.g., number of head produced, weight of hogs sold, mortality rate), a financial indicator will be used as a proxy for technical efficiency. This indicator is the expense ratio, also called the techno-economic efficiency ratio. The expense ratio is computed as follows: expense ratio = [operating expenses – operator's wages – interest expenses] ÷ farm receipts. Mishra and Morehart (2001) showed that this variable is negatively correlated with management and labour income on dairy farms in the United States. The analysis of Morgan and Langemeier (2003) and that of Purdy et al. (1997), which respectively focused on Kansas farms in general and on livestock farms, also showed that the expense ratio was inversely related to financial success. It is therefore reasonable to expect that the coefficient estimated for this variable would be negative.

12. Share of income from government support programs

The coefficient associated with this variable will determine whether the amount of government support[5] in relation to total farm receipts is significantly correlated to financial performance. Intuitively, it seems logical that when additional income is brought in, there should be an increase in the surpluses generated by the farm. However, since government support payments are often provided to compensate for a loss, this is not necessarily the case. Mishra et al. (1999) showed that crop insurance had a positive effect on the profitability of small farms. In this study, no hypothesis is made regarding the significance or direction of the influence of this variable.

5. This includes the sum of payments under provincial crop insurance programs, private hail insurance, Bovine Spongiform Encephalopathy (BSE) compensation, tax rebates and farm income stabilization programs. Withdrawals from NISA and the CAIS program are excluded from support programs.

Limitations

A longitudinal analysis might have yielded a better estimate of operators' management abilities. It would thus have been possible to measure operators' ability to optimize their financial receipts in different situations. Another limitation on the quality of the results has to do with data accuracy in reporting. The measurement of the ability to optimize resources would also have been better if it had been possible to consider the opportunity cost of resources when determining the dependent variable.

Results

Descriptive statistics

Table 1 and Table 2 show the distribution of farms according to their financial success as defined according to the selected criteria.

Table 1 Frequency distribution of the number of Canadian hog farms according to their before-tax operating income in 2004

	Frequency	
Operating income	Number of farms	% of farms
-$100,000 or less	164	3.1
-$99,999 to $0	947	18.1
$1 to $100,000	3005	57.4
$100,001 to $200,000	628	12.0
$200,001 to $300,000	190	3.6
$300,001 to $400,000	94	1.8
$400,001 to $500,000	37	0.7
Over $500,000	169	3.2

Note: Hog farm's average operating income was $81,268 in 2004 and the standard deviation was $593,050 ($n_{weighted}$ = 5,234 farms).

Table 2 Frequency distribution of the number of Canadian hog farms according to their profitability ratio in 2004

Profitability ratio	Frequency	
	Number of farms	% of farms
-0.05 or less	233	4.4
-0.04 to 0	597	11.4
0.01 to 0.05	1 613	30.8
0.06 to 0.10	1 436	27.4
0.11 to 0.15	809	15.5
0.16 to 0.20	315	6.0
0.21 to 1.00	214	4.1
More than 1.00	17	0.3

Note: Hog farm's average profitability ratio was 0.069 in 2004 and the standard deviation was 0.333 ($n_{weighted}$ = 5,234 farms).

On average, hog farms earned $81,268 in 2004. Note that 21.2% of hog farms registered a nil or negative operating income in 2004, which is not viable in the long run. The average profitability ratio was 6.9%. This exceeds the weekly average of charter bank interest rates for five-year guaranteed investment certificates in 2004, which was 2.93% (Bank of Canada, 2005).

An analysis was made to compare the characteristics of farms that experienced good financial success in 2004 in relation to those that were less successful. Two groups were formed consisting of the quartile of farms that earn the highest operating income and the quartile with the lowest operating income. These same groups were used to compare the quartile of farms with a higher profitability ratio to those with a lower profitability ratio.

Table 3 Comparison of the personal characteristics of farm operators in the highest and lowest quartile for operating income and profitability ratio, 2004

Operator characteristics	Operating income		Profitability ratio	
	Low quartile[1]	High quartile[1]	Low quartile[1]	High quartile[1]
	Average in years			
Number of years of experience	26.26	25.87	26.81	22.97
Age[2]	51.62	50.45	51.96	47.86
Operators	Percentage			
35 and under	7.32	9.60	5.42	9.63
36 to 54	57.61	62.47	60.99	66.73
55 and over	35.07	27.93[4]	33.59	23.64[5]
Education[3]				
High school not completed	39.80	37.16	46.81	35.98
High school diploma	17.95	27.80[6]	15.83	26.34[6]
Some post-secondary	17.28	5.31[6]	14.51	4.43[6]
University or college diploma (under bachelor's level)	17.47	22.00	16.70	27.53[5]
University degree	7.49	7.73	6.15	5.72

1. Each quartile represents 1,308 hog producers.
2. Age of the oldest operator on December 31st, 2004.
3. Highest level of formal education that the oldest operator has completed.
4. The means (or proportions) between the two groups are significantly different from one to another to a confidence threshold of 10%.
5. The means (or proportions) between the two groups are significantly different from one to another to a confidence threshold of 5%.
6. The means (or proportions) between the two groups are significantly different from one to another to a confidence threshold of 1%.

Personal characteristics of the operator

The average number of years of experience and the age of the oldest operator are fairly similar between the two groups. However, operators aged 55 and over would appear to be less likely to be responsible for farms that belong to the more financially successful group (table 3). For a larger proportion of operators of farms that do financially better, a high school diploma is the highest level of formal education attained. Those who ended their education after some post-secondary studies are more likely to manage farms that belong to the lowest profitability ratio farm group. Also, operators who obtained a university or college diploma (under the bachelor's level) are more often responsible for farms that have a relatively higher profitability ratio.

Table 4 Comparison of the characteristics of farms in the highest and lowest quartile for operating income and profitability ratio, 2004 (continued)

Farm characteristics	Operating income		Profitability ratio	
	Low quartile[1]	High quartile[1]	Low quartile[1]	High quartile[1]
	percentage			
Number of operators				
Single operator	38.93	23.83[4]	36.23	34.62
Two or more operators	61.07	76.17[4]	63.77	65.38
Farm operating arrangement				
Single-owner	47.23	15.78[4]	45.44	34.38[3]
Corporation	22.66	48.86[4]	20.71	29.08[3]
General partnership	26.59	25.60	30.12	32.66
Co-operative	3.52	9.76[4]	3.73	3.88
Share of household income from off-farm (average %)	31.05	7.25	29.81	10.71
15 or less	51.01	84.13[4]	51.65	72.53[4]
16 to 50	3.05	14.44[4]	6.47	26.71[4]
51 or over	45.95	1.42[4]	41.87	0.76[4]
Share of farm receipts from hog sales (average %)	64.16	66.22	66.85	64.29
25 or less	9.94	13.91	7.06	19.28[4]
26 to 50	20.68	8.36[4]	19.98	3.77[4]
51 to 75	22.99	27.19	22.94	25.11
76 to 90	22.71	23.69	28.35	26.60
91 or over	23.68	26.86	21.68	25.24
Total assets (average value, $)	1,412,000	3,465,000[4]	1,539,590	1,441,000
$250,000 or less	8.52	0.84[4]	6.76	11.90[4]
$250,001 to $1 million	58.11	23.11[4]	53.70	53.48
$1 million to $2 million	17.21	24.24[3]	22.30	17.25[2]
More than $2 million	16.16	51.80[4]	17.24	17.37
Area under cultivation (average acres)	531	1,271[4]	621	538
70 acres or less	14.72	13.94	13.55	19.56[2]
71 to 400 acres	60.78	34.84[4]	56.90	53.61
401 to 760 acres	11.23	24.07[4]	11.18	15.73[2]
761 to 1,600 acres	8.95	13.60[2]	14.33	6.40[4]
1,601 to 2,860 acres	1.13	3.16[2]	0.53	1.06
2,861 acres or over	3.19	10.39[4]	3.51	3.64

Table 4 Comparison of the characteristics of farms in the highest and lowest quartile for operating income and profitability ratio, 2004 (concluded)

Farm characteristics	Operating income		Profitability ratio	
	Low quartile[1]	High quartile[1]	Low quartile[1]	High quartile[1]
	percentage			
Specialization				
Farrow-to-finish	46.59	52.64[3]	47.10	46.22
Farrow	8.99	11.26	9.18	14.09[3]
Feeding-finishing	35.66	21.88	39.50	21.03[4]
Contract	8.76	14.21[3]	4.22	18.66[4]
Geographic location				
Atlantic	3.93	1.96[4]	3.37	2.75
Quebec	18.26	36.28	17.78	34.44[4]
Ontario	49.02	31.73[3]	46.50	23.65[4]
Manitoba	6.46	13.95[4]	5.63	20.58[4]
Saskatchewan	4.58	3.19	10.99	8.70
Alberta	16.48	11.90[3]	14.56	9.10[3]
British Columbia	1.27	0.99	1.17	0.79
Debt ratio (total liabilities/total assets)	0.37	0.39	0.29	0.38
Expense ratio	112.99	65.62[4]	112.47	60.88[4]
Profitability of capital invested (operating income/owner's equity)	-0.07	0.20[4]	-0.06	0.27[4]
Return on investment (operating income/total assets)	-0.04	0.12[4]	-0.04	0.16[4]
Operating income (before tax) ($)	-52,499	285,080[4]	-44,435	197,256[4]
Share of farm receipts from direct program payments	4.14	5.28	3.83	5.50
Operating income plus wage cost of operator and household	-44,875	312,625[4]	-36,934	213,382[4]

1. Each quartile represents 1,308 hog producers.
2. The means (or proportions) between the two groups are significantly different from one to another to a confidence threshold of 10%.
3. The means (or proportions) between the two groups are significantly different from one to another to a confidence threshold of 5%.
4. The means (or proportions) between the two groups are significantly different from one to another to a confidence threshold of 1%.

Farm characteristics

This study finds that farms where only one operator is responsible for the farm often have a lower operating income (table 4). This result supports our working hypothesis. As to operating arrangement, hog farms with a single owner more often fall into the group of less profitable farms, whereas corporations and co-operatives are more likely to realize a

relatively larger operating income. Among more profitable farms, the farming operation accounts for more than half of household income. This distribution may result from the fact that if agricultural production is not the main source of household income – for example, if the farmer is part-time or retired – the planning horizon will be shorter. These farms may use equipment at its full capacity or beyond its useful life, which will increase production costs. As to the proportion of the farm receipts derived from hog sales, mean values are between 64% and 66% for every group, and the differences between them are not significant.

Among the more profitable farms, a greater proportion are farrow-to-finish (and hence not specialized in any particular stage of production) and contract operations. If the groups are instead defined according to the operating income, the proportion of farrow and contract operations that are more successful is greater, whereas among the less profitable farms there are more feeding-finishing operations.

The results show that in 2004, hog farms in Manitoba represented a relatively larger proportion of successful hog operations, according to the two criteria selected. A greater number of Quebec hog farms were among the most profitable farms. Ontario and Alberta had more farms among the least financially successful farms.

When the variables relating to farm size are examined (i.e., total value of assets and area under cultivation), it becomes clear that the mean values for farms generating more income are significantly higher than those of the opposite group. However, these differences are no longer significant when the quartiles are determined by profitability ratio. Thus it would appear that the greater earnings of large farms do not necessarily mean a better return on assets.

Regarding the financial indicators, we observe that the debt ratio ranges between 35% and 39% for all groups. However, the average expense ratio of farms that are less successful financially exceeds that of more profitable farms. This difference suggests that technical efficiency contributes significantly to the financial success of Canadian hog farms.

Results of regressions

The results of these estimates are shown in Table 5. Overall, the R^2 values indicate that for the first regression, the variations in the independent variables explain 44.33% of the variations in operating income. For the model explaining the profitability ratio, the corresponding percentage is 34.85%. The F statistic from the analysis of variance shows that it is preferable to reject the hypothesis that all estimated coefficients are equal to zero for both models.

Table 5 Estimated coefficients for simple regressions explaining operating income and profitability ratio

Independent variables	Dependent variables	
	Operating income	Profitability ratio
	estimated coefficients	
Intercept	153,821[5]	0.2422[5]
Human capital		
Under 35 years of age[1]	21,872	0.00720
Over 55 years of age[1]	14,582	0.01404
High school diploma[2]	12,078	0.00967
Some post-secondary[2]	-2,695	-0.01449
College diploma (below bachelor's level)[2]	-21,999	0.00293
Farm characteristics		
Single operator in charge	-17,822	0.01563[5]
Corporation	-1,270	-0.00008
Share of household income from off-farm	-737	-0.00349
Share of income from hog receipts	75, 425[5]	0.04138[5]
Total assets	0.04619[5]	-0.00000[3]
Farrow-to-finish operation	4,230	-0.00127
Prairies	30,729[5]	0.00471
Expense ratio	- 227,740[5]	-0.23100[5]
Debt ratio	-135,276[5]	-0.19730[5]
Debt ratio squared	74,563[3]	0.24250[5]
Share of income from subsidies	78,795	0.01860
Regression statistics		
F	40.36	27.12
Pr > F	< 0.0001	< 0.0001
R^2	0.4433	0.3485
Shapiro-Wilk (W)	0.6948	0.6734
Pr < W	< 0.0001	< 0.0001

1. Age of the oldest operator on December 31st, 2004.
2. Highest level of formal education that the oldest operator has completed.
3. The estimated coefficients are significantly different from zero to a confidence threshold of 10%.
4. The estimated coefficients are significantly different from zero to a confidence threshold of 5%.
5. The estimated coefficients are significantly different from zero to a confidence threshold of 1%.

Model explaining operating income

None of the variables concerning operator characteristics proved to be significant. Thus, as regards education, these results are consistent with other studies cited, which showed that formal education level has no significant effect on financial success. This model showed that no other operator characteristic was significant.

The model explaining operating income shows that concentrating farm activities on hog production has a significant effect on the operating income. The same is true for total value of assets. A hog farm being located in the Prairies seems to have an upward effect on income. The abundant supply of grain in this region would thus appear to favour increased hog production. Other factors may also contribute to the prosperity of this industry in the Prairie region, and these could be examined in another study.

The expense ratio has a significantly negative influence on operating income. It therefore appears that the farm's efficiency in processing inputs into outputs has a major impact on its financial success.

Model explaining the profitability ratio

None of the variables coding operator characteristics proved to be significant. According to the estimated coefficients with the OLS regression, age and education do not have a significant effect on the profitability ratio. If a single individual is responsible for running the farm, the profitability ratio tends to be higher. This correlation may be due to the fact that hog farms run by more than one operator must meet the needs of more people, and this increases expenses and reduces profitability.[6]

As in the model described above, the relative importance of the hog operation for the farm appears to have a positive and significant effect. Reasons for this relation may be that operators who specialize in this type of production have a better knowledge of it and that the use of equipment approaches its optimal capacity. Another reason may be that producers whose income is more dependent on this type of production will be more likely to adopt new technology, leading to a reduction in the unit cost of production. Unlike the previous model, the model explaining the profitability ratio showed that farm size had a negative influence.

The influence of the expense ratio on financial success is negative. In the future, it would be useful to include more technical data in the analysis of financial success in order to detail which practices result in better financial returns. As in the previous model, the influence of the debt ratio is negative and the level of this influence appears to follow a descending curve.

6. Please note that wage expenses to compensate the labour of the operator(s) were not added to the operation's income. This analysis treats the farm as a legal entity independent of the operator and his/her family.

Conclusions and implications

Generally, farm characteristics appear to have a greater influence on financial success than the personal characteristics of the operator. The regressions show that general education and age are not related to the indicators of hog farms' financial success.

The operating arrangement of the farm does not seem to have a significant impact on its financial performance, despite the fact that a single operator farm is positively related to the profitability ratio. This correlation may be due to the fact that a farm with more than one person in charge has more wage costs, which has a negative influence on income.

Both in the model with operating income as the dependent variable and the one using the profitability ratio, the relative importance of the farm's hog production (i.e. concentration) appears to have a significant positive influence. The development of technical expertise and a greater use of equipment would therefore seem to have some influence on financial results. This implies that economies of scale outweigh the surpluses achieved by reducing the risks through diversification of production. Other studies have confirmed that this type of saving exists (Adhikari et al., 2004; Morgan and Langemeier, 2003; Stark et al., 2002). Rhodes (1995) explains it by the fact that more specialized farms adopt new technology more rapidly, have a better knowledge of the market, have better access to inputs and produce a quality and volume of product that is more appealing to buyers. These results suggest that Canadian hog farmers may improve their probability of financial success by focusing on production technology and expertise.

The regression estimated using cross-sectional data shows that the size of the farm influences the profit margin in an upward direction but has no significant impact on the gross profitability of capital. A panel model might serve to determine whether the lack of correlation between size and profitability is maintained over a given period.

The debt ratio is negatively related to both operating income and the profitability ratio. Since the effect of the debt ratio squared is significant and positive, the negative influence of the debt ratio on financial success would seem to follow a declining curve.

The regressions estimated also showed that a farm's efficiency in processing inputs into outputs is strongly correlated with financial success. Being located in the Prairie region also appears to have a positive impact on operating income, *ceteris paribus*. This link may be explained by the fact that this region is notable for the local abundance of grain, which reduces the local price of livestock feed. This suggests that the growth of hog production seen in the past few years in this region is likely to continue.

The descriptive analysis shows that operators with a smaller share of off-farm household income are more likely to fall into the most financially successful quartile of farms. However, regressions did not show the existence of a significant relationship between these variables. The same is true for the share of income from program payments. The latter result suggests that government programs do not influence the production level and therefore do not create distortions on the market.

According to the regressions performed, a farm identified as a farrow-to-finish operation appears not to significantly affect its financial success in relation to farms specializing in one or more production stages. Despite this, it was found that in the quartile of farms with the highest profitability ratio, farrow operations are relatively more common, while feeding-finishing operations are rarer. The fact that contract operations more often fall into the quartile with the highest operating income and profitability ratio may be merely due to cyclical factors. Previous studies have shown that independent production was generally more profitable but that income was more volatile than for contract producers (Johnson and Foster, 1994).

Measures to improve techno-economic efficiency appear to have a significant and positive influence on financial success. In a future study, it would be interesting to incorporate other indicators of technical efficiency as well as variables concerning management practices so as to measure their impact on the financial success of hog farms.

The same applies to the influence of training. More precise variables as regards the nature of the training could shed more light on the availability of training and incentives related to its acquisition. It would be interesting to measure the influence of technical and/or management-oriented agricultural training on a farm's financial success. It would also be interesting to analyse the effect of using advisory services (whether private or public) or belonging to a management council.

Kauffman and Tauer (1986) showed that the most successful farms tend to see more rapid fluctuations in their debt ratio. More conclusive results might be obtained by developing a panel model. In particular, this would make it possible to determine whether management flexibility influences the financial success of Canadian hog farms.

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Appendix

Table A1 Pearson Correlation Coefficients Matrix

Independent variables	Under 35	Over 55	High school diploma	Some post-secondary	College diploma	Single manager	Corporation	Share of household income from off-farm
Under 35	1.000	-0.168	0.046	0.097	0.148	0.089	-0.093	0.011
Over 55	-0.168	1.000	-0.228	-0.129	-0.082	-0.097	0.019	-0.106
High school diploma	0.046	-0.228	1.000	0.627	0.510	0.014	0.154	-0.054
Some post-secondary	0.097	-0.129	0.627	1.000	0.813	0.027	0.079	-0.021
College diploma	0.148	-0.082	0.510	0.813	1.000	0.058	0.094	0.035
Single manager	0.089	-0.097	0.014	0.027	0.058	1.000	-0.047	0.075
Corporation	-0.093	0.019	0.154	0.079	0.094	-0.047	1.000	-0.012
Share of income from off-farm	0.011	-0.106	-0.054	-0.021	0.035	0.075	-0.012	1.000
Share from hog receipts	-0.090	-0.003	0.054	0.099	0.065	0.060	0.195	0.000
Total assets	-0.051	0.230	-0.088	-0.064	-0.045	-0.135	0.091	-0.034
Farrow-to-finish operation	-0.006	0.063	0.020	0.031	0.025	-0.011	0.096	-0.108
Prairies	-0.144	0.111	-0.076	0.002	-0.048	0.039	-0.117	0.089
Debt ratio	0.125	-0.211	0.161	0.169	0.115	-0.049	0.155	-0.003
Debt ratio squared	0.078	-0.120	0.126	0.153	0.129	-0.004	0.160	0.007
Expense ratio	-0.068	0.132	-0.084	-0.005	-0.067	0.126	0.011	-0.035
Share of income from subsidies	-0.092	-0.040	0.074	0.064	0.044	0.004	0.068	-0.008

Appendix

Table A1 Pearson Correlation Coefficients Matrix (concluded)

Independent variables	Share from hog receipts	Total assets	Farrow-to-finish operation	Prairies	Debt ratio	Debt ratio squared	Expense ratio	Share of income from subsidies
Under 35	-0.090	-0.051	-0.006	-0.144	0.125	0.078	-0.068	-0.092
Over 55	-0.003	0.230	0.063	0.111	-0.211	-0.120	0.132	-0.040
High school diploma	0.054	-0.088	0.020	-0.076	0.161	0.126	-0.084	0.074
Some post-secondary	0.099	-0.064	0.031	0.002	0.169	0.153	-0.005	0.064
College diploma	0.065	-0.045	0.025	-0.048	0.115	0.129	-0.067	0.044
Single manager	0.060	-0.135	-0.011	0.039	-0.049	-0.004	0.126	0.004
Corporation	0.195	0.091	0.096	-0.117	0.155	0.160	0.011	0.068
Share of income from off-farm	0.000	-0.034	-0.108	0.089	-0.003	0.007	-0.035	-0.008
Share from hog receipts	1.000	0.054	0.319	0.133	-0.041	-0.053	0.458	-0.068
Total assets	0.054	1.000	0.182	0.168	-0.053	-0.043	-0.022	-0.050
Farrow-to-finish operation	0.319	0.182	1.000	0.012	-0.110	-0.053	0.175	0.119
Prairies	0.133	0.168	0.012	1.000	-0.108	-0.085	0.066	-0.033
Debt ratio	-0.041	-0.053	-0.110	-0.108	1.000	0.843	-0.081	0.120
Debt ratio squared	-0.053	-0.043	-0.053	-0.085	0.843	1.000	0.027	0.085
Expense ratio	0.458	-0.022	0.175	0.066	-0.081	0.027	1.000	-0.008
Share of income from subsidies	-0.068	-0.050	0.119	-0.033	0.120	0.085	-0.008	1.000

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