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Effect of milk production scale on the economic return of dairy farmers in the Triângulo Mineiro/Alto Paranaíba mesoregion

Efeito da escala de produção de leite na rentabilidade de pecuaristas leiteiros da mesorregião do Triâgulo Mineiro e Alto Paranaíba

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Highlights

Analysis of the effect of production scale on the economic return of dairy activity.
Production scale influenced the economic return of dairy production.
Only farms with a large production scale had positive outcomes.

Abstract

This study proposes to evaluate the relationship between the economic return of dairy production and its scales. Economic and production data were collected from 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba mesoregion, MG, Brazil. The farms were stratified into three scales of milk production: small (less than 150 kg), medium (151 to 400 kg), and large (over 400 kg). Data collected between January and December 2013 were analyzed statistically using SPSS 27.0 software, considering a minimum significance level of 95% ($P < 0.05$). Gross Margin, Net Margin, and Outcome were used as indicators of return. Among the fixed costs, depreciation corresponded to 16.56, 15.90, and 12.54% of total costs for the small, medium, and large producers, respectively. Among the variable costs, feeding accounted for 26.26, 34.94, and 44.58%

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of total costs on the small, medium, and large farms, respectively. Only the large-scale producers had positive outcomes (BRL 27,010.73), whereas the small and medium producers had losses (BRL -28,615.21 and BRL -18,233.83, respectively). In conclusion, increasing the scale of production positively influences the economic return of dairy farming.
Key words: Dairy cattle. Management. Production cost. Profitability.

Resumo

Objetivou-se avaliar a relação entre a rentabilidade da atividade leiteira e suas escalas de produção. Para isso, foram levantados dados econômicos e produtivos de 28 propriedades leiteiras localizadas na mesorregião do Triângulo Mineiro/Alto Paranaíba, MG. As propriedades leiteiras foram estratificadas em três escalas de produção: pequena (inferior a 150 kg), média (entre 151 a 400kg) e grande (acima de 400 kg). Os dados coletados entre janeiro a dezembro de 2013 foram analisados estatisticamente através do software SPSS 27.0, considerando-se nível mínimo de significância de 95% ($P < 0,05$). Foram utilizados como indicadores de rentabilidade a Margem Bruta, a Margem Líquida e o Resultado. Dentre os custos fixos, a depreciação correspondeu a 16,56%, 15,90% e 12,54% dos custos totais para pequenos, médios e grandes produtores, respectivamente. Dentre os custos variáveis, a alimentação representou 26,26%, 34,94% e 44,58% dos custos totais para pequenos, médios e grandes produtores, respectivamente. Somente os grandes produtores apresentaram resultados positivos (R$27.010,73), enquanto que os pequenos e médios produtores obtiveram prejuízos (-R$28.615,21 e -R$18.233,83, respectivamente). Conclui-se que o aumento da escala de produção influencia positivamente a rentabilidade da pecuária leiteira.
Palavras-chave: Bovinocultura de leite. Custo de produção. Gestão. Lucratividade.

Introduction

Dairy production is an extremely important activity for the agricultural sector, making part of income generation for a large number of producers and absorption of rural labor. The state of Minas Gerais (MG) ranks first in milk production in Brazil, with a share of 26.4% of total national production in 2018. The southern region of MG is the largest milk producer in the state, accounting for 17.7% of that amount. Among the mesoregions of MG, Triângulo Mineiro/Alto Paranaíba stands out, having generated 25.9% of the total produced in the state in that same year, which corresponds to 2.3 billion liters of milk. In addition to this, the Triângulo Mineiro/Alto Paranaíba mesoregion has the largest effective herd of cattle, with 658,900 milked cows, which represents 21% of the total in the state (Secretaria de Estado de Agricultura, Pecuária e Abastecimento de Minas Gerais [SEAPA], 2019). In this region, dairy production is usually undertaken by family farms, on a small scale. To increase productivity and profits, many producers unite to form cooperatives (Castanho et al., 2013).

Few farms perform economic analysis, as they are unaware of the costs of milk production particularly, fixed costs. This causes producers to make a decision conditioned to their experience, tradition, and other subjective factors, which makes it difficult to identify critical control points in the production process (Santos & Lopes, 2012).

Increasing the scale of production dilutes the fixed costs of the activity, reducing the total unit cost (per kilogram of milk) and increasing margins (Moraes et al., 2018). For the simple fact that the fixed costs per liter of milk produced are diluted, an increase in scale has a great influence on the profit of dairy farming (Assis et al., 2017). Economic analysis studies allow evaluating the efficiency of dairy farming and enable producers to compare the percentage of disbursements of their investment with those of other dairy farms that compete in the same region (Assis et al., 2017).

Given the above-described scenario, the present study was developed to analyze the relationship between the economic return of dairy farming and the stratification of its scales of production, under the hypothesis that large-scale farms have their fixed costs more diluted, consequently achieving greater profitability and higher returns. Therefore, the objective was to compare and analyze the economic return of 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba mesoregion, state of Minas Gerais, Brazil, based on the stratification of their production scales.

Material and Methods

Data were collected on 28 dairy farms located in the mesoregion of Triângulo Mineiro/Alto Paranaíba, MG, Brazil. Of these farms, eight were located in the municipality of Uberlândia, six in Prata, three in Indianópolis, three in Patos de Minas, two in Monte Alegre de Minas, two in Presidente Olegário, two in Tupaciguara, one in Lagoa Formosa, and one in Canápolis. The data were recorded by the producers during the year 2013 in field notebooks and collected monthly by the researchers. These dairy farms were chosen using non-probability judgmental sampling, considering the following criteria: availability and quality of animal-production and financial data, farmers' consent and interest in participating in the study, and farmers' ease of access to sources of evidence (Lopes et al., 2015).

Economic/financial data underwent monetary correction. The month of January/2014 was considered the initial reference, whose values were updated to March/2022. The IGP-M index from Fundação Getúlio Vargas [FGV] (2022) was used, as it is a good indicator to consider inflation in Brazil (Araújo et al., 2018) that is used in dairy farming (Bassotto et al., 2021).

To analyze the influence of the scale of production on the economic return of dairy farming, the 28 farms were allocated into one of three daily milk production strata: small (less than 151 kg), medium (between 151 and 400 kg), and large (greater than 400 kg), as proposed by Lopes et al. (2006). Therefore, 14 farms were classified as small (50% of the sample), nine as medium (32.1% of the sample), and five as large (17.8% of the sample).

In performing the complete inventory of the assets, the value and useful life of each asset were determined and subsequently grouped into pre-established categories: improvements, equipment, tools, implements, machinery, herd (dams and sires), draft animals, and furniture (Lopes et al., 2004). In situations in which the farmers did not possess information on the value and date of acquisition, the criterion proposed by

Lopes et al. (2004) was adopted to estimate the updated values as well as the remaining useful life.

Gross margin (GM), net margin (NM), and outcome were used as indicators of return. Gross margin corresponds to income minus the effective operating cost (EOC); NM represents income minus the total operating cost (TOC) (Matsunaga et al., 1976); and outcome corresponds to income minus the total cost (TC).

Profitability 1 was estimated as the outcome divided by total revenue multiplied by 100 (Profitability 1 (%) = (Outcome/Total Revenue) × 100). Return 1 was determined by dividing the outcome by the total fixed assets plus EOC, multiplied by 100 (Return 1 (%) = Outcome/(Total Fixed Assets + EOC) × 100) (Serviço Brasileiro de Apoio às Micro e Pequenas Empresas [SEBRAE], 1998). Profitability 2 was considered the division of NM by the total revenue, multiplied by 100 (Profitability 2 (%) = (NM/Total Revenue) × 100), whereas Return 2 was considered the division of NM by the total fixed assets plus EOC, multiplied by 100 (Return 2 (%) = NM/(Total Fixed Assets + EOC) × 100) (Lopes et al., 2011a).

The effective operating cost was calculated and divided into groups, namely, feeding, labor, sanitation, milking, artificial insemination, energy, taxes considered fixed (ITR [rural land property], IPVA [vehicle registration], mandatory insurance, and licensing fee), land lease, and miscellaneous expenses (Lopes et al., 2004, 2006). The total operating cost is the result of the sum of EOC, depreciation (of the following items: improvements, equipment, tools, implements, machinery, draft animals, and furniture), and family labor. Lastly, TC was calculated as the sum of fixed costs (FC) (return on land, return on invested capital, entrepreneur's compensation, taxes considered fixed, and depreciation) and variable costs (VC) (EOC without taxes, return on working capital, or family labor).

Return on invested capital was estimated by adopting the rate of 6.3181% (the accumulated savings index in 2013; https://portalbrasil.net) over the total fixed assets in inventory. Return on land, in turn, was considered the value of lease practiced in the region, estimated at 1 kg of milk/ha/day (Assis et al., 2017). Finally, return on working capital was estimated using the percentage of 6.3181% over 20% of the EOC (Lopes et al., 2015).

The Shapiro-Wilk normality test was performed, using SPSS 27.0 software, to assess the distribution of variables. According to the test results, some of the variables did not show normal distribution. Thus, production and economic indicators were compared between the categories of the independent variable scale of production (small, medium, and large) using the Kruskal-Wallis test, followed by multiple comparison using Dunn's test for the variables without normal distribution. The ANOVA procedure was carried out, followed by multiple comparison by the Bonferroni correction test for the variables with normal distribution. To describe the variables and economic indicators, as well as the technical and managerial indices, descriptive statistics were applied using the mean and standard deviation for the variables that showed normal distribution, and median and interquartile difference for those which did not (Moraes et al., 2018). A minimum significance level of 95% ($P<0.05$) was considered in all statistical analyses.

Results and Discussion

Among the 28 dairy farms analyzed, those which were allocated to the small production stratum predominated, as 50% produced up to 151 kg of milk per day, 32% produced between 151 and 400 kg, and only 18% produced more than 400 kg per day. The total value of fixed assets, as well as the value of land assets (Table 1), were similar between the strata (P>0.05). This shows the existence of land idleness, especially by small and medium producers. Alternatively, considering that the sizes of the small and large farms were different (P<0.05), this may be due to a greater valuation of the land depending on its quality (soil structure and fertility, topography) and where the farm is located (city, near the urban perimeter, access roads, water sources, etc.). Another fact to be considered is that two farms, which belong to the small and large scale strata, are leased and, therefore, were not considered in the calculation of these two variables.

The median equity value (Table 1), disregarding the land, differed (P<0.05) between the stratum of small producers (BRL 247,623.95) and the others (BRL 431,130.35 for the medium and BRL 763,653.47 for large scales), which were similar to each other. This finding points to a behavior that meets the expectations for small producers; however, the similarity between the medium and large strata demonstrates idleness of the infrastructure in the case of the medium producers.

The three groups with the greatest representation of the median in the total value of fixed assets were land (65.10, 70.22, and 46.00%), animals (9.84, 15.24, and 15.67%), and improvements (11.08, 11.17, and 12.51%), in the small, medium, and large production scales, respectively (Table 1). A significant difference (P<0.05) was only present for the animal group, between the small strata and the other two, which were similar to each other. The similarity between the strata for land and improvements possibly contributed to the negative economic return of the small and medium producers, due to the cost of depreciation and returns on invested capital and land.

Results for total fixed assets per hectare and per lactating dam (Table 1) were similar (P>0.05) between the strata, which reinforces the theory of idleness in the use of land and infrastructure, mainly by the small and medium producers. According to Lopes et al. (2012b), the indicators termed fixed assets per hectare and fixed assets per dam can be used as parameters in the construction of a production system, in the absence of a project of economic feasibility, provided that the reference system showed a positive outcome.

Total revenue (Table 2) was calculated considering the incomes from the sale of milk, animals, cheese, and other sources (rental of agricultural machinery, sales of obsolete equipment, and silage sales). The average price received per liter of milk differed (P<0.05) between the small (BRL 1.96) and large (BRL 2.37) production strata, both of which did not differ from the value paid to the medium producers (BRL 2.09). In addition to the volume of liters delivered per day (F. A. Demeu et al., 2015, 2016), the variation in the amount paid per liter of milk may also be related to the quality of milk (Lopes et al., 2012a; Paixão et al., 2014; Teixeira et al., 2015; Lopes et al., 2012a), although this factor was not evaluated in the present study. Thus, calculating values

on investments in feeding, hygiene, genetics, and health, which are transformed into milk of better nutritional composition, less microbiological contamination, and absence of drug residues, as well as increased productivity, can be an advantageous alternative for small and medium producers, since although these investments mean an increase in EOC, this may result in a better subsidy per liter of milk.

In terms of representativeness in the revenue, there was a difference ($P<0.05$) for the sale of milk and animals, whereas the sale of cheese and other sources of income were similar ($P>0.05$) between the strata (Table 3). The farms classified in the stratum of medium production showed superior representativeness in the sale of milk (89.15%) in comparison with the small farms (72.29%); however, neither differed from the large-scale farms (86.82%).

The representativeness of sale of animals was significantly greater on the farms in the small production stratum (25.34%) when compared with the medium-scale farms (10.85%). The large farms also did not differ from the others regarding this item (12.97%) (Table 3). Moraes et al. (2018) found a representativeness of animal sales of 13.86%, i.e., 11.5% less than the result found in the present study for the small production stratum, denoting concern with the sale of this asset. At first, the considerable sale of animals observed in the stratum of small producers may seem attractive. Nonetheless, a more in-depth analysis is necessary, as this practice can lead to a decrease in capital with the sale of animals (Lopes et al., 2011b).

None of the farms sold manure (Table 3), which explains the null values in the contribution of this activity to the total revenue. As a result of technical guidance, the manure was used on the very farm. Of the 28 farms evaluated, 60.71% were assisted: two (7.14%) by technicians from Balde Cheio; nine (32.14%) by EMATER; and six (21.43%) by the program of the Secretariat of Family Agriculture of the Municipality of Uberlândia. The farmers were instructed to have manure pits to make the most of the manure, or to use it directly in the fields. Moraes et al. (2018) stated that the use of manure reduces weeding maintenance expenses, although, at first, it means a reduction in revenues.

Table 1
Resources available on 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba (MG) mesoregion, according to the scale of production, from January to December 2013

Variable (BRL)	Scale of production											
	Small				Small				Small			
	Mean	SD	Median	ID	Mean	SD	Median	ID	Mean	SD	Median	ID
Land equity	628,124.22	413,613.73	562.080.84[a]	547.984.33	1.136.304.79	910,322.25	825.161.86[a]	1,199.500.38	877,583.90	605,353.03	785,252.07[a]	1,089,429.38
Non-land equity	273,811.42	91,005.02	247.623.95[a]	154.842.59	507.365.44	228,286.38	431.130.35[b]	385,055.04	805,308.44	332,483.09	763,653.47[b]	548,372.04
Improve ments	99,395.10	49,807.05	95.686.42[a]	58.753.95	173.103.85	112,596.43	131.254.67[a]	195,132.44	244,013.68	181,861.25	213,493.64[a]	292,645.97
Equipment	12,682.60	13,885.96	8.355.17[a]	7.502.34	19.925.36	14.862.84	16.160.23[a]	25,217.59	37,507.48	28,409.49	30,716.99[a]	53,206.65
Tools	337.46	247.59	392.63[a]	555.5	298.42	305.28	258.87[a]	560.89	791.29	278.93	660.13[b]	530.69
Implements	10,944.37	17,752.98	0.00a	17,312.22	9.987.04	17,726.28	0[a]	16,341.44	28,090.02	28,935.39	32,790.75[a]	53,829.68
Machinery	46,716.10	37,840.75	44,440.09[a]	53,093.50	110,578.18	54,888.94	104.304.77[b]	64,880.37	186,116.38	126,205.67	164,385.19[b]	198,106.80
Herd	101,539.98	49,611.07	84,997.06[a]	79,657.78	192,322.04	81,270.97	179.054.73[b]	131,378.71	305,514.83	83,103.74	267,503.45[b]	147,666.22
Draft animals	2,195.81	2,591.37	862.91a	4,530.30	1,150.55	2,283.06	0.00a	1,725.83	3,106.49	3,741.51	1,725.83[a]	6,903.31
Furniture	0.00	0.00	0.00a	0.00	0.00	0.00	0.00a	0.00	168.27	376.26	0.00a	420.67
Total fixed assets	901,935.64	419,730.93	863,404.33[a]	607.434.22	1,643.670.22	1,010,740.74	1.175.138.35[a]	1,301,580.33	1,682,892.35	905,349.11	1,707,021.50[a]	1,558,743.48
Area (ha)	21.16	10.95	18.08a	11.90	36.67	23.61	30.00[ab]	44.70	54.40	18.89	63.00b	36.50
Land equity/ ha	28,915.34[a]	10,648.52	31,712.10	10.516.77	30,774.16[a]	10,842.20	32.359.29	18,857.91	15,187.29a	9,601.26	21,572.86	15,963.92
Total fixed assets/ha	44,482.29	13,128.12	43,613.07[a]	12.608.63	51,176.75	19,804.59	49.867.15[a]	33,409.56	30,235.99	13,647.93	33,694.34[a]	24,696.18
Fixed assets per lactating dam	66,710.62	35,161.98	55,395.52[a]	29.077.15	62.792.95	33,579.20	53.571.27[a]	12,487.28	34,165.22	14,032.71	33,471.01[a]	9,395.54
Fixed assets per kg of milk sold	35.00	19.25	31.96a	37.34	18.45	11.57	13.76[ab]	12.02	6.24	2.82	5.99b	4.83

SD = standard deviation; ID = Interquartile difference; Different letters in the same row indicate a statistical difference (P<0.05). The Kruskal-Wallis test was used for variables without normal distribution and ANOVA for variables with normal distribution.

Table 2
Summary of the profitability analysis of the dairy activity of 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba (MG) mesoregion, according to scale of production, from January to December 2013 (%)

Variable (BRL)	Scale of production											
	Small				Small				Small			
	Mean	SD	Median	ID	Mean	SD	Median	ID	Mean	SD	Median	ID
Revenue	89,947.95	37,919.38	78,309.28[a]	58,626.78	223,051.95	71,899.71	208,336.76[b]	47,352.86	719,122.86	295,245.06	600,093.21[b]	443,651.89
Milk	57,437.80	29,250.96	56,937.49[a]	45,502.71	192,246.15	45,356.96	174,821.42[b]	38,774.30	633,430.47	326,520.61	502,487.26[b]	484,497.61
Animals	28,465.23	24,227.02	23,406.55[a]	22,554.42	26,183.46	18,838.02	23,190.82[a]	30,040.21	78,387.82	47,288.42	93,021.18[a]	78,134.74
Manure	0.00a	0.00	0.00	0.00	0.00a	0.00	0.00	0.00	0.00[a]	0.00	0.00	0.00
Miscellaneous	1,664.19	6,226.84	0.00[a]	0.00a	4,336.14	13,008.43	0.00[ab]	0.00	7,304.57	12,959.97	1,359.09[b]	17,581.88
Cheese	2,380.72	8,907.84	0.00a	0.00a	286.2	858.6	0.00[a]	0.00	0.00	0.00	0.00[a]	0.00
TOC[1]	90,185.77	38,190.54	76,968.91[a]	62,818.28a	179,635.35	48,042.79	168,402.66[b]	56,379.91	592,125.63	281,621.25	472,538.03[b]	443,302.08
EOC[2]	53,043.35	32,824.20	46,220.28[a]	56,036.36a	123,078.40	34,595.55	115,019.90[b]	50,954.55	488,579.03	266,245.61	348,910.64[b]	415,590.02
Depreciation	19,590.74	9,445.51	21,723.75[a]	14,612.38a	39,005.28	17,197.48	33,499.72[b]	22,683.97	82,484.59	26,976.52	80,619.97[b]	49,428.49
Family labor	17,551.68	0.00	17,551.68[a]	0.00a	17,551.68	8,775.84	17,551.68[a]	0.00	21,062.01	7,849.35	17,551.68[a]	8,775.84
TC[3]	118,563.15	42,403.45	106,218.14[a]	71,852.56	241,285.80	73,726.09	221,939.37[b]	100,537.61	692,112.12	316,785.58	598,476.26[b]	492,571.90
FC[4]	47,388.54	15,317.10	50,140.53[a]	29,961.03	99,201.19	43,848.40	85,860.58[b]	65,108.72	176,663.45	72,656.45	182,856.51[b]	127,273.83
Family labor	11,321.98	5,920.98	11,021.33[a]	9,881.66	29,915.53	18,878.21	23,430.33[b]	36,042.10	39,431.20	25,857.27	51,938.71[ab]	45,315.73
Return on invested capital	16,385.13	5,415.31	15,370.88[a]	9,914.78	30,179.67	13,085.25	25,904.93[b]	20,471.13	54,381.51	21,306.98	55,640.50[b]	36,167.01
Entrepreneur's compensation	0.00a	0.00	0.00	0.00	0.00[a]	0.00	0.00	0.00	0.00[a]	0.00	0.00	0.00
Fixed taxes	90.69	267.17	0.00[a]	14.08	100.72	220.37	0.00[a]	133.75	366.15	818.74	0.00[a]	915.34
Depreciation	19,590.74	9,445.51	21,723.75[a]	14,612.38	39,005.28	17,197.48	33,499.72[b]	22,683.97	82,484.59	26,976.52	80,619.97[b]	49,428.49
VC[5]	71,174.61	33,290.37	64,356.01[a]	57,487.84	142,084.60	33,955.93	136,078.79[b]	37,461.59	515,448.67	266,643.15	388,422.90[b]	419,926.16
EOC[2] w/o txs.	52,952.66	32,875.61	46,220.28[a]	56,779.71	122,977.68	34,613.99	115,019.90[b]	50,954.55	488,212.87	265,475.65	348,910.64[b]	414,674.57
Return on working capital	670.27	414.77	584.05[a]	707.91	1,555.24	437.16	1,453.41[b]	643.84	6,173.78	3,364.33	4,408.90[b]	5,251.59
Family labor (BRL)	17,551.68	0.00	17,551.68[a]	0.00	17,551.68	8,775.84	17,551.68[a]	0.00	21,062.01	7,849.35	17.551.68[a]	8.775.84
Working capital (BRL)	273,811.42	91,005.02	247,623.95[a]	154,842.59	507,365.44	228,286.38	431,130.35[b]	385,055.04	805,308.44	332,483.09	763.653.47[b]	548.372.04
Gross margin* (BRL)	36,904.59	28,269.91	33,054.88[a]	33,567.06	99,973.56	50,121.29	81,278.31[b]	67,530.60	230,543.83	41,001.57	230.075.38[b]	77.770.91
Net margin* (BRL)	-237.82	28,157.28	-3,822.56a	31,749.47	43,416.60	42,147.85	39,375.95[ab]	71,719.49	126,997.23	27,626.99	132.002.38[b]	52.508.35
Outcome (profit or loss)* (BRL)	-28,615.20[a]	30,868.27	-34,670.85	32,842.35	-18,233.84[ab]	44,007.00	-3.480.32	53,057.87	27,010.74b	48,555.30	10.671.01	74.767.07

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Gross margin*/kg milk (BRL)	1.35	1.43	1.15a	1.07	1.07	0.32	0.99[a]	0.51	0.96	0.27	1.07a	0.51
Net margin*/kg milk (BRL)	0.01	1.36	-0.20a	0.91	0.45	0.37	0.52[a]	0.67	0.54	0.21	0.49a	0.39
Outcome (profit or loss)*/kg milk (BRL)	-1.06a	1.43	-1.34	1.46	-0.22ab	0.50	-0.05	0.57	0.16b	0.31	0.03	0.44
Profit 1 (%)	-41.08	41.52	-47.05a	56.46	-9.95	23.33	-1.65[ab]	24.56	5.20	10.23	0.99b	15.04
Return 1 (%)	-3.14	3.81	-3.09a	4.63	-0.53	1.54	-0.36[ab]	2.15	3.73	7.69	0.36b	9.67
Profit 2 (%)	-5.18a	31.16	-6.97	33.63	17.60a	14.92	18.77	23.88	19.20a	6.53	18.36	12.72
Return 2 (%)	0.07	3.62	-0.37a	4.57	3.29	2.69	2.86[ab]	3.76	8.30	7.33	4.68[b]	9.79
Total milk produced (kg)	31,034.57	12,799.71	29,594.00[a]	19,560.00	91,045.78	18,883.52	86,507.00[b]	25,516.50	264,884.80	119,154.78	224,957.00[b]	178,249.50
Amount of milk sold (kg)	30,468.71	12,847.79	29,184.00[a]	20,141.25	90,365.89	19,128.17	85,771.00[b]	26,757.00	264,289.20	118,739.58	224,867.00[b]	177,524.50
Amount of milk consumed internally (kg)	565.86	608.26	485.00a	646.50	679.89	585.10	600.00[a]	411.00	595.60	530.54	719.00a	1,039.50
Price of milk (BRL)	1.97a	0.19	1.94	0.27	2.09ab	0.19	1.94	0.32	2.37b	0.15	2.37[ab]	0.22
TOC[1]/kg milk (BRL)	3.11	1.08	2.59a	1.83	1.99	0.30	2.16[b]	0.43	2.2	0.18	2.16[a]	0.32
EOC[2]/kg milk (BRL)	1.79	0.99	1.51a	1.94	1.37	0.29	1.29[a]	0.43	1.73	0.22	1.73[b]	0.43
TC[3]/kg milk	4.19	1.35	3.99a	2.05	2.61	0.46	2.80[b]	0.86	2.63	0.18	2.59[b]	0.32
FC[4]/kg milk	1.73	0.67	1.62a	0.97	1.08	0.34	1.08[ab]	0.43	0.69	0.28	0.65[b]	0.54
VC[5]/kg milk	2.47	1.04	1.94a	1.89	1.61	0.24	1.51[b]	0.43	1.94	0.22	1.94[ab]	0.43
Total head (units)	50.39	24.92	47.75a	22.75	77.61	31.06	60.00[ab]	46.50	155.40	63.26	169.50[b]	56.50
Initial herd equity value (BRL)	132,158.42	60,688.73	122,512.27[a]	103,689.95	225,199.08	72,419.81	234,281.25[ab]	131,324.78	535,718.81	183,884.27	514,512.69[b]	307,898.63
Final herd equity value (BRL)	166,499.33	83,844.20	155,108.86[a]	144,904.89	263,776.14	71,050.34	285,193.20[ab]	124,745.06	582,531.91	301,422.04	530,476.60[b]	495,258.91
Herd equity variation (BRL)	34,340.91a	32,151.84	34,840.17	54,255.74	38,577.07a	67,188.65	34,300.85	130,397.15	46,813.10a	119,856.53	25,887.43	192,322.04

Different letters in the same row indicate a statistical difference (P<0.05); The Kruskal-Wallis test was used for variables without normal distribution and ANOVA for variables with normal distribution.
[1]Total operating cost; [2]Effective operating cost; [3]Total cost; [4]Fixed costs; [5]Variable costs.
SD = standard deviation; ID = interquartile difference.
*Indicators calculated using the total revenue; Profitability 1: Outcome/Total revenue; Profitability 2: Net margin/Total revenue; Return 1: Outcome/(Effective operating cost + Total fixed assets); Return 2: Net margin/(Effective operating cost + Total fixed assets); Herd equity variation = Final value – Initial value.

Table 3
Representativeness of each item that makes up the revenue of 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba (MG) mesoregion, according to scale of production, from January to December 2013 (%)

Variable	Scale of production											
	Small				Small				Small			
	Mean	SD	Median	ID	Mean	SD	Median	ID	Mean	SD	Median	ID
Sale of milk	65.83	23.63	72.29[a]	28.43	87.85	7.67	89.15[b]	12.90	85.69	7.89	86.82[ab]	13.50
Sale of animals	30.61	17.67	25.34[a]	28.43	10.92	6.18	10.85[b]	11.65	13.61	8.86	12.97[ab]	15.20
Manure	0.00[a]	0.00	0.00	0.00	0.00[a]	0.00	0.00	0.00	0.00a	0.00	0.00	0.00
Other revenues	1.09	4.07	0.00[a]	0.00	1.08	3.25	0.00[a]	0.00	0.70	1.05	0.19[a]	1.67
Cheese	2.47	9.25	0.00[a]	0.00	0.15	0.44	0.00[a]	0.00	0.00	0.00	0.00[a]	0.00

SD = standard deviation; ID = interquartile difference; Different letters in the same row indicate a statistical difference (P<0.05); The Kruskal-Wallis test was used for variables without normal distribution and ANOVA for variables with normal distribution.

The median values of TOC (EOC + Depreciation + Family Labor) (Table 2) differed (P<0.05) between the small stratum (BRL 76,968.92) and the medium (BRL 168,402.66) and large (BRL 472,538.03) strata, whereas the last two were similar to each other. Similar results were observed for the EOC, which represented the average disbursement made by producers to fund the activity. The items that make up the EOC were divided into groups, as it facilitates the monitoring of expenses of the milk production system, thus helping the technician and the producer in a more detailed analysis (Lopes et al., 2019). The representativeness of these items was similar (P>0.05) between the strata and are detailed in Table 4.

Feeding, miscellaneous factors, health, and energy were the most representative expenses in the three scales of production. As already described in the literature (Moraes et al., 2018; Santos & Lopes, 2014), the cost of feeding was the most impacting component, representing, on average, 64.27% of the EOC on the studied farms.

Miscellaneous expenses (maintenance of machinery and facilities, office supplies, cleaning products, taxes that vary according to the amount produced, etc.) were the second most representative item in the EOC, for the medium (9.03%) and large (17.72%) production scales (Table 4). Because miscellaneous expenses are a group composed of distinct expenses, it is worth mentioning that the individualized management of each one, aiming at their reduction, can mean greater gains to the producer of any scale.

The representativeness of sanitation expenditures did not differ between the farms with different production scales (P>0.05). On average, these expenditures represented 5.63% of the EOC (Table 4). There is no value in the literature considered ideal for sanitation. Advocating a value of zero for this item would

be an inconsistency, since a percentage should be invested in prevention, considering that, as stated by F. A. Demeu et al. (2015), this route is more economical than the use of curative drugs.

The average representativeness of the energy group (fuel and electricity) in the EOC was 6.17% (Table 4). For Pelegrini et al. (2019), separating electricity and fuel expenses, used on the farm, from personal and family expenses (household and family vehicles) is a fundamental practice in the management of the activity. As a result, unrealistic or negative outcomes are avoided, causing many to give up on the dairy business not because it is not profitable, but because of the lack of management of the production activity.

According to the literature, labor costs are significantly representative in the EOC, accounting for 15 to 32.9% (Assis et al., 2017; Lopes et al., 2011a; Santos & Lopes, 2014). However, in this study, there was a predominance of family labor, present on 93% of the studied dairy farms, which explains the low median representativeness of hired labor expenses in the EOC (Table 4) for the small (1.28 %), medium (2.64%), and large production (3.58%) strata. No labor was hired on 29% of the studied farms; 50% hired only temporary labor; and only 21% hired permanent and temporary labor.

Total operating cost is calculated as the sum of EOC, depreciation, and family labor (Table 2). The small-scale dairy farms showed a significantly lower median depreciation value (BRL 21,723.76) than the medium (BRL 33,499.72) and large (BRL 80,619.97) farms, which were similar to each other. The fact that the medium-scale stratum was similar to the large-scale stratum indicates idleness of infrastructure in the medium producers. Increasing efficiency and scaling production are two alternatives for reducing TOC (Santos & Lopes, 2012).

Total cost (TC) represented the sum of fixed costs (FC) (sum of return on land, return on invested capital, entrepreneur's compensation, taxes considered fixed, and depreciation) and variable costs (VC) (sum of EOC, return on working capital, and family labor) (Table 2). The entrepreneur's compensation was zero, since there were no producers with another remunerated activity. There was a significant difference ($P<0.05$) in the TC medians between the small stratum (BRL 106,218.13) and the medium (BRL 221,939.37) and large (BRL 598,476.26) scales of production, the last two of which were similar to each other. The items that make up the TC were also divided into groups, and the representativeness of each one was estimated (Table 5), aiming at a more detailed analysis.

The representativeness of FC in the TC differed significantly ($P<0.05$) between the medium (39.90%) and large (26.08%) strata, whose results were similar to that of the small scale stratum (41.54%) (Table 5). According to Santos and Lopes (2012), FC do not represent disbursement (with the exception of taxes), but rather how much the activity should return financially to be competitive, compared with other economic activities. A. A. Demeu et al. (2013) demonstrated that if the FC are not accounted for, the farmer may lose capital in the long run, going into debt.

Among the FC, depreciation was the most representative item in the TC of the three scales (16.56, 15.90, and 12.54%), followed by return on invested capital (14.13, 12.22, and 8.07%) for the small, medium, and large scales, respectively (Table 5). The high contribution of depreciation to the TC is in line with the

high representativeness of miscellaneous expenses in the EOC, which include the amounts spent on the maintenance of machinery and equipment (Table 4). Thus, the fact that these two variables showed similar results between the scales may indicate that there is excess investment in assets and/or idle use on the small and medium farms.

The VC (Table 2) are the same that make up the EOC, minus the amounts referring to taxes considered fixed added to the return on working capital and family labor. The mean representativeness of VC in the TC (Table 5) differed between the small (58.46%) and large production (73.92%) strata, while the latter was similar to the medium production stratum (60.10%).

Return on working capital (rate of return, considering the cumulative 2013 savings index, of 6.3181% over 20% of the EOC value) differed (P<0.05) between the medians of the small production stratum, which showed the lowest value (BRL 584.04), and the medium (BRL 1,453.41) and large strata (BRL 4,408.91), both of which were similar to each other (Table two).

The economic efficiency indicators of gross margin (GM = Gross Income – EOC), net margin (NM = Gross Income – TOC), and outcome (Gross Income – TC) also differed between the strata (Table 2). Gross margin showed a positive result in the three strata, but the median GM value of the small production stratum (BRL 33,054.88) was statistically lower than those of the medium and large strata (BRL 81,278.31 and BRL 230,075.38, respectively), which were similar to each other.

Table 4
Representativeness of each item in the effective operating cost of 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba (MG) mesoregion, according to scale of production, from January to December 2013 (%)

Variable	Scale of production											
	Small				Small				Small			
	Mean	SD	Median	ID	Mean	SD	Median	ID	Mean	SD	Median	ID
Feeding	60.63[a]	22.05	63.12	37.68	67.78[a]	16.04	63.81	30.15	64.41[a]	4.11	66.22	7.25
Labor	7.76	15.35	1.28[a]	9.35	8.16	10.68	2.64[a]	18.06	3.74	1.21	3.58[a]	2.17
Sanitation	7.46	4.07	6.89[a]	3.98	4.33	1.59	3.94[a]	3.15	5.11	2.12	4.23[a]	3.55
Milking	0.70	1.18	0.07[a]	1.51	1.48	1.34	1.03[a]	0.80	1.24	1.37	0.78[a]	2.13
Artificial insemination	1.05	1.63	0.00[a]	2.33	0.75	1.11	0.00[a]	1.30	1.5	1.15	1.38[a]	1.83
Energy	8.87	14.72	4.97[a]	6.6	4.91	4.29	3.93[a]	8.00	4.74	2.74	4.03[a]	4.10
Taxes considered fixes (ITR and IPVA)	0.27	0.87	0.00[a]	0.03	0.09	0.19	0.00[a]	0.12	0.04	0.09	0.00[a]	0.10
Land lease	2.72	5.41	0.00[a]	4.76	1.37	2.80	0.00[a]	2.40	3.44	3.14	1.99[a]	5.30
Miscellaneous expenses	10.54	9.71	6.54[a]	9.15	11.14	10.2	9.03[a]	20.51	15.78	5.1	17.72[a]	9.91

Different letters in the same row indicate a statistical difference (P<0.05); The Kruskal-Wallis test was used for variables without normal distribution and ANOVA for variables with normal distribution.
SD = standard deviation; ID = interquartile difference; ITR = rural land property tax; IPVA = vehicle registration tax.

Table 5

Representativeness of each item in the total cost of 28 dairy farms located in the Triângulo Mineiro/Alto Paranaíba (MG) mesoregion, according to scale of production, from January to December 2013 (%)

Variable	Scale of production											
	Small				Small				Small			
	Mean	SD	Median	ID	Mean	SD	Median	ID	Mean	SD	Median	ID
Fixed costs	41.54[ab]	12.34	37.12	19.96	39.90[a]	6.55	38.2	9.96	26.08[b]	8.66	22.48	16.12
Return on land	10.76[a]	6.34	10.25	11.96	11.74[a]	5.92	10.95	6.67	5.45[a]	3.82	5.28	7.13
Return on invested capital	14.13[a]	2.77	13.74	5.36	12.22[ab]	2.33	12.42	3.58	8.07[b]	2.56	7.28	4.84
Entrepreneur's compensation	0.00[a]	0.00	0.00	0.00	0.00a	0.00	0.00	0.00	0.00[a]	0.00	0.00	0.00
Fixed taxes	0.09	0.28	0.00[a]	0.01	0.05	0.1	0.00[a]	0.07	0.03	0.07	0.00[a]	0.08
Depreciation	16.56[a]	6.53	17.35	11.95	15.90[a]	3.02	16.24	3.69	12.54[a]	3.24	11.73	5.13
Variable costs	58.46[a]	12.34	62.88	19.96	60.10[ab]	6.55	61.8	9.96	73.92[b]	8.66	77.52	16.12
Effective operating cost without taxes	41.39[a]	15.28	47.21	23.89	51.69[ab]	6.93	54.69	11.16	69.49[b]	9.10	74.11	17.33
Feeding	26.26[a]	14	27.46	23.02	34.94[ab]	9.14	31.93	15.5	44.58[b]	4.67	45.02	8.32
Labor	3.71	6.74	0.65[a]	4.92	4.11	5.36	1.35[a]	9.12	2.62	1.02	2.55[a]	1.67
Sanitation	2.99[a]	1.83	2.90	3.50	2.26[a]	0.90	2.17	1.45	3.65[a]	1.85	2.9	3.15
Milking	0.30	0.52	0.03[a]	0.53	0.80	0.78	0.53[b]	0.59	0.93	1.07	0.58[ab]	1.69
Artificial insemination	0.48	0.75	0.00[a]	1.02	0.40	0.56	0.00[a]	0.77	1.09	0.90	0.95[a]	1.34
Energy	2.37[a]	2.21	2.15	3.63	2.58[a]	2.4	1.65	4.47	3.16[a]	1.51	2.64	2.18
Land lease	1.40	2.83	0.00[a]	2.25	0.71	1.43	0.00[a]	1.38	2.54	2.47	1.54[a]	4.22
Miscellaneous expenses	3.88	2.92	2.48[a]	4.02	5.88	5.58	3.79[ab]	10.87	10.93	3.71	12.05[b]	7.13
Return on working capital	0.52[a]	0.19	0.60	0.29	0.65[ab]	0.09	0.69	0.14	0.88b	0.12	0.94	0.22
Family labor	16.54[a]	5.59	16.53	9.59	7.76[b]	4.24	8.20	5.34	3.56b	1.89	2.93	3.50

SD = standard deviation; ID = Interquartile difference; Different letters in the same row indicate a statistical difference (P<0.05); The Kruskal-Wallis test was used for variables without normal distribution and ANOVA for variables with normal distribution.

Net margin was negative in the median of the small production stratum (-BRL 3,822.56), which differed (P<0.05) from the large stratum (BRL 132,003.01). Although the medium-scale farms showed a positive margin (BRL 39,375.95), it did not differ statistically from the others (Table 2). Given the positive values of NM in the strata of medium and large production, we can state that the revenues allowed the payment of all expenses, the creation of a reserve referring to depreciation, as well as remuneration of family labor, which did not occur in the small production stratum. These results reinforce the importance and influence of the scale of production in diluting FC.

Outcome, which indicates profit or loss, differed (P<0.05) between the means of the strata. The small production farms had an average loss of BRL 28,615.21, differing (P<0.05) from the large-scale farms, which showed an average profit of BRL 27,010.73. Although the medium production stratum also had a loss (BRL -18,233.83), it did not differ from the other strata (Table 2). This fact demonstrates that, on average, the dairy farms of the large-scale stratum are capitalizing. The small and medium scale strata exhibited unsatisfactory average outcomes, indicating that the dairy farming activity was not able to return the invested capital and that, on average, these farms are losing capital.

There was a difference (P<0.05) in the medians of Profitability 1 (Outcome/ Total Revenue) between the small and large production strata; however, neither differed from the medium production stratum (Table 2). On the small and medium farms, the median values were negative, with each BRL 100.00 of revenue corresponding to losses of BRL 101.50 and BRL 3.56, respectively, whereas the large farms had a gain of BRL 2.14.

The mean results for Return 2 (Net Margin/Total Revenue) were similar (P>0.05) between all strata. The small production stratum showed a negative mean Return 2, with a loss of BRL 11.17 for each BRL 100.00 of revenue, whereas the medium and large production strata had mean gains of BRL 37.97 and BRL 41.42, respectively (Table 2). The values were higher when compared with those of Return 1, because, according to Lopes et al. (2011a), this indicator does not include the returns on land and invested capital, entrepreneur's compensation, taxes considered fixed, or return on working capital.

Return 1 (Outcome/EOC + Total Fixed Assets) and Return 2 (Net Margin/EOC + Total Fixed Assets) showed median behaviors similar to those observed for Profitability 1, with a difference (P<0.05) between small and large strata, whereas the medium stratum was similar to the others (Table 2). The small, medium, and large production strata showed Return 1 results of -3.09, -0.36, and 0.36% and Return 2 values of -0.37, 2.86, and 4.68%, respectively, that is, all provided higher returns than the savings account for the entire period of 2013 (6.3181%).

To undertake a real analysis of the results, it is necessary to determine whether the herd equity variation was positive, by calculating the difference (in Brazilian reais, BRL) in herd equity value at the end and at the beginning of the study period. This indicator measures the valuation or devaluation of the herd's equity, and, when positive, it may indicate that the herd is growing, that the herd is not yet stabilized, or that there has been an increase in the price of animals (Moraes et al.,

2018). In the present study, this indicator is related to the average animal equity increases in the three scales: small, (BRL 34,340.91), medium (BRL 38,577.06), and large (BRL 46,813.10) (P>0.05) (Table 2).

The median total milk production differed (P< 0.05) between the small production (29,594.00 kg/year) farms compared with those of the medium (86,507.00) and large (224,957.00 kg/year) strata, which were similar to each other (Table 2). Considering the classification of scales, in which large producers are considered those with production above 400 kg/milk/day, the similarity between the medium and large farms denotes their proximity in daily production.

Conclusions

The scale of production influenced the total cost of milk production and, therefore, the profitability and return of the activity. Only the large producers had positive outcomes, that is, they achieved profit, demonstrating that the dairy farming activity was able to produce in the long term and that cattle farmers are capitalizing, with higher returns than those provided by the savings account.

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