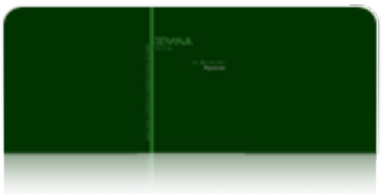

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Effect of the scale of production on the cost-effectiveness of milk production systems belonging to the "Balde Cheio" program

Efeito da escala de produção na rentabilidade de sistemas de produção de leite participantes do programa "Balde Cheio"

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Abstract

This study investigates the cost-effectiveness of 20 demonstration units (DUs) belonging to the "Balde Cheio" program. The units in question are from the state of Rio de Janeiro, Brazil, dating from January to December 2011, and are sorted according to the scale of production (small, medium and large). The data were analyzed using Predictive Analytical software (PASW) 18.0. The scale of production influenced the total cost of milk production, and therefore profitability and cost-effectiveness. The large-scale stratum showed the lowest total unit cost. The positive results in medium and large scales in milk production lead to optimal conditions for long-term production, with the capitalization of cowmen. The items regarding the effective operating cost (EOC) with the biggest influence on the costs of dairy activity in the small scale stratum were food, energy and miscellaneous expenses. In the medium scale, these were food, labor force, and miscellaneous expenses. Finally, in the large scale, they were food, labor force and energy. In the small and large scale, the items regarding the total cost with the biggest influence on the costs of dairy activity were food, labor force, and return on capital, while in the medium scale, they were food, return on capital, and labor force. The average break-even point of 14 of the DUs was higher than the average daily production.
Key words: Dairy cattle. Cost of production. Profitability. Management.

Resumo

Objetivou-se analisar a rentabilidade de 20 unidades demonstrativas (UD) participantes do programa "Balde Cheio", no estado do RJ, no período de janeiro a dezembro de 2011, em função da escala de produção (pequena, média e alta). Os dados foram analisados utilizando-se o software PASW 18.0. A escala de produção influenciou o custo total de produção do leite e, portanto, a lucratividade e rentabilidade. O estrato grande escala apresentou o menor custo total unitário. Por apresentar resultado

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positivo, nos estratos média e grande escalas, a atividade leiteira teve condições de produzir no longo prazo, com capitalização dos pecuaristas. Os itens componentes do custo operacional efetivo que exerceram maiores representatividades sobre os custos da atividade leiteira no estrato pequena escala, foram a alimentação, energia e despesas diversas; no média escala, a alimentação, mão de obra e despesas diversas; enquanto que no estrato grande, foram a alimentação, mão de obra e energia; Na escala pequena e grande, os itens componentes do custo total que exerceram maiores representatividades sobre os custos da atividade leiteira, foram a alimentação, mão de obra e remuneração do capital investido; na escala média foram a alimentação, remuneração do capital investido; e mão de obra. O ponto de equilíbrio médio de 14 UDs foi superior a produção média diária.
Palavras-chave: Bovinocultura de leite. Custo de produção. Lucratividade. Gerenciamento.

Introduction

There are many diverse farming systems in dairy activity. Productive inefficiency is observed in the majority of these systems, which results in low non-zootechnical indices and inflated costs associated with an extractive farming system. This leads to the deterioration of natural resources.

The "Balde Cheio" program was developed by the Brazilian southeastern livestock research center (CPPSE), and the Brazilian agricultural research agency (EMBRAPA) in São Carlos, SP, Brazil. The program derived from the need to assist inefficient dairy farmers by training rural extension professionals and rural producers, promoting the exchange of information on applied technologies regionally, and by monitoring the environmental, economic, and social impacts on farming systems that adopt the proposed technologies (EMBRAPA, 2011).

In the milk agribusiness, several management techniques have been proposed, including the set of technological measures proposed by the "Balde Cheio" program. Researchers have been estimating the production cost and studying the economic viability of milk production. However, few have studied the effect of economies of scale on cost-effectiveness to show which items had greater influence, and to identify the break-even point of milk production systems. This study considers the relevance of dairy activity, and the "Balde Cheio" program for the country as well as the State of Rio de Janeiro – where the research was performed – as well as the lack of scientific studies on milk production systems covered by the program.

Material and Methods

The data analyzed in this research was gathered from 20 milk production systems – called demonstration units (DUs) – belonging to the "Balde Cheio" program, located in the state of Rio de Janeiro, Brazil, in 2011. Each DU has 20 ha of land on average, with an average herd of 46 animals, and productivity of 207.9 liters per day. Regarding the labor force, 12 DUs were run exclusively by family, three DUs hired workers, and five were a combination of both. The judgmental sampling was based on data request, annotated by the farmers in the field notes throughout the year, and collected monthly by the technician responsible for the DU. Of the data submitted by technicians, 20 were complete, and were used for the research. The municipality of Natividade presented two DUs; Valença, Carmo and Campos dos Goitacazes presented three each; and the other municipalities (Quatis, Barra Mansa, Barra do Piraí, Paraíba do Sul, Conceição de Macabú, Santa Maria Magdalena, Aperibé, Itaperuna, and Varre-Sai) presented one DU each.

The calculation of production cost considered the total cost of production, which includes fixed and variable cost, and operating cost, according to Matsunaga et al. (1976). As proposed by Lopes et al. (2004b), in the realization of the full inventory of assets, the value and useful life relating to the

acquisition time of each asset was calculated, and later grouped into pre-established categories: Improvements, machinery, vehicles, equipment, implements, tools, herd, and furniture. In cases where the farmer did not have information regarding the value and date of an acquisition, the criterion proposed by Lopes et al. (2004b) was adopted for the estimation of the updated values and the remaining useful life. Regarding the improvements, each one was measured by being assigned a state of conservation, and recorded a summary of the descriptive report aiming to assist in the estimation of the updated value. Depending on the area, the state of conservation and the finishing standard, a value per m^2 of construction, was estimated. The updated value was the product of the value in m^2 and the improvement area.

The items influencing the effective operating cost of milk production were divided into groups: Labor force, food, health, breeding, milking, taxes, energy, and miscellaneous expenses (LOPES et al., 2004a, 2006).

Gross margin (revenue minus effective operating cost), net margin (revenue minus total operating cost) (MATSUNAGA et al., 1976) and result (revenue minus total cost) (BARROS, 1948), were used as cost-effectiveness indices.

It was estimated that Profitability 1 is calculated as the result divided by total revenue, multiplied by 100 – i.e. Profitability 1 (%) = Result / Total revenue) x 100 – and cost-effectiveness 1 is obtained by dividing the result by the total fixed assets plus the effective operating cost, multiplied by 100 – i.e. Cost-effectiveness 1 (%) = Result / (Total fixed assets + Effective operating cost) x 100 – (SEBRAE, 1998).

Profitability 2 was calculated by the division of the net margin by the total revenue, multiplied by 100 – i.e. (Profitability 2 (%) = Net Margin / Total Revenue) x 100 – and cost-effectiveness 2 was calculated by the division of the net margin by the fixed assets plus the effective operating cost, multiplied by 100 – i.e. (cost-effectiveness 2 (%) = Net margin / (Total fixed assets + Effective operating cost) x 100 – (LOPES et al., 2011).

The total break-even point was calculated by dividing the fixed cost (return on land, return on capital, employer's return, fixed taxes, and depreciation) by the margin of contribution (milk selling price - unit variable cost) – i.e., (Break-even point (Q) = fixed cost / margin of contribution) – according to Lopes and Carvalho (2000).

For the calculation of the operating break-even point, depreciation is divided by the margin of contribution – Depreciation / unit margin of contribution.

For the calculation of the return on capital, the rate of 6.00% per year was applied. For the return on land, the rent value of the region was estimated in 2 kg of milk ha^{-1} day^{-1} (LOPES; CARVALHO, 2000).

To determine the influence of the scale of production on cost-effectiveness of the dairy activity, the 20 DUs were allocated to one of three production strata: Small, medium or large. The daily milk yields of these groups respectively were lower than 151 kg, from 151 to 400 kg, and higher than 400 kg, as proposed by Lopes et al. (2006). Nine DUs were classified as small, nine as medium, and two as large.

For the statistical analysis, productive and economic indices were initially entered and stored in an MS Excel® database, and subsequently exported to PASW 18.0 statistical software. The normality test of Shapiro-Wilk and homogeneity of variance of Levene's test were performed to evaluate the distribution of continuous variables, as some of these variables did not show normal distribution and/or homoscedasticity. These variables were expressed through the median and interquartile range, whereas those presented were described by average ± standard deviation. The comparisons of the economic variables among the categories of independent variables (strata), were performed

by ANOVA, complemented by the Bonferroni correction test for multiple comparisons. Where the data did not show normal distribution and/or homogeneity of variance, the comparisons among the groups were performed by the Kruskal-Wallis test, complemented by the least significant difference (LSD) test for multiple comparison among the average ranks of the variables (MAROCO, 2010). The difference was statistically significant when $P<0.05$.

Results and Discussion

The resources available in the 20 DUs belonging to the "Balde Cheio" program grouped according to the scale of production, and ranging from January to December 2011, are presented in Table 1.

In the cost-effectiveness analysis of the dairy activity, due to the high values of the standard deviations and interquartile differences, the DUs used in this study differed among themselves (Table 2). Total revenue corresponded to the sum of the values obtained from the sale of milk, animals, manure, and other incomes.

The representativeness of the sales of animals (Table 3) in the total revenue was higher than that mentioned by Lopes et al. (2008). The values were 7.55% and 3.14% for the small and large producer strata respectively, and lower than 16.26% for the medium producer stratum, therefore lower than the 20.00% found by FAERJ (2010).

With reference to the sale of manure, none of the DUs marketed this coproduct, justifying the null values in the contribution to total revenue. This was due to the technical orientation of the cowmen to have manure storage tanks to take advantage of most of the manure, or to use them directly in the crops. This practice is in contrast with the observations made by Lopes et al. (2008), which found great waste of this coproduct due to improper storage conditions.

The total ownership cost (TOC) values (EOC + depreciation + family labor force) (Table 2) were diverse ($P<0.05$) among the different strata. The effective operating cost (EOC) (Table 2), which represented the average disbursement made by the producers to afford the activity, also differed among the strata ($P<0.05$). According to Lopes and Lopes (1999), the items that compose it were divided into groups, which allows the monitoring of the expenses of the milk production system, assisting the technician and the farmer with a more detailed analysis.

The representativeness of feeding in the EOC (Table 4), has a greater impact, and was similar ($P>0.05$) across the strata.

It is evident that the labor force group of the small stratum differed ($P<0.05$) from the other two groups (Table 4), showing a lower representativeness in the EOC. This is due to the labor force of small farmers being mostly family, and the DUs in this group's only disbursement being the hiring of temporary labor force. The representativeness in the small stratum was lower than the $12.56 \pm 15.40\%$ found by Lopes et al. (2006), and the 6.00% found in the FAERJ study (2010). In the medium stratum, it was higher than the $13.14 \pm 6.31\%$ found by Lopes et al. (2006), and higher than the 11.00% found in the FAERJ study (2010). However, regarding the large strata, it was higher than the $16.72 \pm 0.61\%$ found by Lopes et al. (2006), and the 9.00% of the FAERJ study (2010).

Table 1. Resources available in 20 demonstration units (DUs) belonging to the "Balde Cheio" program, in the state of Rio de Janeiro, Brazil, grouped according to the scale of production (from January to December 2011).

	Scale of production											
	Small				Medium				Large			
Specification	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**
Equity value of lands (R$)	53,357.82	68,483.87	25,000.00 [a]	78,700.00	111,644.44	81,198.65	74,000.00 [ab]	110,000.00	389,500.00	241,123.41	389,500.00 [bc]	170,500.00
Equity value without land (R$)	114,377.60 [a]	69,378.95	83,962.00	72,280.00	239,455.22 [b]	124,168.41	155,870.00	231,525.00	666,516.50 [bc]	422,434.78	666,516.50	298,706.50
Value in improvements (R$)	25,933.33 [a]	3,576.66	26,000.00	3,200.00	33,128.89 [a]	10,456.22	31,500.00	6,500.00	79,754.00 [bc]	49,149.58	79,754.00	34,754.00
Value in equipment (R$)	997.78	821.27	840.00 [a]	705.00	1,860.00	1,382.64	1,060.00 [a]	1,695.00	2,641.00	1,684.33	2,641.00 [a]	1,191.00
Value in tools (R$)	98.11	16.08	90.00 [a]	17.00	111.89	39.92	90.00 [a]	47.00	93.50	4.95	93.50 [a]	3.50
Value in implements (R$)	444.44	387.66	500.00 [a]	800.00	777.78	731.06	600.00 [a]	0.00	5,250.00	4,596.19	5,250.00 [a]	3,250.00
Value in machinery (R$)	6,498.11	3,071.46	6,178.00 [a]	3,953.00	19,338.89	13,855.45	14,500.00 [a]	23,300.00	34,750.00	49,143.92	34,750.00 [a]	34,750.00
Value of herd (R$)	26,322.22	7,737.53	27,000.00 [a]	10,400.00	71,555.56	38,774.45	57,200.00 [b]	33,200.00	153,500.00	75,660.43	153,500.00 [bc]	53,500.00
Value in livestock (R$)	433.56	259.87	500.00 [a]	1.00	767.78	606.91	700.00 [a]	998.00	758.00	1,071.97	758.00 [a]	758.00
Value in furniture (R$)	292.22	66.67	270.00 [a]	0.00	270.00	0.00	270.00 [a]	0.00	270.00	0.00	270.00 [a]	0.00
Value in vehicles (R$)	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00	0.00	0.00
Total fixed assets (R$)	114,377.60	69,378.95	83,962.00 [a]	72,280.00	239,455.22	124,168.41	155,870.00 [b]	231,525.00	666,516.50	422,434.78	666,516.50 [bc]	298,706.50
Area (ha)	12.74	18.50	5.00 [a]	6.00	20.52	18.08	19.40 [ab]	17.60	50.00	28.28	50.00 [bc]	20.00
Equity value of lands/ha (R$)	10,970.11	12,348.91	7,000.00 [a]	6,501.00	6,555.56	3,176.52	5,000.00 [a]	5,000.00	7,650.00	494.97	7,650.00 [a]	350.00
Total fixed assets ha^{-1} (R$)	15,020.87	15,380.93	11,336.00 [a]	8,919.20	9,846.93	6,170.98	10,574.00 [a]	8,515.55	5,374.62	585.89	5,374.62 [a]	414.28
Fixed assets by lactating matrix (R$)	7,179.64	2,332.87	6,715.44 [a]	2,736.19	6,348.75	1,090.18	6,343.58 [a]	1,744.71	6,214.06	1,135.31	6,214.06 [a]	802.79
Fixed assets per kg of sold milk (R$)	1.76	0.20	1.75 [a]	0.30	1.49	0.29	1.41 [a]	0.20	1.47	0.78	1.47 [a]	0.55

SD = Standard deviation; IR = Interquartile range; Different letters on the same row indicate statistical difference ($P<0.05$)

Table 2. Summary of the cost-effectiveness analysis of the dairy activity of 20 DUs belonging to the "Balde Cheio" program, grouped according to the scale of production (period from January to December 2011).

	Scale of production											
	Small				Medium				Large			
Specification	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**
Total revenue (R$)	34,642.08	8,843.03	36,308.38 [a]	12,661.99	85,327.72	27,045.15	78,867.41 [b]	53,871.49	187,974.64	23,131.11	187,974.64 [c]	16,356.17
Milk (R$)	29,926.41 [a]	8,330.69	31,831.06	8,061.99	73,337.28 [b]	22,147.32	72,627.41	47,931.67	151,082.14 [c]	7,415.66	151,082.14	5,243.67
Animals (R$)	4,660.11 [a]	1,897.14	4,455.00	2,688.00	13,021.25 [a]	5,927.79	12,675.00	8,777.50	33,640.00 [c]	11,115.72	33,640.00	7,860.00
Manure (R$)	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00	0.00	0.00
Other incomes (R$)	500.00	0.00	500.00 [a]	0.00	3,744.00	0.00	3,744.00 [a]	0.00	6,505.00	0.00	6,505.00 [a]	0.00
Total operating cost (TOC) (R$)	29,726.40 [a]	4,992.07	30,684.66	3,923.51	67,150.57 [b]	20,111.35	60,778.07	21,761.00	138,347.53 [c]	42,609.84	138,347.53	30,129.71
Effective operating cost (EOC) (R$)	16,702.20 [a]	4,481.37	17,505.53	3,789.93	51,574.27 [b]	20,026.64	44,192.11	15,722.64	115,583.56 [c]	36,264.93	115,583.56	25,643.18
Depreciation (R$)	3,214.21	685.37	3,200.27 [a]	262.41	7,946.30	4,081.37	6,775.96 [b]	4,830.63	17,858.98	13,281.64	17,858.98 [bc]	9,391.54
Family labor force (R$)	9,810.00	0.00	9,810.00 [a]	0.00	7,630.00	4,325.80	9,810.00 [a]	0.00	4,905.00	6,936.72	4,905.00 [a]	4,905.00
Total cost (TC) (R$)	37,486.14 [a]	5,549.51	37,382.47	5,506.99	84,282.79 [b]	26,731.96	72,839.08	25,773.25	176,281.95 [c]	63,610.05	176,281.95	44,979.10
Fixed costs (FC) (R$)	10,472.87 [a]	3,944.70	8,763.02	2,548.32	23,531.29 [b]	10,983.85	17,951.84	10,863.94	52,325.88 [b]	33,193.90	52,325.88	23,471.63
Return on land (R$)	3,096.41	4,032.46	1,369.85 [a]	2,482.47	6,369.12	5,539.59	5,664.80 [ab]	5,030.31	14,378.41	7,945.63	14,378.41 [bc]	5,618.41
Return on invested capital (R$)	4,162.25	419.87	4,343.40 [a]	573.00	9,215.87	3,876.75	8,129.77 [b]	5,049.55	20,088.50	11,966.63	20,088.50 [c]	8,461.69
Depreciation (R$)	3,214.21	685.37	3,200.27 [a]	262.41	7,946.30	4,081.37	6,775.96 [b]	4,830.63	17,858.98	13,281.64	17,858.98 [b]	9,391.54
Variable costs (VC) (R$)	27,013.26 [a]	4,615.81	27,840.70	3,903.63	60,751.50 [b]	16,815.73	55,327.87	16,194.32	123,956.06 [bc]	30,416.16	123,956.06	21,507.47
Effective operating cost (R$)	16,702.20 [a]	4,481.37	17,505.53	3,789.93	51,574.27 [b]	20,026.64	44,192.11	15,722.64	115,583.56 [c]	36,264.93	115,583.56	25,643.18
Return on working capital (R$)	501.07	134.44	525.17 [a]	113.70	1,547.23	600.80	1,325.76 [b]	471.68	3,467.51	1,087.95	3,467.51 [c]	769.30
Family labor force (R$)	9,810.00	0.00	9,810.00 [a]	0.00	7,630.00	4,325.80	9,810.00 [a]	0.00	4,905.00	6,936.72	4,905.00 [a]	4,905.00
Working capital (R$)	8,706.61	2,394.13	8,759.43 [a]	2,588.20	27,036.37	10,174.72	23,902.05 [b]	8,306.59	61,055.83	19,597.27	61,055.83 c	13,857.37

continue

continuation

	Scale of production											
	Small				Medium				Large			
Specification	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**
Gross margin* (R$)	17,939.88[a]	5,517.67	18,802.85	9,839.31	33,753.45[b]	12,855.16	31,124.74	8,141.58	72,391.08[c]	13,133.82	72,391.08	9,287.01
Net margin* (R$)	4,915.68[a]	5,318.33	5,623.72	9,251.89	18,177.16[b]	12,324.72	13,952.74	8,554.41	49,627.10[c]	19,478.73	49,627.10	13,773.55
Result (profit or loss) * (R$)	-2,844.06[a]	7,525.25	-3,453.18	10,459.93	1,044.94[a]	10,017.07	-1,233.58	6,626.99	11,692.69[a]	40,478.94	11,692.69	28,622.93
Profitability 1 (%)	-13.19[a]	27.07	-11.00	39.27	0.45[a]	10.24	-1.56	10.83	7.60[a]	22.47	7.60	15.89
Cost-effectiveness 1 (%)	-1.94[a]	6.42	-2.13	13.27	0.15[a]	3.22	-0.48	3.78	3.64[a]	7.31	3.64	5.17
Profitability 2 (%)	11.79[a]	12.93	14.38	21.13	20.21[a]	9.28	20.90	15.09	27.24[a]	13.72	27.24	9.70
Cost-effectiveness 2 (%)	4.50	5.51	2.04[a]	10.45	6.18	2.52	6.04[a]	4.07	8.55	7.50	8.55[a]	5.31
Amount of total produced milk (kg)	36,123.26[a]	6,108.54	35,578.30	4,518.50	89,054.29[b]	26,917.41	88,038.50	45,102.00	195,498.00[c]	46,131.65	195,498.00	32,620.00
Amount of sold milk (kg)	35,190.20[a]	5,628.86	35,107.00	3,849.20	84,691.56[b]	25,287.85	84,253.50	46,030.00	180,793.00[c]	26,792.28	180,793.00	18,945.00
Average price of milk (R$)	0.84[a]	0.18	0.86	0.13	0.87[a]	0.06	0.86	0.08	0.84[a]	0.08	0.84	0.06
Break-even point day^{-1} (kg of milk)	396.40	506.28	221.70[a]	145.15	960.76	1,390.73	624.29[ab]	403.42	10,513.10	14,493.81	10,513.10[c]	10,248.67
Operating break-even point day^{-1} (kg of milk)	111.92	110.33	69.22[a]	58.64	374.25	583.00	166.81[ab]	162.55	3,758.07	5,205.48	3,758.07[c]	3,680.83
Initial number of animals (un)	20.22	15.94	15.00[a]	11.00	52.78	33.21	42.00[b]	44.00	133.00	72.12	133.00[bc]	51.00
Final number of animals (un)	21.00	15.64	17.00[a]	7.00	49.56	32.49	39.00[b]	29.00	117.00	70.71	117.00[bc]	50.00
Initial value of biological assets (R$)	27,955.56	12,458.47	26,100.00[a]	16,500.00	85,311.11	50,198.12	63,800.00[b]	40,900.00	268,900.00	183,989.18	268,900.00[bc]	130,100.00
Final value of biological assets (R$)	30,088.89	10,209.58	29,800.00[a]	9,700.00	86,655.56	52,165.87	67,000.00[b]	41,900.00	264,700.00	179,746.54	264,700.00[bc]	127,100.00
Equity variation of the herd (R$)	2,133.33	6,663.10	100.00[a]	4,200.00	1,344.44	8,744.59	3,200.00[a]	4,500.00	-4,200.00	4,242.64	-4,200.00[a]	3,000.00

SD = Standard deviation; IR = Interquartile range; Different letters on the same row indicate statistical difference (P<0.05); * Indices calculated using total revenue; ** Indices calculated using the revenue from milk; Profitability 1: result / total revenue; Profitability 2: net margin / total revenue; Cost-effectiveness 1: result / (effective operating cost + total fixed assets); Cost-effectiveness 2: net margin / (effective operating cost + total fixed assets); Variation of biological assets = final value - initial value; • = Not possible to estimate since it was included in miscellaneous expenses; ■ = Not possible to estimate since there were not producers working in another activity.

Table 3. Representativeness of each item of revenue in 20 DUs belonging to the "Balde Cheio" program, grouped according to the scale of production, in % (period from January to December 2011).

	Scale of production											
	Small				Medium				Large			
Item	Medium	SD	Median	IR	Medium	SD	Median	IR	Medium	SD	Median	IR
Sale of milk	85.99 [a]	4.93	86.01	7.44	86.25 [a]	7.34	83.23	10.79	80.74 [a]	5.99	80.74	4.24
Sale of animals	13.86 [a]	5.19	13.99	7.44	13.40 [a]	7.15	15.58	9.42	17.67 [a]	3.74	17.67	2.64
Sale of manure	0.0 [a]	0.0	0.0	0.0	0.0 [a]	0.0	0.0	0.0	0.0 [a]	0.0	0.0	0.0
Other incomes	0.15	0.46	0.00 [a]	0.00	0.35	1.04	0.00 [a]	0.00	1.59	2.25	1.59 [a]	1.59

SD = Standard deviation; IR = Interquartile range; Different letters on the same row indicate statistical difference (P<0.05)

Besides the EOC, another item of TOC is depreciation, of which the values were different (P<0.05) between the small producer stratum and the other two strata (Table 2). According to Lopes et al. (2008), whilst not being a disbursement, the depreciation value represents a necessary cash reserve to restore assets (facilities, equipment, etc.) at the end of their useful life. Hereby, at the end of the asset's useful life – by keeping the current constant conditions – the cowman would have monetary resources for the acquisition of a new substitute asset, without decapitalization in the medium term. According to Lopes et al. (2006), the increase of productive efficiency, optimizing the use of assets for production and economies of scale, are two alternatives to reduce the total operating cost (TOC).

The total cost (TC) was the sum of the fixed costs (the return on land, return on capital, employer's return, fixed taxes, and depreciation) and variable costs (effective operating costs, return on working capital, and family labor force) (Table 2). There was a significant difference (P <0.05) among the strata. According to Lopes et al. (2006), fixed costs do not represent disbursement (apart from taxes), but demonstrate what the activity should remunerate to be competitive compared to other economic activities. Lopes et al. (2008) demonstrated that whether the fixed costs were included or not, the cowman may lose the assets and become indebted in the long term. The items that compose the TC were also divided into groups, and the representativeness of each one (Table 5) was estimated, attempting a more detailed analysis.

The representativeness of fixed costs in the total cost (Table 5) was similar among the strata. According to Lopes et al. (2006), regardless of the amount of produced milk, excluding acquisition or sale of assets or increase of taxes, the fixed costs will remain constant. To reduce their representativeness in the total cost, both production and productivity must be increased, achieving economies of scale.

The variable costs (Table 2) are similar to the effective operating costs plus the return on working capital and family labor force. There was a difference (P<0.05) among the strata.

Regarding the return on working capital (Table 2) (return on savings account, which in the present study was 6.00% per year, about half of the EOC value in the dairy activity), it is a questionable concept to apply to the dairy farmer, since the vast majority of cowmen have credit lines until the payment of milk, reducing the need for working capital. Its inclusion will increase variable costs, negatively reflecting profitability, and cost-effectiveness. This implies an unrealistic analysis of the results.

Regarding the representativeness of variable costs in the TC (Table 5), there was no difference (P >0.05) among the strata. The values were higher than 57.10% and 64.10% for the small and medium producer strata respectively, and lower than 87.10% for the large producer stratum (LOPES et al., 2006).

Table 4. Representativeness of each item in effective operating cost (EOC) of 20 DUs belonging to the "Balde Cheio" program, grouped according to the scale of production, in % (period from January to December 2011).

	Scale of production											
	Small				Medium				Large			
Item	Medium	SD	Median	IR	Medium	SD	Median	IR	Medium	SD	Median	IR
Feed	69.61 [a]	6.80	70.54	11.18	59.76 [a]	12.68	63.63	19.16	50.69 [a]	13.74	50.69	9.72
Concentrate	48.94 [a]	10.89	50.95	15.21	44.45 [a]	10.06	44.40	12.39	42.02 [a]	19.14	42.02	13.53
Protein concentrate	16.04 [a]	9.22	12.62	10.31	20.76 [a]	14.02	16.51	9.81	9.06 [a]	4.31	9.06	3.05
Energy concentrate	32.12 [a]	11.65	32.53	12.36	21.71 [a]	8.99	22.35	7.10	31.14 [a]	12.26	31.14	8.67
Commercial concentrate	0.79	1.06	0.71 [a]	0.90	1.97	3.28	0.00 [a]	2.65	1.82	2.57	1.82 [a]	1.82
Mineral salt	5.17	3.18	4.77 [a]	4.76	3.40	1.33	3.59 [a]	1.59	3.02	1.45	3.02 [a]	1.02
Dietary fiber	15.50 [a]	6.10	15.44	7.40	11.91 [a]	7.06	12.90	9.12	5.66 [a]	3.95	5.66	2.79
Fertilization	14.94 [a]	6.34	15.23	6.75	10.36 [a]	7.25	12.17	8.32	5.18 [a]	3.85	5.18	2.72
Pesticide	0.44	0.38	0.25 [a]	0.58	1.15	1.54	0.73 [a]	1.44	0.39	0.23	0.39 [a]	0.16
Bought dietary fiber	0.12 [a]	0.36	0.00	0.00	0.39 [a]	0.97	0.00	0.00	0.09 [a]	0.13	0.09	0.09
Labor force	2.71	5.63	0.74 [a]	1.71	16.26	12.19	14.64 [b]	16.71	26.91	6.81	26.91 [bc]	4.82
Sanity	4.89 [a]	2.79	4.52	5.56	5.19 [a]	1.75	5.14	2.03	5.36 [a]	0.54	5.36	0.38
Preventive medication	2.06	1.71	2.01 [a]	2.17	1.79	0.88	2.14 [b]	1.27	1.47	0.01	1.47 [bc]	0.01
Curative medicine	2.68	1.66	2.17 [a]	0.85	3.17	1.89	2.62 [b]	1.03	3.76	0.38	3.76 [c]	0.27
Health examination	0.14	0.23	0.00 [a]	0.24	0.23	0.33	0.00 [a]	0.38	0.12	0.17	0.12 [a]	0.12
Milking	1.19 [a]	0.94	0.90	1.25	1.06 [a]	0.62	0.94	0.16	1.13 [a]	0.42	1.13	0.30
Breeding	0.81	1.99	0.00 [a]	0.00	1.07	1.09	0.90 [a]	1.95	0.54	0.04	0.54 [a]	0.03
Energy	8.18 [a]	3.66	7.87	2.57	4.26 [ab]	1.85	3.96	1.87	6.61 [c]	2.92	6.61	2.06
Maintenance of machinery, facilities	0.89	1.64	0.12 [a]	1.34	1.07	1.62	0.61 [a]	0.91	3.61	3.60	3.61 [a]	2.55
Rent of land	3.04	5.26	0.00 [a]	3.34	2.58	5.14	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00
Miscellaneous expenses	7.48	8.10	8.72 [a]	8.67	8.15	5.14	6.20 [a]	5.58	4.73	0.40	4.73 [a]	0.28

SD =Standard deviation; IR = Interquartile range; Different letters on the same row indicate statistical difference (P<0.05).

Regarding the economic efficiency indices of gross margin (gross revenue minus effective operating cost) and net margin (gross revenue minus total operating cost) (Table 2), there was a difference ($P<0.05$) among the strata. These results were satisfactory (positive), indicating that dairy activity in the three production strata has certain conditions to "survive" in the medium term. Due to the positive values of net margin (Table 2), it can be stated that the revenue allowed all expenses being paid, the depreciation reserve being made, and the family labor force being remunerated.

When analyzing the economic efficiency index (gross revenue minus total cost) to evidence the "survival" in the long term, there was no significant difference ($P>0.05$) among the strata (Table 2). This can be explained by the share of fixed costs that was not influenced by the scale of production, since the value of the large producer stratum was significantly lower ($P<0.05$) than the medium producer stratum, and the latter lower again than the small producers. This showed an unsatisfactory result, indicating that the dairy activity was not able to remunerate the invested capital. In the medium and large-scale strata, the results were satisfactory, indicating that the employer was able to capitalize, besides covering all expenses. By subtracting the average total cost from the average revenue of each stratum (Table 2), it was observed in the medium and large-scale strata that all variable costs could be paid, the reserve referring to the depreciation could be performed, and the invested capital in assets and land was fully remunerated. This fact indicates that, on average, the DUs in question have been capitalized. However, for the small-scale stratum, it was observed that all variable costs could be paid, the reserve referring the depreciation could be performed, but the capital invested in assets and land could not be fully remunerated. Therefore, on average, the DUs in this study have been capitalized with lower yield than the savings account.

When considering the indices of gross margin, net margin, and result, using only the milk revenue, it is observed that the dairy activity has conditions to "survive" in the medium term (Table 2), with possible capitalization lower than the savings account. This is due to the net margin being positive considering only the milk revenue, and the results negative in all the strata. Revenues from the sale of animals and other incomes in the medium and large-scale strata were fundamental to achieve profit, whereas they were not sufficient for the small-scale stratum, thus presenting a loss (negative result). The values of profitability 1 (Result / total revenue) (Table 2) among the strata were similar ($P<0.05$). In the small-scale stratum, the value was negative, which means that for each R$ 100.00 of revenue, there was a loss of R$ 13.19. However, in the medium and large strata, there was a gain of R$ 0.45 and R$ 7.60 per R$ 100 respectively. When comparing the results of these strata with those from the study of Lopes et al. (2006), which showed values for profitability 1 of -34.40%, -31.26%, and -1.20% for the small, medium and large producer strata respectively, it can be stated that the DUs belonging to the "Balde Cheio" program in Rio de Janeiro were more profitable.

When analyzing profitability 2 (net margin / total revenue) (Table 2), there was a similarity ($P>0.05$) between strata, and gains of R$ 11.79, R$ 20.21, and R$ 27.24 for each R$ 100.00 of revenue for the small, medium, and large-scale strata respectively. The values were higher, since this index does not include the return on land, return on capital, employers' return, fixed taxes, and return on working capital.

When the cost-effectiveness 1 (result / effective operating cost + total fixed assets) was analyzed, a similarity was observed among the strata ($P>0.05$). Here, the small producers obtained an income of 1.94% lower than the savings account (6.00% per year), and the medium and large strata obtained 0.15% and 3.64% higher than the savings account respectively. By analyzing the cost-effectiveness 2 (net margin / effective operating cost + total fixed assets), there was similarity among the strata

Table 5. Representativeness of each item in total cost of 20 DUs belonging to the "Balde Cheio" program, grouped according to the scale of production, in % (period from January to December 2011).

	Scale of production											
	Small				Medium				Large			
Item	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**	**Medium**	**SD**	**Median**	**IR**
Fixed costs (FC)	27.70	8.30	25.49 [a]	6.37	27.05	5.80	26.45 [a]	8.30	28.12	8.68	28.12 [a]	6.14
Return on land	7.90	9.69	4.00 [a]	8.13	7.26	5.33	4.65 [a]	7.14	7.85	1.67	7.85 [a]	1.18
Return on capital	11.20 [a]	0.93	11.40	1.01	10.72 [a]	1.33	10.15	2.19	10.88 [a]	2.86	10.88	2.02
Employer's return	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00	0.00	0.00
Depreciation	8.60 [a]	1.60	8.72	2.31	9.06 [a]	1.85	8.79	0.82	9.38 [a]	4.15	9.38	2.93
Variable costs (VC)	71.87	8.27	72.09 [a]	6.49	72.95	5.80	73.55 [a]	8.30	71.88	8.68	71.88 [a]	6.14
Effective operating cost	43.83 [a]	8.30	45.33	6.27	60.33 [b]	5.49	60.67	5.34	66.16 [bc]	3.30	66.16	2.34
Food	30.9 [a]	7.10	31.98	6.13	36.16 [a]	8.56	36.51	9.35	33.76 [a]	10.77	33.76	7.61
Concentrate	22.18 [a]	7.81	24.12	8.95	26.87 [a]	6.59	27.49	7.12	28.11 [a]	14.05	28.11	9.94
Protein concentrate	6.93 [a]	3.79	6.32	4.50	12.59 [a]	8.21	10.50	7.69	6.07 [a]	3.15	6.07	2.23
Energy concentrate	14.90 [a]	6.27	15.79	6.55	13.23 [a]	5.70	14.54	4.74	20.80 [a]	9.14	20.80	6.46
Commercial concentrate	0.35	0.49	0.32 [a]	0.44	1.06	1.64	0.00 [a]	1.69	1.24	1.76	1.24 [a]	1.24
Mineral salt	2.14	1.09	2.04	1.99	2.07	0.87	2.12 [a]	1.30	1.97	0.86	1.97 [a]	0.61
Dietary fiber	6.62 [a]	2.50	5.95	3.04	7.22 [a]	4.59	7.53	6.16	3.68 [a]	2.43	3.68	1.72
Fertilization	6.38 [a]	2.63	5.66	3.21	6.33 [a]	4.70	7.10	5.77	3.36 [a]	2.37	3.36	1.68
Pesticides	0.18	0.16	0.13 [a]	0.17	0.69	0.93	0.43 [a]	0.92	0.25	0.14	0.25 [a]	0.10
Bought dietary fiber	0.06	0.18	0.00 a	0.00	0.20	0.47	0.00 a	0.00	0.06	0.09	0.06 a	0.06
Labor force	1.15	2.51	0.26 a	0.78	9.77	7.53	8.96 b	6.40	17.69	3.62	17.69 bc	2.56
Sanity	2.28 a	1.33	2.40	1.79	3.52 a	1.36	3.63	2.57	3.82 a	0.09	3.82	0.06
Milking	0.57 [a]	0.50	0.44	0.66	0.64 a	0.38	0.58	0.03	0.74 a	0.24	0.74	0.17
Breeding	0.42	1.04	0.00 [a]	0.00	0.68	0.71	0.51 [a]	1.32	0.36	0.04	0.36 [a]	0.03
Energy	3.67 [a]	1.89	3.57	2.37	2.56 [a]	1.10	1.93	1.57	4.32 [a]	1.71	4.32	1.21
Maintenance of machinery, facilities	0.31	0.47	0.06 [a]	0.63	0.65	0.95	0.39 [a]	0.59	2.33	2.27	2.33 [ac]	1.60
Rent of land	1.24	2.36	0.00 [a]	0.89	1.44	2.87	0.00 [a]	0.00	0.00	0.00	0.00 [a]	0.00
Miscellaneous expenses	3.25	4.00	2.72 [a]	3.49	4.91	3.08	3.93 [a]	3.54	3.14	0.42	3.14 [a]	0.30
Return on working capital	0.06	0.18	0.00 [a]	0.00	0.20	0.47	0.00 [b]	0.00	0.06	0.09	0.06 [bc]	0.06
Family labor force	1.15	2.51	0.26 [a]	0.78	9.77	7.53	8.96 [b]	6.40	17.69	3.62	17.69 [bc]	2.56

SD =Standard deviation; IR = Interquartile range; Different letters on the same row indicate statistical difference (P<0.05).

(P>0.05). They showed values of 4.50%, 6.18%, and 8.55% for the small, medium, and large-scale strata respectively, the last two being higher than the savings account.

To perform a realistic analysis of the results, it is necessary to verify whether the variation of biological assets was positive, calculating the difference in Reals (R$) of the value of biological assets at the beginning and at the end of the study period. The variation of biological assets – an index that measures the valuation or the devaluation of the herd – was similar (P>0.05) among the strata (Table 2). This variation, when positive, indicates that the herd is growing, the herd has not yet stabilized, or that the price of animals has increased. In this study, this variation was not proportional to the herd size. This means that the large-scale stratum, which presented the highest number of lactating matrices, obtained the lowest asset variation. This is because the herd was closer to stabilization than in other strata, and because there was a greater exchange of animals of lower genetic potential with animals of better potential, besides part of the resources from the sale of animals being applied to investments in food production. It was observed that the small-scale stratum showed a loss of -R$ 2,844.06. There was, however, an increase in biological assets of R$ 2,133.33. It can be considered that the loss, without analyzing other asset increases, was -R$ 710.73 (-R$ 2,844.06 + R$ 2,133.33). The total amount of produced milk (Table 2) for the medium and large-scale strata was lower than in the study by Lopes et al. (2008), which showed average daily amounts of 85.25, 292.40, and 1,027.95 kg of milk for the small, medium and large strata respectively.

To guide technicians and farmers with regard to the amount of milk produced necessary to cover the total and effective operating costs of the activity, the calculation of the total and operating break-even point was performed (Table 2). The values of the present study, as proposed by Lopes et al. (2008), show that several managerial and even technological efforts should be made to increase daily averages, without increasing the average variable cost that, once increased, will increase the total- and operating break-even point even more. According to these researchers, an alternative is to increase productive efficiency, in other words productivity per matrix, thus optimizing the expenses of labor force, medicines, artificial insemination, fixed taxes, energy, and miscellaneous expenses. Such expenses will not be increased by increasing productivity per matrix.

The total and operating break-even point differed (P<0.05) among the strata (Table 2). The value of fixed assets in machinery and equipment, which is incompatible with the scale of production, caused the strata to show a total and operating break-even point higher than the daily milk production. However, it was observed that the result was positive for the medium and large-scale strata (Table 2). When analyzing the result considering only the sale of milk, negative values were observed, illustrating the importance of the sale of animals in the revenue composition. The values, as highlighted in the study by Lopes et al. (2008), show that several managerial and even technological efforts should be made to increase daily averages, without increasing the average variable cost that, when increased, will increase the total and operating break-even point even more. According to the researchers, an alternative is to increase productive efficiency – or the productivity per matrix – thus optimizing the expenses of labor force, medicines, artificial insemination, fixed taxes, energy, and other miscellaneous expenses. Such expenses will not be increased by increasing productivity per matrix.

Conclusions

This study showed that the scale of production influenced the total cost of milk production, profitability, and cost-effectiveness. The large-scale stratum showed the lowest total unit cost. Due to the positive results in the medium and large scales, milk production had conditions to produce in the long-

term, with the consequent capitalization of cowmen.

The items regarding the effective operating cost with the greatest representativeness on the costs of dairy activity in the small-scale stratum, in descending order, were food, energy, and miscellaneous expenses. In the medium scale stratum, these were food, labor force, and miscellaneous expenses, whereas in the large-scale stratum, they were food, labor force, and energy.

In the small and large scale, the items regarding the total cost with the greatest representativeness on the costs of dairy activity, in descending order, were food, labor force, and return on capital. In the medium scale, they were food, return on capital, and labor force.

The average break-even point of 14 of the 20 DUs was higher than the average daily production.

References

BARROS, H. Economia agrária. Lisboa: Livraria Sá da Costa, 1948. 348 p.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA – EMBRAPA. Projeto balde cheio. São Carlos: EMBRAPA, 2011. Disponível em: <http://www.cppse.embrapa.br/sites/default/files/principal/publicacao/baldecheio0712.pdf>. Acesso em: 15 fev. 2017.

FEDERAÇÃO DA AGRICULTURA, PECUÁRIA E PESCA DO ESTADO DO RIO DE JANEIRO – FAERJ. Diagnóstico da cadeia produtiva do leite do Estado do Rio de Janeiro. Rio de Janeiro: FAERJ: SEBRAE-RJ, 2010. 180 p.

LOPES, M. A.; CARVALHO, F. M. *Custo de produção do leite***.** Lavras: FAEPE, 2000. 42 p. (Boletim Agropecuário, 32).

LOPES, M. A.; CARVALHO, F. M.; LIMA, A. L. R.; CARDOSO, M. G.; CARMO, E. A. Efeito da escala de produção nos resultados econômicos de sistemas de produção de leite na região de Lavras (MG), em 2004 e 2005. *Archivos Latino Americanos de Producción Animal*, Maracaibo, v. 16, n. 3, p. 121-129, 2008.

LOPES, M. A.; LIMA, A. L. R.; CARVALHO, F. M.; REIS, R. P.; SANTOS, I. C.; SARAIVA, F. H. Controle gerencial e estudo da rentabilidade de sistemas de produção de leite na região de Lavras (MG). *Ciência e Agrotecnologia*, Lavras, v. 28, n. 4, p. 883-892, 2004b.

_____. Efeito da escala de produção nos resultados econômicos de sistemas de produção de leite na região de Lavras (MG): um estudo multicasos. *Boletim de Indústria Animal*, Nova Odessa, v. 63, n. 3, p. 177-188, 2006.

_____. Efeito do tipo de sistema de criação nos resultados econômicos de sistemas de produção de leite na região de Lavras (MG). *Ciência e Agrotecnologia*, Lavras, v. 28, n. 5, p. 1177-1189, 2004a.

LOPES, M. A.; LOPES, D. C. F. Desenvolvimento de um sistema computacional para cálculo do custo de produção do leite. *Revista Brasileira de Agroinformática*, Londrina, v. 2, n. 1, p. 1-12, 1999.

LOPES, M. A.; SANTOS, G.; RESENDE, M. C.; CARVALHO, F. M.; CARDOSO, M. G. Estudo da rentabilidade de sistemas de produção de leite no município de Nazareno, MG. *Revista Ciência Animal Brasileira*, Goiânia, v. 12, n. 1, p. 58-69, 2011.

MAROCO, J. *Análise estatística com utilização do SPSS*. 3. ed. Lisboa: Sílabo, 2010. 822 p.

MATSUNAGA, M.; BEMELMANS, P. F.; TOLEDO, P. E. N.; DULEY, R. D.; OKAWA, H.; PEDROSO, I. A. Metodologia de custo de produção utilizada pelo IEA. *Agricultura em São Paulo*, São Paulo, v. 23, n. 1, p. 123-139, 1976.

SERVIÇO BRASILEIRO DE APOIO ÀS MICRO E PEQUENAS EMPRESAS – SEBRAE. Curso de capacitação rural. Goiânia: [s.n.], 1998. 34 p.