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The effect of technological levels on profits of milk production systems participating in the "full bucket" program: a multicase study

Efeito do nível tecnológico na rentabilidade de sistemas de produção de leite participantes do programa "Balde Cheio": um estudo multicasos

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Abstract

The present study examines the effect of technological levels on the profits of 20 demonstration units (DU) participating in the "Full Bucket" ("*Balde Cheio*") program in the state of Rio de Janeiro (RJ), from January to December of 2011, and identifies significant variables that affect total costs and real operating costs and their impact on revenues. Data were analyzed using PASW 18.0 software. A multiple linear regression model of stepwise regression is used to identify production cost components with greater influence on net margins, earnings and profits. Technological levels influenced earnings and profits. DUs of intermediate technological sophistication show positive economic results and are therefore considered economically viable, with the potential to remain in production for the short-, mid- and long-term, thus capitalizing dairy farmers. DUs of low and high technological sophistication show negative results, suggesting the decapitalization of milk producers, as revenues have not covered total costs. The most representative factors that affect real operating costs for DUs of intermediate and high technological sophistication are, in descending order, feed, labor, and other expenses. For DUs of low technological sophistication, the order is feed, other expenses and labor. The most representative components of total cost are found to be feed, labor, and returns on investment.
Key words: Dairy cattle farming, production cost, management, technology

Resumo

Objetivou-se analisar o efeito do nível tecnológico na rentabilidade de 20 unidades demonstrativas (UD) participantes do programa "Balde Cheio", no estado do RJ, no período de janeiro a dezembro de 2011. Pretendeu-se, ainda, identificar os componentes que exerceram maior influência sobre os custos total e operacional efetivo e o impacto de cada um deles na receita. Os dados foram analisados utilizando-se o software PASW 18.0. Utilizou-se o modelo de regressão linear múltipla com o método *stepwise,* para identificar os componentes do custo de produção que mais influenciaram na margem líquida,

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na lucratividade e na rentabilidade. O nível tecnológico influenciou na lucratividade e rentabilidade. Na análise econômica, por apresentar resultado positivo, o estrato com médio nível tecnológico teve viabilidade econômica e condições de produzir no curto, médio e longo prazos, com consequente capitalização dos pecuaristas; enquanto que os estratos com baixo e alto níveis tecnológicos apresentaram resultado negativo, indicando que os produtores estão se descapitalizando, pois as receitas auferidas não foram suficientes para pagar seus custos totais. Os itens componentes do custo operacional efetivo que exerceram maiores representatividades nos estratos médios e alto nível tecnológico, em ordem decrescente, foram a alimentação, mão de obra e despesas diversas; enquanto que no estrato baixo nível tecnológico foram a alimentação, despesas diversas e mão de obra. Com relação aos itens componentes do custo total, foram a alimentação, mão de obra e remuneração do capital investido.
Palavras-chave: Bovinocultura de leite, custo de produção, gerenciamento, tecnologia

Introduction

Milk production, when executed with a business vision, increases economic returns, maximizes the use of available resources for production, recovers areas that have been exhausted due to extractive exploitation, respects the environment, and recovers the producer's self-esteem, thus rendering the activity economically viable (MORAES, 2013).

Numerous dairy cattle production systems, management procedures, technologies, and exploitation methods exist. The "Full Bucket" ("*Balde Cheio*") program, developed by the Animal Production Research Center of the Southeast (*Centro de Pesquisa de Pecuária do Sudeste* - CPPSE) of the Brazilian Agriculture Research Company (*Empresa Brasileira de Pesquisa Agropecuária*- EMBRAPA) in São Carlos, state of São Paulo (SP), Brazil, was created to support inefficient milk producers by training rural workers and producers, promoting information exchange on regionally applied technologies, and monitoring environmental, economic and social effects on production systems that adopt the proposed technologies (BORGES et al., 2011).

Farm owners and/or technicians use cost knowledge to economically evaluate their activities and review production factors (land, labor and capital) in an efficient, thorough and cost-effective manner. Areas of inefficiency can then be identified to target management efforts and/or technological resources to maximize profits or minimize costs (LOPES et al., 2004a). However, production-environment interactions and social and economic considerations also concern dairy farmers (DARNHOFER et al., 2012). Efficiency is the main factor that determines milk production costs. Evaluating whether a milk producer is efficient involves comparing it with similar producers (GOMES; ALVES, 1999).

Technological sophistication is one factor that can influence production costs. Lopes et al. (2005) examined the influence of technological sophistication (low, intermediate and high) on milk production costs in 16 production systems in the region of Lavras, state of Minas Gerais (MG) and found superior cattle/human ratios in systems of high technological sophistication. This trend may be attributable to the intensified use of technology. Manzano et al. (2006) performed an economic evaluation of milk production in six family-run production systems. In observing several milk production system techniques, the authors found a 24.10% decrease in operating costs, a 15.80% decrease in total costs, and a 4% increase in profits and thus deemed the set of methods examined efficient.

Several researchers (OLIVEIRA et al., 2007; FASSIO et al., 2006; MANCIO et al., 1999; OLIVEIRA; PEREIRA, 2009; SCHIFFLER et al., 1999; HOFER; SHIKIDA, 2000; LOPES et al., 2005; MORAES et al., 2004, MARQUES et al., 2002) have attempted to estimate production costs in studying the economic viability of milk production. However, few have studied the effects of technological sophistication on profits or components with the greatest influence on milk production systems. Considering the importance of the “Full Bucket” program to Brazil and to the state of Rio de Janeiro, and given the scarcity of studies on assisted milk production systems, the present study examines the effect of technological sophistication on the profitability of milk production systems participating in the “Full Bucket” program. More specifically, we identify factors with the greatest influence on total and real operating costs and revenues.

Materials and Methods

The data analyzed were drawn from 20 milk production systems, referred to as demonstration units (DUs), that were participants in the “Full Bucket” program of the state of Rio de Janeiro, Brazil as of 2011. Two DUs were located in Natividade, three each in Valença, Carmo and Campos dos Goitacazes, and one each in Quatis, Barra Mansa, Barra do Piraí, Paraíba do Sul, Santa Maria Madalena, Aperibé, Conceição de Macabu, Itaperuna and Varre-Sai. DUs were selected via purposive non-probability sampling based on the following criteria: animal performance and financial data quality and availability; milk producer consent to study participation; and evidence source accessibility. Data were recorded by producers in logbooks throughout the year and collected on monthly visits by the technician responsible for the DU.

Gross margin (revenue minus real operating cost), net margin (revenue minus total operating cost) (MATSUNAGA et al., 1976) and net income (revenue minus total cost) were used as profitability indicators (BARROS, 1948).

The earnings 1 measure was calculated by dividing net income by total revenue, multiplied by 100 (Earnings 1 (%) = Net income / Total revenue) x100. The profit 1 measure was calculated by dividing net income by the sum of the total fixed capital and real operating cost, multiplied by 100 (Profit 1 (%) = Result/(Total fixed capital + Real operating cost) x100 (SEBRAE, 1998). The earnings 2 measure was calculated by dividing net margin by total revenue, multiplied by 100 (Earnings 2 (%) = Net margin / Total revenue) x100. The profit 2 measure was calculated by dividing net margin by total fixed capital plus the real operating cost, multiplied by 100 (Profit 2 (%) = Net margin/ (Total fixed capital + Real operating cost) x100 (LOPES et al., 2011).

A full inventory of assets was conducted to determine the value and useful life relative to the time of acquisition for each asset (depreciation). Assets were then grouped in pre-established categories: machinery, vehicles, equipment, implements, tools, livestock and furniture. If a milk producer could not provide information on values and acquisition dates, criteria proposed by Lopes et al. (2004b) were used to estimate updated values and remaining useful life results.

Real operating cost (ROC) component percentages relative to milk sales revenues were calculated by dividing ROC component expenses to be evaluated by the milk sale revenues (LOPES et al., 2011). A 6% annual rate was used to calculate return on investment, and the leasing value for the region, estimated as 2 kg milk/ha/day, was applied for land remuneration calculations (LOPES; CARVALHO, 2000).

To examine the influence of technological sophistication on milk production profits, the 20 studied production systems were allocated to one of the following technological scales: low, intermediate or high. The process was guided based on inventory data on production infrastructure and performed investment availability, following Lopes et al. (2005, 2009).

Two production systems were deemed systems of high technological sophistication, employing state-of-the-art equipment, such as pipeline mechanical milking systems, dedicating greater investment to machinery and agricultural implements, and operating high-end facilities. These dairy farms possessed animals specialized for milk production (7/8, 15/16 ratios of Holstein cows). Eight production systems were deemed operations of low technological sophistication, as they did not employ machines, including agricultural implements or milking machines, and had invested only marginally in facility upgrades. Herds included mixed breed animals or animals of undefined genetic groups. Ten production systems were included in the intermediate technology group.

For statistical analysis, production and economic indexes were added to MS Excel® databases and then exported to PASW 18.0 statistical software. Continuous variable distributions were evaluated by determining data normality using the Shapiro-Wilk test and homogeneity of variance using the Levene test. Some of the tested variables did not present normal distributions and/or homoscedasticity. These variables are described using the median and interquartile range. The remaining variables are described based on the average ± standard deviation. Comparisons of dependent variables (economic) for the various independent categories (technological levels) were performed through ANOVA testing with post-hoc Bonferroni correction to carry out multiple comparisons. When data did not follow a normal distribution and/or exhibit homogeneity of variance, groups were compared using the Kruskal-Wallis test followed by the LSD test to conduct multiple comparisons between ranked medians (MAROCO, 2010). Tests were performed at $p<0.05$.

Results and Discussion

A summary of milk production profits for the 20 DUs participating in the "Full Bucket" program in the state of Rio de Janeiro is presented in Table 1. The high standard deviations and interquartile ranges observed indicate differences between the studied DUs.

The total revenue for the studied period corresponds to the sum of milk, animal and manure sale revenues and other revenues (machinery sales, machinery rentals, etc.). The observed differences between the three technological level groups ($p<0.05$) were anticipated and are attributable primarily to varying quantities of milk and animals sold, although the representativeness of each item in terms of total revenues was found to be similar for the different groups ($p<0.05$) (Table 2). Animal sales, though farms of low and intermediate technological sophistication did not possess excess animals, were driven by a need to replace animals of low genetic potential with those of higher genetic potential. This resulted in higher investment in animals than in facilities, equipment, etc. The representativeness of animal sales with respect to total revenues (Table 2) was found to be higher than that reported by Lopes et al. (2005) (13.80%, 10.00% and 6.70% for farms of low, intermediate and high technological sophistication, respectively) and lower than the 20% value reported by the FAERJ (2010), which highlights the influence of the sale of male animals.

Regarding manure sales, none of the studied DUs sold this sub-product, and hence, the product does not contribute to total revenues. This is attributable to the fact that milk producers had built dunghills to maximize manure utility or to use manure directly on crops. This result differs from those of Lopes et al. (2008a), who observed high degrees of manure waste due to inadequate storage facilities. Reis et al. (2001) found that 0.84% of revenues originate from manure sales, and Lopes et al. (2009) reported values of 0.99%, 1.44% and 7.59% for systems of low, intermediate and high technological sophistication, respectively. These researchers noted that manure usage increases pasture and grassland soil fertility while decreasing chemical fertilizer expenses and thus decreasing overall expenses, although revenues decline at first.

Table 1. Summary of profit analysis results on milk production in 20 demonstration units participating in the "Full Bucket" program in the state of Rio de Janeiro, grouped based on technological sophistication (from January to December of 2011).

Continue ...

Specification	Technological level											
	Low				Medium				High			
	Average	SD	Median	IR	Average	SD	Median	IR	Average	SD	Median	IR
Total revenue (R$)	39.845,61[a]	16.731,80	37.519,72	18.283,86	80.855,28[b]	43.253,83	70.262,04	55.975,72	164.179,90[c]	56.781,95	164.179,90	40.150,90
Milk (R$)	35.148,23[a]	16.878,85	32.839,72	13.174,86	69.149,68[ab]	36.525,75	61.242,04	47.508,35	129.427,40[bc]	38.040,08	129.427,40	26.898,40
Animals (R$)	4.634,88[a]	3.270,34	3.859,50	4.335,00	11.331,20[ab]	7.440,97	9.020,00	11.068,25	31.500,00[c]	14.142,14	31.500,00	10.000,00
Manure (R$)	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 revenue (R$)	62,50	176,78	0,00[a]	0,00	374,40	1.183,96	0,00[a]	0,00	3.252,50	4.599,73	3.252,50[a]	3.252,50
Total operating cost (TOC) (R$)	34.527,07[a]	12.222,79	31.355,74	10.962,04	62.370,38[b]	25.578,98	60.520,21	34.602,62	145.304,50[c]	44.932,95	145.304,50	31.772,40
Real operating cost (ROC) (R$)	21.055,82[a]	11.083,74	17.745,26	9.944,24	47.296,39[b]	24.470,51	45.105,63	28.655,14	123.093,24[c]	37.806,37	123.093,24	26.733,14
Depreciation (R$)	3.661,25[a]	1.345,34	3.304,71	1.293,20	6.245,00[ab]	2.691,63	5.907,63	3.953,16	22.211,26[c]	7.126,58	22.211,26	5.039,26
Family labor (R$)	9.810,00	0,00	9.810,00[a]	0,00	8.829,00	3.102,19	9.810,00[ab]	0,00	0,00	0,00	0,00[c]	0,00
Total cost (TC) (R$)	44.971,71	16.470,37	39.060,67[a]	12.079,53	76.068,28	33.056,53	70.838,71[b]	41.021,61	185.606,84	63.314,11	185.606,84[bc]	44.769,83
Fixed cost (FC) (R$)	13.474,21	6.670,81	10.159,84[a]	10.155,69	18.651,22	10.353,38	15.187,26[ab]	12.419,35	58.820,80	24.373,55	58.820,80[bc]	17.234,70
Land remuneration (R$)	4.886,96	4.692,59	2.718,41[a]	6.695,76	4.847,79	5.605,87	2.619,97[a]	4.240,09	13.186,53	9.631,21	13.186,53[a]	6.810,29
Return on invested capital (R$)	4.926,00	1.685,38	4.451,95[a]	1.157,45	7.558,43	3.059,14	6.981,47[b]	5.777,91	23.423,02	7.615,76	23.423,02[bc]	5.385,15
Producer remuneration (R$)												
Fixed taxes (R$)												
Depreciation (R$)	3.661,25[a]	1.345,34	3.304,71	1.293,20	6.245,00[ab]	2.691,63	5.907,63	3.953,16	22.211,26[c]	7.126,58	22.211,26	5.039,26
Break even point/ day (kg milk)	208,8	61,39	222,70[a]	37,77	507,33	388,83	453,35[ab]	394,71	12.420,79	11.795,94	12.420,79[c]	8.340,99

... Continuation

Specification	Technological level											
	Low				Medium				High			
	Average	SD	Median	IR	Average	SD	Median	IR	Average	SD	Median	IR
Variable cost (VC) (R$)	31.497,50 ^{a}	11.416,25	28.087,62	10.242,57	57.417,06 ^{b}	24.106,07	55.632,69	29.514,79	126.786,04 ^{c}	38.940,56	126.786,04	27.535,13
Real operating cost (R$)	21.055,82 ^{a}	11.083,74	17.745,26	9.944,24	47.296,39 ^{b}	24.470,51	45.105,63	28.655,14	123.093,24 ^{c}	37.806,37	123.093,24	26.733,14
Remuneration of working capital (R$)	631,67 ^{a}	332,51	532,36	298,33	1.291,67 ^{b}	861,54	1.257,32	1.003,43	3.692,80 ^{c}	1.134,19	3.692,80	801,99
Family labor (R$)	9.810,00 ^{a}	0,00	9.810,00	0,00	8.829,00 ^{ab}	3.102,19	9.810,00	0,00	0,00 ^{c}	0,00	0,00	0,00
Working capital (R$)	10.527,91 ^{a}	5.541,87	8.872,63	4.972,12	23.648,19 ^{b}	12.235,25	22.552,82	14.327,57	61.546,62 ^{c}	18.903,18	61.546,62	13.366,57
Gross margin* (R$)	18.789,79 ^{a}	7.411,14	18.634,61	9.871,05	33.558,90 ^{a}	20.450,90	25.318,08	21.394,02	41.086,66 ^{a}	18.975,58	41.086,66	13.417,76
Net margin* (R$)	5.318,53 ^{a}	6.523,09	4.914,87	9.028,16	18.484,90 ^{a}	19.007,73	10.968,37	23.950,42	18.875,40 ^{a}	11.848,99	18.875,40	8.378,50
Net income (profit or loss)* (R$)	-5.126,10	7.270,73	-4.765,91 ^{a}	7.402,58	4.787,00	13.207,63	1.864,93 ^{b}	9.142,69	-21.426,94	6.532,16	-21.426,94 ^{bc}	4.618,93
Earnings 1 (%)	-17,95 ^{a}	27,52	-12,39	27,41	1,69 ^{a}	12,21	2,24	17,13	-13,15 ^{a}	0,57	-13,15	0,40
Profit 1 (%)	-3,86 ^{a}	5,80	-4,65	8,64	1,13 ^{a}	3,67	0,78	6,06	-2,82 ^{a}	0,68	-2,82	0,48
Earnings 2 (%)	10,35 ^{a}	13,35	11,06	21,81	18,54 ^{a}	11,18	18,07	17,64	10,90 ^{a}	3,45	10,90	2,44
Profit 2 (%)	3,83 ^{a}	4,71	4,17	6,74	6,09 ^{a}	4,06	6,77	6,31	2,25 ^{a}	0,27	2,25	0,19
Total quantity of milk produced (kg)	45.536,10	19.906,77	37.671,40 ^{a}	13.509,25	79.530,31	42.506,64	73.342,25 ^{b}	56.687,85	179.001,00	69.461,93	179.001,00 ^{bc}	49.117,00
Quantity of milk sold (kg)	42.731,98	15.817,21	36.745,75 ^{a}	11.893,43	78.154,50	42.221,17	71.187,25 ^{b}	57.824,25	158.560,50	58.233,78	158.560,50 ^{bc}	41.177,50
Quantity of milk produced/day (kg)	124,76 ^{a}	54,54	103,21	37,01	217,89 ^{ab}	116,46	200,94	155,31	490,41 ^{c}	190,31	490,41	134,57
Quantity of milk sold / day (kg)	117,07 ^{a}	43,33	100,67	32,58	214,12 ^{ab}	115,67	195,03	158,42	434,41 ^{c}	159,54	434,41	112,82
Average milk price (R$)	0,80 ^{a}	0,12	0,80	0,16	0,90 ^{a}	0,12	0,86	0,06	0,83 ^{a}	0,06	0,83	0,05
Total operating cost (R$) / kg	0,82 ^{a}	0,08	0,84	0,13	0,85 ^{a}	0,13	0,87	0,24	0,93 ^{a}	0,06	0,93	0,04
Real operating cost (R$) / kg	0,47 ^{a}	0,09	0,47	0,09	0,61 ^{b}	0,06	0,60	0,07	0,79 ^{c}	0,05	0,79	0,04
Total cost (R$) /kg	1,06 ^{a}	0,09	1,05	0,12	1,03 ^{a}	0,13	1,05	0,23	1,18 ^{a}	0,03	1,18	0,02

SD = Standard deviation; IR = Interquartile range; Different letters within the same line indicate statistically significant differences (p<0.05);* Indicators were calculated based on total revenues; Earnings 1: net income / total revenue; Earnings 2: net margin / total revenue; Profit 1: net income / (real operating cost + total fixed cost); Profit 2 : net margin / (real operating cost + total fixed cost); Herd asset variation = final value - initial value; • = Could not be estimated because it was included in other expenses; = Could not be estimated because there were no producers working in another activity.

Table 2. Representativeness of each revenue item for 20 demonstration units participating in the "Full Bucket" program in the state of Rio de Janeiro, grouped based on technological sophistication in % (from January to December of 2011).

Specification	Technological level											
	Low				Medium				High			
	Average	SD	Median	IR	Average	SD	Median	IR	Average	SD	Median	IR
Milk sales	86,92 [a]	7,01	84,78	8,46	85,72 [a]	5,42	84,94	8,74	79,59 [a]	4,36	79,59	3,08
Animal sales	12,91 [a]	7,20	15,22	8,80	13,97 [a]	5,23	15,06	6,91	18,82 [a]	2,10	18,82	1,49
Manure sales	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 revenues	0,17	0,49	0,00 [a]	0,00	0,31	0,98	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 line indicate statistically significant differences (p<0.05).

Total operating costs (TOC) (Table 1) were calculated as the sum of the real operating cost (expenditure) and cost of asset depreciation and family labor remuneration. Differences observed between technological groups (p<0.05) are mainly attributable to quantities of milk and animals produced, indicating that intensified milk production and larger animal quantities correspond with higher TOC values.

Significant variations in ROC, which represent average producer expenditures on dairy farming financing, were observed across different technological levels (Table 1) (p<0.05). This occurred for the same reasons as those observed for TOC. Feed had the greatest effect on ROC (Table 3). Its representativeness was similar between firms of low and intermediate technological sophistication and between firms of intermediate and high technological sophistication but different between low and high technologically intensive systems (p<0.05). This is attributable to the greater representativeness of labor at the high technological scale, producing lower feed values than those observed for the remaining technological groups. Feed expenses relative to ROC were, with the exception of highly technologically intensive systems, slightly higher than those reported by Lopes et al. (2009), who observed values of 57.36%, 57.10% and 46.21% for firms of low, intermediate and high technological sophistication, respectively. In this study, as in others, no data are available on the percentage representativeness of roughage, protein concentrate, energy concentrate, and mineral salt for ROC or feed. The low representativeness of feed for ROC observed by Lopes et al. (2009) was most likely related to low degrees of productivity/ha.

ROC labor representativeness did not vary significantly between systems of low and intermediate technological sophistication and differed significantly between firms of low and high technological sophistication (p<0.05) (Table 3). This may be attributable to the presence of family labor in four DUs (40%) of the intermediate technological group and in the vast majority of low technological level dairy farms studied, among which expenditures were solely dedicated to temporary labor contracts. Firms of high technological sophistication strictly employed hired labor, thus resulting in high labor representativeness. Labor representativeness was higher for firms of high technological sophistication and lower for low and intermediate groups than reported by Lopes et al. (2005) (14.07%, 5.48% and 16.65%).

Health expenses (Table 3) related to the use of curative and preventive drugs and health exams were fairly consistent across the groups. Ratios of preventive to curative drugs were 67.40%, 56.00% and 58.5%, for the low, intermediate and high group, respectively. The degree of ROC health representativeness (Table 3) was similar to the value reported by Lopes et al. (2005) for the low technological level (4.60%) and higher for the intermediate and high technological levels (3.77% and 2.47%, respectively).

No significant differences in the representativeness of milking (acquisition of pre- and post-teat dip solutions, acid and alkaline detergents, paper towels, disinfectants, and remaining products used for milking) were observed between the groups (Table 3). When compared with the results of Lopes et al. (2009), who reported 0.40%, 0.47% and 2.90% for the low, intermediate and high technological levels, respectively, our results suggest that producers of low and intermediate technological sophistication are more concerned with milk quality. This is likely attributable to technical assistance received through the "Full Bucket" program.

As predicted, no significant differences in reproduction expenses were observed between groups (semen, liquid nitrogen, insemination materials, etc.) (Table 3). Low reproduction representativeness (in percentage) in the ROC may be attributable to the fact that the eight DUs (100%) of low technological sophistication and five DUs (50%) of intermediate technological sophistication used natural breeding methods following technical recommendations given early on in the "Full Bucket" program to farmers who needed to produce quality roughage feed before focusing on genetic improvement. Genetic improvement may be achieved faster and more easily by buying more cows than by waiting for a female calf to be born through artificial insemination by a cow of low genetic potential for breeding (MORAES, 2013). The remaining seven DUs (35% of the total) used artificial insemination methods.

No significant differences in the representativeness of other expenses were observed between different strata ($p<0.05$). The values were lower than those reported by Lopes et al. (2009) (15.13, 9.60 and 15.65% for low, intermediate and high technological level, respectively) because these researchers included milk transportation expenses, fees and variable taxes depending on production, and expenses with maintenance of assets, machines and equipment in the other expenses category.

In addition to ROC, another component of TOC is the depreciation. Depreciation was not significantly different between the low and intermediate technological level but was higher for the high technological level ($p<0.05$) (Table 1). This was most likely due to the machine, implements and facilities for the high technological level group that were not compatible with milk production, resulting in higher depreciation representativeness in the TOC.

Total cost (TC) was calculated as the sum of the fixed costs (FC) (sum of land remuneration, invested capital, producer, fixed taxes, and depreciation) and variable costs (VC) (sum of real operating costs, remuneration of working capital and family labor) (Table 1). Significant differences were observed between the low technological level and the remaining groups ($p<0.05$). This was because the majority of the low technology farms were family based, in general presenting low revenue and investing little in machinery and equipment. Fixed costs do not represent expenditure (except for taxes) but represent what the activity should remunerate to be competitive compared with other economic activities (LOPES et al., 2006). Lopes et al. (2008a) highlighted that if the fixed costs are not considered, the producer may lose assets and go into debt in the long term. The TC components were also divided into groups, and their representativeness was estimated to perform a more detailed analysis (Table 4).

Table 3. Representativeness of each ROC item for 20 demonstration units participating in the "Full Bucket" program in the state of Rio de Janeiro, grouped based on technological sophistication in % (from January to December of 2011).

Specification	Technological level											
	Low				Medium				High			
	Average	SD	Median	IR	Average	SD	Median	IR	Average	SD	Median	IR
Feed	62,32 [a]	10,39	63,01	13,67	62,69 [ab]	10,19	61,33	12,85	41,80 [bc]	4,49	41,80	3,18
Concentrate	44,70 [a]	10,12	42,68	15,62	45,58 [a]	10,81	44,10	14,11	34,83 [a]	11,29	34,83	7,98
Protein concentrate	17,43	15,28	11,14 [a]	14,43	16,61	7,56	15,34 [a]	7,94	13,46	11,02	13,46 [a]	7,79
Energy concentrate	25,23	15,49	28,90 [a]	22,99	27,85	7,42	27,65 [a]	9,45	21,36	0,26	21,36 [a]	0,19
Commercial concentrate	2,04	3,20	1,07 [a]	1,91	1,11	1,49	0,36 [a]	2,14	0,00	0,00	0,00 [a]	0,00
Mineral salt	4,35	3,57	2,11 [a]	4,98	3,95	1,12	3,57 [a]	1,24	2,62	1,68	2,62 [a]	1,18
Roughage	13,27 [a]	7,00	12,50	11,06	13,16 [a]	5,85	13,75	6,32	4,35 [a]	5,12	4,35	3,62
Fertilization	12,19 [a]	7,85	11,93	12,54	12,19 [a]	5,90	11,71	6,37	4,09 [a]	4,75	4,09	3,36
Pesticides	0,61	0,78	0,29 [a]	0,78	0,89	1,28	0,48 [a]	0,56	0,26	0,37	0,26 [a]	0,26
Bought roughage	0,47	0,99	0,00 [a]	0,25	0,08	0,19	0,00 [a]	0,00	0,00	0,00	0,00 [a]	0,00
Labor	7,92	10,00	2,20 [a]	14,61	8,79	10,16	5,55 [ab]	13,48	31,80	2,68	31,80 [c]	1,89
Health	4,77 [a]	2,98	3,72	5,77	5,37 [a]	1,56	5,22	1,15	4,77 [a]	1,38	4,77	0,97
Preventive drug	1,96 [a]	1,74	1,40	1,38	1,83 [a]	0,99	2,18	1,69	1,80 [a]	0,48	1,80	0,34
Curative drug	2,78 [a]	1,82	2,19	2,38	3,27 [a]	1,67	2,63	1,05	2,65 [a]	1,95	2,65	1,38
Health exam	0,03 [a]	0,08	0,00	0,00	0,28 [a]	0,33	0,16	0,47	0,31 [a]	0,10	0,31	0,07
Milking	0,90	0,62	0,78 [a]	0,94	1,21	0,82	0,88 [a]	0,53	1,08	0,37	1,08 [a]	0,26
Reproduction	0,14	0,31	0,00 [a]	0,06	1,37	1,82	0,88 [a]	2,09	1,18	0,99	1,18 [a]	0,70
Energy	6,17 [a]	3,87	5,75	3,61	5,78 [a]	3,14	5,42	4,67	6,42	2,48	6,42 [a]	1,75
Land lease	3,13	4,97	0,00 [a]	4,87	2,35	4,98	0,00 [a]	0,00	0,00	0,00	0,00 [a]	0,00
Other expenses	8,94 [a]	7,19	8,66	5,70	6,13 [a]	5,22	5,84	6,99	4,90 [a]	0,99	4,90	0,70

SD = Standard deviation; IR = Interquartile range; Different letters on the same line indicate statistically significant differences (p<0.05).

Table 4. Representativeness of each total cost item for 20 demonstration units participating in the "Full Bucket" program in the state of Rio de Janeiro, grouped based on technological sophistication in % (from January to December of 2011).

Specification	Technological level											
	Low				Medium				High			
	Average	SD	Median	IR	Average	SD	Median	IR	Average	SD	Median	IR
Fixed costs (FC)	29,46	8,27	26,81 ^{a}	4,76	23,85	4,66	21,45 ^{a}	5,37	31,27	2,46	31,27 ^{a}	1,74
Land remuneration	10,12	9,32	8,32 ^{a}	7,60	5,44	4,96	3,67 ^{a}	4,11	6,60	2,94	6,60 ^{a}	2,08
Return on investment	11,09 ^{a}	0,98	11,46	1,26	10,09 ^{ab}	1,05	9,76	1,20	12,66 ^{ac}	0,21	12,66	0,15
Producer remuneration	*	*	*	*	*	*	*	*	*	*	*	*
Depreciation	8,25 ^{a}	1,66	8,46	2,04	8,32 ^{ab}	1,47	8,42	1,74	12,01 ^{c}	0,26	12,01	0,18
Variable costs (VC)	68,42	8,24	71,16 ^{a}	4,21	72,88	4,51	75,14 ^{a}	6,01	65,56	3,27	65,56 ^{a}	2,31
Real operating cost	43,00 ^{a}	9,20	44,46	6,72	56,77 ^{b}	6,17	57,35	8,18	63,56 ^{bc}	3,20	63,56	2,26
Feed	27,96 ^{a}	6,81	28,68	9,56	37,39 ^{a}	5,95	38,66	5,36	27,94 ^{a}	4,00	27,94	2,83
Concentrate	20,63 ^{a}	7,55	20,73	9,19	27,25 ^{a}	6,65	26,35	9,50	23,37 ^{a}	8,36	23,37	5,91
Protein concentrate	8,15	8,70	5,42 ^{a}	4,74	9,91	4,53	10,07 ^{a}	3,04	9,12	7,68	9,12 ^{a}	5,43
Energy concentrate	11,49 ^{a}	7,43	11,51	11,81	16,64 ^{a}	4,73	15,26	5,82	14,26 ^{a}	0,69	14,26	0,49
Commercial concentrate	0,99	1,60	0,41 ^{a}	1,01	0,69	0,97	0,18 ^{a}	1,35	0,00	0,00	0,00 ^{a}	0,00
Mineral salt	1,75	1,19	1,05 ^{a}	1,35	2,33	0,57	2,29 ^{a}	0,74	1,73	1,06	1,73 ^{a}	0,75
Roughage	5,59 ^{a}	2,57	5,18	2,88	7,81 ^{a}	3,66	7,76	3,51	2,84 ^{a}	3,31	2,84	2,34
Fertilization	5,05 ^{a}	3,01	4,90	3,80	7,22 ^{a}	3,67	7,21	3,45	2,67 ^{a}	3,07	2,67	2,17
Pesticides	0,30	0,45	0,13 ^{a}	0,25	0,54	0,80	0,27 ^{a}	0,36	0,17	0,24	0,17 ^{a}	0,17
Bought roughage	0,24	0,50	0,00a	0,13	0,05	0,12	0,00 a	0,00	0,00	0,00	0,00 a	0,00
Labor	3,90	5,08	0,77 ^{a}	7,68	5,63	6,43	3,59 ^{ab}	8,70	21,25	2,55	21,25 ^{ac}	1,80
Health	2,12 ^{a}	1,34	1,97	1,62	3,27 ^{a}	1,13	3,38	0,99	3,16 ^{a}	0,80	3,16	0,57
Milking	0,43	0,32	0,38 ^{a}	0,46	0,72	0,46	0,57 ^{a}	0,35	0,72	0,22	0,72 ^{a}	0,16
Reproduction	0,08	0,18	0,00 ^{a}	0,03	0,81	1,01	0,49 ^{a}	1,37	0,80	0,69	0,80 ^{a}	0,49
Energy	2,70 ^{a}	1,75	1,93	1,67	3,30 ^{a}	1,46	3,43	2,29	4,25 ^{a}	1,50	4,25	1,06
Machinery and facility maintenance	0,35	0,47	0,10 ^{a}	0,64	0,58	0,90	0,23 ^{a}	0,64	2,15	2,29	2,15 ^{a}	1,62
Land lease	1,28	2,21	0,00 ^{a}	1,55	1,34	2,82	0,00 ^{a}	0,00	0,00	0,00	0,00 ^{a}	0,00
Other expenses	4,18	3,94	2,87 ^{a}	2,54	3,74	3,17	3,78 ^{a}	3,37	3,28	0,78	3,28 ^{a}	0,55
Remuneration of working capital	1,35 ^{a}	0,28	1,39	0,24	1,61 ^{b}	0,60	1,80	0,37	2,00 ^{bc}	0,07	2,00	0,05
Family labor	24,07 ^{a}	7,31	25,11	5,77	14,50 ^{b}	8,07	13,94	8,51	0,00 ^{bc}	0,00	0,00	0,00

SD = Standard deviation; IR = Interquartile range; Different letters on the same line indicate statistically significant differences ($p<0.05$). * = Could not be estimated because there were no producers working in other activities.

Variable costs (Table 1) are the same components as the real operating costs, in addition to the remuneration of working capital and family labor. Significant differences were observed between groups ($p<0.05$) due to the quantities of milk produced and total animals in the herds. Regarding the working capital remuneration (Table 1) (savings interest rate, which was 6% p.a. in this study, over half the ROC for dairy farming), its application to the milk producer is questionable because the great majority of dairy farmers are given credit in the market until the milk payment, decreasing the need for own working capital. Its inclusion will increase the variable costs, negatively reflecting on earnings and profit and resulting in an unrealistic analysis of results.

No significant differences in economic efficiency, gross margin (gross revenue minus ROC) and net margin indicators (gross revenue minus TOC) (Table 1) were observed between groups ($p<0.05$). A significant difference was anticipated, especially given the varying quantities of milk and animals sold. Gross and net margins were satisfactory (positive), demonstrating that milk production for all groups can "survive" in the short and intermediate term. Positive net margin values (Table 1) show that revenues allowed for depreciation reserves and family labor remuneration.

Economic efficiency results (gross revenue minus TC) were not significantly different between the intermediate and high technology groups, though they were found to vary significantly between these and the low technology group ($p<0.05$) (Table 1). A difference was expected due to varying quantities of milk and animals sold. This can be attributed to fixed costs, especially returns on investment and depreciation, suggesting an inadequate application of technological resources at the expense of milk production and idleness among DUs of low and high technological sophistication. Unsatisfactory results for these groups indicate that milk production could not fully cover invested capital. In the long term, DUs will be capitalizing less than savings account revenues.

No differences in earnings 1 (result/total revenue) were observed between different technological groups (Table 1) ($p<0.05$). This value was found to be negative for firms of low and high technological sophistication, as for every R$100.00 in revenue, there was a loss of R$17.95 and R$13.15, respectively. However, firms of intermediate technological sophistication experienced a gain of R$1.69. No differences in the profit 2 variable (net margin/total revenue) were observed between groups ($p<0.05$), and gains of R$10.35, R$18.54 and R$10.90 per R$100.00 in revenue were observed for firms of low, intermediate and high technological sophistication, respectively. These values are higher because this indicator does not consider land, invested capital, producer, fixed tax, and working capital remuneration (LOPES et al., 2011).

No differences in the profit 1 variable (net income/ROC + total immobilized) were observed between groups ($p<0.05$). Firms of low and high technological sophistication showed revenues of 3.86% and 2.82%, respectively, which are lower than those found for the savings account. The intermediate technological group showed 1.13% higher revenues than savings. No differences in the profit 2 variable (net margin/ROC + total fixed) were observed between groups ($p<0.05$). Profit 2 was 3.83%, 6.09% and 2.25% for the low, intermediate and high technological levels, respectively. The value for the intermediate technological level was higher than that for savings.

To obtain more realistic analysis results, it is necessary to determine whether herd asset variations were positive. This is achieved by calculating the difference (in reais (R$)) between herd asset values at the start and end of the evaluated period. The result is the degree of herd asset variation, an index that measures herd asset valuation or depreciation. No differences in herd asset variation were observed between groups ($p<0.05$) (Table 1). Such variation, when positive, may indicate that a herd is growing, that it has not yet stabilized, or that animal price valuation has occurred. In the present study, this variation was not proportional to the size of the herd; i.e., the high technological group showed the lowest degree of asset variation, although it included more lactating cows than the low and intermediate technological groups. This is likely attributable to investments in feed production and to the need to replace animals of low genetic potential with those of higher potential using animal sales proceeds. The high technology group (Table 1) achieved the largest net margin (R$ 18,875.40) and degree of animal asset depreciation (-R$ 21,450.00) (final animal asset value - initial animal asset value) relative to the other firms. Losses, without analyzing other asset value increases, were -R$42,876.94 (-R$21,426.94 - R$21,450.00).

The representativeness of each component of ROC relative to revenue is shown in Table 5. Because some farms do not perform cost control procedures and due to our long data collection period (minimum 12 months), the relationship between ROC components and total revenues, i.e., how much revenue the dairy farmer spends per month on feed, labor, health expenses, etc., can be used as an alternative indicator, as these data are easily obtainable (LOPES et al., 2011). From such calculations, farm conditions can be evaluated. This indicator is especially recommended for economically viable farms, as it can be used as a reference for dairy farmers that do not yet calculate production costs.

Table 5. Representativeness of each real operating cost / milk revenue (ROC /MI) item for 20 demonstration units participating in the "Full Bucket" program in the state of Rio de Janeiro, grouped based on technological sophistication in % (from January to December of 2011).

Specification	Technological level											
	Low				Medium				High			
	Average	SD	Median	IR	Average	SD	Median	IR	Average	SD	Median	IR
ROC / milk revenue	56,65[a]	10,24	53,61	6,68	65,07[a]	9,82	64,16	10,69	90,38[a]	0,05	90,38	0,04
Feeding	37,20[a]	9,26	36,53	10,17	42,94[a]	8,16	43,37	9,82	39,64[a]	3,72	39,64	2,63
Concentrate	27,05[a]	9,50	24,70	13,79	31,01[a]	6,75	31,99	7,62	32,98[a]	10,25	32,98	7,25
Protein concentrate	11,28	12,60	6,00[a]	7,95	11,29	4,74	11,97[a]	5,66	12,71	10,28	12,71[a]	7,27
Energy concentrate	14,58[a]	9,59	15,23	14,03	18,98[a]	4,99	18,79	6,78	20,28[a]	0,03	20,28	0,02
Commercial concentrate	1,19	1,69	0,60[a]	1,43	0,74	0,97	0,24[a]	1,65	0,00	0,00	0,00[a]	0,00
Mineral salt	2,59	2,13	1,28[a]	3,09	2,73	0,86	2,92[a]	1,09	2,50	1,62	2,50[a]	1,15
Roughage	7,56[a]	3,44	7,52	5,30	9,21[a]	4,54	10,07	4,59	4,16[a]	4,91	4,16	3,47
Fertilization	6,88[a]	4,00	7,21	6,57	8,54[a]	4,59	8,61	4,82	3,91[a]	4,56	3,91	3,22
Pesticides	0,42	0,63	0,17[a]	0,43	0,61	0,84	0,30[a]	0,53	0,25	0,35	0,25[a]	0,25
Bought roughage	0,26	0,52	0,00[a]	0,15	0,05	0,14	0,00[a]	0,00	0,00	0,00	0,00[a]	0,00
Labor	4,59	5,71	1,22[a]	8,74	6,14	6,61	4,16[ab]	11,72	30,16	2,13	30,16[c]	1,50
Health	2,89[a]	1,89	2,36	3,48	3,79[a]	1,58	3,93	1,63	4,53[a]	1,37	4,53	0,97
Milking	0,56[a]	0,42	0,50	0,64	0,79[a]	0,43	0,64	0,46	1,03[a]	0,36	1,03	0,26
Reproduction	0,10	0,25	0,00[a]	0,03	0,87	1,03	0,58[a]	1,54	1,12	0,93	1,12[a]	0,65
Energy	3,48[a]	1,77	3,29	1,97	3,82[a]	1,98	3,28	2,72	6,11[a]	2,44	6,11	1,72
Maintenance of machinery and premises	0,57	0,90	0,13[a]	0,80	0,62	0,89	0,28[a]	0,78	3,14	3,42	3,14[a]	2,42
Land lease	1,72	2,71	0,00[a]	2,79	1,70	3,59	0,00[a]	0,00	0,00	0,00	0,00[a]	0,00
Other expenses (variable taxes)	5,54[a]	4,65	4,79	4,16	4,40[a]	3,79	4,45	4,72	4,64[a]	0,87	4,64	0,62

SD = Standard deviation; IR = Interquartile range; Different letters on the same line indicate statistically significant differences (p<0.05).

Conclusions

Degrees of technological sophistication, characterized in the present study based on production infrastructure and the availability of performed investments, affected earnings and profits among the production systems analyzed. This economic analysis revealed positive results for firms of intermediate technological sophistication, which showed the lowest total unit costs and positive results overall. These farms thus exhibit favorable conditions for long-term production, thus capitalizing dairy farmers. Firms of low and high technological sophistication showed negative results and producer decapitalization, as revenues did not cover total costs.

Components of greater representativeness relative to real operating costs were found to be, in descending order, feed, other expenses and labor for the low technological level, feed, labor and other expenses for the intermediate technological level, and feed, labor and energy for the high technological level. Components of higher representativeness relative to total production costs were found to be, in descending order, feed, family labor and returns on investment for the low and intermediate technological levels and feed, labor and returns on investment for the high technological level.

References

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

BORGES, M. S.; GUEDES, C. A. M.; ASSIS, R. L. Um estudo do "Projeto Balde Cheio" como vetor de desenvolvimento sustentável do pequeno produtor de leite. *Revista Brasileira de Agropecuária Sustentável*, Viçosa, MG, v. 1, n. 1, p. 151-161, 2011.

DARNHOFER, I, GIBBON, D.; DEDIEU, B. *Farming systems research into the 21st century:* the new dynamic: the new dynamic. Netherlands: Springer Science & Business Media, 2012. 503 p.

FASSIO, L. H.; REIS, R. P.; GERALDO, L. G. Desempenho técnico e econômico da atividade leiteira em Minas Gerais. *Ciência e Agrotecnologia*, Lavras, v. 30, n. 6, p. 1154-1161, 2006.

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, 2010. 181 p.

GOMES, A. P.; ALVES, E. Identificando ineficiências na produção de leite. *Boletim do Leite*, Piracicaba, v. 6, n. 1, p. 1-2, 1999.

HOFER, E.; SHIKIDA, P. F. A. Estudo do custo de produção do leite na Província de Santa Fé (Argentina) e no Estado do Paraná (Brasil). *Revista Paranaense de Desenvolvimento*, Curitiba, v. 1, n. 98, p. 99-107, 2000.

LOPES, M. A.; DIAS, A. S.; CARVALHO, F. de M.; LIMA, A. L. R.; CARDOSO, M. G.; CARMO, E. A. do. Resultados econômicos de sistemas de produção de leite com diferentes níveis tecnológicos na região de Lavras MG nos anos 2004 e 2005. *Ciência e Agrotecnologia*, Lavras, v. 33, n. 1, p. 252-260. 2009.

LOPES, M. A.; CARDOSO, M. G.; CARVALHO, F. M.; DIAS, A. S.; LIMA, A. L. R.; CARMO, E. A. Resultados econômicos da atividade leiteira na região de Lavras (MG) nos anos 2004 e 2005: um estudo multicasos. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, Belo Horizonte, v. 60, n. 3, p. 428-435, 2008a.

LOPES, M. A.; CARDOSO, M. G.; DIAS, A. S.; CARMO, E. de A. do. Efeito da escala de produção nos resultados econômicos de sistema de produção de leite na região de Lavras (MG) em 2004 e 2005. *Archivos Latinoamericanos de Producción Animal*, Maracaibo, v. 16, n. 3, p. 121-129, 2008b.

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

LOPES, M. A.; LIMA, A. L. R.; CARVALHO, F. de 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). *Revista Ciência e Agrotecnologia*, Lavras, v. 28, n. 4, p. 883-892, 2004a.

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

______. Resultados econômicos de sistemas de produção de leite com diferentes níveis tecnológicos na região de Lavras, MG. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, Belo Horizonte, v. 57, n. 4, p. 485-493, 2005.

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.

LOPES, M. A.; LIMA, A. L. R.; CARVALHO, F. de M.; REIS, R. P.; SANTOS, I. C.; SARAIVA, F. H. Efeito da escala de produção nos resultados econômicos de sistemas de produção de leite na região de Lavras(MG): um estudo multicascos. *Boletim da Indústria Animal,* Nova Odessa, v. 63, n. 3, p. 177-188, 2006.

MANCIO, A. B.; SCHIFFLER, E. A.; LONDOÑO HERNÁNDEZ, F. I. Eficiência técnica e econômica de quatro empresas de produção de leite da região de São Carlos, SP. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, Belo Horizonte, v. 51, n. 3, p. 283-286, 1999.

MANZANO, A.; NOVAES, N. J.; CAMARGO, A. C.; ESTEVES, S. N.; FREITAS, A. R. Efeitos da implantação de técnicas agropecuárias na intensificação de sistemas de produção de leite em estabelecimentos familiares. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 35, n. 2, p. 618-628, 2006.

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

MARQUES, V. M.; REIS, R. P.; SÁFADI, T.; REIS, A. J. Custos e escala na pecuária leiteira: estudo de casos em Minas Gerais. *Ciência e Agrotecnologia*, Lavras, v. 26, n. 5, p. 1027-1034, 2002.

MATSUNAGA, M.; BEMELMANS, P. F.; TOLEDO, P. E. N.; DULLEY, R. D.; OKAWA, H.; PEDROSO, I. A. Metodologia de custo de produção utilizada pelo IEA. *Agricultura em São Paulo*, São Paulo, v. 23, n. 2, p. 123-139, 1976.

MORAES, A. C. A.; COELHO, S. G.; RUAS, J. R. M.; RIBEIRO, J. C. V. C.; VIEIRA, F. A. P.; MENEZES, A. C. Estudo técnico e econômico de um sistema de produção de leite com gado mestiço F1 Holandês-Zebu. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, Belo Horizonte, v. 56, n. 4, p. 745-749, 2004.

MORAES, F. de. *Análise de rentabilidade de sistemas de produção de leite participantes do Programa "Balde Cheio" no Estado do Rio de Janeiro*. 2013. Dissertação (Mestrado em Ciências Veterinárias) - Universidade Federal de Lavras, Lavras.

OLIVEIRA, A. S.; CUNHA, D. N. F. V.; CAMPOS, J. M. S.; VALE, S. M. L. R.; ASSIS, A. J. Identificação e quantificação de indicadores-referência de sistemas de produção de leite. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 36, n. 2, p. 507-516, 2007.

OLIVEIRA, A. S.; PEREIRA, D. H. Gestão econômica de sistemas de produção de bovinos leiteiros. In: SIMPÓSIO BRASILEIRO DE AGROPECUÁRIA SUSTENTÁVEL, 1., 2009. Viçosa, MG. *Anais...* Viçosa, MG: FUNARBE, 2009. p. 106-133.

REIS, R. P.; MEDEIROS, A. L.; MONTEIRO, L. A. Custo de produção da atividade leiteira na região sul de Minas Gerais. *Organizações Rurais e Agroindustriais*, Lavras, v. 3, n. 2, p. 45-54, 2001.

SCHIFFLER, E. A.; MANCIO, A. B.; GOMES, S. T. Efeito da escala de produção nos resultados econômicos da produção de leite B no Estado de São Paulo. *Revista Brasileira de Zootecnia*, Viçosa, v. 28, n. 2, p. 425-431, 1999.

SERVIÇO BRASILEIRO DE APOIO ÀS MICRO E PEQUENAS EMPRESAS - SEBRAE. Curso de capacitação rural**.** Goiânia, 1998. 34 p.