DOI: 10.5433/1679-0359.2019v40n1p323

Effect of workforce diversity on the cost-effectiveness of milk production systems participating in the "full bucket" program

Efeito do tipo de mão de obra na rentabilidade de sistemas de produção de leite participantes do programa "balde cheio"

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Abstract

This study aimed to analyze the effect of each workforce type on the cost-effectiveness of 20 dairy farms participating in the "Full Bucket" program, from January to December 2011, in the State of Rio de Janeiro. A stepwise multiple linear regression was used to identify the production cost components that most affected net margin, profitability, and cost-effectiveness. Workforce type influenced both profitability and cost-effectiveness, as well as total production cost. Economic analysis showed that farms with a hired workforce had the lowest total unit costs and a positive result. This way, the activity is able to produce in the long term and farmers are capitalizing. The farms that adopted mixed and family workforce had a positive net margin and a negative result, obtaining conditions to produce in the medium term. The highest representativeness on the items of effective operating cost in the family workforce stratum, in a descending order, were food, miscellaneous expenses, and energy. The most representative items in the mixed and hired workforce strata were food, workforce, and miscellaneous expenses.

Key words: Dairy cattle. Production cost. Management. Family workforce.

Resumo

Objetivou-se analisar o efeito do tipo de mão de obra na rentabilidade de 20 propriedades participantes do programa "Balde Cheio", entre janeiro a dezembro de 2011, no estado do RJ. O modelo utilizado foi o de regressão linear múltipla com o método *stepwise*, visando identificar os componentes do custo de produção que mais influenciaram na margem líquida, lucratividade e rentabilidade. O tipo de mão de obra influenciou a lucratividade e rentabilidade, e também o custo total de produção. Na análise econômica, as propriedades com mão de obra contratada tiveram os menores custos totais unitários e resultado positivo. Desta forma, a atividade tem condições de produzir no longo prazo e os produtores estão se capitalizando. Os estratos que adotaram mão de obra mista e familiar apresentaram margem líquida positiva e resultado negativo, obtendo condições de produzir no médio prazo. As maiores

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Received: Dec. 01, 2017 - Approved: Oct. 19, 2018

representatividades sobre os itens do custo operacional efetivo no estrato da mão de obra familiar, em ordem decrescente, foram a alimentação, despesas diversas e energia. Os itens mais representativos, nos estratos da mão de obra mista e contratada, foram alimentação, mão de obra e despesas diversas.
Palavras-chave: Bovinocultura de leite. Custo de produção. Gerenciamento. Mão de obra familiar.

Introduction

Several facts have contributed to dairy producers realizing the need to manage the activity well, becoming more profitable, efficient, and competitive, as well as assuming a position of an entrepreneur, regardless of the scale of production of their properties (LOPES et al., 2010).

To be successful, it is essential that the producers manage well the variables that are under their control since product price is an uncontrollable factor. This is a strategy to make product competitive, reducing production costs and maximizing the gains of scale (REIS et al., 2001).

People employed in rural activity are those with ties of kinship with producers, permanent employees (those hired to work on a continuous basis), temporary employees (those hired for a temporary and/or occasional period), partner employees (those who work by receiving a share of the production, e.g. half, third, fourth, etc.), and other conditions that do not fall into the previous forms (IBGE, 2006). The Federal Law 11,326, dated July 24, 2006, article 3, paragraph II, considers a family farmer to be the one who predominantly uses the family's own workforce in the economic activities of his/her establishment or enterprise (BRASIL, 2006).

Fassio et al. (2006) evaluated the economic results of milk production systems and realized the need to professionalize the management of the studied production systems, investing in the training of producers and workforce through the transfer of technologies and the diffusion of technical information. Therefore, they observed that labor relations become more professional as production increases, becoming less dependent on the family workforce.

The Southeast Livestock Research Center (CPPSE), of the Brazilian Agricultural Research Corporation (EMBRAPA), in São Carlos, SP, developed the "Full Bucket" program, which aims at assisting inefficient milk producers through training of technicians and extension workers. This project promotes the exchange of information on applied technologies and monitors environmental, economic, and social impacts on the studied production systems (EMBRAPA, 2013).

A number of researchers (FASSIO et al., 2006; OLIVEIRA et al., 2007; MANCIO et al., 1999; SCHIFFLER et al., 1999; HOFER; SHIKIDA, 2000) have been concerned with studying economic viability and estimating the cost of production of rural milk farms. However, few of them have studied the effect of the type of workforce on the cost-effectiveness and have shown which components exerted a higher influence on the total and effective operating cost and identified the break-even point. Due to the great importance that the "Full Bucket" program has for Brazil and the State of Rio de Janeiro, as well as the scarcity of scientific papers on the subject, this study aimed to analyze the effect of the type of workforce on the cost-effectiveness of milk production systems participating in the "Full Bucket" program. Specifically, this study also aimed to identify the components that exerted a higher representativeness on the final production costs, as well as estimate the break-even point.

Material and Methods

The studied data came from 20 properties located in the State of Rio de Janeiro that participated in the "Full Bucket" program in 2011. These properties were chosen by non-probabilistic sampling by

judgment, taking into account criteria such as quality and availability of zootechnical and economic data, interest and consent of the producer to conduct the research, and access to the property throughout the year (LOPES et al., 2015). The data were written down in field notebooks by producers throughout 2011 and collected monthly by the technician responsible for the property.

The cost-effectiveness indicators used were 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).

Profitability 1 and cost-effectiveness 1 were calculated by the formulas Profitability 1 (%) = (Result/Total revenue) × 100 and Cost-effectiveness 1 (%) = Result/(Total fixed assets + Effective operating cost) × 100, respectively. Profitability 2 (Profitability 2 (%) = Net margin/Total revenue) × 100) and Cost-effectiveness 2 (Cost-effectiveness 2 (%) = Net margin/(Total fixed assets + Effective operating cost) × 100) (LOPES et al., 2011) were also estimated in this study.

In order to carry out a complete inventory of the assets, the value and useful life in relation to the acquisition time of each asset were calculated and later grouped into the pre-established categories equipment, vehicles, tools, improvements, machinery, implements, herds, and furniture. When the producer did not have information regarding the value and date of acquisition, as well as the remaining useful life, the criterion proposed by Lopes et al. (2004b) was adopted.

The break-even point was estimated by dividing the fixed cost by the contribution margin (LOPES et al., 2004a). The division between depreciation and unit contribution margin was considered for the calculation of the operating break-even point.

In order to estimate the percentage of each item that makes up the effective operating cost (EOC) in relation to milk sales revenue, we considered the division of the disbursement with the component item of EOC to be evaluated by the revenue from the milk sale (LOPES et al., 2011). The return on invested capital was calculated by applying the rate of 6.00% per year and for land remuneration, we used the lease value practiced in the State of Rio de Janeiro, estimated at 2 kg of milk/ha/day (LOPES; CARVALHO, 2000).

In order to analyze the influence of the type of workforce on the cost-effectiveness of the dairy activity, the 20 properties were classified into family (exclusively family, with contraction of sporadic workforce for occasional jobs), mixed (share of family and hired workforce during the whole period), and hired (exclusively hired workforce) workforce, as recommended by Lopes et al. (2007).

For statistical analysis, productive and economic indices were initially registered in an MS Excel® database for later export to the statistical software PASW 18.0. The Shapiro-Wilk normality test and Levene's equality of variance were performed to evaluate the distribution of continuous variables, being detected that some of them had no normal distribution and/or homoscedasticity. Therefore, these variables were expressed through the median and interquartile range, while those with normal distribution were described by the mean ± standard deviation. The comparisons of dependent (economic) variables among the independent categories (strata) were performed by ANOVA and complemented by the Bonferroni correction test for multiple comparisons. When the data did not present a normal distribution and/or equality of variance, the comparisons between groups were performed by the Kruskal-Wallis test and complemented by the LSD test for multiple comparisons between ranked medians of the variables (MAROCO, 2010). The difference was statistically significant when $P<0.05$.

Results and Discussion

A summary of the cost-effectiveness analysis of the dairy activity of the 20 properties participating in the "Full Bucket" program is shown in Table

1. The high values of standard deviations and interquartile ranges show that the studied properties were different from each other. During the period, the total revenue corresponded to the sum of the values raised by the sale of milk (85.50, 91.77, and 82.07%), animals (14.39, 8.23, and 16.67%), manure (0.00, 0.00, and 0.00%), and other revenues (sales of machinery, rental of machinery, and others) (0.11, 0.00, and 1.26%) in the family, mixed, and hired strata, respectively.

The differences between the production strata ($P<0.05$) can be explained mainly by the amount of milk and animals sold even though the representativeness of each of these items in the total revenue was similar ($P>0.05$) between strata. The family and mixed strata did not have surplus animals, but the sales of animals were carried out. This was due to the need to replace low potential animals by others with a higher genetic potential, justifying the higher investment in livestock when compare to facilities, equipment, and other investments. The representativeness of this item in the total revenue was higher when compared to that mentioned by Lopes et al. (2010), with values of 6.00% for the family stratum and close to 8.00 and 16.00% for the mixed and hired strata, respectively.

No property sold manure, which justifies the null values in the share of total revenue. This was due to the technical orientation that recommended storing the manure aiming to make the most of it or to use it directly in the crops, unlike the observations made by Lopes et al. (2008), who found a high waste of this by-product due to inadequate storage conditions. Reis et al. (2001) found percentages of 0.84% of the revenue for the sale of manure and Lopes et al. (2010) reported values of 1.00, 0.00, and 3.00% for family, mixed, and hired strata, respectively. Lopes et al. (2004b) showed that the use of manure improves soil fertility of pastures and forage production areas, as well as minimizes the amount spent on the acquisition of chemical fertilizers, serving as a reduction of expenses although it initially implies a reduction in revenue.

The total operating cost (TOC) (Table 1) was obtained by summing up the effective operating cost (disbursement) with the cost of depreciation of assets and the remuneration of the family workforce. The family stratum obtained different values ($P<0.05$). We expected that among the strata there would be a difference ($P<0.05$) mainly due to the quantities of produced milk and animals. This was because two properties (40.00%) of the hired workforce stratum presented values related to TOC close to the mixed workforce stratum, which can also be observed by means of the high value of the standard deviation.

The effective operating cost (EOC) (Table 1), which represented the average disbursement made by the producers to cover the activity, was different ($P<0.05$) between the hired workforce stratum and the others, but similar to each other ($P>0.05$). The items composing EOC were divided into groups (Table 2) since according to Lopes and Lopes (1999), this allows monitoring the expenses of the milk production system, assisting the technician and producer in a more detailed analysis.

Table 1. Summary of the cost-effectiveness analysis of the dairy activity of 20 properties participating in the "Full Bucket" program in the State of Rio de Janeiro grouped according to the type of workforce (from January to December 2011).

	Type of workforce											
	Family				Mixed				Hired			
Specification	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Mean	SD	Median	IQR
Total revenue (R$)	42.743,63	17.078,92	40.157,67 [a]	19.669,56	68.990,06	9.922,07	69.078,89 [b]	9.921,77	147.156,75	39.131,23	124.029,00 [c]	51.341,14
Milk (R$)	36.677,72	15.506,28	33.916,33 [a]	18.239,56	63.610,06	12.670,25	69.078,89 [b]	11.751,77	120.114,95	28.572,84	102.529,00 [bc]	47.745,32
Animals (R$)	6.024,25	3.523,77	5.105,00 [a]	3.559,00	5.380,00	5.005,72	6.240,00 [ab]	4.950,00	24.992,00	9.765,53	21.500,00 [c]	7.035,00
Manure (R$)	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$)	41,67	144,34	0,00 [a]	0,00	0,00	0,00	0,00 [a]	0,00	2.049,80	2.971,71	0,00 [a]	3.744,00
Total operating cost (TOC) (R$)	37.153,67 [a]	13.274,40	32.460,77	11.292,49	59.412,96 [b]	10.738,88	54.351,72	9.803,64	113.289,30 [bc]	39.121,53	112.674,36	27.372,24
Effective operating cost (EOC) (R$)	23.578,98 [a]	12.141,75	19.141,11	10.787,51	43.690,43 [b]	9.982,44	40.091,37	9.483,37	94.715,58 [bc]	34.728,77	94.396,92	20.070,16
Depreciation (R$)	3.764,69 [a]	1.265,79	3.304,71	1.127,12	5.912,53 [b]	1.306,16	6.323,35	1.256,77	14.649,72 [bc]	7.802,61	10.488,71	7.302,08
Family workforce (R$)	9.810,00	0,00	9.810,00 [a]	0,00	9.810,00	0,00	9.810,00 [ab]	0,00	3.924,00	5.373,16	0,00 [c]	9.810,00
Total cost (TC) (R$)	45.448,82	14.482,37	40.270,15 [a]	14.753,73	74.860,67	7.387,48	72.304,81 [b]	7.048,09	144.340,46	51.231,91	136.026,78 [bc]	22.182,86
Fixed costs (FC) (R$)	11.458,48	3.981,03	10.159,84 [a]	4.726,86	20.049,53	4.681,31	17.986,40 [b]	4.326,93	42.859,42	19.601,41	40.075,51 [bc]	12.598,15
Remuneration of land (R$)	2.913,58	3.465,09	2.015,09 [a]	1.831,43	6.463,40	4.564,78	7.205,17 [ab]	4.519,35	11.918,68	6.934,60	8.760,00 [bc]	12.419,33
Return on invested capital (R$)	4.780,21	1.228,44	4.496,34 [a]	886,26	7.673,59	1.169,83	8.217,10 [b]	1.070,96	16.291,02	7.543,65	11.760,51 [bc]	6.599,33

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Remuneration of the entrepreneur (R$)	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Taxes considered fixed (R$)	●	●	●	●	●	●	●	●	●	●	●	●
Depreciation (R$)	3.764,69	1.265,79	3.304,71 [a]	1.127,12	5.912,53	1.306,16	6.323,35 [b]	1.256,77	14.649,72	7.802,61	10.488,71 [bc]	7.302,08
Operating break-even point/day (kg of milk)	131,54	104,72	104,71 [a]	122,96	157,58	144,12 [a]	157,58	101,91	1.889,20	3.176,87	166,81 [a]	1.606,28
Variable costs (VC) (R$)	33.990,33 [a]	12.330,82	29.525,34	11.111,14	54.811,15 [b]	10.281,92	51.104,11	9.767,87	101.481,04 [bc]	33.388,05	99.250,90	28.460,19
Effective operating cost (R$)	23.578,98 [a]	12.141,75	19.141,11	10.787,51	43.690,43 [b]	9.982,44	40.091,37	9.483,37	94.715,58 [bc]	34.728,77	94.396,92	20.070,16
Return on working capital (R$)	601,35 [a]	370,00	532,36	256,01	1.310,71 [b]	299,47	1.202,74	284,50	2.841,47 [bc]	1.041,86	2.831,91	602,10
Family workforce (R$)	9.810,00 [a]	0,00	9.810,00	0,00	9.810,00 [ab]	0,00	9.810,00	0,00	3.924,00 [c]	5.373,16	0,00	9.810,00
Working capital (R$)	11.789,49 [a]	6.070,87	9.570,56	5.393,76	21.845,22 [b]	4.991,22	20.045,69	4.741,68	47.357,79 [bc]	17.364,38	47.198,46	10.035,08
Gross margin* (R$)	19.164,65	6.369,29	18.139,48 [a]	10.408,62	25.299,62	7.173,92	23.894,08 [ab]	7.069,89	52.441,17	18.331,61	54.504,42 [bc]	14.836,22
Net margin* (R$)	5.589,96 [a]	5.524,37	4.942,01	9.968,63	9.577,09 [ab]	6.491,98	7.120,19	6.133,39	33.867,46 [c]	17.610,47	34.117,46	11.270,99
Result (profit or loss)* (R$)	-2.705,18	6.761,33	-3.379,26 [a]	8.836,07	-5.870,62	3.674,75	-4.319,28 [a]	3.420,36	2.816,29	25.394,57	1.623,19 [a]	36.528,43
Profitability 1 (%)	-11,56	24,46	-7,72 [a]	22,77	-9,07	6,93	-5,48 [a]	6,19	2,57	16,10	1,35 [a]	29,82

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Cost-effectiveness 1 (%)	-1,90 [a]	5,40	-2,24	6,11	-3,17 [a]	2,68	-2,28	2,57	1,41 [a]	4,68	0,34	7,00
Profitability 2 (%)	10,89 [a]	11,29	12,66	16,62	13,82 [a]	9,28	9,03	8,30	23,57 [a]	11,91	28,37	20,01
Cost-effectiveness 2 (%)	4,21	4,59	3,81 [a]	7,22	4,03	1,33	3,76 [a]	1,31	6,70	4,54	7,14 [a]	6,67
Total amount of milk produced (kg)	44.026,91	17.012,16	37.800,25 [a]	11.712,40	79.271,50	13.713,56	86.308,00 [b]	12.285,25	150.291,30	47.886,78	129.884,00 [bc]	40.871,50
Amount of milk sold (kg)	43.088,82	17.060,55	36.973,75 [a]	10.683,18	72.582,17	11.077,80	71.280,00 [b]	11.020,25	141.141,90	38.800,25	118.497,50 [bc]	44.465,00
Amount of milk for domestic consumption (kg)	190,34	129,15	153,00 [a]	169,75	2.009,33	1.528,17	1.255,00 [b]	1.381,50	1.746,20	1.826,60	1.451,00 [bc]	1.200,00
Amount of milk for calves (kg)	747,75	837,67	560,00 [a]	999,75	4.680,00	5.865,53	2.780,00 [a]	5.630,00	7.403,20	11.141,14	2.058,00 [a]	7.288,00
Amount of milk produced/day (kg)	120,62	46,61	103,56 [a]	32,09	217,18	37,57	236,46 [b]	33,66	411,76	131,20	355,85 [bc]	111,98
Amount of milk sold/day (kg)	118,05	46,74	101,30 [a]	29,27	198,86	30,35	195,29 [b]	30,19	386,69	106,30	324,65 [bc]	121,82
Average price of milk (R$)	0,85	0,15	0,85 [a]	0,10	0,87	0,09	0,86 [a]	0,09	0,86	0,05	0,87 [a]	0,08
Total operating cost (R$)/kg	0,87	0,11	0,89 [a]	0,16	0,82	0,08	0,85 [a]	0,07	0,80	0,12	0,73 [a]	0,18
Effective operating cost (R$)/kg	0,53	0,12	0,54 [a]	0,16	0,60	0,08	0,64 [a]	0,07	0,66	0,12	0,64 [a]	0,17
Total cost (R$)/kg	1,08	0,10	1,11 [a]	0,15	1,04	0,06	1,01 [a]	0,06	1,02	0,16	1,00 [a]	0,27

SD = Standard Deviation; IQR = interquartile range. Different letters in the same row indicate a statistical difference (P<0.05). *Indicators calculated using the total revenue. 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); Equity variation of the herd = final value − initial value; • = not estimated because it is included in the miscellaneous expenses; ▪ = not estimated because there were no producers working in another activity. Source: Survey data.

Table 2. Representativeness of each item in the effective operating cost (EOC) of 20 properties participating in the "Full Bucket" program in the State of Rio de Janeiro grouped according to the type of workforce (%) (from January to December 2011).

	Type of workforce											
	Family				Mixed				Hired			
Item	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Mean	SD	Median	IQR
Feeding	66,96 [a]	7,75	67,35	13,03	55,57 [ab]	10,48	61,43	9,17	47,76 [bc]	7,42	44,97	7,82
Concentrate	47,39 [a]	9,71	45,62	15,51	40,65 [ab]	11,71	34,32	10,34	38,48 [bc]	10,69	40,81	13,78
Protein concentrate	16,45	9,04	13,49 [a]	10,52	24,44	21,91	15,30 [ab]	20,43	12,36	6,40	11,53 [bc]	8,74
Energy concentrate	30,36 [a]	9,97	30,78	8,66	12,57 [ab]	8,11	16,27	7,45	24,20 [c]	7,83	21,55	1,01
Commercial concentrate	0,58	0,97	0,00 [a]	0,75	3,64	5,10	1,45 [a]	4,74	1,92	1,79	2,57 [a]	3,46
Mineral salt	4,72 [a]	2,72	4,03	3,15	2,90 [ab]	1,65	2,18	1,53	2,84 [bc]	1,09	3,46	1,68
Roughage	14,84 [a]	5,17	15,25	4,51	12,02 [a]	9,68	6,97	8,63	6,44 [a]	4,70	7,96	5,62
Fertilization	13,95 [a]	5,43	13,35	4,48	10,32 [a]	11,14	4,19	9,79	5,84 [a]	4,38	6,95	5,10
Pesticides	0,76	1,17	0,31 [a]	0,60	0,77	1,34	0,00 [a]	1,16	0,57	0,54	0,52 [a]	0,49
Roughage purchased	0,13	0,32	0,00 [a]	0,00	0,93	1,60	0,00 [a]	1,39	0,03	0,08	0,00 [a]	0,00
Workforce	3,14	5,80	0,63 [a]	1,93	16,94	8,27	14,59 [b]	8,01	25,27	7,95	28,06 [bc]	8,86
Health	5,46	2,64	5,75 [a]	5,16	4,25	1,24	4,57 [a]	1,21	4,65	0,92	4,98 [a]	1,35
Preventive medication	2,01 [a]	1,55	2,15	2,03	1,62 [a]	0,63	1,31	0,57	1,72 [a]	0,79	1,48	0,67
Curative medication	3,26 [a]	2,02	2,61	2,44	2,52 [a]	0,91	2,62	0,90	2,72 [a]	1,08	2,44	1,16
Health examination	0,19 [a]	0,31	0,00	0,30	0,11 [a]	0,19	0,00	0,16	0,21 [a]	0,21	0,24	0,38
Milking	1,24	0,84	1,04 [a]	1,10	0,57	0,35	0,51 [a]	0,35	0,97	0,22	0,90 [a]	0,16
Breeding	0,69 [a]	1,66	0,00	0,31	1,15 [a]	1,09	0,87	1,06	1,10 [a]	1,09	0,54	1,40
Energy	7,03 [a]	3,59	7,12	2,93	3,17 [a]	0,54	2,90	0,48	5,24 [a]	2,16	4,67	2,18
Maintenance of machines, facilities	0,71 [a]	1,32	0,09	1,07	0,60 [a]	0,72	0,21	0,63	2,63 [a]	2,54	1,01	4,21
Land rental	2,18 [a]	4,49	0,00	0,77	3,89 [a]	6,73	0,00	5,83	2,14 [a]	4,79	0,00	0,00
Miscellaneous expenses	7,15 [a]	7,29	7,10	8,66	9,62 [a]	4,01	10,78	3,88	5,58 [a]	1,21	5,59	1,19

SD = Standard Deviation; IQR = interquartile range. Different letters in the same row indicate a statistical difference ($P<0.05$). Source: Survey data.

The representativeness of feeding in EOC (Table 2), the group with the highest impact, was similar (P>0.05) between the family and mixed strata, which was similar (P>0.05) to that of the hired workforce. Food expenses in relation to EOC in the family stratum showed slightly higher values (LOPES et al., 2010) when compared to those presented for the family, mixed, and hired strata, with values of 63.66, 57.39, and 53.11%, respectively, while for the mixed and hired strata, it was slightly lower.

The group workforce (Table 2) in the family stratum had the lowest representativeness in EOC and was different (P<0.05) from the other strata, which were similar (P>0.05) to each other. This happened because the family stratum presents the only disbursement in the temporary workforce, while in the others, besides the temporary workforce, the disbursement is also made in the hired workforce. When considering the study of Lopes et al. (2010), the family stratum was well below 11.56%, while the other strata presented values close to 16.80 and 22.38% for the mixed and hired strata, respectively.

Expenditures on animal health (Table 2) are those related to the use of curative and preventive medication, as well as health examinations. A similarity (P>0.05) was observed among the strata. The ratio of 61.6, 64.2, and 63.20% was obtained for the family, mixed, and hired strata, respectively, when the means of the preventive medication were divided by the curative medication. This fact demonstrates the prophylactic orientation and awareness of the importance of animal health among producers. In this case, the producers are also generally concerned with disease prevention. However, two properties (16.60%) of the family stratum had a ratio of 5.80 and 0.00% of the preventive by curative medication. In the mixed stratum, a property (33.30%) presented a ratio of 35.80%, while in the hired stratum, a property (20.00%) showed a ratio of 29.40%. Thus, a higher precision is required by the program technicians in the prophylactic guidelines for these properties, which have not been adequately concerned with prophylaxis since prevention reduces the expenses with curative medications, milk disposal, and the involuntary disposal of animals.

Regarding the representativeness of the group milking (obtaining pre and post dipping solutions, acid and alkaline detergents, paper towel, disinfectants, and other products used in milking), no significant difference (P>0.05) was observed between the strata (Table 2). Lopes et al. (2010) observed percentage values of 0.60, 0.42, and 0.99% for the family, mixed, and hired strata, respectively. In this sense, a greater concern regarding milk quality by the family stratum is observed in this study, possibly due to the influence of the technical assistance. Among the 20 properties, 13 (65.00%) had a mechanical milking machine.

In the group breeding (acquisition of semen, liquid nitrogen, materials for insemination, among others), no significant difference (P>0.05) was observed between the strata (Table 2). In terms of percentage, the small representativeness of EOC can be explained because ten properties (83.30%) of the family stratum, two properties (66.60%) of the mixed stratum, and one property (20.00%) of the hired stratum used the natural mating, as guided by technicians. These properties were in the initial phase of the "Full Bucket" program and needed to produce a quality roughage food before the genetic improvement, which can be faster and more easily achieved through the purchase of cows instead of waiting a heifer from the artificial insemination of a cow of low genetic potential to develop and give birth. The other seven properties (35.00% of the total), adopted the artificial insemination technique. This low representativeness of EOC has been observed in several other studies (LOPES et al., 2006; PRADO et al., 2007; LOPES et al., 2011).

In the group energy (electricity and fuel), a similarity (P>0.05) was observed between the strata. In this sense, a higher representativeness of

the family stratum was observed when compared to the 2.45% found by Lopes et al. (2010). On the other hand, a lower representativeness of the mixed and hired strata was observed when compared to the 9.61 and 6.47%, respectively, found by Lopes et al. (2010).

The percentage contribution of the group maintenance of machinery and facilities in EOC (Table 2) did not differ significantly (P>0.05) among the strata. However, from the manager's point of view, a higher numerical value was observed for the strata of the hired workforce due to higher investments in facilities and machines.

The representativeness of the group land rental in EOC did not show a statistical difference (P>0.05) between the strata. Three properties (25.00%) of the family stratum, one (33.30%) of the mixed stratum, and one (20.00%) of the hired stratum had disbursement with a lease agreement.

The representativeness of the group miscellaneous expenses (cleaning products, office supplies, hygienic materials, fixed taxes, etc.) was similar (P>0.05) between the strata. These data are lower than the 14.45, 10.21, and 11.31% for the family, mixed, and hired strata, respectively, found by Lopes et al. (2010), perhaps because the researchers considered in the group of miscellaneous expenses the fees, variable taxes as a function of production, milk freight, machinery and equipment, and expenses with maintenance of facilities. In addition, the values of this study are well below the 18.14% mentioned by Lopes and Carvalho (2010).

In addition to EOC, another component of TOC is the depreciation, whose values were different (P<0.05) between the family stratum and the others, which were similar (P>0.05) to each other (Table 1). This fact is justified by the similarity (P>0.05) of the equity value without considering the land between the mixed and hired strata. Although not a disbursement, the depreciation value represents a cash reserve that should be made to replenish the assets (facilities, equipment, etc.) at the end of their useful life. This means that at the end of the useful life of the good and remaining constant the current conditions, the producer would have monetary resources to acquire a new substitute good, with no decapitalization in the medium term (LOPES et al., 2008).

Another component of TOC is the family workforce (Table 1). In this sense, a difference (P<0.05) was observed between the hired stratum and the others, which were similar (P>0.05) to each other, as expected. This situation occurred mainly due to the existence of 100.00% of the family workforce in properties of the family stratum.

The total cost (TC) was the sum of fixed costs (FC) (sum of the remuneration of land, capital invested, entrepreneur, taxes considered fixed, and depreciation) and variable costs (VC) (sum of effective operating costs, return on working capital, and family workforce) (Table 1). A significant difference (P<0.05) was observed between the family workforce stratum and the others, which were similar to each other. A difference (P<0.05) between the strata was expected since it is believed that the greater the need for the workforce is, the higher the production and, consequently, the variable costs. Although the mixed and hired strata were similar (P>0.05), from the manager's point of view the values are quite different and can be explained mainly by the amount of produced milk and animals.

Fixed costs do not represent disbursements (except for taxes), but they demonstrate what the activity should pay to be competitive when compared to other economic activities (LOPES et al., 2006). If the fixed costs are not contemplated, the cattle rancher may lose the assets and become indebted in the long term (LOPES et al, 2008). The items that make up the TC were also divided into groups and estimated the representativeness of each one (Table 3) aiming at a more detailed analysis.

Regarding remuneration of land (Table 1), a similarity (P>0.05) was observed between the family and mixed strata, as well as between the mixed and hired strata. In fact, most of the properties of the family and mixed strata present similar total values of land equity. The return on invested capital (Table 1) presented a difference (P<0.05) between the family stratum and the others, which were similar to each other.

The remuneration of the entrepreneur and taxes considered fixed had null values since there were no producers with other gainful activity, and fixed taxes such as the rural property tax and ownership tax on vehicles were not possible to determine because they were computed in the miscellaneous expenses.

The representativeness of fixed costs in the total cost (Table 3) was similar among the strata, which was not expected since the higher the volume of milk produced and the sale of animals, the greater the "dilution" of this cost. When compared to the study of Lopes et al. (2011), it was higher than the 24.10% of the total cost but close to the 27.20% found by Lopes et al. (2008). These results show that the investments in all strata because they are above the averages, are dimensioned for a milk production much higher than the average found. This fact serves mainly for two properties (40.00%) of the hired stratum since it has a total equity value well above average. In this sense, the FC/TC ratios were 33.01 and 33.78%, respectively. Regardless of the amount of milk produced, fixed costs remain constant when there is no acquisition or sale of goods and no increase in taxes. In order to be less representative of the total cost, both production and productivity must be increased, achieving an economy of scale (LOPES; CARVALHO, 2000).

Table 3. Representativeness of each item in the total cost of 20 properties participating in the "Full Bucket" program in the State of Rio de Janeiro grouped according to the type of workforce (%) (from January to December 2011).

	Type of workforce											
	Family				Mixed				Hired			
Item	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Mean	SD	Median	IQR
Fixed costs (FC)	25,75	7,43	23,75 [a]	6,42	27,10	7,56	26,03 [a]	7,50	29,29	4,95	29,53 [a]	4,21
Remuneration of land	6,68	8,28	3,82 [a]	5,23	9,00	6,51	10,43 [a]	6,39	8,28	4,48	6,44 [a]	2,77
Return on invested capital	10,72 [a]	0,98	10,72	1,48	10,25 [a]	1,32	9,88	1,28	11,10 [a]	1,86	11,94	2,89
Remuneration of the entrepreneur	*	*	*	*	*	*	*	*	*	*	*	*
Depreciation	8,35 [a]	1,47	8,54	2,11	7,85 [a]	1,24	8,37	1,15	9,90 [a]	2,55	10,95	3,51
Variable costs (VC)	71,47	7,11	73,42 [a]	4,10	70,41	7,08	72,30 [a]	6,89	67,67	5,03	67,88 [a]	5,82
Effective operating cost	46,77 [a]	9,68	47,73	8,66	55,49 [ab]	7,57	56,36	7,53	62,22 [bc]	3,74	61,30	4,83
Feeding	33,25 [a]	8,27	33,94	9,48	32,70 [a]	9,86	35,86	9,48	31,26 [a]	5,96	30,77	7,32
Concentrate	23,89 [a]	7,82	25,21	9,40	23,54 [a]	7,27	22,12	7,17	25,38 [a]	8,29	26,24	11,83
Protein concentrate	8,22 [a]	5,09	7,59	4,64	14,35 [a]	12,75	10,11	12,21	8,18 [a]	4,48	8,00	5,99
Energy concentrate	15,41	5,53	16,95 [a]	5,98	7,34	5,10	8,10 [a]	5,06	15,97	5,99	14,26 [a]	0,97
Commercial concentrate	0,26	0,44	0,00 [a]	0,37	1,85	2,52	0,84 [a]	2,36	1,23	1,15	1,66 [a]	2,10
Mineral salt	2,20 [a]	0,97	2,16	1,32	1,75 [a]	1,22	1,09	1,08	1,83 [a]	0,65	2,05	0,98
Roughage	7,16 [a]	2,45	7,56	3,91	7,41 [a]	6,85	3,47	5,94	4,06 [a]	2,79	5,18	3,48
Fertilization	6,67 [a]	2,37	7,21	2,80	6,50 [a]	7,64	2,09	6,62	3,67 [a]	2,60	4,47	3,22
Pesticides	0,42	0,74	0,17 [a]	0,30	0,45	0,78	0,00 [a]	0,67	0,36	0,34	0,34 [a]	0,27
Roughage purchased	0,07	0,18	0,00 a	0,00	0,46	0,80	0,00 a	0,69	0,02	0,05	0,00 a	0,00
Workforce	1,61	3,12	0,29 a	0,77	9,38	3,27	8,47 b	3,17	16,50	5,36	16,61 bc	4,84
Health	2,78 a	1,56	2,64	2,51	2,48 a	0,93	2,28	0,92	3,04 a	0,66	3,31	0,86
Milking	0,66 a	0,49	0,56	0,65	0,34 a	0,21	0,33	0,21	0,63 a	0,14	0,58	0,02
Breeding	0,37	0,89	0,00 a	0,15	0,72	0,74	0,51 a	0,72	0,73	0,71	0,38 a	0,98
Energy	3,39 a	1,75	3,40	2,42	1,81 a	0,11	1,86	0,10	3,40 a	1,34	3,19	0,85
Maintenance of machines, facilities	0,28	0,42	0,05 a	0,63	0,38	0,49	0,12 ab	0,43	1,67	1,58	0,70 bc	2,42
Land rental	0,91	2,04	0,00 a	0,22	1,94	3,35	0,00 a	2,90	1,38	3,08	0,00 a	0,00
Miscellaneous expenses	3,51	3,96	2,87 a	3,72	5,73	2,74	7,12 a	2,46	3,61	0,61	3,83 a	0,52
Return on working capital	1,32 a	0,50	1,44	0,30	1,74 ab	0,24	1,74	0,24	1,96 bc	0,12	1,95	0,12
Family workforce	23,38 a	6,44	24,38	7,48	13,19 ab	1,25	13,57	1,20	3,49 bc	4,90	0,00	7,21

SD = Standard Deviation; IQR = interquartile range. Different letters in the same row indicate a statistical difference ($P<0.05$). * = not estimated because there were no producers working in another activity. Source: Survey data.

The variable costs (Table 1) are the same as the effective operating costs, plus the return on working capital and family workforce. A difference (P<0.05) was observed between the family stratum and the others, which were similar to each other.

Regarding the return on working capital (Table 1) (the return rate of the savings account, which in this research was 6.00% per year, over half the EOC value in the milk activity), it is questionable to apply it to the milk producer because the vast majority of producers have commercial credit until the milk is paid, with no need for working capital. Its inclusion increases variable costs, negatively reflecting profitability and cost-effectiveness, leading to an unrealistic analysis of the results.

The representativeness of variable costs in TC (Table 3) was similar (P>0.05) among the strata. The values for the family and mixed strata were lower than 88.4 and 76.30%, respectively, and higher than 59.60% in the hired stratum (LOPES et al., 2010).

Regarding the economic efficiency indicators gross margin (gross revenue minus effective operating cost), the family stratum was similar (P>0.05) to the mixed stratum, which was similar (P>0.05) to the hired stratum. The net margin (gross revenue minus the total operating cost) (Table 1) presented a difference (P<0.05) between the hired stratum and the others, which were similar to each other. These results were mainly due to the amount of milk and animals sold, being also satisfactory (positive) and evidencing that the milk activity in the production strata is able to survive in the short and medium term, respectively. According to the positive values of net margin (Table 1), the revenue allowed a reserve related to the depreciation and the remuneration of the family workforce.

The economic efficiency indicator (gross revenue minus total cost) showed a similarity (P>0.05) between the strata. The result of the hired stratum was satisfactory (positive), what evidences that, in addition to covering all expenses, the entrepreneur was able to capitalize. In the family and mixed strata, the result was unsatisfactory, evidencing that the milk activity was not able to fully remunerate the invested capital. In the study of Lopes et al. (2010), all strata had a positive gross margin, while the net margin was positive in the mixed and hired strata.

By subtracting the average of the total cost from the average revenue in the hired stratum (Table 1), we observed that all variable costs could be paid, the depreciation reserve could be accomplished, and the capital invested in assets and land could be fully remunerated. This evidences that the studied properties in this stratum, are in general capitalizing. However, the family and mixed strata showed that all variable costs could be paid and the depreciation reserve could be accomplished, but that the capital invested in goods and land could not be fully remunerated. This fact evidences that the studied properties of these strata are, on average, decapitalizing over time, not improving the production efficiency.

When considering the indicators gross and net margin and result using only the milk revenue, we could observe (Table 1) in the mixed and hired strata that the milk activity is able to "survive" in the short and medium term, with a possibility of decapitalization since the result was negative in both strata. In the family stratum, the milk activity would be able to "survive" only in the short term since the net margin and result were negative only when considering the milk revenue. The revenue from the sale of animals and other revenue in the hired stratum was essential for the profit, but it was not enough for the family and mixed strata, presenting a negative result.

Profitability is an indicator used to compare similar activities. The values of profitability 1 (result/total revenue) (Table 1) among the strata were similar (P<0.05). In the family and mixed strata, the value was negative and means that for each R$ 100.00 of revenue there was a loss of R$ 11.56 and R$ 9.07, respectively, while in the hired stratum there was a gain of R$ 5.41. When analyzing

the profitability 2 (net margin/total revenue), a similarity (P>0.05) was observed between strata and gains of R$ 10.89, R$ 13.82, and R$ 26.41 for each R$ 100.00 of revenue, for the family, mixed, and hired strata, respectively. The values were higher because this indicator does not include the remuneration of land, return on invested capital, remuneration of the entrepreneur, and the return on working capital.

Cost-effectiveness is an indicator for comparing different activities. When the cost-effectiveness 1 was analyzed (result/effective operating cost + total fixed assets), a similarity was observed between the strata (P>0.05). The cost-effectiveness 2 (net margin/effective operating cost + total fixed assets) showed a similarity between the strata (P>0.05). They presented values of 4.21, 4.03, and 7.59% for the family, mixed, and hired strata, respectively, the latter being higher than the savings account.

In order to perform a real analysis of results, it is necessary to verify if the herd equity variation was positive by calculating the difference (in R$) of the herd equity value at the end and beginning of the study period. The herd equity variation, an index that measures herd equity valuation or devaluation, was similar (P>0.05) among the strata (Table 1). This variation, when positive, may be an indication that the herd is growing, the herd is not yet stabilized or the animals became valued. In this study, this variation was not proportional to herd size, i.e. the hired workforce stratum, which presents the highest number of animals in lactation, obtained the lowest equity variation because the herd was closer to stabilization when compared to the other systems, as well as because there was a higher exchange of animals of lower genetic potential by others of better potential. The family stratum showed a loss of R$ 2,705.18 but had an equity increment in animals of R$ 3,275.00. Thus, the result can be considered as R$ 569.82 (R$ 3,275.00 − R$ 2,705.18) without analyzing other equity increases.

The average price paid for milk in all strata was similar (P>0.05). The hired stratum, which presented the highest produced volume, was expected to receive the highest average price (Table 1) when compared to the other strata, as observed by Lopes et al. (2008), due to the volume and quality bonus. In the present study, there is no data referring to payment for quality, which could also be a reason for the lowest unit value paid to milk in the hired stratum when compared to the mixed stratum.

Conclusions

The type of workforce influences the total cost of milk production and hence the profitability and cost-effectiveness. The properties with hired workforce have the lowest total unit costs and, because they present a positive result, the dairy activity is able to produce in the long term and the cattle rancher are capitalizing. The strata that adopted mixed and family workforce have a positive net margin and negative result and are able to produce in the medium term, but they decapitalize in the long term.

The components of the effective operating cost that have the greatest representativeness on the costs of the dairy activity in the family workforce stratum, in a descending order, are food, miscellaneous expenses, and energy. In the strata of mixed and hired workforce, the most representative items are food, workforce, and miscellaneous expenses. In the composition of total production costs, the items with the highest representativeness in the family and mixed strata, as well as for the hired stratum, are food, family workforce, and return on invested capital.

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