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Effect of different alternative roughages on the profitability of milk production systems with F1 Holstein x Zebu cows[1]

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ABSTRACT

It was analyzed, by means of simulation, the effect of using four different rougahge alternatives during the dry period on the yield of milk production system using F1 Holstein x Gir cows. The rougahge alternatives were, as follows: 1) use of fresh sugar cane (*Saccharum officinarum* L.) for three months and corn silage (*Zea mays* L.) for three months, 2) use of corn silage for six months, 3) use of sorghum silage for six months, and 4) use of fresh sugar cane enriched with urea and ammonium sulfate for six months. The F1 Holstein x Gir herd of the Experimental Farm Felixlândia (FEFX) of the Agricultural Research Corporation of Minas Gerais (EPAMIG), located in the municipality of Felixlândia, state of Minas Gerais, central region of the state was used as reference. The inventory expenses, revenue and other data were registered in CUSTO BOVINO LEITE 1.0 software, aiming to generate the results for the profitability analysis. Fresh sugar cane was the rougahge alternative with the best profitability in milk production system with F1 Holstein x Gir cows, even with a smaller volume of milk produced.

Key words: corn silage; dairy cattle; production cost; simulation; sorghum silage; sugar cane.

RESUMO

Efeito de diferentes alimentos volumosos na rentabilidade de sistema de produção de leite com vacas F1 Holandês X Zebu

Analisou-se, por meio de simulação, o efeito do uso de quatro diferentes alternativas de volumosos durante o período da seca na rentabilidade de sistema de produção de leite com vacas F1 Holandês x Gir: 1) uso da cana-de-açúcar *in natura* (*Saccharum officinarum L.*) por três meses e silagem de milho (*Zea mays L.*) por três meses; 2) uso da silagem de milho durante seis meses; 3) uso da silagem de sorgo durante seis meses; e 4) uso da cana-de-açúcar *in natura* enriquecida com ureia e sulfato de amônio, durante seis meses. A referência zootécnica foi do rebanho composto por vacas F1 Holandês x Gir da Fazenda Experimental de Felixlândia (FEFX) da Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), localizada no município de Felixlândia–MG, região central do estado. O inventário com despesas, receitas e demais dados foram cadastrados no *software* CUSTO BOVINO LEITE 1.0, visando gerar os resultados para a análise de rentabilidade. A cana-de-açúcar *in natura* foi a alternativa volumosa com a melhor rentabilidade em sistema de produção de leite com vacas F1 Holandês x Gir, mesmo com um menor volume de leite produzido.

Palavras-chaves: bovinocultura leiteira; custo de produção; cana-de-açúcar; silagem de milho; silagem de sorgo; simulação.

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INTRODUCTION

It has been argued whether "milk" is a good business or whether milk activity is profitable. However, when the Brazilian agribusiness profile is analyzed, an increase in milk production over the last ten years due to the increase in the productivity of farms has been achieved. Hence, as milk production increases, it is understood that the investments have been made for the activity and it is assumed that there is an economic return. Regardless of the answer that "milk" is a good deal, or not, the fact is that the current situation of Brazilian agribusiness requires a more skilled producer, with a broader business vision, making sound decisions and effective actions. However, it is necessary to combine production technologies to management technologies. According to Guimarães (1997), the analysis of economic activity is a strong assistance to decision-making in the agricultural business, necessary and indispensable for the manager.

Neiva (2000) considered dairy farm as a business and found the existence of an enormous potential for aggregating economic value to the production. The study concludes that by applying appropriate technical guidance and simple management practices, the financial results can be significantly increased. From the administrative point of view, Helfert (2000) cites that judgment of operations is generally based on the analysis of the income statement (profit/loss); however, to perform economic judgment, it is necessary to adjust the available financial data so that they reflect the values and current economic conditions. According to Buarque (1984), the most widely used criterion for measuring the merits of an investment is simple profitability, ratio of the likely average profit and the total investment, which has the advantage of being easy to be determined.

Results of studies on milk production systems on pastures with F1 Holstein x Zebu cows of the Experimental Farm of Felixlândia, which belongs to Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), show average total milk production per cow, evaluated at nine calvings, of 3,305 kg per lactation with an average duration of 276 days (Pereira, 2012), reaching average daily milk production over 10kg. According to Ruas *et al*. (2014), this is as twice as much the average domestic production. In addition, according to those authors, animal productivity is directly linked to the genotype-environment interaction and this has been the main reason for using *Bos taurus* x *Bos indicus* (Zebu) animals in the Brazilian dairy cattle. Considering the average daily production of genetic groups, it is verified that the Holstein x Gir F1 animals had higher yields than Guzerá and Nellore-based groups, because Gir breed is the most specialized in milk production of Zebu breeds.

Nutrition is a very important factor for animal performance, in which good quality and low cost roughage supplementation is necessary in the dry season to economically allow dairy farming.

According to Schiffler *et al*. (1999), an adequate nutrition is one of several factors that respond for an efficient dairy exploitation because it allows the animal to express its productive genetic potential. However, the more productive, the more demanding the animal is in relation to nutrition. According to Costa *et al*. (2011), several factors influence the bio-economic value of forage, such as the following: nutritional value, agricultural capacity and productivity of the region, climate, production level of animals, production costs, and availability of financial resources, availability and cost of concentrated diets, management capacity of risks and knowledge of the producers.

Silages of corn (*Zea mays* L.) and sorghum (*Sorghum bicolor*) provide satisfactory performance of cows in milk production, combined with higher nitrogen use efficiency in the rumen, even with the highest ratio between roughage and concentrate (Santos, 2011).

Studies have evidenced that, despite the low digestibility and limited intake of dry matter, sugarcane provides average milk production cows conditions similar to corn silage, since over 50% of the concentrate is used in the diet (Mendonça *et al*., 2004). According to Oliveira *et al*. (2009), despite its advantages, the use of sugarcane as roughage for cattle collides with management errors that reduce the animals' voluntary intake, especially because of the low quality fiber.

The objective of this study was to analyze the milk production system profitability with F1 Holstein x Zebu cows using different alternatives of roughage during the dry season.

MATERIAL AND METHODS

This study combined technologies for production and management, that is, from information on animal performance (production), profitability results (management) could be found.

The use of four different roughage alternatives was analyzed by means of simulation during the dry period in milk production system profitability using F1 Holstein x Gir cows. In the simulation, during the six months of the dry season, the alternatives to roughage were: 1) use of fresh sugarcane (*Saccharum officinarum* L.) enriched with urea and ammonium sulfate, for three months and corn (*Zea mays* L.) silage for three months; 2) use of corn silage for six months; 3) use of sorghum silage for six months; and 4) use of fresh sugarcane enriched with urea and ammonium sulfate for six months. During the rainy season

(summer), the cows were kept for six months in pastures divided into paddocks, formed by *Brachiaria decumbens* and *Brachiaria brizantha* grasses, which is a situation common to all alternatives. According to Gomide *et al*. (2001), *Brachiaria decumbens* pastures are able to sustain crossbred cows with an average milk production of 11.0 kg/animal/day. The concentrated supplementation was held during milking and in accordance with milk production of the cows, at the proportion of 1.0 kg for 3.0 kg of milk produced from 5.0 kg of milk.

Animal performance control was the herd consisted of F1 Holstein x Gir cows of the Felixlândia Experimental Farm (FEFX) of the Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), located in the municipality of Felixlândia, state of Minas Gerais, in the central region of the state. According to Köppen classification, the climate in the region is classified as tropical savannah, with two distinct seasons, dry winter (from May to October) and rainy summer (from November to April). The average annual rainfall is 1,126 mm.

For thirty days, the cows in the pre-calving period were offered 0.8 kg of concentrate per day during the dry season. The water, in drinking fountains and/or dams, and mineral mixture in covered troughs were available. After 24 hours after calving, cows were conducted to the system of cows in production. Those with production over 8 kg of milk per day were milked twice daily; with the production between 5 and 8 kg of milk per day, were milked once. Cows with production below 5 kg of milk per day were released with the offspring and when they completed 90 days of pre-calving, they were separated from their calves. To stimulate milk ejection, calves followed their mothers in the milking parlor. They are from finishing crossing and were sold in separation.

Management and animal genetics were regarded similar to FEFX production system and the results of animal performance found in the literature were applicable to this system. Only the production infrastructure was different and, for calculation purposes, it was considered the hypothetical system of milk production with 68 F1 Holstein x Gir cows milked by two workers in a herringbone type-milking parlor with moat and double wings with four cows at each side. The milking machine used was one with open system with "bucket at the foot" with four sets of pumps.

The calculations of this study were based on production data (Table 1) and reproductive data (Table 2) from the milk production system with F1 Holstein x Gir cows of FEFX - EPAMIG and on technical indexes and management of F1 Holstein Gir cows found in the literature (Table 3). It was based, also, during the period from May 1/2011 to April 30/2012, on the values related to the sale of animals and products and market indicators (Table 4), price quotations obtained from Cepea Bulletin (Centro de Estudos Avançados em Economia Aplicada – Região de referencia de Minas Gerais) and on the economic and financial data of the hypothetical milk production system.

To analyze the profitability, first was defined the infrastructure of the hypothetical system of milk production and then the inventory was carried out (registration of all movables and improvements as well as their characteristics: date and acquisition value, useful life and waste value). Such information was recorded at the beginning of the experiment, that is, May 1/2011. According to Lopes *et al*. (2004), the inventory consists of verifying the existence of goods, the detailed description of the physical aspects, the classification into groups according to their specific category (improvements, equipment, tools, machinery, furniture, cattle, livestock, vehicles and implements) and assessment of monetary value, according to the state of use.

Information relating to costs (labor, food, hygiene, etc.) and income (milk and animals) were estimated according to literature and recorded in appropriate spreadsheet for this purpose. It should be noted that expenses inherent to the alternative use of roughage were considered as well as the resulting revenue since costs and production performance are different for each situation. Monthly information related to market indicators required by the software (value for entrepreneur payment, rental value of the land, monthly real rate of interest and value of the land) were defined according to the current market values.

The inventory with expenses, income and other data were registered in the software CUSTO BOVINO LEITE 1.0, in order to generate the results for the profitability analysis. Such software includes the methodologies of the total production cost (classical), which involves the fixed and variable costs, used by Barros (1948), and operating costs proposed by Matsunaga *et al*. (1976).

From an economic point of view, the analysis of the various uses of production factors and prices, in this study, was based on the principles of the theory of production, which technologically relates the physical quantity of products with production factors, and on the principles of theory of production costs, which relates the physical quantity of products with the prices of production factors. Based on those principles, in a production activity and according to the business objective of maximizing the results, the objective is to achieve as a maximum production as possible for a particular total cost or to obtain the total minimum cost for a particular level of production due to the use of given combination of factors (Vasconcellos & Garcia, 2014). According to Ferguson (1991), the physical conditions of production and the prices of resources jointly establish the cost of production, a very important factor for individual companies and for firms and the economy as a whole.

The inventory and information from market indicators (real interest rate, manager's remuneration etc.) were considered equal to the four alternatives. The expenses related to the milk production of each roughage alternative were estimated and were equal to all items of the effective operational cost, except for the food item, which varied because of the intake of dry matter (DM), according to Santos (2011), and the production cost of roughage used in the study. For calculation purposes, rent of the pasture and the production cost of the roughage placed in the trough according to the average values practiced in the region. In relation to the revenue, the difference in the volume of milk produced by cows according to the roughage alternative was estimated according to Santos (2011).

The generated results were tabulated in a spreadsheet developed in MS Excel® and compared with each other using descriptive statistical analysis (Lopes *et al*., 2009). It is noteworthy that because the focus of this study is a comparison of the use of different roughages on the profitability of a milk production system, estimates of parameters of a production function were not made neither a cost function for each roughage. In other words, it was not the objective of this study to evaluate difference in profitability inherent to particular roughage, but rather a comparison between them, respecting the productive, reproductive, economic and financial data and the technical indexes and management and market indicators of each analyzed situation.

RESULTS AND DISCUSSION

A summary of the profitability of the milk production system analysis with F1 Holstein x Gir cows using different alternatives of roughage during the dry season is shown in Table 5. The use of fresh sugarcane, such as roughage, presented lower milk production during the period, therefore, lower revenue. However, due to lower cost of production, it showed better economic results (profit), resulting in an increase in the profitability.

The highest revenue was achieved with the use of corn silage (R$ 251,610.93 and the lowest was achieved with the use of fresh sugarcane (R$ 230,403.04). This can be explained by the fact that with the same selling price of milk in the period and the same revenue value with the animals, the alternative of higher milk production in the

Table 1: Means and standard deviations of milk production of F1 Holstein x Gir cows in different calving orders used in this study

Calving order	Total production (kg)	Daily average production (kg)	Length of lactation (days)	Maximum average production (kg)
First	2,426.36^{e}±710.45	8.14^{g}±2.03	297.97^{a}±49.55	13.23^{e}±3.13
Second	3,048.47^{d}±833.12	10.82^{f}±2.39	280.96^{b}±42.16	17.32^{d}±8.31
Third	3,391.39^{c}±895.43	11.84^{e}±2.26	285.57^{b}±50.39	18.06^{d}±2.84
Fourth	3,646.20^{b}±874.48	12.92^{d}±2.16	281.29^{b}±43.72	19.17^{c}±3.25
Fifth	3,886.23^{a}±899.45	14.00^{c}±2.61	278.00^{b}±43.13	20.76^{b}±6.65
Sixth	4,005.36^{a}±938.86	14.46^{b}±2.31	276.29^{b}±43.97	21.28^{b}±3.53
Seventh	4,033.58^{a}±810.55	15.20^{a}±2.51	265.94^{c}±34.05	22.18^{a}±3.21
Eighth	3,961.23^{a}±644.66	15.33^{a}±1.97	259.24^{c}±34.29	22.13^{a}±2.90
Ninth	3,881.94^{a}±669.57	15.51^{a}±2.69	251.79^{d}±29.67	22.23^{a}±3.10

Means followed by different lower case letter in the same column are different ($p < 0.05$) by the Scott-Knott test
Source: Pereira (2012)

Table 2: Reproductive indices of F1 Holstein x Gir cows in function of the calving order used in this study

Calving order	Weight at calving (kg)	Service period (days)	Calving interval (days)	Age at calving (months)
First	442.4^{d}	160.4^{a}	446.0^{a}	33.7
Second	473.7^{c}	90.2^{b}	376.0^{b}	48.3
Third	497.2^{b}	76.2^{b}	361.4^{b}	60.7
Fourth	502.6^{b}	72.0^{b}	355.2^{b}	72.6
Fifth	500.8^{b}	89.1^{b}	375.9^{b}	84.3
Sixth	519.9^{a}	79.9^{b}	370.1^{b}	96.6
Seventh	529.6^{a}	96.2^{b}	382.1^{b}	108.8
Eighth	534.7^{a}	67.3^{b}	347.6^{b}	121.4
Ninth	541.1^{a}	76.9^{b}	350.1^{b}	130.5

Means followed by different lower case letters in the same column are different ($p < 0.05$) by the Scott-Knott test
Source: Oliveira *et al.* (2012)

period provided the highest total revenue. According to Santos (2011), milk production of F1 Holstein x Zebu cows fed corn silage and sorghum silage did not differ, - 13.76 kg vs. 12.54 kg, ($p > 0.05$), but it was higher than the production of cows fed fresh sugarcane and sugarcane silage, 11.13 kg versus 9.76 kg, which did not differ among each other.

Total operating cost (TOC) was higher with the use of corn silage, followed by corn silage plus fresh sugar cane, silage sorghum and fresh sugarcane (Table 5). This is because besides the difference in the amount of dry matter (DM) consumed, which is 11.55, 10.03 and 7.71 kg/day for corn silage, sorghum and fresh sugarcane silage, respectively, according to Santos (2011), the price of the

Table 3: Technical and management indices of F1 Holstein x Gir cows found in the literature and used in this study

Item	Value
Birth rate [1]	98.13%
Calving interval – average 9 calvings[1]	373.82 days
Mortality rate of calving until 12 months [2]	7.0%
Mortality rate of heifers from 12 to 18 months[2]	1.0%
Mortality rate of heifers from 18 to 24 months [2]	1.0%
Mortality rate of cows - annual[2]	1.0%
Total production during lactation – average 9 calvings[3]	3,586.75 kg
Lactation length – average 9 calvings[3]	275.23 days
Milk production – average per day (9 years) [3]	13.03 kg/day
Weight of the cow at calving – average 9 calvings[1]	504.66
Annual remodeling rate – considering 9 calvings	12%
Dry matter intake corn silage [4]	11.55 kg
Dry matter intake sorghum silage [4]	10.03 kg
Dry matter intake fresh sugar cane[4]	7.71 kg
Milk production /cow/day – corn silage [4]	13.76 kg
Milk production /cow/day – sorghum silage [4]	12.54 kg
Milk production /cow/day – fresh sugar cane[4]	11.13 kg
Average weight of calf at weaning [5]	174.6 kg

[1] Oliveira *et al.* (2012); [2] Campos and Ferreira (2006) [3] Pereira (2012); [4] Santos (2011);
[5] Pereira *et al.* (2010)

Table 4: Values related to animals and products trade and to the Market indicators used in this study

Item	Value
Milk commercialization	Monthly price - Cepea[1]
Calf (a) – average weight 175.6 kg	@ ox - Cepea[1]
Disposable cow	17 @ cow - Cepea[1]
Heifers F1 30 months – pregnant 6 months	30 @ ox - Cepea[1]
Heifers F1 10 months – weaned	20 @ ox - Cepea[1]
Concentrate – period average	R$0.63/kg
Concentrate:milk ration (over 5 kg milk)	1:3
Pasture rent - monthly	20% @ ox - Cepea[1]
Production cost – corn silage in the trough[2]	R$93.50/ton.
Production cost – sorghum silage on the trough[2]	R$79.00/ton.
Production cost – fresh sugar cane on the trough[2]	R$51.00/ton.
Hired labor – per worker per month	SM + 36.8% of charges
Minimum wage (SM) – 2011	R$545.00
Correction index from 11/2011 to 09/2013 (IGP-M)	1.1222637
Real interest rate – monthly	0.5%
Manager salary	R$0.00
Production system area	10 ha
Land per ha	R$10,000.00
Rental – control	1 litter milk/day/ha

[1] Cepea. Control region: Minas Gerais (MG)
[2] Average values practiced in the region in the study period

feeds also varies. The larger the consumption of roughage, which is more expensive, the higher the effective operational cost (EOC). Since depreciated cost (DC) of the system was equal to the presented alternatives, TOC was higher for the alternative of higher EOC.

However, all roughage alternatives were positive in the period analyzed, that is, it was possible to cover the fixed costs and variable costs and still obtained some profit (Table 5). Therefore, positive gross and net margins evidence that the evaluated production systems are being paid and presenting the possibility of growth in the short and long term.

According to Varian (2003), however, in line with the traditional microeconomic theory, or the neoclassical cost theory, the only level of reasonable long-term profit for a competitive company that has constant to scale returns in all product levels is profit zero. Most people judge this statement as surprising because the premise is that companies have the ultimate objective of maximizing profits in the short and long term. In addition, three cases could occur with a company that tried to expand indefinitely in a situation where it could just get zero profit in the long term, according to that author. First, loss of efficiency by becoming such a large company, which means no to scale constant returns; second, by becoming so large, it would take control of the market and would influence the price of the product for having few competitors; and third, in a situation of positive profits and the possibility of access for competitors to the technology used, an increase in competition would happen, which would decrease the price of the product and the profit of all companies, consequently.

By dividing the revenue from the sale of animals (R$ 48,065.75) by the total revenue (R$ 241,137.98), the result is the average percentage of 19.9% of the contribution from the sale of animals in the total revenue. This value is above the average of 12.45%, found by Lopes *et al*. (2004) in a study with data from 16 milk production systems located in the region of Lavras. Moraes *et al*. (2004) reported a value of 25% of the sale of weaned calves in total revenues, in a study with F1 Holstein-Zebu herd.

It can be seen that depreciate costs responded for 13.89% of TOC (Table 6) on average, which is close to the value of 14.37% obtained by Lopes *et al*. (2004). The fixed costs/ total cost ratio was 24.89%, which is lower than the 34.06% reported by Lopes *et al*. (2004). It was found that the use efficiency of assets (improvements and equipment) of the

Table 5: Profitability summary comparative of the of milk farming of milk production systems using different roughage alternatives during dry season from May/2011 to April/ 2012

Specification	Sugarcane and corn silage	Corn silage	Sorgghum silage	Fresh sugar cane	Mean	Standard deviation
Revenue (R$)	240,765.70	251,610.93	241,772.24	230,403.04	241,137.98	8,669.15
Milk (R$)	192,699.95	203,545.18	193,706.49	182,337.29	193,072.23	8,669.15
Animals (R$)	48,065.75	48,065.75	48,065.75	48,065.75	48,065.75	0.00
Manure (R$)	0.00	0.00	0.00	0.00	0.00	0.00
Outher revenues (R$)	0.00	0.00	0.00	0.00	0.00	0.00
Total operational cost (TOC) (R$)	159,899.32	174,449.68	161,734.30	145,348.96	160,358.07	11,915.69
Effective operational cost (EOC) (R$)	137,721.40	152,271.76	139,556.38	123,171.04	138,180.15	11,915.69
Depreciate cost (DC) (R$)	22,177.92	22,177.92	22,177.92	22,177.92	22,177.92	0.00
Family member (R$)	0.00	0.00	0.00	0.00	0.00	0.00
Total cost (TC) (R$)	185,276.45	200,117.81	187,100.44	170,325.95	185,705.16	12,198.02
Fixed cost (FC) (R$)	46,065.49	46,065.49	46,065.49	46,065.49	46,065.49	0.00
Land payment (R$)	112.00	112.00	112.00	112.00	112.00	0.00
Invested capital payment (R$)	22,832.31	22,832.31	22,832.31	22,832.31	22,832.31	0.00
Manager salary (R$)	0.00	0.00	0.00	0.00	0.00	0.00
Fixed taxes (R$)	943.26	943.26	943.26	943.26	943.26	0.00
Depretiation (R$)	22,177.92	22,177.92	22,177.92	22,177.92	22,177.92	0.00
Variable cost (VC) (R$)	139,210.96	154,052.32	141,034.95	124,260.46	139,639.67	12,198.02
Effective operational cost (without/tax) (R$)	136,778.14	151,328.50	138,613.12	122,227.78	137,236.89	11,915.69
Working capital remunaration (R$)	2,432.82	2,723.82	2,421.83	2,032.68	2,402.79	283.61
Family labor (R$)	0.00	0.00	0.00	0.00	0.00	0.00
Gross margin (R$)	103,987.56	100,282.43	103,159.12	108,175.26	103,901.09	3,261.96
Net margin (R$)	80,866.38	77,161.25	80,037.94	85,054.08	80,779.91	3,261.96
Result (profit or loss)(R$)	55,489.25	51,493.12	54,671.80	60,077.09	55,432.82	3,543.67
Profitability (%)	23.05	20.47	22.61	26.07	23,05	2.31
Rentability (%)	8.85	8.02	8.69	9.80	8.84	0.74
Total produced milk (kg)	223,424.00	235,521.00	224,297.00	211,327.00	223,642.25	9,886.80

production system in this study was proportionally better due to the lower investment in immobilized for roughage production has reduced the fixed cost/total cost ratio.

The depreciate ratio by TOC is inverse to the amount of milk produced. It can be seen that the use of corn silage presented the lowest percentage in that ratio (12.71%) and the highest daily milk production (645.26 kg), while the use of fresh sugarcane resulted in the highest percentage (15.26%) and the lowest daily milk production (578.98 kg). This fact is due to production scale because the depreciation value is divided by a larger amount (amount of milk) making the value per unit proportionally smaller, that is, a "dilution" of costs has occurred.

The COE/TOC ratio was higher with the use of corn silage (86.75%) due to its largest consumption by the cows and its higher purchase cost increased COE. This resulted in an increase of 30.8% in the equilibrium point of the system with the use of corn silage (600.58 kg milk/day) compared to that with fresh sugar cane (459.23 kg milk/day). According to Sanvicente (1987), the analysis of the equilibrium point is valid for a particular operating capacity; whether changes occur, the initial analysis will need to be reviewed. However, this analysis is more applicable in a short-term perspective, because the operation capacity cannot be changed.

Animal productivity was 12.25 kg of milk per cow per day, on average, a value close to 14.28 found by Lopes *et al*. (2006) and higher than the average of 9.65 reported by Lopes *et al*. (2004). The yield of five milking cows per hectare is higher than 1.17 (Lopes *et al*., 2006) and 0.47 (Lopes *et al*., 2004). All this resulted in an average yield per hectare per year of 22,364.23 kg of milk, showing excellent production and reproductive efficiency of those cows in this type of milk production system, when compared to the averages of 6,057.37 and 1,622.58 reported by Lopes *et al*. (2006) and Lopes *et al*. (2004), respectively.

In relation to production of milk per labor, an average of 306.36 kg milk/man/day was found. This value is lower than that found by Yamaguchi *et al*. (2008), in a survey conducted in the North of Minas Gerais, which was 326.33 kg milk/man/day, well above the average recorded by Lopes *et al*. (2004), 10 production systems, which was 143.68 kg milk/man/day, and higher than the production recorded by Schiffler *et al*. (1999), which was 246.12 kg milk/man/day.

By evaluating the composition of the COE (Table 7), it can be seen that feeding represented, on average, 50.37%. It is observed that feeding using corn silage provided the highest percentage (55.25%) among the four alternatives; however, it was the alternative that had the lowest proportion of concentrate (17.35%). By using fresh sugarcane, the lowest percentage (44.60%) was obtained in the COE and the highest proportion of concentrate (21.48%). As for labor, the average percentage of 13.11% is consistent with the average of 13.37% found by Lopes *et al*. (2004). Regarding miscellaneous expenses, the average percentage of 23.41% is high and well above the average of 10.83% reported by Lopes *et al*. (2004), which may be explained by the high freight cost, which in turn is related to external factors such as quality of roads and distance traveled, mostly.

By subtracting the total cost of the average price of milk, it is observed (Table 8) that with the use of corn silage plus fresh sugarcane, corn silage, sorghum and fresh sugarcane silage, profits of R$ 0.03, R$ 0.01 and R$ 0.03

Table 6: Technical / management indices of dairy farming of milk production systems using different roughage alternatives during the dry season, from May 2011 to April 2012

Specification	Sugarcane and corn silage	Corn silage	Sorghum silage	*Fresh sugar cane*	Mean	Standard deviation
Depreciation / TOC (%)	13.87	12.71	13.71	15.26	13.89	1.05
COE / COT (%)	85.54	86.75	85.70	84.09	85.52	1.09
Family labor / COT (%)	0.00	0.00	0.00	0.00	0.00	0.00
Fixed cost / total cost (%)	24.86	23.02	24.62	27.05	24.89	1.66
Variable cost / Total cost (%)	75.14	76.98	75.38	72.95	75.11	1.66
Depreciation / Total cost (%)	11.97	11.08	11.85	13.02	11.98	0.80
Animal productivity / day (kg of milk)	12.24	12.91	12.29	11.58	12.25	0.54
Animal productivity / ha/ year (kg of milk)	22,342.40	23,552.10	22,429.70	21,132.70	22,364.23	988.68
Sold daily production (kg of milk)	612.12	645.26	614.51	578.98	612.72	27.09
Daily production (kg of milk)	612.12	645.26	614.51	578.98	612.72	27.09
Balance point /kg milk / day (kg of milk)	527.17	600.58	537.44	459.23	531.11	57.87
Number of milking cows / ha (un)	5.00	5.00	5.00	5.00	5.00	0.00
Milk production / labor (kg / service)	306.06	322.63	307.26	289.49	306.36	13.54
Matrices / man ratio (un)	34.00	34.00	34.00	34.00	34.00	0.00
Herd / man total ratio (un)	65.00	65.00	65.00	65.00	65.00	0.00
Labor quantity (un)	2.00	2.00	2.00	2.00	2.00	0.00

Table 7: Representation of each item in the effective operational cost of dairy farming of milk production systems, in %, using different roughage alternatives during the dry season, from May 2011 to April 2012

Specification	Sugarcane and corn silage	Corn silage	Sorghum silage	Fresh sugar cane	Mean	Standard deviation
Feeding	50.49	55.25	51.15	44.60	50.37	4.39
Concentrade	19.19	17.35	18.94	21.48	19.24	1.70
Mineral salt	0.94	0.85	0.93	1.05	0.94	0.08
Rougahge	30.36	37.06	31.28	22.07	30.19	6.17
Labor	13.08	11.82	12.91	14.64	13.11	1.16
Sanity	3.28	2.97	3.24	3.67	3.29	0.29
Milking	4.37	3.95	4.31	4.89	4.38	0.39
Reproduction	1.56	1.41	1.54	1.75	1.57	0.14
Energy	3.86	3.49	3.81	4.32	3.87	0.34
Miscelaneous costs	23.36	21.11	23.05	26.14	23.41	2.07

Table 8: Average production costs of dairy activity of milk production systems using different roughage alternatives during the dry season, from May 2011 to April 2012

Specification	Sugarcane and corn silage	Corn silage	Sorghum silage	Fresh sugar cane	Mean	Standard deviation
Milk average price (R$) / kg	0.86	0.86	0.86	0.86	0.86	0.00
Total operational cost (R$) / kg	0.72	0.74	0.72	0.69	0.72	0.02
Effective operational costCost (R$) / kg	0.61	0.64	0.62	0.58	0.61	0.03
Total cost (R$) /kg	0.83	0.85	0.83	0.81	0.83	0.02
Fixed cost (R$) / kg	0.21	0.20	0.21	0.22	0.21	0.01
Variable cost (R$)/ kg	0.62	0.65	0.63	0.59	0.62	0.03

and R$ 0.05 per kg of milk were obtained, respectively. Therefore, all alternatives were economically and financially viable, even without considering the income from the sale of animals.

Despite the excellent results of animal performance cited in the literature regarding the productivity of animals with an average production of 13.76 kg of milk per cow per day (Santos, 2011), the use of corn silage in this study was the alternative that presented the worst economic and financial results with profitability of 20.47% and income of 8.02%. To become a good option and reach the same profitability of the use of fresh sugarcane, its cost would have be R$ 74.00/t; a value almost impossible to be achieved since the average practiced in the region during the study period was R$ 93.50/ton.

Besides presenting the best profitability among the roughage alternatives during the dry season, the use of fresh sugarcane also presented the best profitability. Regarding profitability, where the total investment in the activity is taken into account, when making a comparison with the financial investment in savings (return of 6% per year), investment in milk production activity with the use of such roughage (profitability of 9.8% per year), as presented in this study proved to be the best investment option. It should be stressed that the comparison with investment in savings was because it is considered safe and the most popular investment in Brazil, although is not always the best alternative offered in the financial market. According to Buarque (1984), based on the yield rate, when different investment alternatives are compared, it can be selected that one that allows the greatest amount of resource recovery per investment unit.

CONCLUSION

Fresh sugarcane (*Saccharum officinarum* L.) during the dry season, was the roughage alternative with the highest profitability in milk production system with F1 Holstein x Gir cows, even with a smaller volume of produced of milk.

The use of corn (*Zea mays* L.) silage, despite providing lower cost with concentrated, presented the highest total operating cost because, in addition to the higher consumption by cows, this was the roughage that presented the highest purchase cost. Even as the roughage that presented the highest productivity of cows and therefore, the highest revenue, it was not that one that presented the highest profitability.

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