

Production costs and economic indicators in the complete cycle of crossbred dairy calves

Custos de produção e indicadores econômicos no ciclo completo de bezerros mestiços leiteiros

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Abstract

The complete rearing cycle of dairy calves is not yet widely adopted by rural producers, possibly because they do not perceive these animals as potential meat producers or are unaware of their production capabilities. This study aimed to assess the economic viability of rearing dairy calves through their entire growth cycle. Sixteen Holstein × Gyr crossbred animals were assessed, originating from dairy farming, with an average initial weight of 40.67 ± 5.27 kg and slaughtered at 10 months of age, reaching a final weight of 320.4 ± 45.87 kg. These calves were reared in a feedlot system and received a mash diet without the inclusion of roughage. The experiment was conducted on a farm primarily focused on dairy farming, situated in the municipality of Turvânia, GO, Brazil. Economic evaluations were conducted at the conclusion of the production cycle, with the calculation of the value of the *arroba* (@ = 15 kg) produced. Data were analyzed using a production cost structure methodology, which included effective operating cost, total operating cost, and total cost. The following economic indicators were examined: gross revenue, gross margin, net margin, and the break-even point. Results were highly promising, demonstrating a profit from raising dairy male calves, with a net margin per animal of BRL 321.50. Additionally, these animals displayed noteworthy potential for weight gain and carcass quality. A total of 149.19 @ were produced, averaging 9.32 @ per animal, with a production cost of BRL 105.52, encompassing expenses such as milk consumption, concentrate diet, and labor, which amounted to BRL 1.18 per month per animal. These findings underscore the economic feasibility of this rearing system.

Keywords: Cattle farming. Financial analysis. Profitability.

Resumo

O ciclo completo de bezerros leiteiros ainda não é muito utilizado pelos produtores rurais, por não considerarem esses animais como produtores de carne, ou pelo motivo de não conhecerem o potencial de produção. Objetivou-se avaliar os índices econômicos do ciclo completo em bezerros leiteiros. Foram avaliados 16 animais mestiços Holandês x Gir, oriundos da atividade leiteira com peso médio inicial de $40,67 \pm 5,27$ kg, abatidos aos 10 meses de vida com peso final de $320,4 \pm 45,87$ kg, mantidos em sistema de confinamento recebendo dieta farelada sem o uso de volumoso. O experimento foi conduzido em uma propriedade com principal fonte renda à atividade leiteira, no município de Turvânia-GO. As avaliações econômicas foram feitas no final do ciclo de produção, com o cálculo do valor da arroba (@) produzida, para a interpretação dos dados utilizou-se a metodologia da estrutura de custos de produção: custo operacional efetivo, custo operacional total e custo total. Foram analisados os seguintes indicadores econômicos: receita bruta, margem bruta, margem líquida e ponto de equilíbrio. Os resultados obtidos foram satisfatórios, ao apresentarem lucro com utilização dos machos leiteiros, com Margem Líquida por animal de R\$ 321.50, além do potencial de ganho de peso e qualidade de carcaça desses animais. Foram produzidas 149,19 @ com média de 9,32 @ animal⁻¹, com o custo de produção de R\$ 105,52 incluindo o leite consumido, dieta concentrada e a mão-de-obra no valor de R\$ 1,18 ao mês por animal, demonstrando viabilidade econômica do sistema.

Palavras-chave: Análise financeira, Bovinocultura, Rentabilidade.

Introduction

Given the notable advancements and significant transformations in the dairy industry, milk producers are increasingly recognizing the importance of efficient animal husbandry as a key factor in their operations. This shift towards efficiency not only enhances competitiveness but also empowers them to adopt an entrepreneurial mindset, regardless of the scale of their production system (Lopes et al., 2009).

Effective livestock planning and financial management have become essential strategies for overseeing the entire production system with the ultimate goal of generating profit for rural producers. Achieving this objective hinges on efficient management practices, cost reduction, optimal utilization of available resources, scaling up production, and, to lower feed expenses—a significant cost component in the system. To make

most importantly, making informed technical decisions (Araújo et al., 2012).

While the dairy sector plays a major role in Brazil's economy, many producers remain dissatisfied with the price per liter of milk and demonstrate concerns regarding male calves born from dairy operations, which are viewed as a problem.

Historically, male calves on dairy farms were typically culled at birth. However, a more recent strategy involves integrating these dairy calves into beef production, capitalizing on their potential for meat production, especially when they are not destined for dairy purposes (Maher et al., 2021). Managing the complete life cycle of these animals necessitates close monitoring of production costs, which, in turn, calls for strategic procurement of inputs and the utilization of by-products

this endeavor appealing, a preliminary assessment of diets, costs, and the

availability of inputs in the local market is necessary.

This approach represents a compelling alternative for generating a viable and sustainable secondary income source for producers, offering profitability with a relatively low investment. Meat from dairy herds also carries substantially lower greenhouse gas emissions compared to beef production, aligning with environmental sustainability goals. Therefore, maximizing the utilization of surplus male calves is recommended from both an economic and environmental standpoint (Rutherford et al., 2021).

Within this context, the objective of this study is to evaluate the economic indicators associated with the complete life cycle of dairy calves.

Material and Methods

The study was conducted in Turvânia, GO, Brazil, on a farm situated along the GO 060 highway (16°36'14.88" S, 50°13'31.14" W, 627 m above sea level). The local climate experiences a minimum temperature of 18 °C and a maximum temperature of 33 °C. Dairy production is the primary source of income for this farm, with an annual milk production of 275,000 L. The farm maintains around 70 lactating cows in a semi-intensive system, allowing the animals to graze in pastures during the rainy season and confining them during the dry period of the year.

The research project received approval from the Ethics Committee for the Use of Animals (approval no. 010/2019). Sixteen calves sourced from the farm's dairy operations were selected for feedlotting based on specific criteria, including initial age and body weight similarity. These calves had an average initial age of 40 ± 20 days and an average weight of 40.67 ± 5.27 kg at the outset of the experiment.

They were crossbreeds between Holstein and Gyr cattle.

Initially, the calves were individually identified using numerical ear tags placed between the first and second ribs. They were then weighed using a measuring tape to measure chest circumference, with the conversion from centimeters to kilograms following the table for cattle, with an approximate accuracy of 95%, provided by the National Rural Learning Service - GO.

Each calf had an individual record containing its mother's name, birth weight, and any observations regarding health issues such as parasitic infections, diarrhea, pneumonia, or other abnormalities. Notably, 13 of the animals experienced keratoconjunctivitis. The treatment protocol involved intramuscular administration of enrofloxacin 10% and vitamin A in three doses. Additionally, a spray containing oxytetracycline hydrochloride (equivalent to 30 mg of oxytetracycline base) and 10 mg of hydrocortisone was applied twice daily for five days.

The animals were housed in a wooden corral equipped with feeders and drinkers, as part of an intensive system. They had access to the open area without natural or artificial shading. The corral had a space allowance of 10 m² animal⁻¹, aligning with the well-being guidelines for adult cattle, with troughs spaced one linear meter apart.

Feeding for the calves involved twice-daily suckling, with two liters of milk provided during each feeding session. The milk was sourced from the farm's cows and continued to be supplied to the calves until they reached 60 days of age. The weaning process was gradual, spanning the final 10 days, during which the milk supply was reduced to one daily feeding of 4 L. In the five days leading up to complete weaning, the milk quantity

was further halved, with a restriction to two liters per day.

With regard to the diet, the animals commenced their feeding regimen from the initial days of the project. This early introduction to nutrition allowed the calves to consume an adequate quantity of feed to fulfill their nutritional requirements and promote satisfactory growth.

The diet was tailored to each stage of the animals' development and according to their respective weights. A 20-day adaptation period involved the gradual incorporation of roughage. At the outset, the animals consumed a diet comprising 80% roughage and 20% concentrate. By the 3rd to 5th day, the ratio shifted to 70/30%. This proportion further evolved to 60/40% from the 6th to the 8th day, 50/50% from the 8th to the 10th day, 40/60% from the 11th to the 15th day, 20/80% from the 16th to the 20th day, and eventually, by the 21st day, it became a 100% concentrate diet. As the concentrate portion increased, roughage was gradually phased out, culminating in an exclusively concentrate-based diet (Total Diet) This approach maintained an estimated intake of 3.5% of live weight (LW) in dry matter (DM) throughout all phases, including pre-weaning, growth, and finishing.

The diet composition primarily relied on readily available and economically viable ingredients for the producer. By-products such as soybean hulls and cottonseed cake served as a source of fiber for the animals, as no roughage was used. These same ingredients were employed to optimize the cost per kilogram of the diet. The concentrate formula consisted of ground corn (29.25%), soybean hulls (52.64%), soybean meal (3.92%), cottonseed cake (9.94%), mineral mixture (0.99%), urea (1.59%), calcitic limestone (1.17%), common salt (0.49%), and monensin 40% (0.005%). A base of 160

was used in the mixture, supplemented with an additional 1%. It is important to stress that the diet already provided all the essential nutrients required for the optimal performance of the animals.

Feeding occurred twice daily, at 08h00 and 18h00, ensuring minimal disruption to the daily routine at the farm. This regimen aimed for a daily weight gain of 1,200 kg, with *ad libitum* access to water provided through reinforced concrete drinkers. Trough readings were taken before the morning feeding, allowing for a surplus of up to 5% of the provided feed. Regular analyses were conducted on each batch of diet, primarily focused on visual assessment of the animals' acceptance due to variations in particle sizes between the by-products used.

The animals were weighed every 30 days using a measuring tape to ensure that feed consumption did not exceed the estimated requirements. Prior to slaughter, the cattle underwent a 12-h fasting period to obtain accurate body weights. Slaughter operations took place in a refrigerated slaughterhouse in accordance with the humanitarian laws in force by the Regulation on the Industrial and Sanitary Inspection of Animal Products.

The economic viability of the experiment was evaluated based on various factors, including the cost of feed per @ produced, which involved dividing expenses by the @ gained during each phase (pre-weaning, growth, and finishing). This calculation incorporated labor costs at an average regional rate. Feed conversion ratio was calculated by dividing the amount of feed consumed by the animals by their weight gain. The cost of the diet during each life stage and the number of days in the feedlot were also used as metrics.

Additional metrics considered in the economic analysis included Effective Operating Cost (EOC), Total Operating Cost (TOC), Total Cost (TC), Gross

Income (GI), Gross Margin (GM), Net Margin (NM), and the break-even point (Silva & Buss, 2011).

The calculation of the Effective Operating Cost (EOC) encompasses all expenditures related to feed, medicines, equipment, outsourced labor, electricity, and any other costs associated with the production or sale of the final product. Total Operating Cost (TOC) evaluates the activity by adding depreciation to the aforementioned EOC value. Total Cost includes the TOC and the opportunity cost on fixed capital at 6% (TOC + Opportunity Cost).

Gross Income (GI) represents the revenue generated from the sale of animals, whether received in cash or through installments. Gross Margin measures the profit or loss realized throughout the full cycle activity, calculated by subtracting EOC from GI, which essentially captures all revenue inflows to the farm (GI – EOC).

Net Margin indicates the sustainability of the activity, determined as the difference between TOC and GI. The final outcome (profit or loss) is ascertained through the subtraction of GI from TC. The break-even point holds significant importance, indicating the minimum threshold at which the animals should be sold. This point is derived by dividing the TC values by the value of the @ sold.

The statistical analyses conducted were descriptive in nature, with data processing and consistency checks performed using Excel spreadsheets. Tables were formulated to facilitate the assessment of the economic feasibility of

a full-cycle system for animals within dairy operations.

Results and Discussion

The animals achieved an individual average daily weight gain of 0.920 kg, while the target was set at 1.200 kg, all without the inclusion of roughage in their diet. The observed average daily weight gain of the confined animals fell short of the estimated goal due to the accumulation of loam during the rainy phase of the experiment, which hindered their consumption.

In a study conducted by Fontes et al. (2007), which involved animals aged 19 ± 5 months and a diet comprising 44% corn silage and 56% concentrate, a daily weight gain of 0.960 kg per animal was achieved. These animals were crossbred Holstein \times Gyr, in the finishing and fattening phase, which were considerably older than the animals in our current study. Despite the age difference, the study reported satisfactory weight gain, comparable to that observed in total-diet feedlots featuring dry and mash diets.

Table 1 describes the average values along with standard deviations for initial and final average weights, feed conversion, and arrobas (@, unit of mass representing 15 kg) produced per animal. Freitas Neto et al. (2014) reported an average daily gain of 1,500 kg in crossbred dairy males initially raised on *Brachiaria* pastures. These animals were subsequently transitioned to a feedlot setting, exhibiting an average live weight of 242.98 kg at 15 months of age, and were slaughtered upon reaching 390 kg.

Table 1. Initial weight, average weight, @ produced, feed intake, and feed conversion of dairy calves at 10 months in a complete cycle in the feedlot system receiving a total mashed diet.

Average initial weight (kg)	Average final weight (kg)	@ produced	Average feed intake (kg)	Feed conversion, as-fed
40.67 ± 5.27	320.40 ± 45.87	9.32	1,074.87	3.84

@ = 15 kg.

Neumann et al. (2015) obtained higher ADG compared to the study under consideration, with Holstein animals showing an ADG of 1.285 kg and a feed conversion ratio of 4.22. The tested diets involved 100% concentrate, 55% concentrate with corn silage, and 55% concentrate with oat hay. Almeida Júnior et al. (2008) also investigated Holstein calf performance after weaning and reported an average feed conversion ratio of 4.48. This indicates that the animals in our study exhibited favorable feed conversion when compared to findings from other studies.

Vaz et al. (2015) emphasize that male dairy animals exhibit satisfactory development potential for meat production. This assertion was supported by the findings of Missio et al. (2017), who conducted a comprehensive assessment of male dairy animals' suitability for meat production, meeting market requirements (carcass dressing percentage, ADG, and meat

physicochemical properties) both quantitatively and qualitatively. Their study involved the evaluation of 16 Nellore animals: eight Holstein × Guzerat and eight Holstein × Gyr. These animals were slaughtered upon reaching a live weight (LW) of 480 kg and were fed 'Mulato II' grass silage in two different proportions (100 and 400 g kg⁻¹).

The cost of feeding these animals amounted to BRL 761.45 animal⁻¹, taking into account a diet cost of BRL 0.642 per kilogram. When accounting for the cost of milk consumed, valued at BRL 0.90 per liter, the total cost per animal increased to BRL 961.45 (Table 2). This cost can be considered appealing due to the high-quality diet provided to the animals. However, it is important to note that it represents the most significant cost factor within the system, as it involves the utilization of grains (such as corn and soy) and milk, which compete with human food resources.

Table 2. Cost per animal including milk (suckling) and the concentrate diet.

Total head	Cost of milk consumed per animal (BRL)	Average feed cost (BRL)	Cost of feed consumed per animal (BRL)	Total per animal (BRL)
16	200	0.642	761.45	961.45

In the Brazilian context, feed expenses constitute the largest portion of the costs. As emphasized by various authors, evaluating the economic viability of an activity or system should not rely solely on gross revenue parameters. In feedlot systems, farmers are particularly concerned with daily rates and production cycles, which is one of the main topics researched and analyzed. Economic parameters such as feed, medicine, and labor costs are critical factors and may vary based on momentary needs of production system and regional conditions (Valério et al., 2014).

The study resulted in an average production of 149.19 @ animal⁻¹ with an average weight of 9.32 @ animal⁻¹. The production cost per animal, including milk consumed, concentrate feed, and labor (valued at BRL 1.18 per month per animal), was BRL 105.52 (Table 3). Pacheco et al. (2016) reported similar values in their study analyzing live cattle prices and production costs during the fattening cycle, with an average value of BRL 104.20. These values are considered satisfactory as they are below the break-even point, indicating efficient financial management and the animals' ability to gain weight effectively.

Table 3. Quantitative initial averages in @ produced and production cost.

Variable	Value
Days in feedlot	304
Initial weight (kg)	40.67
Final weight (kg)	320.4
Average daily weight gain (kg)	0.920
Arrobas produced	149.19
Production cost (BRL)	15,743.20
Cost of each arroba produced (BRL)	105.52

Pacheco et al. (2016) also analyzed the relevance of different months for economic viability in feedlot systems. They found that the months of May to August and September to December were more favorable for investment, whereas January to April were riskier due to fluctuations in input prices, particularly grains, which are a significant factor in feedlot systems. Economic analyses, when aligned with market dynamics and practical field applications, can lead to a secure and economically sustainable investment outcome.

The profitability of feedlotting calves from dairy herds is subject to market

fluctuations regarding input prices and the region where the activity is developed (Missio et al., 2009).

In our study, the EOC accounted for 71.54% of the total GI, encompassing all variable costs such as feed, facilities, equipment for animal handling, energy, medicines, and labor. In comparison, Barbieri et al. (2016) reported a higher EOC at 74.45% of the GI, with 85.14% of the EOC attributed to variable costs, including vaccines, dewormers, and feed, differing from the findings of our study (Table 4).

Table 4. Existing capital structure of variable costs for feeding and suckling dairy calves in a complete cycle (pre-weaning, growth, and finishing).

Variable	BRL	%
EOC/Feed	12,183.20	79.19
EOC/Milk	3,200.00	20.80
Total EOC/Feeding	15,383.20	20.80

Pacheco et al. (2014) investigated crossbred steers fed different proportions of concentrate with sugar cane and found that feed costs accounted for approximately 69.51% of total costs (roughage + concentrate).

Lopes et al. (2013) evaluated two feedlot systems in Minas Gerais, reporting a TOC/@ of BRL 75.04 in feedlot 1, consisting of Nellore and Angus × Nellore cows and steers over a five-month period, and BRL 72.57 in feedlot 2, composed of Holstein × Gyr steers and cows with breed compositions of 3/8 and 5/8 Holstein × Gyr. These values are higher than those in our study, which closed at BRL 113.93. The 10-month feedlotting time in our study supposedly significantly increased variable costs (EOC), which are prone to fluctuations in input prices at certain times of the year.

Missio et al. (2009) reported lower TC values, totaling BRL 805.94 animal⁻¹. Their study evaluated nine-month-old Charolais × Nellore crossbred animals in

a feedlot and did not include suckling expenses in their calculation. In contrast, in our present study, TC amounted to BRL 1,061.92 animal⁻¹, with this indicator showing variability primarily due to the inclusion of input costs related to feed (milk and total diet), which accounted for 94% of the total cost. This cost disparity can be attributed to the absence of roughage in the diet of the animals and their extended time in the feedlot, with market prices fluctuating primarily for corn and soybean meal in the region.

Table 5 provides a breakdown of all variable costs in this study. It is worth noting that the descriptions provided include facilities (troughs, drinkers, mixers, management corrals, and feed factory) that were already present on the farm, resulting in lower installation expenses. Values for depreciation and newly acquired assets were based on the service-life manual adopted by SENAR-GO.

Table 5. Effective operating cost (EOC), total operating cost (TOC), and total cost (TC) of the complete cycle of dairy calves.

Cost	Value	%
EOC		
Feeding	15,383.20	92.86
Medications	80.00	0.48
Identification earring	25.60	0.15

General materials	16.50	0.09
Labor	360.00	2.17
Electricity	150.00	0.90
Trough	120.00	0.72
Drinker	30.00	0.18
Animals	400.00	2.41
Total EOC	16,565.30	100.00
TOC		
Total EOC	16,565.30	97.49
Depreciation	425.43	2.50
Total TOC	16,990.73	100.00
TC		
Total TC	16,990.73	94.00
Opportunity cost	1019.44	6.00
CT total	18,010.17	100

Table 6 presents the values obtained from the sale of dairy calf carcasses. However, it is important to emphasize that this variable is based on the payment per @,

influenced by factors such as regional practices, cultural traditions, and, notably, the age at which these animals are slaughtered and enter the market.

Table 6. Revenue from the sale of hot carcasses of dairy calves raised in a feedlot system slaughtered at 10 months.

Variable	Mean values given		
	BRL / @	@	Total
Value / Animal	135.50	10.68	1,447.14
Value / Lot	135.50	170.88	23,154.24

Gross margin is a key indicator for assessing the results of the activity carried out by the investor. It is essential to exercise caution in interpreting this indicator, as an inadequate assessment may mask the true outcome of the investment. It should be noted that this indicator does not account for facility and

equipment depreciation. In this study, GM showed a positive value when variable expenses (EOC) were subtracted (Table 7).

Pacheco et al. (2016) reported lower values for different months of the fattening cycle: BRL 79.84 in Jan/Apr, BRL 122.96 in May/Aug, and BRL

121.08 in Sep/Dec, with an annual average of BRL 107.96. A positive GM

signifies short-term activity viability.

Table 7. Economic indicators of dairy calves raised in a feedlot system.

Indicator	BRL/animal	Total BRL
Gross margin	411.80	6,588.94
Net margin	385.22	6,163.52
Profit	321.50	5,144.07

As is typical in all business activities, profitability is assessed through the NM indicator, which signifies the sustainability of the activity in the medium and long term. The results obtained in this experiment indicate that the activity is highly promising, yielding favorable outcomes. Therefore, the complete-cycle technique for dairy males can be profitable when thoroughly analyzed and planned.

Net margin in this study amounted to BRL 385.21 animal⁻¹, representing 26.61%. This value is lower than that reported by Silva et al. (2018), who observed a NM of 5.70% in feedlot animals fed grain and citrus byproducts. In contrast, Barbieri et al. (2016) reported higher values, with a NM of 68.55% in a feedlot involving dairy animals crossed with beef cattle. This higher NM was due to the production of @ at 218% more than the break-even point.

The profit or loss indicator, calculated as GI – TC, yielded significant results. Notably, the diet accounted for the majority of production costs. Consequently, feeding strategies involving by-products have the potential to enhance profitability. In this context, the utilization of dairy males generated a profit of BRL 321.50 animal⁻¹.

The break-even point represents the threshold necessary to achieve productivity without incurring losses, indicating the quantity to be sold or

produced to cover the expenses of the activity. In this study, the break-even point was calculated at 120.7 @, with a corresponding value of BRL 132.95. However, the actual values achieved were higher, at 149.19 @ and BRL 135.50. This demonstrates the profitability and high returns associated with the practice of feedlotting dairy calves. Barbieri et al. (2016) found even higher values, as they produced 218% more than the break-even point with Nellore crossbred and dairy-purpose animals with a higher initial weight (330 kg), possibly explaining the disparities in the results.

Financial indicators and production cost analyses illustrate the economic viability of a complete cycle of feedlot dairy calves, positioning it as a potential secondary source of income. This study has the potential to shift the perceptions of rural entrepreneurs, transforming what was once considered a loss in dairy activity into a promising endeavor, given the favorable results obtained.

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