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Bioeconomic performance of a feedlot bull with different genetic groups

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ABSTRACT

Livestock systems require a thorough analysis of zootechnical and financial indicators. In this sense, the objective of this study was to evaluate the bioeconomic performance of feedlot bulls with different genetic groups in 2012 and 2013. The experiment was carried out on a farm in Paragominas, State of Pará. The confined animals belonged to the Nellore (NE), ½ Angus ½ Nellore (AN) and ½ Charolais ½ Nellore (CH) breeds. The indicators analyzed were the cost of production and economic indicators. Additionally, zootechnical indicators were evaluated, being considered NE, AN, and CH as treatments in a completely randomized design. The financial results of the total production cost were R$ 118,493.21 in 2012, and R$ 111,166.35 in 2013, and the profitability obtained was 11% in 2012 and 8% in 2013. Regarding the zootechnical indicators, the CH genetic group showed superiority (P <0.01) compared to the NE genetic group for the variables initial weight (IW), final weight (FW), weight gain (WG), average daily weight gain (DWG), and carcass yield (CY). The confinement proved to be economically viable, with positive margins and satisfactory profitability, and the CH genetic group had the best indicators and the highest increase in the final revenue of the activity.

Keywords: zootechnical performance, racial crossing, economic analysis, fattening of beef cattle.

Desempenho bioeconômico de um confinamento de novilhos com diferentes grupos genéticos

RESUMO

Sistemas pecuários requerem uma profunda análise dos indicadores zootécnicos e financeiros. Neste sentido, o objetivo deste estudo foi avaliar o desempenho bioeconômico de um confinamento de novilhos com diferentes grupos genéticos nos anos de 2012 e 2013. O experimento foi desenvolvido em uma propriedade localizada no município de Paragominas, Estado do Pará. Os animais confinados pertenciam às raças Nelore (NE), ½ Angus ½ Nelore (AN) e ½ Charolês ½ Nelore (CH). Os indicadores analisados foram o custo de produção e indicadores econômicos. Adicionalmente, foram avaliados indicadores zootécnicos, sendo considerados NE, AN e CH como tratamentos em um delineamento inteiramente casualizado. Os resultados econômicos do custo total de produção foram de R$ 118.493,21 no ano de 2012 e R$ 111.166,35 no ano de 2013, e a lucratividade obtida foi de 11% em 2012 e 8% em 2013. Em relação aos indicadores zootécnicos, o grupo genético CH apresentou superioridade (P<0,01) em comparação ao grupo genético NE para as variáveis peso inicial (PI), peso final (PF), ganho de peso (GP), ganho de peso médio diário (GMD) e rendimento da carcaça (RC). O confinamento referido apresentou-se viável economicamente, com margens positivas e lucratividade satisfatória, sendo o grupo genético CH o que apresentou melhores indicadores e maior incremento na receita final da atividade.

Palavras-chave: desempenho zootécnico, cruzamento racial, análise econômica, engorda de bovinos de corte.

1. Introduction

Confinement was consolidated as a tool for intensifying production, helping to meet the demand for beef, providing a shortening of the livestock cycle with the production of precocious bulls, and increased the working capital turnover ratio. In this sense, the use of improved breeds is advantageous in feedlots, with the crossing between *Bos taurus* (Angus and Charolais) genotypes, a species widely raised in the southern country, and *Bos indicus* (Nellore), widely used in Brazil, and is receiving more importance in the recent decades (Vaz and Restle, 2001). Several studies (Koger, 1980; Restle et al., 1999; Menezes and Restle, 2005) prove the benefits of crossing between these two genetic groups, resulting from the effects of heterosis, as well as the complementarity of breeds, essentially for reproductive traits, gain weight, adaptation to the environment and carcass quality, consequently impacting the profitability of production systems.

Despite its numerous benefits, the feedlot termination system involves the use of advanced technology, the selection of animals that adapt to the process and the choice of the best nutritional plan (Wedekin et al., 1994); therefore the high efficiency concerning the beef production in a feedlot is linked to a higher cost per arroba (@ - unit equivalent to 15 kilograms or 33 pounds) (Lopes and Magalhães, 2005). In this way, the efficiency of the process goes through strict cost control (Ferreira et al., 2005), whose determination has the purpose of verifying whether the system is being economically viable.

For the degree of intensification in which it involves high investments and greater risks, management becomes essential not only to control the activity but also to increase its competitiveness (Restle et al., 2007). In this sense, bioeconomic analysis is an important aid tool, associating economic analysis with animal performance data.

The impact of productive technologies is assessed by measuring integrated zootechnical and economic indices, a need that has served as a basis for the development of bioeconomic models that combine financial results and animal performance (Amer et al., 1994) as well as studies that evaluate the relationship between these two variables in different systems, under different environments, with different categories of animals (Ferreira et al., 2009; Vitorri et al., 2007; Lopes et al., 2005; Lopes and Magalhães, 2005).

Given the above, the present study aimed to evaluate the bioeconomic performance of the feedlot system in Paragominas, PA, considering different genetic groups of beef cattle.

2. Material and Methods

The study was conducted on a farm in Paragominas, PA, where the different cattle breeds were used as a treatment: bulls of the Nellore (NE), ½Angus ½Nellore (AN) and ½Charolais ½Nellore (CH), with average initial age of 21 months (+ -30 days). The confinement structure had a collective stall with an area of 1,298.3 m^2, feed trough 38.56 meters long and 29.5 centimeters deep, mineral salt trough 2.59 meters length, shading area with 1.90 m^2 per animal and drinker with float and capacity of 5,200 liters.

The experimental period in confinement occurred in the years 2012 and 2013. In 2012, 67 animals were used: 22 NE, 22 AN, and 23 CH, which remained 88 days confined. In 2013, 63 animals, 21 NE, 21 AN, and 21 CH were confined for 80 days. The weighing was carried out every 28 days, always considering a solid fast of 16 hours. The initial weight was considered at the first weigh-in after an adaptation period of 19 days.

The animals were selected at the beginning of the experiment looking for the lowest variation coefficient for the initial weight into the genetic groups; however, among genetic groups, the variation coefficient was higher due to the greater heterosis of the crossbreeding.

About the diet provided during the experiment, corn silage and concentrate composed of ground corn (substituted by ground sorghum grain at the end of the second stage of the experiment), soybean meal, and mineral-protein supplement were used (Table 1). Four daily meals were provided at the following times: 4:00 am, 8:00 am, 1:00 pm and 6:00 pm.). The roughage to concentrate (RC) ratio was gradually decreased with an increase of 1 kg of concentrate and a reduction of 1 kg of silage every five days. The experiment started with an RC ratio of 90:10, reaching the end of the experiment with an RC ratio of 75:25. This increase in concentrate aims to increase the diet energy content, to provide higher speed in weight gain, consequently decreasing the time in confinement and the costs with feeding and labor.

Regarding the economic analysis, the inventory of all goods used in the activity was considered for the cost of production, such as fixed costs (labor and depreciation), variable costs (fuel, mineral salt, mineral-protein supplement, soybean meal, corn grain, maintenance, corn silage, purchase of animals, and energy), and capital opportunity costs.

The cost of silage was calculated through the production cost, adding the costs with seeds, fertilizers, labor, machinery, diesel oil and canvas and dividing by the total kg of silage produced. The cost of the concentrate was calculated through the purchase price, freight, labor, and equipment for the mixture.

Table 1. The proportion of ingredients used in the concentrates (C1 to C6) provided in the experiment (%) in the years 2012 and 2013, Paragominas, Pará.

Concentrates	Corn grain		Sorghum grain		Soybean meal		Mineral-protein supplement	
	2012	2013	2012	2013	2012	2013	2012	2013
C1	65	65	-	-	20	25	15	10
C2	75	70	-	-	10	20	15	10
C3	78	78	-	-	10	14	12	8
C4	84	82	-	-	6	10	10	8
C5	-	60	-	22	-	10	-	8
C6	-	-	-	82	-	10	-	8

Depreciation was calculated using the straight-line method, according to the standard recommendation for the residual value of each asset, which is 10% of the initial value for vehicles and machines and 5% for improvements and implements (Nogueira, 2007).

The opportunity cost of capital was calculated from a real interest rate of the savings account (Flores et al., 2006). The values of the expenditure cost (fixed costs + variable costs), operating cost (fixed costs with depreciation + variable costs), and total cost (operating cost + capital opportunity costs) are following the methodology applied by Oaigen et al. (2009).

The economic indicators were expressed by the gross margin (revenue - expenditure cost), operating margin (revenue - operating cost), and net profit margin (revenue - total cost), following the methodology of Flores et al. (2006). For indirect costs, which required apportionments, the apportionment methodology per animal unit was followed (Flores et al., 2006).

The physical break-even point (fixed cost ÷ unit revenue - variable unit cost), the monetary break-even point (physical break-even point x unit price), and profitability ratio (profit ÷ revenue x 100).

With the data, it was possible to calculate indicators of daily cost indexed in arroba, daily cost (operating cost ÷ total days), and net profit per arroba (net margin ÷ total production of arroba). The cost per arroba ((operating cost - animal acquisition cost) ÷ arroba production in the feedlot) was adapted from Pacheco et al., 2006.

The economic indicators were corrected according to the General Price Index (IGP, 2020) for May 2020.

The analysis of financial data, such as fixed and variable costs, depreciation, opportunity costs, and measurement of economic indicators, was performed using Microsoft Office Excel.

The zootechnical indicators of each genetic group were measured from the average of the two years for the initial weight (IW) and final weight (FW), and the values for weight gain (WG) were corrected for 88 days so that it was possible to the statistical comparison. The correction was carried out due to the shorter confinement time in 2013 (80 days); for this reason, the average daily gain of the animals was multiplied by the difference of eight days between the two years. The animals were slaughtered according to a visual evaluation, which was carried out through the evaluation of body condition score (BCS), classified from 1 to 9, according to Spitzer (1986); 1 for a very thin animal and 9 for a very fat animal. The carcass yield (CY) was calculated using the final weight (FW) of each animal and the hot carcass weight (HCW), where CY = (HCW * 100) ÷ FW.

A completely randomized experimental design with three treatments (racial groups) and an average of twenty-two animals (repetitions) per treatment were used. All data from the zootechnical indicators were subjected to analysis of variance, and the averages were compared through the Tukey-test at 5% probability by the IBM SPSS Statistics 20 software (IBM, 2011).

3. Results and Discussion

The zootechnical results in 2012 and 2013 are described in tables 2 and 3, respectively. The NE group differed statistically from the AN and CH groups for the variables: initial weight, final weight, weight gain, and average daily weight gain; the groups AN and CH did not differ statistically from each other for these variables. According to Vaz and Restle (2001), the highest values of heterosis are verified for the characteristics in which there is greater genetic distance between breeds. The proximity in the zootechnical results observed in the AN and CH groups is mainly due to the smaller genetic distance between the Angus (British) and Charolais (continental) breeds, resulting in similar indices.

Table 2. Zootechnical indicators of bulls finished in a feedlot in 2012, Paragominas, Pará.

	2012					
GENETIC GROUPS	IW	FW	WG	DWG	LS	CY
NE	374,50 ^{b}	513,59^{b}	138,68^{b}	1,576^{b}	88,00^{b}	53,01^{b}
AN	436,79 ^{a}	571,73^{a}	135,09^{b}	1,782^{b}	76,00^{a}	55,12^{a}
CH	428,25 ^{a}	574,52^{a}	146,70^{a}	2,037^{a}	72,00^{a}	56,88^{a}

IW: Initial weight, FW: Final weight, WG: Weight gain, DWG: Average daily weight gain, LS: Length of stay, RC: Carcass yield, NE: Nellore, AN: Angus, CH: Charolais. Means followed by the same letter do not differ by the Tukey test at the 5% probability level.

Table 3. Zootechnical indicators of bulls finished in a feedlot in 2012, Paragominas, Pará.

	2013					
GENETIC GROUPS	IW	FW	WG	DWG	LS	CY
NE	381,90^{b}	483,95^{b}	102,04^{b}	1,302^{b}	78,00^{b}	52,75^{b}
AN	456,19 ^{a}	567,52^{a}	111,33^{a}	1,568^{a}	71,00^{a}	53,81^{b}
CH	451,24 ^{a}	565,81^{a}	114,57^{a}	1,614^{a}	71,00^{a}	56,00^{a}

IW: Initial weight, FW: Final weight, WG: Weight gain, DWG: Average daily weight gain, LS: Length of stay, RC: Carcass yield, NE: Nellore, AN: Angus, CH: Charolais. Means followed by the same letter do not differ by the Tukey test at the 5% probability level.

These results agree with the results found by Marcondes et al. (2011), where Nellore animals had lower DWG than the crossbred animals (½Angus ½Nellore), 1.12 kg/day and 1.32 kg/day, respectively. Goulart et al. (2008) also found higher results in ½Angus ½Nellore animals (1.70 kg/day) than Nellore animals (1.53 kg/day).

Regarding the variable carcass yield (CY), the NE and AN groups had similar results, and the CH group had higher CY results than the others. Restle et al. (2000), when comparing the carcass characteristics of different racial compositions Charolais x Nellore, obtained, in the first generation of crossing, the best results for slaughter weight, carcass weight, carcass yield, and better conformation when compared to pure animals, and an even lower percentage of bone in the carcass, both in the first and second generation, demonstrating the better performance of animals from crossbreeding.

When evaluating the economic performance of different genetic groups, Pacheco et al. (2006) found higher total net profit and total and monthly profitability in the group composed of a higher degree of Charolais (5/8 Charolais 3/8 Nellore), further demonstrating that the degree of crossing has an influence not only on zootechnical performance but also on financial results and should, therefore, be considered when planning the production system.

The initial weight plays a decisive role in the final weight and economic indicators. Both results in the present study and by Ferreira et al. (2004) demonstrate that heavier animals at the beginning of confinement remain for a shorter time and promote higher economic margins. The influence of weight gain is also evidenced in the gross revenue on the sale of animals, which was carried out based on the carcass yield, on the values of the arroba, which was R$ 97.00/arroba and R$ 95.75/arroba not considering the carcass yield, and reached the values of R$ 103.57/arroba and R$ 105.10/arroba considering the carcass yield, in 2012 and 2013, respectively.

Although the cost of the arroba produced in the feedlot reached values above the sale price (R$ 124.75 and R$ 152.35 in 2012 and 2013, respectively), the weight of entry into the feedlot diluted the costs, promoting net profit per arroba of R$ 9.61 and R$ 6.36, in 2012 and 2013, respectively. The average values of carcass yield (CY) were 52.88%, 54.47%, and 56.44% for NE, AN, and CH, respectively. In the comparisons between NE-AN, NE-CH, and AN-CH, the statistical differences showed P>0.05; P<0.01, and P=0.01, respectively. Similar results were found by Restle et al. (2000) in the carcass yield of animals belonging to the Charolais and Nellore crosses due to the exploration of the complementarity of racial traits.

Restle et al. (2002), when studying the effect of the genetic group and the heterosis on the carcass in cull cows, obtained higher carcass yield in Nellore animals than Charolais. However, when evaluating F1 animals, carcass yield was 2.35% higher than that of pure animals, leading to an increase in slaughter weight.

Regarding the length of stay in confinement, a variable that directly interferes with production costs, the NE group differed from the others, totaling 16 days in 2012 and 9 days in 2013 above the others. Considering the daily costs of confinement (R$ 1,321.07 and R$ 1,362.95), the NE genetic group promoted a surplus expenditure of R $ 21,137.12 and R$ 12,266.55, respectively. Gottschall et al. (2009) highlight that the daily weight gain has a negative correlation with the time of the animals in confinement, in agreement with the obtained data, where the NE group had the lowest entry weight.

Production costs (Table 4), such as feeding, represented 23.52% and 18.73% of variable costs, in 2012 and 2013, respectively. From this total, 75.50% and 24.50% refer to the average cost with concentrate and silage in the two years of the experiment. These values have less impact compared to other studies since the farm produces silage and mixes the concentrate.

The acquisition of animals represented 65.17% and 66.64% of total production costs in 2012 and 2013, respectively. Lopes and Magalhães (2005); Fernandes et al. (2007); Lopes et al. (2011) highlight the impact of the acquisition of animals on the cost of confinement, representing, in some scenarios, a limiting factor for the activity, followed by feeding. Thus, the choice of animals should be based on variables such as age and weight gain, which are determinants for the system viability. According to Gottschall et al. (2009), very young animals, with a low weight of entry into the feedlot, will remain in the system for a longer time until slaughter, consequently increasing costs.

Table 4. Total production costs of bulls finished in a feedlot, in 2012 and 2013 in Paragominas, Pará.

Description	2012		2013	
	Total value	Percentage	Total value	Percentage
FIXED COSTS	R$ 8,532.62	7.20%	R$ 12,186.42	10.96%
Labor	R$ 6,211.55	5.24%	R$ 9,895.73	8.90%
Depreciation	R$ 2,257.10	1.90%	R$ 2,257.10	2.03%
Others (accounting services, internet)	R$ 63.97	0.05%	R$ 33.59	0.03%
OPPORTUNITY COST	R$ 2,239.01	1.89%	R$ 2,130.73	1.92%
VARIABLE COSTS	R$ 107,721.58	90.91%	R$ 96,849.20	87.12%
Purchase of animals	R$ 77,177.97	65.13%	R$ 74,062.86	66.62%
Feeding	R$ 27,873.96	23.52%	R$ 20,816.56	18.73%
Others	R$ 2,669.65	2.25%	R$ 1,969.78	1.77%
TOTAL	R$ 118,493.21	100.00%	R$ 111,166.35	100.00%

The other variable costs represented 2.25% and 1.77% of total production costs in 2012 and 2013, respectively; these are common costs across the production system, so they were prorated by animal unit (AU), and only the values that represented the animals in the experiment were considered. The revenue obtained was higher than the total production costs, generating positive margins in all economic indicators in 2012 and 2013. The net margin was R$ 11,876.10 and R$ 9,335.59 in 2012 and 2013, respectively.

Table 5 contains the economic indicators, meat production (in arrobas), and the physical and monetary break-even point. The physical and monetary break-even point represents the weight gain necessary to cover the costs of the activity and the minimum revenue that must be generated by each animal in confinement, respectively.

The reduction in economic and zootechnical indicators in the 2013 experiment has as determining factors, the reduction of animals in the experiment, which went from 67 to 63 animals, the decrease in carcass yield, and the reduction in average daily weight gains.

The confinement resulted in the profitability of 3.67 and 2.67% a.m. in 2012 and 2013, respectively. Although the costs are higher than the amount paid for the arroba considering the carcass yield, the net profit per arroba was positive, that is, although confinement is an activity that needs a significant outlay, the use of animals with excellent feed conversion results in a shorter time of confinement, generating an increase in the enjoyment (total production of the herd concerning the initial herd in a certain period) of the property and the maximization of the capital turnover. Also, according to Porto et al. (2009), confinement allows pasture areas to be vacated, which can be used by categories of animals that are younger and more efficient in food conversion.

Lopes and Magalhães (2005) found profitability of 0.23%, lower than the present work. This is due to the several variables that can impact this result, as in a study by O'Connor et al. (1997), where the purchase price, the sale price, the conversion efficiency and the corn price were the variables that most affected the profitability of fattening in confinement systems. Lopes et al. (2011), when evaluating the feasibility of finishing of Red Norte and Nellore bulls in confinement, obtained negative economic indicators, explained by the high cost of acquiring animals and the cost of feeding. Thus, the choice of the genetic group to be used, the weight of entry into the feedlot, besides other variables that were not explained in this work, such as the benefit-cost ratio of the implanted diet, market analysis and selling price (future market) are some of the factors with the greatest impact on the feasibility of this termination system and must be evaluated together.

The results corrected through the IGP (for May 2020) were even more satisfactory, reaching average profitability of 28.61%. This is due to an increase of 93,24% in the sale value of the arroba (considering the carcass yield), and the expenditure cost increased by 50.68% in the period.

The revenue from animals' sale was determined by the carcass yield achieved (Table 6). Thus, simulations were carried out for each year of the experiment, where the carcass yield averages of the different genetic groups were considered for all animals for one year of the experiment, thus generating three simulations per year and two simulations per genetic group.

According to Table 6, it was possible to observe that the carcass yield of the NE genetic group in 2012, the NE genetic group in 2013 and the AN genetic group in 2013 would promote a decrease of - 3.77%, - 4.23% and - 2.30% in the respective 2012 and 2013 revenues. However, the carcass yields of the CH genetic group would increase the revenue by 3.25% and 1.67%, in 2012 and 2013, respectively, as would the AN genetic group in 2012 (0.06%). These data corroborate with that found in the zootechnical performance averages of the CH group (Tables 2 and 3), which obtained a superior performance in all the evaluated traits.

The simulation shows the impact of using animals that have the precocious conformation and good carcass yield, especially from crossbreeding.

Table 5. Economic indicators of bulls finished in a feedlot in 2012 and 2013 in Paragominas, Pará.

Description	2012	2020*	2013	2020*
Expenditure cost (R$)	113,997.11	176,207.61	106,778.53	156,464.92
Operational cost (R$)	116,254.21	179,696.46	109,035.62	159,772.28
Total cost (R$)	118,493.22	183,157.34	111,166.36	162,894.50
Revenue (R$)	130,369.32	249,725.05	118,371.22	225,617.12
Gross margin (R$)	16,372.21	73,517.44	11,592.69	69,152.20
Operating margin (R$)	14,115.11	70,028.59	9,335.59	65,844.84
Net margin (R$)	11,876.10	66,567.71	7,204.86	62,722.62
Cost/arroba (@)* (R$)	124.75	192.83	152.35	223.24
Net profit/arroba (@)*** (R$)	9.61	212.52	6.36	273.23
Monetary break-even point (R$)	2,154.07	1,478.14	2,446.97	1,465.19
Physical break-even point (kg)	614.89	10,332.17	708.79	10,241.65
Profitability rate (%)	11.00	28.04	8.00	29.18
Production of arroba in feedlot (@)	313.23	313.23	229.56	229.56

*Values for 2020 were corrected according to the IGP, ** Cost per arroba (@) produced in the feedlot, *** Net profit by the total arroba sold.

Table 6. Simulation of the revenue based on the constancy of the carcass yield of each genetic group of bulls finished in feedlot. Paragominas, Pará.

Carcass Yield	Simulated Revenue (R$)	Real Revenue (R$)	Increment (%)
NE 2012 (53.01%)	125,448.73		-3.77
AN 2012 (55.12%)	130,442.07	130,369.32	0.06
CH 2012 (56.88%)	134,607.13		3.25
NE 2013 (52.75%)	113,368.37		-4.23
AN 2013 (53.81%)	115,646.49	118,371.22	-2.30
CH 2013 (56.00%)	120,353.16		1.67

4. Conclusions

The feedlot system showed positive margins and satisfactory profitability, being, therefore, economically viable. The zootechnical indicators demonstrated the superiority of the F1 AN x NE and AN x CH genetic groups in confinement to the detriment of the use of purebred (NE). Under the conditions of the finishing system, climate, payment conditions, and appreciation of the carcass weight by the slaughterhouse, the CH genetic group has better bioeconomic efficiency.

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