https://doi.org/10.22319/rmcp.v10i3.4896

Article

Economic evaluation of post-weaning and finishing cattle supplemented on pasture

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Abstract:

The objective of this study was to evaluate the economic viability, through different supplementation strategies, of the post-weaning and finishing stages of cattle supplemented on *Brachiaria brizantha* cv. Marandu pastures during the rainy and dry seasons. The experimental period was 447 d. The study comprised the post-weaning and finishing stages of 22 intact male crossbred (½ Holstein-Zebu) cattle with an average initial weight of 164.09 ± 12.13 kg and an average age of 7 mo. The animals were distributed in a randomized design with 11 replications per treatment. The following supplementation strategies were tested: strategy 1 (S1): Mineral mix in the 1st and 3rd periods and protein-energy supplementation at 0.2 % of the body weight (BW) in the 2nd period; and strategy 2 (S2): protein-energy supplementation at 0.4 % BW in the 1st and

3rd periods, and protein-energy supplementation at 0.6 % BW in the 2nd period. Strategy 1 resulted in a lower cost per arroba produced and lower cost per hectare, generating a greater net profit per hectare and consequently a higher internal rate of return. When herbage is available, mineral supplementation supplied during the rainy season, associated with low levels of protein-energy supplementation in the dry season (S1), is of greater economic attractiveness for the development of the project, as it leads to higher internal rates of return and net present values in the entire period.

Key words: Internal rate of return, Net present value, Supplementation on pasture.

Received: 16/05/2018

Accepted: 30/07/2018

Introduction

The use of supplementation provides greater efficiency to pasture usage, making it an auxiliary tool in pasture management that leads to higher stocking rates and better animal performance and ultimately resulting in a shorter production cycle and increased productivity to the system. However, when a producer chooses to implement supplementation on pasture, forage intake by the animal should be maximized so that it can have better performance, but the viability of the technique must be taken into account at all times.

Supplementation is a biologically viable technique[1], because it produces a positive effect on the weight gain of animals or on gain per area. However, the producer must be alert as to the balance between the biological and economic responses, since the economic viability of the system is and will always be a dependent local factor.

Whenever dietary supplementation is practiced in grazing-cattle production systems, there will be alterations in the cash flow of the farm, because it will be necessary to invest capital in the purchase of the supplement. In this regard, research involving the use of supplementation for grazing cattle must be subjected to economic analysis, and the obtained information must be quickly passed to farmers, the group with greatest interest in these results.

Given the above-stated facts, this study aimed to evaluate the economic viability of rearing beef cattle on pasture under different supplementation strategies during the post-weaning and finishing stages.

Material and methods

The experiment was conducted in Ribeirão do Largo - BA, Brazil (15°26′46″ S, 40°44′24″ W, 800 m asl). The experimental period was 447 d, which were divided into 1st rainy season, 168 d; dry season, 180 d; and 2nd rainy season, 99 d. The study comprised the post-weaning and finishing stages of 22 intact male crossbred (½ Holstein-Zebu) cattle with an average initial weight of 164.09 ± 12.13 kg and an average age of 7 mo. The animals were distributed in a randomized design with 11 replications per treatment. The following supplementation strategies were tested: strategy 1 (S1): mineral mix in the 1st and 3rd periods (1st and 2nd rainy seasons) and protein-energy supplementation at 0.2 % of the BW in the 2nd (dry) period; and strategy 2 (S): protein-energy supplementation at 0.4 % BW in the 1st and 3rd (rainy) periods, and protein-energy supplementation at 0.6 % BW in the 2nd (dry) period.

The animals were managed under the intermittent grazing method, in a pasture formed by *Brachiaria brizantha* cv. Marandu (6.5 ha) that was divided into six paddocks with equal area. Cattle were subjected to the control of ecto- and endo-parasites and vaccinated according to the calendar of the health authority of Bahia State (EBDA) and identified by numbered earrings.

Paddocks had a central food court equipped with uncovered plastic troughs (80 cm/animals) with double access and drinkers with an automatic refill system and capacity for 500 L of water. Concentrate and mineral supplements were supplied daily at 1000 h.The animals remained seven days in each paddock, and the groups of animals rotated across the paddocks throughout the grazing cycle, aiming to minimize the paddock (environment) effects. Ingredients used in the supplements provided in both strategies are described in Table 1.

Table 1: Proportion of ingredients from supplements (as-is basis)

Ingredient (%)	Strategy 1		Strategy 2	
	Rainy season	Dry season	Rainy season	Dry season
	Supplement		Supplement	
	Mineral (*ad libitum*)	0.2%[1] BW	0.4%[1] BW	0.6%[1] BW
Corn	-	45.43	45.43	45.43
Soybean meal	-	45.43	45.43	45.43
Urea + AS[2]	-	4.99	4.99	4.99
Mineral mix[3,4]	100	4.63	4.63	4.63

BW= body weight; [1]Protein-energy [2]Urea + ammonium sulfate (9:1) [3]Composition: calcium- 235 g; phosphorus- 160 g; magnesium- 16 g; sulfur- 12 g; cobalt- 150 mg; copper- 1.600 mg; iodine- 190 mg; manganese- 1.400 mg; iron- 1.000 mg; selenium- 32 mg; zinc- 6.000 mg; fluorine(maximum) 1.600 mg [4]Composition: calcium- 175 g; phosphorus- 100 g; sodium- 114 g; magnesium- 15 g; zinc- 6.004 mg; manganese- 1.250 mg; copper- 1.875; iodine- 180 mg; cobalt- 125 mg; selenium- 30 mg; fluorine(maximum) - 1.000 mg.

Proposed indexes were used(2) as parameters of economic evaluation of the supplementation strategies; these are described as follows:

Number of animals per treatment (n);

Experimental period (days);

Initial and final body weights - obtained by weighing the animals after a 12-h fasting period, and average body weight in the experimental period (arithmetic mean between initial and final body weights (BW));

Pasture area occupied by each treatment - the total experimental area was divided by the number of elements → 6.5 ha/2 = 3.25 ha;

Average stocking rate - the average body weight of each animal was multiplied by the number of animals per treatment and divided by the pasture area available per treatment and subsequently divided by 450 (corresponding to one animal unit (AU)) →SR = [{(averageBW * 11)/3.25}/450];

Average daily gain of the animals - the weight gain in the experimental period was divided by the number of days in the evaluation period → (finalBW – initialBW)/number of days in each period - ADG during the experiment: S1 0.57 kg/d and S2 0.69 kg/d;

Carcass dressing percentage - In the post-weaning phase, a dressing percentage of 50 % was considered, and, at finishing, the animals from S_1 obtained 47.39 %, while S2 animals had 50.48 %;

Average daily intake of concentrate supplement per animal in kg/d - 0.27 kg/d for S1 and 0.57 kg/d for S2 - obtained by the daily supply of chromium oxide together with the supplement, according to methodology proposal[3];

Cost per kilogram of concentrate supplement - obtained based on the price of inputs and the respective composition, on a fresh-matter basis, of each concentrate supplement, in which corn: R$ 0.82kg; soybean meal: R$ 1.975 kg; urea: R$1.912 kg; and mineral mix: R$1.36kg →Current prices at the commercial fair ofItapetinga-BA, Brazil (November/2015); Price of the arroba (@ = 14.7 kg) of unfinished cattle-mean values referring to the price of the unfinished cattle in the months of June (2014 and 2015) in Bahia State; Price of the @ of the finished cattle in November 2015, according to the Friboi packing plant (JBS Group) in Itapetinga-BA, Brazil;

Costs with medications, maintenance of fences and of pastures, and taxes per animal, according to[4] ;

Cost with labor, in @ per hectare. Values were obtained according to the data supplied by the owner of the farm where the experiment took place.

After the described indices were obtained, it was possible to calculate the production and profitability values of the production system with each of the evaluated supplementation strategies. The variables are detailed as follows:

Weight gain per hectare (kg/ha) during the experimental periods → average daily gain multiplied by the number of animals per treatment and by the experimental period, divided by the area occupied by each treatment (ADG * 11 * n of days in the experimental period)/3.25 ha;

Meat production per hectare (kg/ha) during the experimental period → weight gain per hectare multiplied by the dressing percentage (DP) considered;

Meat production per hectare (@/ha) during the experimental period → meat production in kg/ha divided by 15; Supplement intake per hectare (kg/ha) in the experimental periods → average supplement intake (kg/d) multiplied by the number of animals per treatment and by the experimental period by the area occupied by each treatment: (supplement intake * 11* n of days in the experimental period) / 3.25 ha;

Cost with supplement per hectare (R$/ha) in the experimental period → supplement intake per hectare (kg/ha) multiplied by the price of supplement (R$/kg);

Cost with supplement per arroba produced (R$/@) in the experimental period → cost with the supplement per hectare (R$/ha) divided by the amount of @ produced per hectare;

Cost with labor in R$ per arroba produced (R$/@) → cost with labor per hectare, divided by the number of arrobas produced per hectare;

Costs with medications, pasture maintenance, and taxes per arroba produced (R$/@) were calculated according to the production cost data (R$/ha) published in ANUALPEC[4], divided by the number of arrobas produced per hectare;

Total cost per arroba produced (R$/@) → Sum of costs per arroba (R$/@) with supplement, labor, medications, pasture maintenance, and taxes;

Participation of the cost of supplement in the total cost of arroba produced (%)→ cost with supplement per arroba produced (R$/@), divided by the total cost of arroba produced (R$/@), multiplied by 100;

Total cost per animal in the experimental period (R$/animal) → total supplement intake (daily intake * number of days in the experimental period), multiplied by the price of the supplement (R$/kg) plus costs with labor, medication, pasture maintenance, and taxes per animal described in Table 2;

Total cost per hectare in the experimental period (R$/ha) → total cost per arroba produced (R$/@) multiplied by the number of arrobas produced per hectare;

Net profit per hectare (R$/@), only considering the weight gain in the experimental period with the use of supplementation →number of arrobas produced per hectare, multiplied by the price of the arroba of the finished cattle (Table 2);

Gross revenue per animal (R$/animal), considering only the weight gain in the experimental period with the use of supplementation → Gross revenue per hectare (R$/ha), multiplied by the pasture area used (3.25ha per treatment), divided by the number of animals per treatment (11 animals);

Net revenue, or operating profit, per hectare (R$/ha), considering only the weight gain in the experimental period with the use of supplementation → result of the subtraction of the total cost per hectare from the net revenue per hectare (R$/ha);

Total gross revenue per hectare (R$/ha),considering the final body weight of the animals as the sale weight at the price of the @ of the finished cattle (Table 2) → final body weight divided by 30, multiplied by the price of the arroba of finished cattle (R$145.00), multiplied by the number of animals per treatment (11 animals), divided by the pasture area occupied by each treatment (3.25 ha);

Cost with the purchase of the unfinished cattle per hectare(R$/ha) →initial body weight divided by 30, multiplied by the price of the arroba of unfinished cattle (R$ 145.00 - average price of the unfinished cattle in the months of June (2014 and 2015) in Bahia State), multiplied by the number of animals per treatment (11 animals), divided by the pasture area occupied by each treatment (3.25 ha);

Capital invested per hectare (R$/ha) → sum of the cost with the purchase of unfinished cattle per hectare (R$/ha) and the total cost per hectare in the experimental period (R$/ha), considering the costs with supplement, labor, medications, maintenance of fences and pasture, and taxes per hectare;

Reals returned per real invested (R$) → net revenue per hectare divided by the total cost per hectare; Monthly rate of return (%)→ the net revenue per hectare was divided by the total cost per hectare and multiplied by 100; next, the result was divided by the experimental period and multiplied by 30 d → {(Net revenue ha/Total cost ha) * 100} /n of days of experimental period] * 30;

Return on the investment per hectare (R$/ha/n of days of experimental period), considering an investment in the savings account with an average interestrate of 6 % per annum. →capital invested in the period per hectare, multiplied by 6%/365, and then multiplied by the experimental period (number of days of experimental period); Percentage of return of the activity (%)→ net revenue, divided by the invested capital, both in R$/ha, multiplied by 100;

Profitability index (%)→ net revenue (R$/ha), divided by the gross revenue (R$/ha), multiplied by 100. The profitability index indicates the available revenue after the payment of the feed cost (operating cost divided by the gross revenue in R$/ha/period in days multiplied by 100).

Table 2: Performance variables of production of crossbred steers under different supplementation strategies

Performance	Supplementation strategy		CV (%)	*P*-value
	S1	S2		
Weight gain, kg/ha	865.33	1055.59	12.39	0.0012
Meat production, kg/ha	410.41	533.60	13.65	0.0002
Production, @ of meat/ha	27.36	35.57	13.65	0.0002
Stocking rate, AU/ha	2.19	2.40	15.87	0.1845

S1= mineral supplementation in the 1st and 3rd periods and protein-energy supplementation at 0.2% BW in the 2nd period; S2= protein-energy supplementation at 0.4% BW in the 1st and 3rd periods and protein-energy supplementation at 0.6% BW in the 2nd period. CV= coefficient of variation; BW = body weight.

Two indices were adapted and used[5] for economic analysis: IRR (internal rate of return) and NPV (net present value). The calculation of the IRR of an investment indicates if it will increase the worth of a company. Therefore, an investment may or may not be made upon analyzing its IRR. For its calculation, it is necessary to project a cash flow that indicates money inputs and outputs stemming from the investments.

The internal rate of return shows the return on the investment. Therefore, in managerial terms, IRR corresponds to the profitability rate expected from investments in a project. To determine whether the IRR is good or not, a common practice is to compare it with the cost of the invested capital; if the estimated IRR is greater than the cost of capital, then the project is accepted. Otherwise, the project will not be economically viable. In the case of comparison between two or more treatments, the higher the estimated IRR is, the more profitable the treatment will be; i.e., according to the acceptance criteria, the higher the result obtained in the project, the greater the attractiveness for its implementation; also, the investment alternative with the highest IRR will almost always be the preferred one.

The calculation of NPV, in turn, represents a mathematical-financial formula that determines the current value of future payments discounted at a proper interest rate, minus the cost of the initial investment. Basically, it is the calculation of how much the future payments added to an initial cost would be worth currently. The concept of money's worth in time is adopted; e.g., R$ 1,000.00 today will not be worth the same(R$ 1,000.00) in one year, because of the opportunity cost of, for instance, investing this amount in the savings account to earn interest.

Thus, the internal rate of return is the 'R' value that equates the next expression to zero:

$$NPV = CFo + \frac{CF1}{(1+R)^1} + \frac{CF2}{(1+R)^2} + \frac{CF3}{(1+R)^3} + ... + \frac{CFn}{(1+R)^n}$$

in which:

CF= net cash flows (0, 1, 2, 3,...,n) and, r= discount rate.

The internal rate of return was calculated by projecting the capital inputs and outputs generated by the investment in question. For this purpose, the following variables were considered:

Capital invested per hectare in the period (R$/ha/n of days in the experimental period, 447 d) → sum of the cost with the purchase of the unfinished cattle and of the cost with the capital invested per hectare;

Daily gross revenue per hectare (R$/ha d) → division of the total gross revenue of each experimental period and total experimental period, per hectare (R$/ha), considering the final body weight of the animals as the sale weight at the price of the arroba of finished cattle, by the number of days in the experimental period.

The experimental period was considered as the period of investment. In this way, a capital injection was considered as follows: Total experimental period (447 d): (daily gross revenue * 30 d) *14 mo + (daily gross revenue * 27 d); Rainy season 1 (168 d): (daily gross revenue * 30 d) *5 mo + (daily gross revenue * 18 d); Dry season (180 da: (daily gross revenue * 30 d) *6 mo; Rainy season 2 (99 d): (daily gross revenue * 30 d) *3 mo + (daily gross revenue * 9 d).

For the other economic index used in the analysis of investments (NPV), three hurdle rates (HR) were considered; these were 5, 10, and 15 % per year, representing 0.41 %, 0.83 %, and 1.25 % per month, respectively.

Upon calculating the NPV of the investment in question, the above-described variables were considered. The following mathematical expression represents the calculation of NPV[5]:

$$NPV = \sum_{t=o}^{n=i} NF/(1+R)^t$$

in which: NPV = net present value; NF = net flow (difference between inputs and outputs); n = number of flows; R = discount rate; t = period of analysis (i = 1, 2, 3...).

For the statistical analysis of economic data, each animal was used as an experimental unit. The studied variables were interpreted statistically by analysis of variance and the F test at the 10% probability level.

Results

The weight gains per hectare (kg/ha) and meat production per hectare variables differed (P<0.10) between the two supplementation strategies (Table 2).

Total weight gains per hectare and meat production were higher (P<0.10) in strategy S2, increasing from 410.41 kg/ha (27.36@/ha) to 533.60 kg/ha (35.57@/ha), in strategies S1 and S2, respectively. This is corroborated by the difference observed in the ADG of the animals, from 0.57 kg/d in S1 to 0.69 kg/d for S2.

The stocking rate observed during the experimental period in the two supplementation strategies did not present differences (P>0.10). The average stocking rate found in this study was 2.29 AU/ha.

The animals supplemented with strategy S2 had higher (P<0.10) concentrate intake and costs with supplement when compared with those supplemented with strategy S1, of the orders of 461.68 %, 465.60 %, and 331.35 %, respectively (Table 3).

Table 3: Operating costs used in the composition of total costs per production of different supplementation strategies for crossbred steers

Variable	Supplementation strategy		CV (%)	*P*-value
	S1	S2		
Concentrate intake per period, kg/ha	416.68	2341.16	10.85	<0.0001
Cost with supplement, R$/ha	604.19	3417.33	10.85	<0.0001
Cost with supplement, R$/@	22.66	97.78	20.26	<0.0001
Cost with labor, R$/@	5.17	3.99	14.47	0.0004
Cost with medications, R$/@	2.03	1.66	12.82	0.0017
Cost with pasture maintenance, R$/@	8.76	6.75	14.47	0.0004
Cost with taxes - IRR,R$/@	0.44	0.34	14.47	0.0004
Total cost per arroba produced, R$/@	39.08	110.54	18.39	<0.0001
Cost per animal, R$	310.05	1141.21	8.89	<0.0001
Participation of supplement in total cost, @ (%)	57.48	88.40	3.44	<0.0001

S1= mineral supplementation in the 1st and 3rd periods and protein-energy supplementation at 0.2% BW in the 2nd period; S2= protein-energy supplementation at 0.4% BW in the 1st and 3rd periods and protein-energy supplementation at 0.6% BW in the 2nd period. CV= coefficient of variation; IRR= internal rate of return; BW= body weight.

The costs with labor, medication, pasture maintenance, and taxes differed (P<0.10) between the supplementation strategies adopted. When the supplement cost was added to these costs, the total cost per arroba produced differed (P<0.10) between the two strategies, for which strategy S2 was 2.82 times higher. Also in this context, the cost per animal in strategy S2 was 3.68 times higher than that in S1. The participation of the cost with concentrate in the total cost of arrobas produced represented 57.48 % in strategy S1, whereas in S2 this value was 88.40 % .

The cost with the purchase of unfinished cattle in reals in both supplementation strategies did not differ (P>0.10) (Table 4). The difference in weight gain (kg/ha) (P>0.10) between the two strategies, as a result of variations in ADG, led to a difference (P<0.10) in gross revenue per hectare, which considers the final sale price of the animals. The total cost per hectare (R$/ha) between the strategies differed (P<0.10), and the cost of strategy S2 was 3.69 times higher than that of strategy S1, demonstrating an advantage of using S1. The net revenue in the period (R$/ha), observed in each supplementation strategy, was superior in S1 (P<0.10), in which the animals were supplemented with a mineral mix in the rainy periods and with concentrate supplement (0.4% BW) in the dry period of the year.

Table 4: Economic analysis of different supplementation strategies for crossbred steers

Variable	Supplementation strategy		CV (%)	*P*-value
	S1	S2		
Unfinished cattle purchase cost, R$	792.22	793.98	23.33	1.0000
Gross revenue per animal, R$/animal	1172.16	1524.01	13.65	0.0002
Gross revenue per hectare, R$/ha	3967.30	5158.20	13.65	0.0002
Total cost per hectare, R$/ha	1046.40	3863.13	8.88	<0.0001
Net revenue in the period, R$/ha	2920.90	1295.07	31.82	<0.0001
Invested capital, R$/ha	3727.79	6550.46	12.91	<0.0001
R$returned per R$invested	3.83	1.34	19.01	<0.0001
Monthly rate of return, %	18.99	2.29	31.00	<0.0001
Profitability, %	73.04	23.76	19.61	<0.0001
Return from investment at 6% per annum, R$/ha	197.02	197.46	23.33	1.0000

S1= mineral supplementation in the 1st and 3rd periods and protein-energy supplementation at 0.2% BW in the 2nd period; S2= protein-energy supplementation at 0.4% BW in the 1st and 3rd periods and protein-energy supplementation at 0.6% BW in the 2nd period. CV= coefficient of variation; BW= body weight.

Strategy S1 required greater (*P*<0.10) capital investment as compared with S2. Thus, S1 allowed a higher (*P*<0.10) return on the capital invested in the activity. The monthly rates of return and profitability were higher (P<0.10) in strategy S1, which showed to be 73 % more profitable than supplementation strategy S2 (Table 4).

Considering the application of the invested capital (6 % return) per hectare in each supplementation strategy in an investment fund (savings account; 6 % per annum), no difference was observed (*P*>0.10) between the two feeding strategies (Table 4).

The internal rate of return did not show differences (*P*>0.10) between the supplementation strategies (Table 5).

Table 5: Monthly internal rate of return and net present value of different supplementation strategies for crossbred steers

Variable	Supplementation strategy		CV (%)	*P*-value
	S1	**S2**		
Internal rate of return, %	0.20	−0.30	6.83	0.1521
Net present value, HR5%	2595.44	930.62	35.46	<0.0001
Net present value, HR10%	2472.84	771.23	37.00	<0.0001
Net present value, HR15%	2355.78	619.02	38.71	<0.0001

S1= mineral supplementation in the 1st and 3rd periods and protein-energy supplementation at 0.2% BW in the 2nd period; S2= protein-energy supplementation at 0.4% BW in the 1st and 3rd periods and protein-energy supplementation at 0.6% BW in the 2nd period. HR - hurdle rate. CV= coefficient of variation; BW= body weight.

The net present value, irrespective of the hurdle rate considered, showed differences (*P*<0.10) between the supplementation strategies: 172.02 %, 202.26 %, and 241.84 % for the rates of 5, 10, and 15 %, respectively, which were higher for strategy S1.

Discussion

Total weight gain per hectare and meat production were higher (P<0.10) in strategy S2, the greater protein-energy supply from the concentrate supplement(6) would explain the better performance found for the group of animals on S2. Working with supplementation for beef cattle kept(7) on a Tanzania grass pasture and subjected to mineral mixture and concentrate supplementation at 0.2, 0.4, and 0.6 % BW and did not observe increase in the weight gains of animals explained by the high herbage allowance adopted in the experiment (average 12.88 t/ha herbage mass), contrasting the results of the present study.

The stocking rate observed during the experiment is higher than the Brazilian national average of 0.5 AU/ha(8). Similarly, when working with cows on a Marandu grass pasture(9) employing two supplementation systems (0.5 and 1.0 % BW) and two energy sources (oat grain and broken corn), found an average stocking rate of 1.68 AU/ha, which is also higher than the national average.

Evaluating the effect of different supplementation levels on the performance of purebred Nellore ― a mineral mix and supplementation with concentrate at 0.2, 0.4, and 0.6 % BW(7) ― observed increases in concentrate intake, cost per animal, and total cost, respectively, for the treatments. Higher costs were found for strategy S1, explained by the lower number of arrobas produced, as compared with strategy S2.

Comparing feeding strategies (mineral supplementation at 0.2 and 0.3 % BW) in the production of crossbred steers on a *Brachiaria brizantha* cv. Marandu pasture(10) they found that supplementing animals with concentrate supplement (0.3 % BW) during the rainy and dry seasons led to a 3.11 times higher production cost per animal as compared with the group of animals supplemented only with mineral salt in the rainy seasons and with concentrate supplement (0.2 % BW) in the dry period of the year.

This result reinforces the idea that it is important to know the percentage of formation of production costs; in this case, of the arrobas produced. Detailing the costs to produce one arroba allows the producer to seek alternatives that minimize them; one of these alternatives is designing supplementation strategies aimed at satisfactory gains throughout the entire production cycle associated with cost reduction.

In a supplementation program, a large part of the economic return achieved is a consequence of additional weight gains and anticipated emptying of pastures, which makes them available for other groups of animals or facilitates management practices[11].

The cost with the purchase of unfinished cattle in reals in both supplementation strategies did not differed as a function of the initial body weight. Evaluating the economic response of four levels of supplementation (mineral salt 0.3%, 0.6%, and 0.9% BW) in the finishing of Nellore steers on a *Brachiaria brizantha* pasture in Southeast Bahia State[12] they found, similarly to the present study, higher gross revenues per animal and per hectare for the highest supplementation level. This result was possibly due to the increased amount of arrobas produced and also the differences between the moments when the animals were sold, which represent, in practice, different prices as a function of the month of sale of the lots of animals.

Reviewing and discussing protein energy supplementation[13] it was reported an increase in invested capital in their experiment in which they compared mineral salt with concentrate supplementation in the amounts of 0.125, 0.25, 0.50, and 1.0 % BW. The highest performance level, which consequently provided the highest daily revenue, was not the most economically viable; in this way, treatments 0.25 and 0.50 % live weight represented the greatest profitability. This result can be explained by the increased daily cost as the supplementation levels were increased, and these data agree with the results of the present study.

In a study conducted with Nellore steers finished on *Brachiaria brizantha* pastures in Southeast Bahia State, Brazil, tested four levels of concentrate supplementation (control, 0.3, 0.6, and 0.9 % BW)[6] they found higher rates of return and profitability for the lowest supplementation levels, because an increase in costs was observed together with the increase in supplementation levels, which is in line with the results found in the present study.

This is due to the lower feed cost observed in treatment S1, which led to a lower total cost of this treatment, as described previously. The positive values of NPV show that both strategies were able to cover the initial investment to purchase the animals, generating additional revenue. Thus, in treatment S1, the NPV were always higher than those in treatment S2, proving its higher profitability. In financial analysis[14] they found economic viability in supplements provided at levels lower than 0.3 % live weight. For the supplementation levels of 0.6 % to 0.9 % LW, however, the authors obtained losses as compared with the supply of mineral mix.

In any production system, the economic viability determines the direction to be followed by the many segments of the production chain; among them is the use of forage supplementation, in which case positive and negative aspects should be considered when aiming at an improvement in biological performance despite the increased production cost. To seek balance between biological productivity and financial sustainability is the challenge of modern animal science.

Conclusions and implications

The mineral or protein-energy supplementation strategies generate benefits to beef cattle farming, with positive effects on performance variables. Mineral supplementation strategies in the rainy season associated with protein-energy supplementation in the amount of 0.2 % of the body weight during the dry season provides the best economic results.

Literature cited

1. Silva F, Sá J, Schio A, Silva R, Ítavo L, Mateus R. Suplementação a pasto: disponibilidade e qualidade x níveis de suplementação x desempenho. Rev Bras Zootec 2009; 8 (1):371-389.

2. Almeida V, Silva R, Queiroz A, Oliveira A, Silva F, Abreu Filho G, Lisboa M, Souza S. Economic viability of the use of crude glycerin supplements in diets for grazing cross bred calves. Rev Bras Zootec 2014;43(7):382-389.

3. Detmann E, Souza MA, Valadares Filho SC, Queiroz AC, Berchielli TT, Saliba EOS, *et al*. Métodos para análise de alimentos – INCT – Ciência Animal. Instituto Nacional de Ciência Tecnologia de Ciência Animal 2012.

4. Anualpec - Anuário da Pecuária Brasileira. FNP Consultoria & Comércio 2013;20;1-360.

5. Martin N, Serra R, Oliveira M, Ângelo J, Okawa H. Sistema integrado de custos agropecuários - CUSTAGRI - Informações econômica 1998; 28(1):7-28.

6. Silva R, Prado I, Carvalho G, Silva F, Santana Júnior H, Souza D, Dias D, Pereira M, Marques J, Paixão M. Novilhos nelore suplementados em pastagens: Consumo, desempenho e digestibilidade. Arch Zoot 2010;59(3):549-560.

7. Cabral L, Zervoudakis J, Coppedê C. Suplementação de bovinos de corte mantidos em pastagem de *Panicummaximum* cv. Tanzânia-1 no período das águas. Rev Bras S Prod Anim 2008; (2): 293-302.

8. Ítavo L, Ítavo C, Dias A, Novais M, Silva F, Mateus R, Schio A. Desempenho produtivo e avaliação econômica de novilhos suplementados no período seco em pastagens diferidas, sob duas taxas de lotação. Rev Bras S Prod Anim 2007;(3):229-238.

9. Agulhon R, Jobim C, Branco A, Calixto JM. Fontes energéticas e níveis de suplementação para vacas em pastagem de capim-marandu

(*Brachiariabrizantha* Hochst ex. A. Rich. Stapf) no inverno. Rev Bras Zootec 2005;34(1):151-158.

10. Souza, S. Estratégias de suplementação para produção de novilhos mestiços recriados e terminados em pastagens [Dissertação]. Itapetinga, Bahia, Brasil. (Universidade Estadual do Sudoeste da Bahia) 2015.

11. Socreppa L, Moraes E, Moraes K, Oliveira A, Drosghic L, Botini L e Stinguel H. Glicerina bruta para bovinos de corte em pastejo no período das águas: viabilidade produtiva e econômica. Rev Bras S Prod Anim 2015;16(1):232-243.

12. Pinheiro A, Silva R, Junior H, Prado I, Costa L, Lacerda J, Breda A. Avaliação Econômica de Diferentes Níveis de Suplementação na Terminação de Novilhos Nelore em Pastagens de *Brachiaria brizantha.* Rev Sci Prod Anim 2010;(21):110-113.

13. Andrade M, Resende R. Suplementação proteico energética de bovinos de corte sob pastejo no período das águas aspectos econômicos. FAZU em Revista 2013; 72-78.

14. Porto M, Paulino M, Valadares FS, Sales M, Leão M, Couto V. Fontes suplementares de proteína para novilhos mestiços em recria em pastagens de capim-braquiária no período das águas: desempenho produtivo e econômico. Rev Bras Zootec 2009; 38 (8): 553-1560.