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ANIMAL PRODUCTION

Body size and its effects on productive efficiency of cows with predominant Nellore genetic composition

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ABSTRACT. This study was developed to evaluate productive efficiency during the lactation period of cows with predominant Nellore genetic composition based on their body size. Cows were divided into the following categories: light (≤ 316 kg), moderate (≥ 317 and ≤ 400 kg), or heavy (≥ 401 kg). Body weight change and total gain from birth to 210 days of age of calves born from heavy cows (0.155±0.03 and 111.6±5.1 kg) were higher than those of calves born from light (0.064±0.03 and 91.0±4.3 kg) and moderate (0.144±0.03 and 97.7±4.0 kg) cows. Calf production index differed ($p < 0.05$) with the herd of heavy cows (93.5±3.2 kg), producing 57.4 and 19.7% more kilograms of calf than light (59.4±2.7 kg) and moderate (78.1±2.4 kg) cows, respectively. Heavy Nellore cows produce heavier calves and have a better reproductive performance, which lead to a better calf production index. However, they require a larger area for the same herbage allowance. Calves born from heavier Nellore cows gain more weight from birth to 210 days of age and are heavier from 210 to 270 days of age.

Keywords: weaning; calf production; lactation; production per area.

Tamanho corporal e seus efeitos na eficiência produtiva de vacas com composição genética predominante de bovinos Nelore

RESUMO. O estudo objetivou avaliar a eficiência produtiva durante a lactação de vacas com predominância Nelore de diferentes tamanhos corporais no sul do Brasil. Foram formados três grupos de vacas a partir do peso vivo: leves (≤ 316 kg), moderadas (≥ 317 e ≤ 400 kg) ou pesadas (≥ 401 kg). A variação de peso corporal e o ganho total do nascimento aos 210 dias dos bezerros de vacas pesadas (0,155±0,03 e 111,6±5,1 kg) foram superiores aos filhos de vacas leves (0,064±0,03 e 91,0±4,3 kg) e moderadas (0,144±0,03 e 97,7±4,0 kg). O índice de produção de bezerros apresentou diferença ($p < 0,05$) com o rebanho de vacas pesadas (93,5±3,2 kg) produzindo 57,4 e 19,7% mais quilogramas de bezerro que as leves (59,4±2,7 kg) e moderadas (78,1±2,4 kg), respectivamente. Vacas Nelores pesadas produzem bezerros mais pesados ao nascimento e possuem melhor desempenho reprodutivo, determinando o melhor índice de produção de bezerro; porém, as mesmas necessitam de maior área para a mesma oferta de forragem. Bezerros filhos de vacas Nelore com maior peso corporal possuem maior ganho de peso do nascimento aos 210 dias e são mais pesados aos 210 e 270 dias de idade.

Palavras-chave: produção de bezerro; lactação; produção por área.

Introduction

The Brazilian meat-livestock industry has unsatisfactory production indices when compared with the main world producers (Ferraz & Felício, 2010). Nellore is the most common breed in numerical terms, as it participates in over half of the herds as pure and crossbreds and corresponds to approximately 80% of the zebu animals raised in the country (Anuário da Pecuária Brasileira, ANUALPEC, 2017).

Calf production is the main stage of beef cattle production, and despite usually generating less profit than the backgrounding and finishing phases, it is the supporting basis for the maintenance of the activity (Christofari et al., 2008; Gomes, Abreu, Carvalho, & Zen, 2013). As such, it constitutes a key factor to increase the cattle herd production.

In recent years, there have been considerable raises in production costs without the products derived from beef cattle following a compatible valuation, which culminates in profit decreases for the producers (Gonçalves et al., 2017). Therefore, efficient beef production is essential for the success of the activity and for the industry to be able to meet the constantly growing demand for meat. In this regard, production-efficiency measures can be used as a low-cost strategy. Efficiency in the production process is intrinsically linked to the productivity of cows, their maintenance cost, as well as the interaction between these two factors, upon the growth and body composition of their offsprings (Silva et al., 2015). Determining the individual efficiency of the dam at weaning which can be calculated as the percent ratio between the calf and cow weights is a great tool that reflects the potential of a given type or size of animal and breed in a given environment (Araújo et al., 2014). The body size of a cow interferes with its production efficiency. In this scenario, the adaptability of the animal to the feeding conditions, climate, and other resources of the production system in which it is inserted is a fundamental factor. Thus, its nutritional requirements must be adjusted according to the availability of nutrients and type of environment (Simioni, 2003).

The present study was undertaken to evaluate the productive efficiency during the lactation period of cows with predominant Nellore genetic composition of different body sizes in the south Brazil.

Material and methods

The experiment involved the evaluation of performance and productivity data of a breeding herd composed of 66 cows with predominant Nellore genetic composition (purebred; ¾ N ¼ C; and 5/8N 3/8C [N = Nellore; C = Charolais]) and their calves. Observations were made from calving until the calves were nine months old. Cows were three to twelve years old, and this age gap was minimized through an equivalent distribution of ages within the weight groups. The experiment took place in the Department of Animal Science at the Federal University of Santa Maria, located in the 'Central Depression' region of Rio Grande do Sul, Brazil.

Groups were formed based on the difference in weight, adopting the mean weight of the lot (358 kg) and the standard deviation of the mean (53 kg). A cut-off point of 0.8 standard deviations of the mean was used as basis. Groups were named 'light', for animals whose weight was lower than or equal to 0.8 standard deviations below the mean (cows weighing ≤ 316 kg); 'moderate', for cows whose weight was between 0.8 standard deviations below and 0.8 standard deviations above the mean (cows weighing ≥ 317 and ≤ 400 kg); or 'heavy', for cows whose weight was above 0.8 standard deviations above the mean (cows weighing ≥ 401 kg).

The diet consisted basically of natural pasture, with a stocking rate of 0.9 AU ha^{-1}, supplemented with mineral mixture (common salt plus dicalcium orthophosphate, containing 80 ppm phosphorus) consistent with the requirements of the animal categories. Throughout the experimental period, including suckling, weaning, and post-weaning, the cow-calf pairs or the different categories were maintained in a single lot, in the same environment, and under the same management conditions.

Grasses and leguminous species constitute a great part of the botanical composition of natural pastures, and the former are represented mostly by the species bahiagrass (*Paspalum notatum*) at hilltops and hillsides and stoloniferous species such as carpetgrass (*Axonopus fissifolius*) in humid lowlands. Some trefoils are present among the leguminous species, but the predominant family is *Desmodium*. When under a high animal stocking rate; e.g., at a herbage allowance of 4% of the live weight per hectare, the plant community is reduced, thereby elevating the number of composite species such as common soliva (*Soliva pterosperma*), flax-leaved fleabane (*Conyza bonariensis*), "flor-das-almas" (*Senecio brasiliensis*) (Andrade et al., 2015). Lately, South African lovegrass (*Eragristis plana Nees*) has been spreading (Andrade et al., 2015).

Cows and calves were weighed in the first 24 h after calving and at 63, 150, and 210 days of age. Additionally, they were weighed at an average age of 270 days. Daily weight changes were determined as the difference between the weighing events divided by the number of days between them. On the weighing days, the animals also had their body condition score assessed, with values ranging on a scale from 1 to 5 (Fontoura Júnior, Siewerdt, Dionello, & Corrêa, 2009).

Milk yield was estimated by the the direct method, via manual milking. Therefore, on the day prior to the evaluation, calves were separated from their mothers at 13h00 and reunited at 19h00 for approximately 20 min. This management procedure was aimed at depleting the cows' udder. After this suckling calves were once again separated from the cows until the next morning, remaining in the corral at night, while the cows were kept in paddocks with sufficient herbage and water. Cows started to be milked at 07h00 of the next day. For this management procedure, the cows were kept in a restraining chute. To facilitate the descent of the milk the application of 1 ml of oxytocin intramuscularly was used. Twenty-four-hour milk yield was estimated by using the equation proposed by Restle, Pacheco, Moletta, Brondani, and Cerdótes (2003), as shown below:

$$MY = \frac{(MMY * 2) * 60\ min * 24h}{TMM}$$

where MY: milk yield estimated for 24h on the milking day (kg day^{-1}); MMY: milk yield obtained from the manual milking of two quarters of the udder; and TMM: time in minutes between the last suckle and milking. Evaluations for the estimate of the milk production by the cows took place at 21, 42, and 63 days post-calving. To estimate the total milk yield, each result of the evaluation was multiplied by 21, representing the total production in the 21 days, and the three evaluation periods were summed.

Calves were early-weaned at 42 or 63 days after calving, in the three cow groups. After weaning, the cows remained in the same pasture area, which was reduced only to maintain the stocking rate of 0.9 AU ha^{-1}. After the stress generated by weaning and by the period in the corral was over, calves were also maintained under the same animal load on a natural pasture, while receiving concentrate supplementation balanced for the category (18% CP and 70% TDN), in the amount of 1% of their body weight until 210 days of age.

Natural service was adopted for the reproductive management, using a bull-to-cow ratio of 1:25, for a period of 90 days. Andrological examination and libido test for reproductive aptitude were performed on the bulls prior to the breeding season. Pregnancy was diagnosed by ultrasonography at 60 days after the end of the reproduction period.

The calf production index was calculated as proposed by Vaz, Lobato, and Restle (2010) by associating the calf weight at 210 days with the cows' pregnancy rate. The result was expressed in kilograms of calf produced per cow kept in the herd of the previous year. Productive efficiency estimates were obtained from quantified traits. Productive efficiencies were assessed at calving and at 210 days, considering a ratio of kilograms of calf at 210 days per 100 kg of cow at calving or at 210 days, respectively (Ribeiro, Restle, Rocha, Mizubuti, & Silva, 2001). Total cow and calf weight gains (kg) from calving to 210 days were used for the estimate of productivity.

Productive efficiency was also analyzed according to the pasture area used for each cow-calf pair as a function of the fixed 0.9 AU ha^{-1} stocking rate. For this step, calves were considered to occupy grazing areas and consume pasture after three months of age.

Simulations were undertaken using Excel software to evaluate the area necessary to allocate the cow-calf pair and other categories present in the cow-calf production system. In the simulation, male calves and surplus replacement females would be sold aiming at the mating of the replacement heifers at two years old, adopting a stocking rate of 0.9 AU ha^{-1} (1 AU = 450 kg body weight).

These data were generated based on the number of cows in each group and their reproductive performance. The production and sale of the herds were calculated as a function of the body weight gains and the likely adult body weights of each group, as well as of the weight gains achieved in the present study. The body weight used for cows and calves was the average weight from calving to seven months, and these values were used to estimate the occupation of those categories. Calf mortality rates of 4 and 3% were adopted for males and females, respectively (Gonçalves et al., 2017). The body weights of cull cows were estimated considering a body condition score of 4.5 points.

The experiment was set up as a completely randomized design. Collected data were subjected to analysis of variance, including the fixed effect of cow size in the statistical model. Cow age, calf sex, and calving order were used as co-variables. Analyses were carried out via the GLM procedure, using Statistical Analysis System (SAS, 2004) and adopting 5% as the maximum significance level by the "t" test. Pregnancy rate was analyzed by the chi-square method (Gomez & Gomez, 1984).

Results and discussion

The average weights of the groups differed ($p < 0.05$) from each other at calving, and this difference remained throughout the evaluated period (Table 1). Despite the weight differences of the groups, their body condition scores did not differ ($p > 0.05$), indicating a real difference in body structure across them, which was not due to a larger deposition of body fat.

Although the weight groups did not differ in average daily body weight change from calving to 63 days, the negative performance of the 'heavy' category is noteworthy (0.072 kg day^{-1}). Though little, it may hinder the subsequent conception in the long term (Vieira, Lobato, Torres Junior, Cezar, & Correa, 2005). When the daily weight change was evaluated in a longer period, from calving to 210 days, the 'heavy' group had a lower ($p < 0.05$) performance (0.27 kg day^{-1}) than the 'moderate' group

(0.38 kg day^{-1}), which in turn did not differ ($p > 0.05$) from the 'light' cows (0.32 kg day^{-1}). These results can be explained by the weight loss until 63 days post-calving observed in the larger animals, suggesting greater nutritional requirements for maintenance, which leads to decreased availability of nutrients for weight gain. In this regard, this group of cows was under negative energy balance during this period.

The body condition scores of cows at 63 days post-calving and at the end of the breeding season demonstrate that irrespective of the weight group, they were above the average, with mean values of 3.09, 3.13, and 3.10 obtained by the light, medium, and heavy categories, respectively. In theory, these values characterize that the cows are suitable for the reproduction activity. According to Fontoura Júnior et al. (2009), the ideal body condition score for females to be submitted to reproduction is the average or above it. Those authors also stated that the chances of reproductive problems are higher in animals with a body condition score below the average. Ferreira, Miranda, Figueiredo, Costa, and Palhano (2013) evaluated lactating multiparous zebu cows with body condition scores between 3 and 4 or between 2.0 and 2.5 and found that those with a better score had higher pregnancy rates (a 31.3% superiority).

Calf birth weight differed ($p < 0.05$) across the cow weight groups. Calves born from heavy cows were heavier than those born from light cows, but did not differ from the calves born from moderate cows. However, when calf weight was expressed relative to the cow weight, similar values were found: 8.8, 8.6, and 8.1% for the light, moderate, and heavy groups, respectively. Boligon et al. (2013) mentioned that calves are heavier at birth when their mothers have larger biotypes. However, those authors also stressed the increased probability of occurrence of dystocia, claiming that in cows with a body weight of 400 to 450 kg, the birth weight of their offspring should be around 35 kg, on average.

The difference in calf birth weight ($p < 0.05$) is probably due to the smaller intrauterine and uterus spaces within the abdominal cavity. When compared with taurus breeds, Nellore animals have smaller thoracic perimeter and ischial and ileal openings, which lead to a smaller space within the abdominal cavity to house the vital organs and the digestive tract (Mota, Mariz, Ribeiro, Silva, & Lima Júnior, 2015), which competes for space with the uterus during pregnancy. This fact is further aggravated by the lower development of some animals compared with others of the same genetic group. Mota et al. (2015) found larger morphometric measurements ($p < 0.05$) as a consequence of larger body weights. Lesser development persistence during the lactation of calves born from light cows is likely a consequence of the lower intrauterine development and consequent lower birth weight. Cows undergo morpho-physiological changes throughout their life that influence their production. With respect to the animal's age, growing heifers typically produce lighter calves because of lower milk production (Rodrigues et al., 2014), incomplete development of their reproductive organs, reduced uterine irrigation, as well as because of a possible competition of nutrients between mother and calf (Araújo et al., 2014).

Table 1. Adjusted means and standard deviations for performance variables of cows with predominant Nellore genetic composition of different body sizes and their calves.

Description	Body size		
	Light	Medium	Heavy
Cows - Body weights and changes, kg			
At calving	309.6±4.8^{c}	362.8±4.4^{b}	408.5±5.2^{a}
63 days post-calving	315.7±6.7^{c}	370.3±6.2^{b}	404.0±7.9^{a}
End of breeding season	331.6±7.1^{c}	391.8±6.5^{b}	425.2±8.4^{a}
210 days post-calving	364.6±8.2^{c}	429.8±7.6^{b}	456.2±9.8^{a}
Daily change, from calving to 63 days	0.097±0.06^{a}	0.120±0.06^{a}	–0.072±0.08^{a}
Daily change, from calving to 210 days	0.319±0.035^{ab}	0.381±0.032^{a}	0.273±0.042^{b}
Cows - Body condition score, points,			
At calving	3.06±0.06^{a}	3.07±0.06^{a}	3.13±0.07^{a}
63 days post-calving	3.09±0.07^{a}	3.13±0.06^{a}	3.10±0.087^{a}
End of breeding season	3.28±0.07^{a}	3.32±0.07^{a}	3.27±0.09^{a}
Calves, kg*, points#			
Birth weight*	27.5±1.2^{b}	31.4±1.1^{ab}	33.1±1.4^{a}
Weight at 210 days*	118.6±4.5^{b}	129.2±4.1^{b}	144.8±5.3^{a}
Weight at 270 days*	122.4±5.1^{c}	137.8±4.2^{b}	154.1±6.1^{a}
Daily weight change from birth to 210 days*	0.516±0.024^{b}	0.556±0.023^{b}	0.639±0.029^{a}
Weight gain from birth to 210 days*	91.0±4.3^{b}	97.7±4.0^{b}	111.6±5.1^{a}
Daily weight change from 210 to 270 days*	0.064±0.03^{b}	0.144±0.03^{a}	0.155±0.03^{a}
Body condition score at 210 days#	2.59±0.04^{a}	2.57±0.03^{a}	2.67±0.04^{a}

$^{a, b, c}$ Means in the row differ at the 5% level by the t test.

The difference in body weight between the calves was more marked when they reached 210 and 270 days of age. In both periods, the calves born from heavy cows were heavier ($p < 0.05$) than those born from the other groups, reaching weight differences of 11.8 and 25.9% at 270 days in comparison with those born from moderate and light cows, respectively. This finding can be attributed to the fact that there are no nutritional restrictions for this category at that age and weight, and thus they can better express their growth potential. This fact contributes to a better performance of calves born from cows with larger biotypes.

Pregnancy rates differed across the groups (Table 2). However, the average was close to the southern Brazilian index (56.4%), which may be in part due to the stocking rate adopted (0.9 AU ha^{-1}). According to Fagundes, Lobato, and Schenkel (2003), elevated stocking rates do not allow for good development of the natural pasture, resulting in less herbage availability to the animals, which is incompatible with high reproduction rates. Those authors found a pregnancy rate of only 22.0% in an experiment with natural pasture and a stocking rate of 0.8 AU ha^{-1}. The higher values in the present study are due to the adoption of early weaning performed at 42 or 63 days post-calving. However, when early weaning is coupled with better management of the natural pasture and genotypes better adapted to the adversities of the south region of Brazil, pregnancy rates can reach 86.5% (Vaz et al., 2010).

When calf production was extrapolated to the total number of cows exposed to service, according to the calf production index, a difference was noted ($p < 0.05$), with the herd of heavy cows producing 57.4 and 19.7% more kilograms of calf than the light and moderate cows, respectively. However, when this relationship was analyzed considering only calved animals (kilograms of calf at 210 days for each kilogram of cow that calved), the difference between light and moderate cows (16.5 and 18.1 kg) no longer exists. In this scenario, the greatest productivity ($p < 0.05$) remains in favor of the heavy group (20.7 kg). This fact can be explained by the higher pregnancy rate obtained by heavy cows.

In the evaluation of productive efficiency regarding the calf weight at weaning relative to the weight of cows at calving and weaning (kg for every 100 kg of cow), no differences were observed ($p > 0.05$) between the cow body weight groups. The larger proportion of kilograms of calf in relation to the cow weight both at calving and at weaning are indicative of efficiency, as they demonstrate production as a function of the cost of maintenance of the females, which is the highest production cost. These efficiencies can be influenced by the time of birth of the calves and cow age (Bocchi, Teixeira, & Albuquerque, 2004), cow genetic group and calf sex (Ribeiro et al., 2001), nutritional level pre- and post-partum (Ribeiro et al., 2001; Vaz et al., 2016), and calf age at weaning (Moura et al., 2014; Vaz et al., 2010). The present findings are corroborated by the literature, where the cow body size did not lead to increased calf weights relative to the cow weight (Vaz et al., 2016), these two variables being actually proportional to the size of the dam.

The real area occupations during the 210 days represent the surface area necessary for the cow-calf development and production. Real occupation grew ($p < 0.05$) with body size, with areas of 1.00, 1.17, and 1.27 ha necessary for light, moderate, and heavy cows, respectively. Cows of the moderate group had a 21.4% higher requirement for maintenance (kg TDN from calving to 210 days) than light cows, and this difference was even higher in comparison with heavy cows (33.3%). An evaluation of the cost-benefit of nutrients consumed for the production of one kilogram of calf showed better efficiency of light compared with moderate weight and heavy cows (Table 2), as they require smaller amounts of nutrients per kilogram of calf produced.

When the occupied area is related to the production of kilograms, the differences found so far denoting greater production by larger cows cease to exist, with differences no longer present between the groups ($p > 0.05$). Light cows were 4.6 and 15.2% more productive than moderate and heavy cows, respectively. This fact is of paramount importance, as it determines the efficiency of production systems, where herds with more animals in the same area provide a dilution of the fixed costs, thereby increasing profitability (Silva et al., 2017; Vaz, Lobato, & Restle, 2014).

In evaluating a production system, one should consider the area required to produce each unit of product. In this way, the simulation of a production system with the values obtained in the present study considering a 500-ha area indicated capacity to allocate 425, 360, and 328, light, moderate, and heavy cows, respectively (Table 3). Considering all the categories in the system for calf production, total herds of 730, 653, and 612 animals was obtained, respectively.

Table 2. Adjusted means and standard errors for reproductive performance and productive efficiency of cows with predominant Nellore genetic composition of different body sizes.

Description	Body size		
	Light	Moderate	Weight
Pregnancy, % *	50.44[e]	60.53[d]	65.80[d]
Calf production index, kg [A]	59.4±2.7[c]	78.1±2.4[b]	93.5±3.2[a]
Calf production index kg^{-1} of cow at 210 days [B]	16.5±0.7[b]	18.1±0.7[b]	20.7±0.8[a]
Productive efficiency at calving, kg [C]	38.7±1.4[a]	35.7±1.3[a]	36.2±1.6[a]
Productive efficiency at 210 days, kg [D]	32.9±1.2[a]	30.0±1.1[a]	32.2±1.5[a]
Milk yield, L	219.0±19.4[a]	236.7±17.9[a]	257.1±23.0[a]
Total cow-calf pair weight gain, kg	146.0±7.1[b]	164.7±6.5[a]	159.3±8.4[a]
Average real occupation during lactation, ha [E]	1.00±0.03[c]	1.17±0.02[b]	1.27±0.02[a]
Production per real occupation, kg produced ha^{-1} [F]	144.7±4.7[a]	138.4±4.3[a]	125.6±5.6[a]
Cow requirements in the 210 days, kg TDN [#G]	889.5	1080.1	1185.7
Weaning efficiency, kg TDN [#H]	7.5	8.4	8.2
Performance efficiency, kg TDN [#I]	9.8	11.1	10.6

[a, b, c] Means in the row differ at the 5% level by the t test; [d,e] Means in the row differ at the 5% level by the chi-squared test. [A]Calf weight at 210 days × Pregnancy rate/100; [B] [(Calf weight at 210 days × Pregnancy rate/100)/Cow weight at 210 days * 100; [C] Calf weight at 210 days/Cow weight at calving * 100 = kg calf 100 kg^{-1} cow; [D] Calf weight at 210 days/Cow weight at 210 days * 100 = kg calf 100 kg^{-1} cow; [E] (Cow weight + Calf weight)/(450 kg * 0.9 AU ha^{-1}) = ha/Cow-calf pair; [F] (Total cow + calf weight gain)/Average real occupation until 210 days = kg ha^{-1}; [G] TDN requirement (kg day^{-1}) * 210 days; [H] Requirement in kg of TDN in the 210 days/Calf weight at 210 days = kg TDN kg^{-1} of calf ; [I] Requirement in kg TDN in the 210 days/Calf weight gain in the 210 days = kg TDN/Calf weight change in the 210 days. [#]Adapted from National Research Council (NRC, 2000).

Table 3. Simulation, production of body weight, and economic viability of herds of cows with predominant Nellore genetic composition of different sizes.

Description	Body size		
	Light	Moderate	Heavy
Herds, number of animals			
Cows	425	360	328
Bulls	17	14	13
Male calves	103	105	104
Female calves	103	105	104
Replacement heifers	82	70	64
Total herd	730	653	612
Sales, number of animals			
Cull cows	85	72	66
Calves	103	105	104
Culled female calves	18	33	38
Sales, weights (kg)			
Culled cows	380	435	475
Culled male and female calves	119	129	145
Production from the system for sale (kg)			
Production of culled cows	32.300	31.320	31.350
Production of cull male and female calves	14.399	17.802	20.590
Production of cows and calves (1)	46.699	49.122	51.940
Production from the system kept in the herd (kg)			
Production of cows kept	18.700	19.296	12.497
Production of replacement female calves	7.462	6.839	7.142
Production of replacement heifers	8.938	9.240	8.960
Production of cows, calves, and heifers (2)	35.100	35.375	28.599
Total production of the herd (1+2)	81.799	84.497	80.539

Considering culling and renewal of the herd at 20% per year, along with the sales of surplus replacement calves, a maximum of 11.2 and 5.7% more total kilograms per year would be sold with heavy cows when compared with light and moderate cows, respectively. This sale is a consequence of the maintenance of the herds over time with their stability. This higher total estimated production favorable for heavy cows can be explained by their superior pregnancy rate (65.8%), which, in spite of the smaller herd, provided a similar number of calves at weaning in the simulation, which were also heavier ($p < 0.05$; Table 1).

According to the total production values of the herds, taking into account the kilograms produced and sold in the herds in the simulation, a similarity was observed between them. No analysis of their economic efficiency was undertaken, however, although more head were counted as their body size decreased. This fact likely leads to higher variable costs (Fabricio et al., 2017), which are key factors for production. On the other hand, the fixed costs of a system have the greatest influence on the economic outcome (Silva et al., 2017); therefore, in cow-calf production systems, they should be diluted as much as possible so that better economic results can be attained (Ávila, Pacheco, & Pascoal, 2016).

Conclusion

Nellore predominance cows of higher body size produce heavier calves at birth, and have better reproductive performance, determining better calf production indices, but they need more area at the same forage supply.

Calves from Nellore predominance cows with higher body weight gain more weight from birth to 210 days and are heavier at 210 and 270 days of age.

Milk production up to 63 days post-partum of Nellore predominance cows are not affected by their body size.

Smaller cows are more productive when the herd production is associated with the area used.

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