Environmental effects on pre-weaning traits in Santa Gertrudis cattle[1]

Efeitos ambientais sobre características da pré-desmama em bovinos da raça Santa Gertrudis

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Abstract

We aimed to evaluate environmental effects on pre-weaning traits of Santa Gertrudis cattle. We used 213 standardized records for adjusted 205-day weight at weaning (W205), average daily gain from birth to weaning (AGD), and number of days to gain 160 kg from birth to weaning (D160), obtained from the Santa Gertrudis Breeders' Association for animals born between 1990 and 1997. The files were edited with information regarding cow age at calving (CAC) and contemporary group (CG),for which the effects of year and season of birth, animal category, herd, and sex were considered. It was observed that cow age at calving, which had linear and quadratic effects, and effect of contemporary group were significant (P<0.0001) for the evaluated traits. Estimated averages were 198.05 ± 40.64 kg, 0.790 ± 0.198 kg day^{-1},and 288.05 ± 67.18 days for W205, ADG, and D160, respectively. Males were 4.67 kg heavier (197.17 kg) than females, on average. Regarding the animal category effect, the classified females were 2.3% heavier than the unclassified males, on average. On average, animals born in the dry season were 1.6% lighter than those born in the rainy season (197.18 kg). Thus, environmental effects are important and should be considered in any analysis model.
Key words: Contemporary group. Precocity of growth. Selection criteria.

Resumo

O objetivo deste estudo foi avaliar os efeitos ambientais sobre as características da pré-desmama em bovinos da raça Santa Gertrudis. Foram utilizados 213 registros de peso à desmama padronizado aos 205 dias (P205), ganho médio diário do nascimento à desmama (GMD) e número de dias para ganhar 160 kg do nascimento até a desmama (D160), oriundos da Associação dos Criadores de Santa Gertrudis, de animais nascidos no período de 1990 a 1997. Os arquivos foram editados com as informações da idade da vaca ao parto (IVP) e grupo de contemporâneos (GC) que considerou os efeitos de ano e estação de nascimento, categoria animal, rebanho e sexo. Por meio dos resultados obtidos observou-se que a idade da vaca ao parto, efeitos linear e quadrático e o grupo de contemporâneos foram significativos (P<0,0001) para as características avaliadas. As médias estimadas foram de 198,05 ± 40,64 kg, 0,790 ± 0,198 kg dia^{-1}e 218,05 ± 67,18 dias para P205, GMD e D160, respectivamente. Os machos foram 4,67 kg mais pesados (197,17 kg) do que as fêmeas. No efeito de categoria animal as fêmeas selecionadas

mostraram-se 2,3% superiores aos machos. Animais nascidos na estação da seca foram 1,6% mais leves em relação aos que nasceram nas águas (197,18 kg). Assim, as avaliações dos efeitos ambientais tornam-se importantes e devem ser consideradas no modelo de análise.

Palavras-chave: Critérios de seleção. Grupo de contemporâneos. Precocidade de crescimento.

Introduction

The opening of new markets, accompanied by human population growth, exposes beef producers to the challenge of intensifying animal production, to produce more in less time, without decreasing product quality or economic efficiency.

According to Corrêa et al. (2006), one of the tools to increase productive performance in herds is animal genetic improvement through selection of genetically superior animals, with the goal of genetic improvements in future generations. To reach this goal, characteristics of economic interest were studied, and the animal husbandry environment was evaluated.

In beef cattle, pre-weaning traits are of great economic importance. Pereira and Muniz (2013) stated that at this stage, the first data on the performance of the animal are obtained and it is possible to evaluate both the genetic potential of growth of the calf and the maternal ability of the cow. Some characteristics can be evaluated during this breeding phase, such as the adjusted 205-day weight at weaning (W205), average daily gain from birth to weaning (ADG), and number of days after birth for the animal to gain 160 kg (D160).

W205 is one of the first factors obtained to evaluate the performance of the animal. To make comparisons among weights of weaned calves of different ages, it is necessary to make corrections between the ages, such that there are no advantages or disadvantages for those who were weaned at a greater or lesser age. Cardoso et al. (2001) explained that the calf age adjustments at weaning are most often completed by the average daily gain for the standard age of 205 days and that these adjustments assume linear growth. ADG is a feature of great importance, because fast growth is a desirable

characteristic in beef cattle; thus, animals with higher growth capacity need less time to reach the age of slaughter (SARMENTO et al., 2003).

Similar to ADG, according to Fries et al. (1996), the D160 provides breeders with a shorter time to produce certain market units rather than waiting to obtain heavier animals. The identification and selection of fast-growing animals at this stage have been used by farmers to improve the efficiency of breeding systems (CORRÊA et al., 2006).

According to the Brazilian Association of Santa Gertrudis Breeders (ACSG, 2018), the Santa Gertrudis breed was developed in 1929 by the owners of the King Ranch Farms in Texas, USA, with the goal of obtaining beef cattle that would reunite high productivity and rusticity. They are adapted to southern United States climatic conditions. The breed was introduced to Brazil in 1953 by the same breeders of the King Ranch Farms, including 34 males and 225 females.

The breed was the result of the programmed crossbreeding between zebuine and taurine animals of the Brahman and Shorthorn breeds, respectively, being composed of 3/8 Brahman + 5/8 Shorthorn (LUCHIARI FILHO; MOURÃO, 2006). There are few published studies regarding the Santa Gertrudis breed in Brazil. The generation of scientific information about this breed is of great importance because the breed presents good adaptability to Brazilian conditions.

It should be noted that several factors may interfere with the development and expression of genetic potential. In the pre-weaning phase, performance traits, W205, ADG, and D160 may be influenced by environmental factors, such as cow age at calving, year of birth, season of birth, sex, herd, and diet. In this context, the objective of this

study was to evaluate the environmental effects of pre-weaning traits on Santa Gertrudis cattle.

Material and Methods

The data used came from zootechnical records for Santa Gertrudis cattle regarding animals registered by the Santa Gertrudis Breeders' Association (ACSG) from 1990 to 1997 by several breeders. The animals were weighed every four months, as often as possible, and they were classified into three categories: classified females (CF), unclassified males, that were young or without technical approval (M), and unclassified females (UF).

A new file was prepared with the following information: animal number, animal category, date of birth, mother number, mother's date of birth, weight at birth, and weighing dates. The files were evaluated for consistency and the animals that did not have complete information were eliminated. Also, adjustments were made as follows:

Adjusted 205-day weight at weaning in kg:

$$W205 = \frac{WW - BW}{CA} \times 205 + BW$$

Average daily gain up to weaning, in kg day^{-1}:

$$ADG = \frac{WW - BW}{CA}$$

Days to gain 160 kg from birth to weaning, in days:

$$D160 = \frac{160}{ADG}$$

where:

WW = Weaning weight;

BW = Birth weight;

CA = Calf age (days);

160 = Expected weight at the end of the period in kg;

ADG = Average daily weight gain from birth to

weaning, in kg.

An average of 35.7 kg of weight at birth was considered for all animals because of the absence of this record for many individuals. This average value was generated from the weights in the files in an effort to eliminate as few observations as possible.

With the adjusted 205-day weight, ADG and D160 were calculated. Contemporary groups were formed considering the effects of year of birth, season of birth, rainy season (October to March) or dry season (April to September), sex, animal category, and breeder.

The cow age at calving (CAC) was approximated with whole numbers ranging from two to 13 years, and older animals were eliminated. This value was considered a covariate with linear and quadratic effects. Contemporary groups containing less than two observations were deleted from the analysis file.

To compare the performance of the animals, the observations were analyzed by the Least Squares Method, by the following model:

$$Y_{ijk} = \mu + GC_i + b_1(X_{ijk}) + b_2(X_{ijk}) + e_{ijk}$$

where:

Y_{ijk} = observation (performance) of the k-th animal;

μ = general average;

GC_i = fixed effect of the i-th contemporary group (i ≤ 69);

b_1 and b_2 = coefficients of linear and quadratic regression, respectively;

X_{ijk} = fixed effect of the j-th cow age at calving in years (l = 2....13);

e_{ijk} = random error associated with each observation ijk.

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Based on the averages estimated for the 69 contemporary groups formed, the averages for year of birth, season of birth, sex, animal category, and breeder were calculated.

To estimate the effect of CAC on calf performance, the following equation was used:

$$\hat{y} = b_0 + b_1 x + b_2 x^2$$

where:

b_0 = intercept;

b_1 and b_2 = coefficients of linear and quadratic regression, respectively;

x = cow age at calving, in years.

The intercept (b_0) was obtained as follows:

$$b_0 = \mu - b_1 \bar{x} - b_2 \bar{x}^2$$

where:

μ = general average estimated by the model;

b_1 and b_2 = coefficients of linear and quadratic regression, respectively;

$\bar{x}$ = weighted average of the cow age at calving, in years;

$\bar{x}^2$ = weighted mean square of the cow age at calving.

Thus, the regression equation can be represented as:

$$\hat{y} = \mu - b_1 \bar{x} - b_2 \bar{x}^2 + b_1 x + b_2 x^2$$

Results and Discussion

The values obtained for W205 (Table 1) were lower than those obtained by Ferraz et al. (2000) of 221.11 kg, Taylor (2006) of 247.7 and 254.7 kg, and Tholon et al. (2010) of 213.29 kg for animals of the same breed.

Table 1. Average (± standard deviations) and maximum and minimum values for weight adjusted for weaning (W205), average daily gain from birth to weaning (ADG), and number of days for the animal to gain 160 kg from birth to weaning (D160).

Traits	N	Average ± SD	Minimum	Maximum	CV (%)
W205 (kg)	213	198.05 ± 40.64	105.76	308.92	11.23
ADG (kg day^{-1})	213	0.790 ± 0.198	0.340	1.33	13.72
D160 (days)	213	218.05 ± 67.18	20.18	470.15	16.88

N = Number of observations; SD = Standard Deviation; CV = Coefficient of Variation.

Comparison with other breeds yielded a similar result in the study of Ribeiro et al. (2009), who analyzed data for Nelore animals, and observed an average of 198.77 kg. Guimarães et al. (2003) and Fialho et al. (2015) evaluated the weight at 205 days for Tabapuã and Nelore animals, respectively, and obtained lower values (170.35 and 175.59 kg) than in this study. However, it should be emphasized that animals of zebuine origin have, in general, lower average values in relation to animals that present taurine breeds in their genetic composition, as in the case for Santa Gertrudis.

The estimated general average for ADG was 0.790 ± 0.198 kg day^{-1}, which is higher than that found by Oxford et al. (2009) of 0.676 kg day^{-1} and lower than that of Taylor (2006) and Ferreira et al. (2010) of 1.00 and 0.840 kg day^{-1}, respectively, for Santa Gertrudis animals. This average was close to that found by Martins et al. (2000) of 0.771 kg day^{-1} for Nelore animals. However, lower average values were obtained by Lopes et al. (2009) with an ADG of 0.701 kg day^{-1} for Brangus animals. Fialho et al. (2015) observed an ADG of 0.650 and 0.700 kg day^{-1} for Nelore and Brangus, respectively.

The animals of the Santa Gertrudis breed averaged 218.05 ± 18.67 days to gain 160 kg from birth to weaning, a time shorter than that found by Gemin et al. (2004) of an average of 285 days for Guzerá animals. Santos et al. (2011), Pereira and Muniz (2013), Ferreira et al. (2014), and Fialho et al. (2015) analyzed data from Nellore animals and found averages of 237, 306, 233, and 248 days, respectively. Thus, the Santa Gertrudis breed in this study gained 160 kg from birth to weaning in a shorter period of time.

The contemporary groups significantly influenced the traits studied (Table 2), indicating that it is necessary to consider these sources of variation when comparing the performance of animals. Tholon et al. (2010) classified animals into contemporary groups consisting of animals born in the same year, season of birth, farm, and sex to evaluate the environmental effects on different growth traits of Santa Gertrudis cattle raised in Brazil. The authors observed that the environmental effects considered had significant effects on all growth variables from birth to 24 months of age.

CAC presented a linear and quadratic effect on the pre-weaning characteristics (Table 2). Figures 1, 2, and 3 represent the effect of CAC on W205, ADG, and D160, respectively. It was observed that cows whose calving occurred at the age of seven years weaned the heaviest calves (209.59 kg). Therefore, it is suggested that the cull of cows occurs after that age.

Table 2. Degrees of freedom and mean squares for sources of variation included in the model adjusted for weight at weaning (W205), average daily gain from birth to weaning (ADG), and number of days for the animal to gain 160 kg from birth to weaning (D160).

Source of Variation	Degrees of freedom	Mean Squares		
		W205 (kg)	ADG (kg day^{-1})	D160 (days)
Contemporary Group	68	3577.3438*	0.085*	9548.17*
Cow age at Calving (L)	1	8970.2093*	0.21*	24.005.38*
Cow age at Calving (Q)	1	9695.5401*	0.23*	25.327.28*
Residual	138	602.2782	0.014	1722.30
R² (%)	-	75.66	75.66	74.31

* = P<0.0001; R² = Coefficient of determination; L = cow age at calving - linear effect; Q = cow age at calving - quadratic effect.

Figure 1. Effect of cow age at calving on weight corrected at 205 days of age (W205, in kg) of Santa Gertrudis cattle.
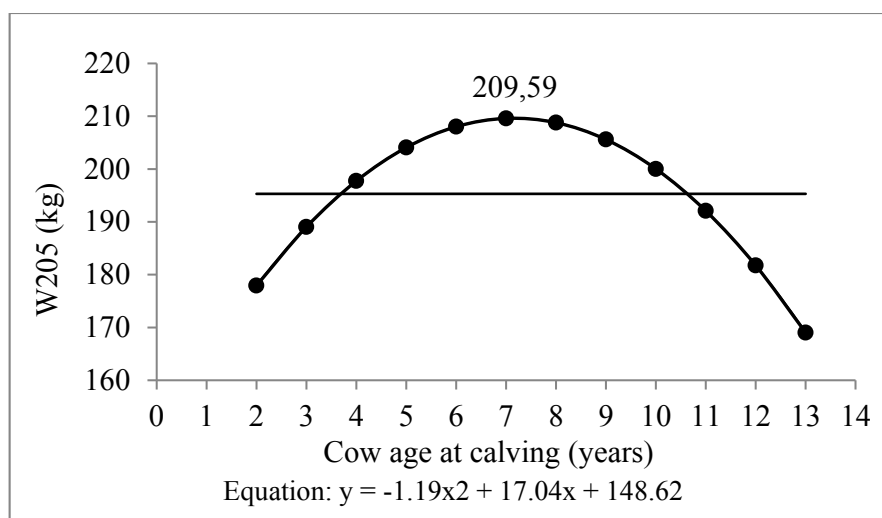

Equation: y = -1.19x2 + 17.04x + 148.62

Figure 2. Effect of cow age at calving on the average daily gain from birth to weaning (ADG, in kg day^{-1}) of Santa Gertrudis cattle.
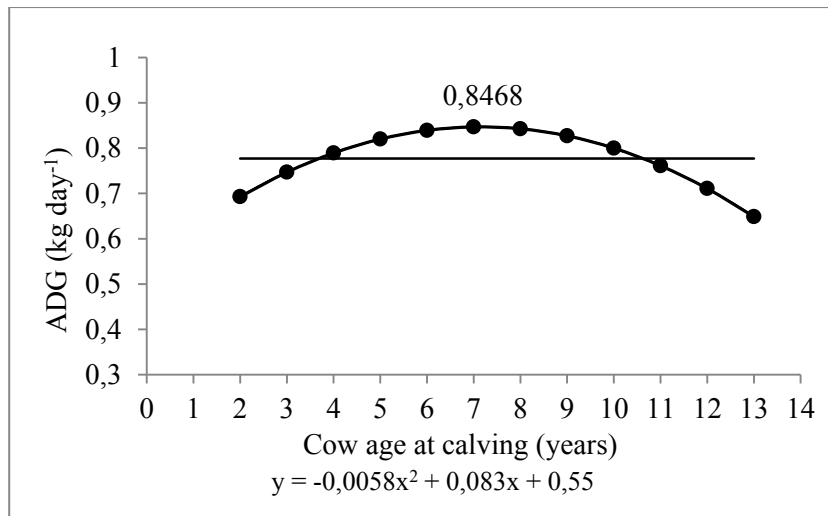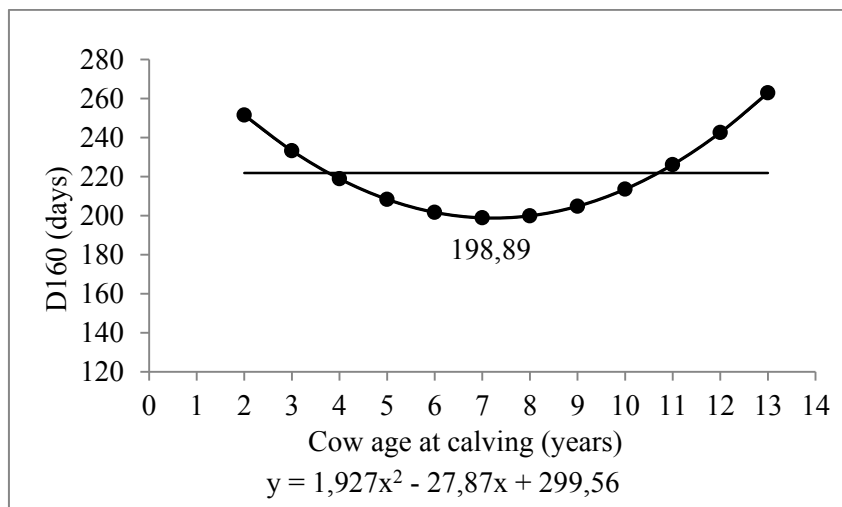

Figure 3. Effect of cow age at calving on number of days to gain of 160 kg from birth to weaning (D160, in days) in Santa Gertrudis cattle.

The older and younger cows had calves with lower performance for the traits studied. It is believed that much of the maternal influence may be caused by changes in milk production capacity over the course of years. According to Bocchi and Albuquerque (2005), many young or very old cows tend to wean lighter calves. The authors explained that the effect of cow age and/or calving order is closely linked to calf development in the pre-weaning period, mainly because of maternal ability. In addition, other variations may also alter the living environment of the animals and influence their performance characteristics, such as variation in pasture supply, climate, soil, and management, among other factors. Some studies have also identified the influence of cow age on calving performance on pre-weaning calves (TEIXEIRA; ALBUQUERQUE, 2003; BOCCHI et al., 2004).

Table 3 shows that contemporary groups with animals born in 1995 were weaned heavier (246.74

kg), had higher values of ADG (1.028 kg day^{-1}), and the lowest D160 (160.30 days). For the other years, there were oscillations in the averages, and 1993 was the year that the animals weaned with lower weights (180.92 kg), had the lowest ADG (0.707 kg day^{-1}) and higher D160 values (246.57 days). Possibly, the oscillations among the averages are caused by variation in climate, management, pasture quality, or rainfall, by which the animals were affected and could have influenced their performance. There may also be a relationship with the management of the animals, where in some years the number of purebred classified females was lower than that of unclassified females. Classified females may present greater genetic potential for maternal ability, thus favoring the growth of their offspring.

It was observed that the contemporary group containing males had the highest averages (197.17 kg) for the evaluated traits, were 2.37% heavier than females for W205, and had an ADG value (0.786 kg day^{-1}) that was 2.93% higher (Table 4). Similar results were obtained by Ferreira et al. (2010) who found an ADG value of 0.823 kg day^{-1} for females and 0.861 kg day^{-1} for males for the same breed. D160 for males (223.61 days) were 1.04% higher than that for females.

It was observed that the contemporary group containing the classified female category presented the highest average for W205 (201.78 kg) and ADG values (0.809 kg dia^{-1}), and was 2.28% higher in relation to males for W205 (Table 5). The classified female category included purebred females classified by the ACSG, which have under gone evaluations that verified their possible genetic potential for traits of interest for production. The female and male categories were composed of young animals or those without technical approval.

Table 3. Averages of weight adjusted for weaning (W205), average daily gain from birth to weaning (ADG), and number days for the animal to gain 160 kg from birth to weaning (D160) according to the year of birth.

Year of Birth	N	Averages		
		W205 (kg)	ADG (kg/day)	D160 (days)
1990	2	221.22	0.904	218.71
1991	85	193.71	0.769	226.80
1992	22	196.68	0.784	224.98
1993	34	180.92	0.707	246.57
1994	34	185.38	0.729	230.78
1995	11	246.74	1.028	160.30
1996	9	182.40	0.714	243.67
1997	16	195.78	0.779	222.98

N = Number of observations.

Table 4. Averages of weights adjusted for weaning (W205), average daily gain from birth to weaning (ADG), and number days for the animal to gain 160 kg from birth to weaning (D160) according to the animal sex.

Sex	N	Averages		
		W250 (kg)	ADG (kg/day)	D160 (days)
Male	93	197.17	0.786	223.61
Female	120	192.50	0.763	225.96

N = Number of observations.

Table 5. Averages of weights adjusted for weaning (W205), average daily gain from birth to weaning (ADG), and number days for the animal to gain 160 kg from birth to weaning (D160) according to the animal category.

Animal Category	N	Averages		
		W250 (kg)	ADG(kg day⁻¹)	D160 (days)
Female	27	172.92	0.668	253.67
Classified Female	52	201.78	0.809	209.38
Male	134	197.17	0.786	225.96

N = Number of observations.

The rainy season, comprised of the spring and summer seasons (September to March), is characterized by having months with high precipitation and high temperatures, which favor the food supply. Conversely, the dry season includes the fall and winter seasons (March to September). The dry season is characterized by dry months with low temperatures and wind, resulting in food shortages. This relationship may explain the higher averages for the animals that were born in the rainy season, which presented higher W205 (197.18 kg) and ADG values (0.786 kg day⁻¹) in relation to the animals that were born in the dry season which exhibited 194.06 kg and 0.771 kg day⁻¹, respectively (Table 6).

The averages for the traits studied ranged from 121.84 to 252.66 kg for W205, from 0.419 to 1.057 kg day⁻¹ for ADG, and from 397 to 151 days for D160. The variability among the averages for the characteristics studied reflects the contrast in management for each factor and the environmental conditions in general. Caution with feeding, management, and use of certain breeding herds is essential regarding he differences observed. Moreover, it is also important to consider the individual's genetic potential.

Table 6. Average of weights adjusted to weaning (W205), average daily gains from birth to weaning (ADG), and number of days for the animal to gain 160 kg from birth to weaning (D160) according to the season of birth.

Season of Birth	N	Averages		
		W205 (kg)	ADG (kg/day)	D160 (days)
Rainy	134	197.18	0.786	220.16
Dry	79	194.06	0.771	228.13

N = Number of observations.

Conclusion

It is necessary to include properly adjusted environmental factors, such as the cow age at calving, year of birth, season of birth, sex, herd, and diet in the model of analysis of pre-weaning growth traits for results that are more accurate and reliable.

The cow age at calving influenced the pre-weaning traits studied. Moreover, it is important to verify the ages at which females are put in and pulled out of the productive system in the selection herds. In addition, the animal category revealed the importance of selection.

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