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Performance in preweaning pure and crossbred calves in the Mato Grosso do Sul Pantanal region, Aquidauana, Mato Grosso do Sul State, Brazil

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ABSTRACT. Purebred and crossbred calves (n = 3,871) were selected that were born in the sub-region of the Pantanal of Aquidauana (Brazil), derived from Nellore, Brangus, Wagyu, and ½ Brangus + ½ Nellore cows, which were artificially inseminated by bulls of the Aberdeen Angus, Red Angus, Brangus, Nellore, and Wagyubreeds. Parameters such as weaning weight, daily gain from birth to weaning, and the number of days to gain 160 kg, were assessed inthese calves and phenotypic correlations between the traits were evaluated. Data were analyzed using two statistical models. The first model included sire breed effects, the genetic group of the cow, sex, year of birth (AN), birth season (EN), and the interaction AN ⋆ EN. The second model included the genetic group of the calf, sex, AN, EN, and the interaction AN ⋆ EN. The genetic group of the cow and calf and the interaction AN ⋆ EN did not significantly affect body weight ($p < 0.05$). The average weaning weights of progeny were as follows: Aberdeen Angus bulls, 177.70 ± 3.28 kg; Red Angus, 180.31 ± 3.46 kg; Brangus, 181.48 ± 3.15 kg; Nellore, 175.43 ± 3.60 kg; and Wagyu, 173.16 ± 2.96 kg.

Keywords: growth, cross, gain, weight.

Desempenho na pré-desmama de bezerros puros e cruzados na região do Pantanal do Mato Grosso do Sul, Aquidauana, Estado do Mato Grosso do Sul, Brasil

RESUMO. Utilizaram-se informações de 3.871 bezerros puros e cruzados, provindos de fêmeas das raças: Nelore, Brangus, Wagyu e ½ Brangus *vs.* ½ Nelore, as quais receberam o sêmen proveniente de touros das raças Aberdeen Angus, Red Angus, Brangus, Nelore e Wagyu para avaliar efeitos sobre o peso a desmama, ganho diário de peso do nascimento a desmama e o número de dias para se obter 160 kg de bezerros nascidos na sub-região do Pantanal de Aquidauana (Brasil), avaliando correlações fenotípicas entre as características. Analisaram-se os dados, utilizaram-se dois modelos estatísticos. O primeiro incluiu efeitos de raça do touro, grupo genético da vaca, sexo, ano de nascimento (AN), estação de nascimento (EN) e interação AN⋆EN. O segundo incluiu grupo genético do bezerro, sexo, AN, EN e interação AN⋆EN. Grupo genético da vaca e interação AN⋆EN do bezerro não influenciou ($p < 0.05$) no peso ao desmame. Observou-se peso médio ao desmame para filhos de touros Aberdeen Angus de 177,7 ± 3,3 kg, Red Angus de 180,3 ± 3,5 kg, Brangus de 181,48 ± 3,2 kg, Nelore de 175,4 ± 3,6 kg e Wagyu de 173,1 ± 3,0 kg.

Palavras-chave: crescimento, cruzamento, ganho, peso.

Introduction

The sub-region of Aquidauana Pantanal occupies 9.4% of the Pantanal area (138.183 km^2) (Silva & Abdon, 1998) and features predominantly sandy soil (Pott, Catto & Brum, 1989). The area reportedly suffers critical periods of restricted food availability, due to factors such as the nutritional value of its pastures (Santos, Costa, Souza, Moraes & Arrigoni, 2002), periodic flooding (Silva, Santos, Silva, McManus & Petzold, 2005), and a hot-humid tropical climate with well-defined dry and wet seasons.

The beef cattle industry is critical for the region, with greater emphasis being placed on the calf-weaning phase, as it generates the main product marketed by cattle farmers (Abreu, Lopes, Baptista, Torres & Santos, 2006; Santos, Abreu, Souza & Catto, 2009). Cattle production in this region

however, is challenging because of the prevailing agro-climatic conditions.

Several breeds can adapt to the environments in which they are raised (Silva, Fraga, Espíndola Filho & Pedrosa, 2008). The Zebu, for example, is quite hardy and adaptable to tropical climates, whereas *Bos taurus* demonstrates high yield potential only under appropriate conditions (Ducatti et al., 2009; Prado, 2008a, b. Thus, crossing breeds can be a viable alternative to improve the production rates of cattle herds raised in the sub-region of Aquidauana Pantanal (Teixeira, Albuquerque, Alencar & Dias, 2006).

Crossbred animals can demonstrate desirable traits, because of the potential for increased genetic variation and heterosis (Pacheco et al., 2014). Teixeira & Albuquerque (2005) reported better performance in weaned crossbred calves (*Bos taurus* x *Bos indicus*) in comparison to purebred animals. The superior performance of crossbred animals could be attributed to the additive effects of heterozygous genes of the parent breeds and to heterosis (Muniz & Queiroz, 1998).

Other factors reportedly influence the growth of an animal, including gender, environmental management, maternal ability, maternal environment, and year and season of birth (Malhado, Carneiro, Martins Filho & Azevedo, 2009; Menezes, Pedrosa, Pedrosa & Fernandes, 2013; Oliveira et al., 2006; Vieira et al., 2005). However, few studies with pure- and crossbred (Wagyu, Nellore, and Brangus) calves have been conducted in the sub-region of Aquidauana Pantanal.

One of the techniques commonly used to verify the genetic potential of animals is to estimate the effect of the interaction between genetic and environmental factors, which can interfere with the performance of the progeny, by measuring the calf's weight at weaning (Bocchi, Teixeira & Albuquerque, 2004; Costa, Queiroz, Oliveira & Fries, 2009; Pereira & Muniz, 2013). Among the variables that can be included in this evaluation, are the daily gain from birth to weaning and the number of days to attain a given weight (Souza et al., 2011). These traits are directly related to the animal's growth rate (Malhado et al., 2005; Souza et al., 2011).

The aim of the present study was to evaluate the effects that influence the weaning weight, daily gain from birth to weaning, and the number of days to gain160 kg in pure- and cross-bred calves born in the Pantanal of Aquidauana, Mato Grosso do Sul State, Brazil.

Material and methods

Data were recorded from 3,871 calves, all sons of Nellore, Brangus, Wagyu, and ½ Brangus + ½ Nellore dams that were artificially inseminated within a fixed time frame by Aberdeen Angus, Red Angus, Brangus, Nellore, and Wagyu bulls.

Calves were raised on a farm in the sub-region of Aquidauana Pantanal (Brazil). The climate according to Köppen & Geiger (1928) is hot humid tropical, with a rainy season in the summer and a dry season in the winter. Annual rainfall varies from 1200 to 1300 mm, with an average annual temperature of 26 °C. Nutritional management systems generally consist of extensive, predominantly *Brachiaria brizantha* pasture, supplemented with mineral salt *ad libitum*. Herd health management generally follows the recommended technical standards for the region.

Performance information of calves was analyzed until weaning in the following genetic groups: Nellore; Brangus; Wagyu; ½ Aberdeen Angus + ½ Brangus; ½ Aberdeen Angus + ½ Nellore; ½ Red Angus + ½ Brangus; ½ Red Angus + ½ Nellore; ½ Brangus + ½ Nellore; ½ Wagyu + ½ Nellore; ½ Wagyu + ½ Brangus; and ½ Wagyu + ¼ Brangus + ¼ Nellore. The weight at weaning was standardized to 205 days using the following formula: $WW = (GBW \times 205) + BW$, in which WW is adjusted weaning weight to 205, BW is the birth weight and GBW is daily gain from birth to weaning. GBW is calculated by the formula $GBW = (WWo - BW)/ID$, where WWo is the weaning weight observed, BW is the birth weight, and ID is the age at weaning. The number of days to gain 160 kg (D160) was calculated by the formula $D160 = 160/GBW$.

Statistical analysis of the data was conducted using the SAS program. The data were analyzed by two statistical models using the PROC GLM procedure. The first includes the fixed effects of bull breed, cow genetic group, sex, year of birth, birth season (dry: May to September; wet: October to April), and interaction between birth season and year of birth. The second model includes the fixed effects of genetic group of the calf, sex, year of birth, birth season (dry: May to September; and wet: October to April) and interaction between birth season and year of birth.

For both models, the interaction between birth season and year of birth was not found to be statistically significant, and was therefore eliminated from further analysis.

Results and discussion

Averages of 183.1 ± 27.5 kg for WW, 0.69 ± 0.13 kg for GBW, and 238 ± 47 days for D160 were observed. The effects of sex, season, and year of birth showed were significant ($p < 0.001$) in both models (Table 1), indicating the need to consider these variables when comparing the performance of

animals, and to include them in contemporary training in genetic evaluation. These results are consistent with those reported by Brandt, Müllenhoff, Lambertz, Erhardt and Gauly (2010); Menezes et al. (2013); and Pereira and Muniz (2013).

Table 1. Summary of analyses of variance for weaning weight (WW), daily weight gain from birth to weaning (GBW), and number of days to gain 160 kg (D160) according to the model analyzed.

Variation source	DF	Mean Squares		
		Model 1		
		WW	GBW	D160
Bull Breed	4	2985.72**	0.05*	5951.37***
Genetic Group of Cow	3	1586.99ns	0.03ns	3457.75ns
Sex of calves	1	111198.31***	2.43***	316701.87***
Birth Station (E)	1	72742.34***	2.00***	331274.64***
Birth Year (A)	1	12088.59***	0.51***	37386.51***
Error		2981	2981	2946
Variation source	DF	Model 2		
		WW	GBW	D160
Genetic Group of Calf	10	3841.31***	0.08***	6939.12***
Sex of calves	1	113699.96***	2.49***	321102.83***
Birth Station (E)	1	72175.70***	1.98***	242540.46***
Birth Year (A)	1	12802.56***	0.53***	34171.96***
Error		2978	2978	2943

*p < 0.05; **p < 0.01; ***p < 0.001; ns: not significant; DF: degrees of freedom; WW: adjusted weaning weight; GBW: daily weight gain from birth to weaning; D160: number of days to gain 160 kg.

The observed effects of sexual dimorphism may be related to the greater weight of males, and consequently the generally higher hormonal levels and metabolic rates, which in turn leads to greater feeding capacities and faster growth, in comparison to those of females (Biffani et al., 1999). Birth-year effects can be associated with any improvements in environmental conditions (Souza et al., 2011), or fluctuating soil and weather conditions (Sarmento, Pimenta Filho, Ribeiro, & Martins Filho, 2003) over a number of years.

The effects of birth season are mainly associated with the increased availability and quality of forage for the dams, thereby facilitating a peak in milk production (McManus et al., 2002). Another factor associated with the season of birth, is low precipitation (dry season) at colder times of the year that results in a lower incidence of parasites and diseases (Menezes et al., 2013). In contrast, the warmer season associated with high humidity, facilitates an increase in parasites that can compromise normal development in the calf.

The genetic group of the dam was associated with significant differences in performance between calves in the pre weaning phase. The dam's influence decreased, however, when growth and approximate weaning weight were taken into consideration, and was insignificant at the point of weaning. Sarmento et al. (2003) found that differences in calf weight at weaning were related to maternal factors from the pre-natal phase (due to placental differences) to the postnatal period (related to maternal skills and milk production).

Genetic variability was evidenced by significant differences in the performance of calves at weaning due to breed of the bull (model 1) and genetic group of the calf (model 2). The progeny of Brangus and Red Angus bulls demonstrated higher average WW and GBW and fewer days to gain 160 kg (Table 2). Nellore and Wagyu breeds produced lighter calves and gained less weight than did other breeds.

Table 2. Performance characteristics of weaned Nellore, Brangus, Wagyu, and crossbred calves according to the breed of bull.

Breed of Bull	Square means and standard errors		
	WW (kg)	GBW (kg day^{-1})	D160 (days)
Aberdeen Angus	177.70 ± 3.28^{ab}	0.66 ± 0.02^{ab}	245 ± 6^{a}
Red Angus	180.31 ± 3.46^{a}	0.68 ± 0.02^{ac}	239 ± 6^{b}
Brangus	181.48 ± 3.15^{a}	0.68 ± 0.02^{a}	242 ± 6^{ab}
Nellore	175.43 ± 3.60^{b}	0.65 ± 0.02^{b}	246 ± 7^{a}
Wagyu	173.16 ± 2.96^{b}	0.65 ± 0.01^{bc}	248 ± 6^{ab}

Values represent means of least squares ± standard errors. Means followed by different letters in the same column are significantly different (p < 0.05). WW: adjusted weaning weight; GBW: daily weight gain from birth to weaning; D160: number of days to gain 160 kg.

In another study in the Pantanal region, Nellore animals showed lower daily weight gains than did crossbred animals native to the region (Mariante et al., 2005). Bianchini et al. (2008) found a lower growth rate in purebred Zebu animals compared to European cattle or crossbred European x Zebu.

Muniz and Queiroz (1998) reported significant differences between the performance of purebred and crossbred calves, confirming the superiority of crossbred continental breeds. In addition, Kippert, Rorato, Lopes, Weber and Boligon (2008) reported significant differences between pre- and post-weaning performance in a multiracial population of Aberdeen Angus x Nellore.

The superiority of crossbred animals was observed in both models (p < 0.05) for weaning weight and gain from birth to weaning in male calves, and for animals born in the dry season, resulting in fewer days to gain 160 kg. Significant differences between traits for calves born in different years are presented in Table 3.

Males had higher weaning weights and higher gains from birth to weaning, with fewer days to reach 160 kg. These findings are consistent with those of Silveira et al. (2004), who also observed that males were, on average, 8.1% heavier than females.

The soil and climate of the Pantanal region may have influenced the birth year and season of birth. During the wet season, there was a significant increase of 22 days for the calves to gain 160 kg. According to Pott et al. (1989), there are two periods

of marked food restriction in the Pantanal region: one, from the height of the rainy season to its end; and the other, at the end of the dry season. Therefore, calves born in either of these two periods can have lower body weights in comparison to other animals born in times of greater food availability.

Table 3. Performance traits of weaned Nellore, Brangus, Wagyu, and crossbred calves according to the effects of sex, season, and year of birth.

	Model 1		
	WW (kg)	GBW (kg day^{-1})	D160 (days)
Calf Sex			
Female	171.49 ± 2.90^{b}	0.63 ± 0.01^{b}	254 ± 5^{a}
Male	183.73 ± 2.89^{a}	0.69 ± 0.01^{a}	233 ± 5^{b}
Birth Season			
Dry	183.67 ± 2.89^{a}	0.69 ± 0.01^{a}	232 ± 5^{b}
Humidity	171.56 ± 2.94^{b}	0.63 ± 0.01^{b}	254 ± 5^{a}
Birth Year			
2006	181.03 ± 2.88^{a}	0.68 ± 0.01^{a}	238 ± 5^{b}
2010	174.20 ± 3.05^{b}	0.64 ± 0.01^{b}	249 ± 5^{a}
	Model 2		
Female	172.09 ± 1.45^{b}	0.64 ± 0.01^{b}	254 ± 3^{a}
Male	184.49 ± 1.44^{a}	0.69 ± 0.01^{a}	233 ± 3^{b}
Birth Season			
Dry	184.33 ± 1.48^{a}	0.70 ± 0.01^{a}	232 ± 3^{b}
Humidity	172.25 ± 1.47^{b}	0.63 ± 0.01^{b}	254 ± 3^{a}
Birth Year			
2006	181.81 ± 1.50^{a}	0.69 ± 0.01^{a}	238 ± 3^{b}
2010	174.77 ± 1.65^{b}	0.64 ± 0.01^{b}	249 ± 3^{a}

Values represent the average of least squares ± standard errors. Means followed by different letters in the same column are significantly different ($p < 0.05$). WW: the adjusted weaning weight; GBW: daily gain from birth to weaning; D160: number of days to gain 160 kg.

Teixeira and Albuquerque (2005) studied the environmental effects that affect gain in pre weaning Angus, Hereford, Nellore, crossbred Angus x Nellore, and Hereford x Nellore animals and found that those born earlier in the spring (July to September) fared better. Their results are consistent with those of McManus et al. (2002).

Ideally, most animals should be sold at the same age. Crossbred animals with comparatively slower growth rates however, represent a significant cost to farmers. Slower growth rates lead to a longer maintenance period at pasture, causing subsequent delays in the breeding season, a decrease in the reproductive efficiency of females, and a longer calving interval.

Calves of ½ Brangus x ½ Red Angus (195.4 ± 5.9 kg) and Brangus (186.3 ± 1.4 kg) showed greater weights and higher gain from birth to weaning (0.74 ± 0.03 kg and 0.70 ± 0.01 kg, respectively), with 219 ± 10 days and 236 ± 2 days to gain 160 kg, respectively, in comparison to the other breeds and crosses (Table 4).

The Wagyu breed demonstrated comparatively lower weaning weight (161.38 ± 10.43 kg), lower gain from birth to weaning (0.60 ± 0.05 kg), and a greater number of days to reach 160 kg (256 ± 20 days). However, despite the relative underperformance, this breed is the focus of study in several countries (including United States, Australia, and Canada) because of desirable carcass traits such as higher levels of marbling.

Table 4. Performance to weaning of Nellore, Brangus, Wagyu, and crossbred calves according to calf breed.

Calf Breed	Square Means and Standard Deviation		
	WW (kg)	GBW (kg day^{-1})	D160 (days)
Nellore	175.59 ± 1.63^{b}	0.65 ± 0.01^{d}	248 ± 3^{a}
Brangus	186.27 ± 1.39^{ac}	0.70 ± 0.01^{ac}	236 ± 2^{bc}
Wagyu	161.38 ±10.43^{bc}	0.60 ± 0.05^{bd}	256 ± 20^{abcd}
½ Aberdeen Angus + ½ Brangus	173.73 ± 3.88^{bd}	0.64 ± 0.02^{bd}	249 ± 7^{ab}
½ Aberdeen Angus + ½ Nellore	178.29 ± 0.80^{bd}	0.67 ± 0.01^{bd}	247 ± 1^{a}
½ Red Angus + ½ Brangus	195.37 ± 5.90^{a}	0.74 ± 0.03^{a}	219 ± 10^{c}
½ Red Angus + ½ Nellore	180.12 ± 1.33^{d}	0.67 ± 0.01^{b}	242 ± 2^{d}
½ Brangus + ½ Nellore	177.04 ± 3.76^{bd}	0.66 ± 0.02^{bd}	252 ± 6^{a}
½ Wagyu + ½ Nellore	175.47 ± 6.20^{bcd}	0.66 ± 0.03^{abd}	243 ± 11^{abcd}
½ Wagyu + ½ Brangus	177.50 ± 2.16^{bd}	0.67 ± 0.01^{bd}	243 ± 4^{abd}
½ Wagyu +¼ Brangus + ¼ Nellore	180.40 ± 2.29^{bd}	0.68 ± 0.01^{bcd}	243 ± 4^{abd}

Values represent means of least squares ± standard errors. Means followed by different letters in the same column are significantly different ($p < 0.05$).WW: the adjusted weaning weight; GBW: daily gain from birth to weaning; D160: number of days to gain 160 kg.

According to National Beef Quality audits, marbling is a major concern for suppliers, restaurant owners, and retailers, because the degree of intramuscular fat (marbling) is directly related to the juiciness and flavor of beef (Radunz, Loerch, Lowe, Fluharty & Zerby, 2009). Taninaka, Santos, Meneghini and Bernardino (2015) studied the economic viability of the full production cycle of the Wagyu breed, and reported that it can be highly profitable if the value of the final product can be differentiated.

Conclusion

Sexual dimorphism, season, and calf birth year should be considered when comparing the performance of calves. The breed of the sire caused variation in calf performance, and progenies of Brangus and Red Angus breeds, exhibited superior traits. Progeny of the Wagyu breed demonstrated comparatively lower performance for all characteristics under investigation.

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