Archives of Veterinary Science v.6, n.2, p.19-30, 2001
Printed in Brazil
ISSN: 1517-784X

ENVIRONMENTAL AND GENETIC EFFECTS INFLUENCING PRE AND POST-WEANING GROWTH TRAITS OF TABAPUÃ CATTLE IN BRAZIL
(*Efeitos ambientais genéticos que influenciam pesos pre e pós-desmama em bovinos tabapuã no Brasil*)

FERRAZ FILHO, P.B.[1]; RAMOS, A.M.[2]; SILVA, L.O.C.[3]; SOUZA, J.C.[4]; ALENCAR, M.M.[5]

[1]Assistant Professor at DCN/UFMS, CAPES scholarship; [2]Head Professor at DPEA/FCA/UNESP, CNPq's Researcher;
[3]Cientific Researcher at Brazilian Agricultural Research Corporation (Embrapa);
[4]Assistant Professor at DZ/UFPR;
[4]Professor at DZ/UFPR.

ABSTRACT – Data on 11505 animals of the Tabapuã cattle breed, born from 1975 to 1995, in 71 herds distributed in six states of Brazil, were analyzed to study the effects of environmental factors on`them and to estimate the heritabilities of body weights at 205 (W205), 365 (W365) and 550 (W550) days of age. The mathematical model used in the analyses of variance included the fixed effects of sex, year and month of birth, farm (herd) and age of the dam as a covariable, and the random effects of sire. The variance components were estimated using the least squares procedure. The estimated means for W205, W365 and W550 were 159.67 ± 1.06, 222.42 ± 1.48 and 285.39 ± 2.29 kg, respectively. The males were, on the average, heavier than the females. The differences among years, months and farms were quite evident for three traits. The age of the dam at calving affected only W205 and W365, with maximum weights at 8.0 and 6.3 years, respectively. The heritability estimates and their standard-errors were equal to 0.20 ± 0.03 (W205), 0.33 ± 0.03 (W365) and 0.24 ± 0.03 (W550).

Key words beef cattle, growth traits, heritability , non genetic factors.

RESUMO – Foram objetivos deste estudo avaliar os efeitos de fatores de ambiente e obter estimativas de herdabilidade de pesos de bovinos da raça Tabapuã. Dados correspondentes a 11505 animais nascidos no período de 1975 a 1995, criados em 71 fazendas distribuídas em seis estados do Brasil, foram analisados para estudar os pesos aos 205 (P205), 365 (P365) e 550 (P550) dias de idade. O modelo matemático utilizado nas análises de variânciaincluiu os efeitos fixos de fazenda, mês e ano de nascimento, sexo do animal e a idade da vaca como covariável, e o efeito aleatório de touro. Os componentes de variância usados para estimar as herdabilidades foram obtidos pelo método dos quadrados mínimos. As médias estimadas para P205, P365 e P550 foram 159,67 ± 1,06, 222,42 ± 1,48 e 285,39 ± 2,29 kg, respectivamente. Os machos foram, em média, mais pesados do que as fêmeas. As diferenças entre os anos e meses de nascimento e fazendas foram evidentes para as três características. A idade da mãe ao parto influenciou apenas P205 e P365, com pesos máximos atingidos às idades de 8,0 e 6,3 anos, respectivamente. As estimativas de herdabilidade foram iguais a 0,20 ± 0,03 (P205), 0,33 ± 0,03 (P365) e 0,24 ± 0,03 (P550).

Palavras chave: gado de corte, características de crescimento, fatores não genéticos herdabilidade.

Correspondence should be addressed to FERRAZ·FILHO, P.B.: Cx. Postal 210, 79603-011 – Três Lagoas-MS – Brazil, e-mail pbferraz@ceul.ufms.br.

Introduction

The Brazilian agricultural activity, mainly the sector of beef cattle, needs to maximize the potential of the production systems, in order to be adjusted to the political, economical and social changes that are taking place in the world. In a time when economic system rewards for efficiency, it is a priority to reduce the length of the production time. In practical cattle production systems, that means to identify the genetically superior animals for Traits that indicate both growth and sexual precocity.

The economical performance of the production system is attributed, among other factors, to the animal performance, which, in turn, is a result of the environment, the genotype and the interaction between these. According to EUCLIDES FILHO (1996), the understanding of the relationship between genotype and environment becomes necessary to optimize production and to reach higher productivity, competitiveness and efficiency, and also to establish production systems sustained for medium and long periods.

As animal production depends on the combined and simultaneous action of environment and genetic, the improvement of both these factors can promote production. The improvement of the traits of economical importance in cattle through selection depends on the knowledge of the amount of existing variation in the population and on how much of this variability is due to genetic differences. However, to do this, it is necessary to know the non-genetic sources of variation that act on the traits to eliminate the differences caused by the environment, evidencing those caused by hereditary factors, easing the identification of the animals that contribute to increase the productivity of the herds.

TABLE 1 – SUMMARY OF THE ANALYSES OF VARIANCE FOR WEIGHTS AT 205 (W205), 365 (W365) AND 550 (W550) DAYS OF AGE, FOR TABAPUÃ CATTLE (1975-1995), BRAZIL.

Source of variation	Degrees of freedom	Mean squares (kg²)		
		W205/ P205	W365/P365	W550/P550
Sire	248		3596***	
Herd/stat	70		11300***	
Month of birth	11		66161***	
Year of birth	20		20408***	
Sex	1		1145598***	
Age of dam at calving				
Linear	1	23260***	3369*	56
Quadratic	1	26954***	6375**	578
Error	11152	396	768	1828
R^2 (%)		29	37	--

* P<0.05; ** P<0.01; *** P<0.001

The influence of environmental factors such as herd, year and season of birth, sex of the animal and age of the dam at calving on cattle growing traits are reported by NOBRE *et al.* (1985), ELER *et al.* (1989), SILVA (1990), EUCLIDES FILHO *et al.* (1991), NÁGERA *et al.* (1991), FERRAZ FILHO (1996), MASCIOLI *et al.* (1997) and SOUZA (1997).

The objectives of this study were to evaluate body weigths of Tabapuã cattle at 205 (W205, weight at weaning), at 365 (W365, weight at one year old) and at 550 (W550, weight at yearling) days of age, raised on pasture in several herds located in different areas of Brazil, identifying the sources of non-genetic variation on these traits, and to estimate heritability of them.

Material and Methods

The data used were from the Body Weight Control System of the Brazilian Zebu Breeders Association (ABCZ). The information integrates the System of Support for Zebu Improvement kept by an agreement between ABCZ and the Brazilian Agricultural Research Corporation (Embrapa). The data were from Tabapuã (a zebu breed) animals, born from 1975 to 1996 and raised on pasture in 174 farms distributed in 23 states from different areas of Brazil. Such information was provided by Embrapa's National Beef Cattle Research Center (CNPGC).

The data file contained initially 39,239 observations, relative to 20,158 (51.4%) male calves and 19,081 (48.6%) female calves, sired by 780 bulls and out of 15,077 cows. From that total, a sample composed of animals the progeny of bulls with at least five descendents, belonging to states with at least nine farms (herds), with observations weighing from 113 to 229 kg for W205, from 140 to 316 kg for W365 and from 156 to 432 kg for W550, was selected for evaluation. With these restrictions, a file was obtained with 11,505 animals (5,077 males and 6,428 females), sired by 249 bulls, from 71 farms located in the states of Bahia, Goiás, Minas Gerais, Paraná, São Paulo and Rio Grande do Sul.

The data were analyzed by the least squares method, using the following linear model:

$$Y_{ijklmn} = \mu + T_i + F_j + M_l + A_k + S_m + b_1(X_{ijklmn} - \overline{X}) + b_2(X_{ijklmn} - \overline{X})^2 + e_{ijklmn}$$

where:

Y_{ijklmn} = dependent variable (W205, W365 and W550) of the nth descendent of the ith bull, belonging to the jth farm, born in the kth month of the lth year and of mth sex;

μ = general average for the analyzed characteristics;

T_i = random effect of sire *i*;

F_j = fixed effect of herd *j*;

M_k = fixed effect of month of birth *k*

A_l = fixed effect of year of birth *l*;

S_m = fixed effect of sex *m*

X_{ijklmn} = age of the cow at calving;

b_1 = linear regression coefficient on age;

b_2 = quadratic regression coefficient on age; and

$e_{hijklmn}$ = random error, normal and independently distributed with zero mean and variance σ^2.

To adjust the weights to 205, 365 and 550 days of age, for the age of dam effect the following function was used:

$$Y = b_0 + b_1 X_i + b_2 X_i^2$$

where:

Y = adjusted weight for the X_i^{th} age of the cow;

b_0 = estimator of the regression constant, obtained as

$$b_0 = \overline{Y} + b_1\overline{X}_i + b_2\overline{X}_1^2,$$

where, $\overline{Y}$ is the least squares mean of the trait in question, b_1 and b_2 are as previously defined, and $\overline{X_i}$ and $\overline{X_i^2}$ are the observed means of the ages and the squared ages of the dams at calving, respectively.

The heritabilities (h^2) of the traits were obtained using the following formula:

$$\hat{h}^2 = \frac{4\hat{\sigma}_a^2}{\hat{\sigma}_a^2 + \hat{\sigma}_e^2},$$ where $\hat{\sigma}_a^2$ and $\hat{\sigma}_e^2$ are the estimates of the additive genetic and residual variance components, respectively. The standard errors of the estimates of the heritability coefficients were calculated according to SWIGER et al. (1964).

The analyses of variance were carried out using the GLM procedure (SAS, 1996).

Results and Discussion

The observed means of the weights at 205, 365 and 550 days of age and their respective standard deviations were equals to 171.09 ± 19.90, 223.14 ± 27.72 and 285.90 ± 42.76 kg, with coefficients of variation of 11.63%, 12.42% and 14.95%, respectively. In all three cases, the values are high when compared with those reported by LEDIC *et al.* (1985).

A summary of the analyses of variance of the trait studied is presented in TABLE 1. It can be seen that all effects included in the model were significant sources of variation ($P<0,05$, $P<0,01$ and $P < 0.001$), except for age of the dam at calving that did not influence W550.

The differences among individuals in a herd are partly attributed to the genetic differences among the individuals. Since one half of the genes of the individuals come from the sire, significancy of the sire effect for the traits studied is expected. SOUZA e RAMOS (1995), FERRAZ FILHO (1996), MARTINS *et al.* (1996), MASCIOLI *et al.* (1996) e BIFFANI *et al.* (1999a,b) also found significant sire effects on growth traits of beef cattle in Brazil.

The herds was responsible for 7.34, 5.83 and 7.34% of the total variation in W205, W365 and W550, respectively. A variety of factors such as climate, economics, natural resources, management and genetics contribute to the differences among the herds. In this study, data on animals from 71 herds located in six different states of Brazil were used. Important differences among herds were also reported by MARQUES et al. (1983), ROSA *et al.* (1986), SILVA (1990), FERRAZ FILHO (1996), SOUZA (1997).

Month of birth was responsible for 6.97, 5.37 and 1.68% of the total variation on W205, W365 and W550, respectively. According to OLIVEIRA *et al.* (1993), the birth time effect should be related with the favorable or adverse conditions concerning the period of rains and drought to which the animals were subjected when reaching a certain age. For this study, the adjusted means are presented in TABLE 2 by month of birth.

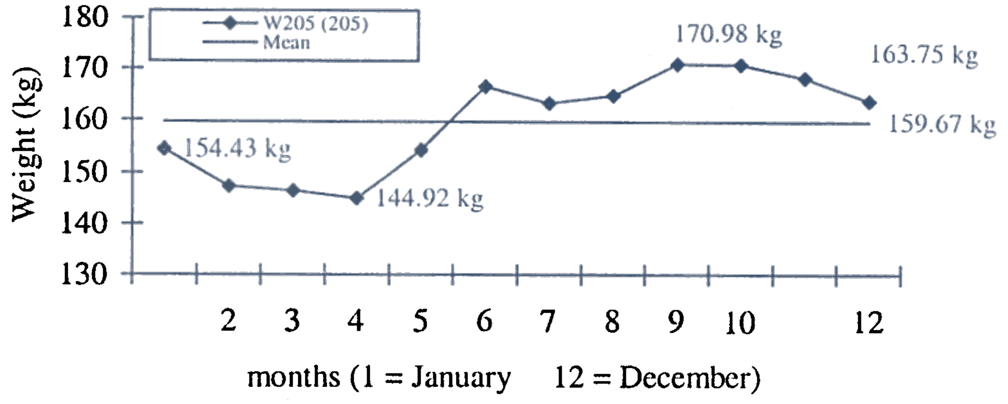
TABLE 2 – LEAST SQUARE MEANS AND NUMBER OF OBSERVATIONS FOR THE WEIGHTS AT 205 (W205), 365 (W365) AND 550 (W550) DAYS OF AGE, ACCORDING TO THE MONTH OF BIRTH, 1975-1995. BRAZIL.

Month[a]	N° of observation	Mean ± standard error		
		W205 P205	W365 P365	W550 P550
1	781	154.43 ± 1.27	216.73 ± 1.77	291,64 ± 2.73
2	375	147.27 ± 1.48	220.01 ± 2.05	274,32 ± 3.17
3	315	146.45 ± 1.56	222.04 ± 2.17	266,57 ± 3.34
4	163	144.92 ± 1.92	227.71 ± 2.67	268,27 ± 4.12
5	131	154.36 ± 2.06	227.63 ± 2.87	278,04 ± 4.43
6	310	166.59 ± 1.56	228.17 ± 2.17	281,30 ± 3.35
7	1013	163.29 ± 1.24	230.37 ± 1.72	293,01 ± 2.65
8	2052	164.76 ± 1.14	236.07 ± 1.59	292,66 ± 2.46
9	1659	170.98 ± 1.15	222.37 ± 1.61	289,22 ± 2.48
10	1564	170.90 ± 1.14	214.90 ± 1.58	292,42 ± 2.45
11	1781	168.27 ± 1.10	210.38 ± 1.53	299,06 ± 2.36
12	1361	163.75 ± 1.14	212.68 ± 1.58	298,18 ± 2.45

[a] Month of birth (1 = January,. 12 = December)

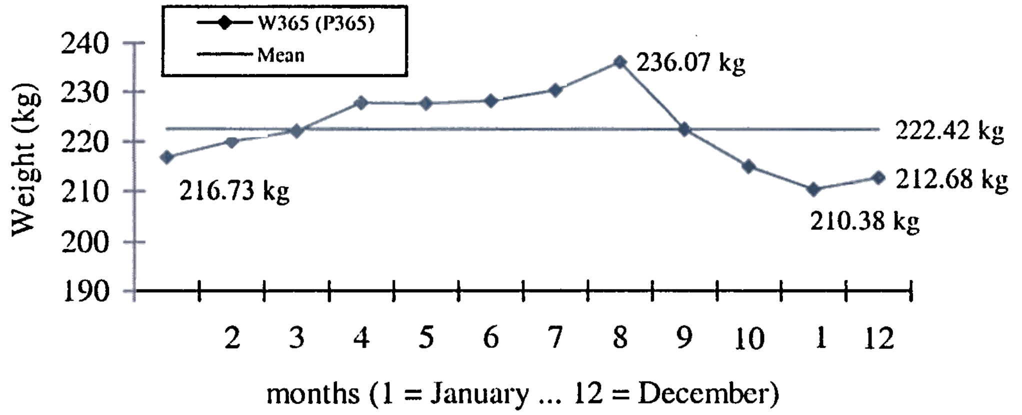
The highest weights at 205 days were shown by the animals born from June to December, while the animals born from January to May were the lightest ones (FIGURE 1). The reason for this is that some cows that calf from January to May wean their calves during the dry season, when the pastures become scarce and little nutritious, so their milk production is reduced, affecting pre-weaning development of the calf. On the other hand, those cows that calf from June to December wean their calves during or at the end of the raining season, when forrage production is plenty and milk production is high.

FIGURE – EFFECT OF MONTH OF BIRTH ON WEIGHT AT 205 (W205) DAYS OF AGE



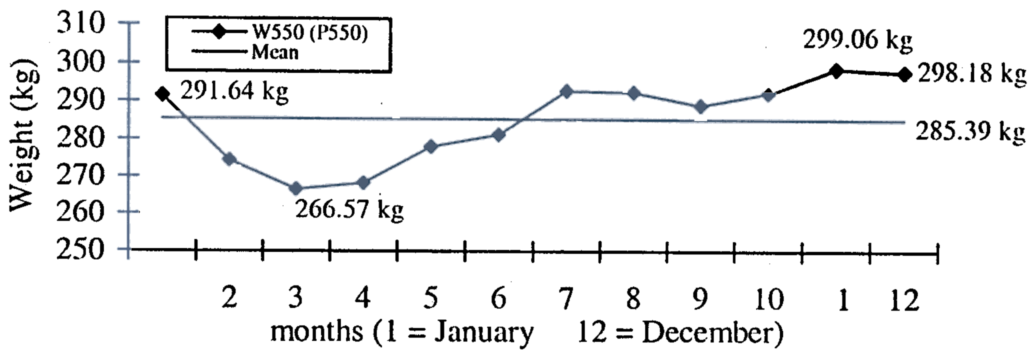
The period from April to August was the most favorable for the W365, while the period from October to February was the most unfavorable (FIGURE 2). This effect has a lot to do with the month of weighing. When weighing at one year occurs during or at the end of the rainy season, the animals are heavier than when weighing occurs during the dry season. For the weight at 550 days of age, the best and the worst periods of birth are November – December and March – April, respectively (FIGURE 3). Good performance at this age, coincides with the best time of pastures in Brazil. Authors as TORRES *et al.* (1979) with Gir cattle, OLIVEIRA *et al.* (1993) with Guzerá cattle, SOUZA and RAMOS (1995) with Nellore cattle, FERRAZ FILHO (1996) with polled Nellore cattle and MASCIOLI *et al.* (1997) with Canchim cattle, all analyzing the growth of animals on pasture, observed that the month of birth affected the performance of them.

FIGURE 2 – EFFECT OF MONTH OF BIRTH ON WEIGHT AT 365 (W365) DAYS OF AGE



The analyses of variance in TABLE 1 show that year of birth was responsible for 1.26, 3.01 and 2.70% of the total variation on W205, W365 and W550, respectively. The estimated means are presented in TABLE 3 by the year of birth.

FIGURE 3 – EFFECT OF MONTH OF BIRTH ON WEIGHT AT 550 (W550) DAYS OF AGE.



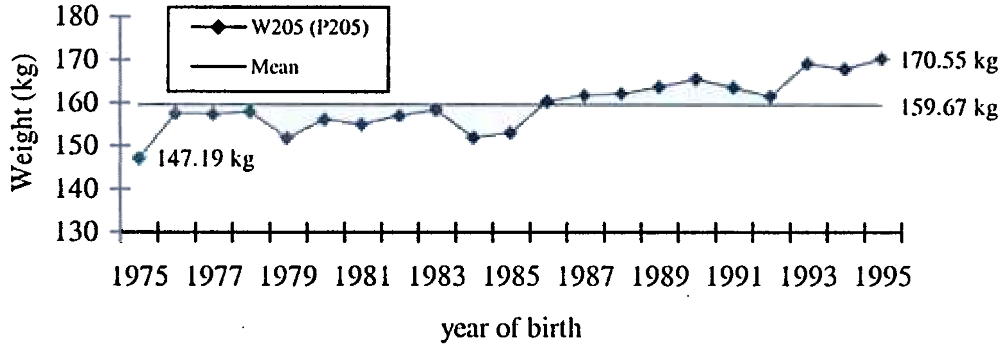
In the cases of weight at 205 days of age, the heaviest animals were born in 1995 (170.55 ± 2.31 kg) and the lightest ones in 1975 (147.19 ± 5.61 kg). For the weight at 365 days, the heaviest animals were born in 1983(242.05 ± 2.59 kg) and the lightest ones in 1980 (201.32 ± 2.55 kg), while at 550 days the lightest animals were born in 1991 (263.36 ± 2.59 kg) and heaviest ones in 1983 (317.71 ± 3.99 kg).

TABLE 3 – LEAST SQUARE MEANS AND NUMBER OF OBSERVATIONS FOR THE WEIGHTS AT 205 (W205), 365 (W365) AND 550 (W550) DAYS OF AGE, ACCORDING TO YEAR OF BIRTH. 1975-1995, BRAZIL.

		Mean ± standard error		
Year	N° of observations	W205 *P205*	W365 *P365*	W550 *W550*
1975	19		215.50 ± 7.81	
1976	75		228.50 ± 4.62	
1977	159		212.05 ± 3.74	
1978	126		217.18 ± 3.56	
1979	195		202.06 ± 3.04	
1980	376		201.32 ± 2.55	
1981	290		209.51 ± 2.43	
1982	245		220.00 ± 2.53	
1983	201		242.05 ± 2.59	
1984	363		231.03 ± 2.25	
1985	571		228.22 ± 1.96	
1986	739		235.,07 ± 1.76	
1987	1066		223.68 ± 1.66	
1988	1105		224.21 ± 1.64	
1989	967		228.63 ± 1.65	
1990	1195		226.57 ± 1.61	
1991	973		225.39 ± 1.68	
1992	878		226.84 ± 1.71	
1993	840		220.60 ± 1.76	
1994	1002		214.89 ± 1.73	
1995	120		237.59 ± 3.22	
			222.42 ± 1.48	

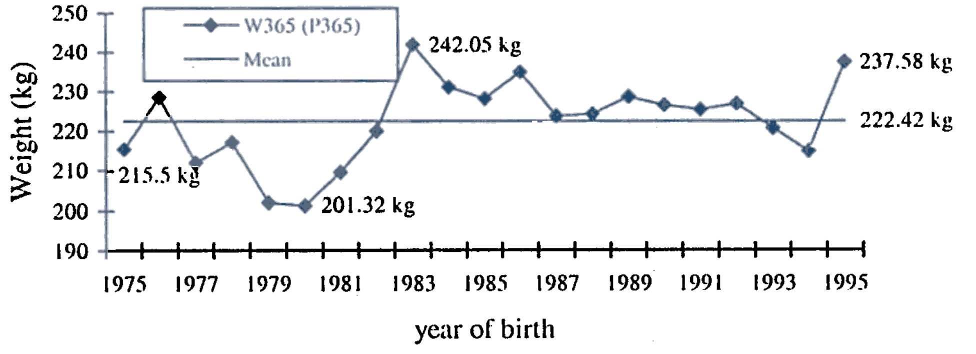
The behavior of the yearly weight means around the overall mean illustrated in FIGURES 3, 4, 5 and 6, can be attributed to the annual variations of the pasture, as observed by MILAGRES *et al.* (1985), LEDIC *et al.* (1986), ROSA *et al.* (1986), SILVA *et al.* (1987), ELER *et al.* (1989), OLIVEIRA *et al.* (1993), FERRAZ FILHO (1996), SOUZA (1997) and BIFFANI *et al.* (1999b).

FIGURE 4 – EFFECT OF YEAR OF BIRTH ON WEIGHT AT 205 (W205) DAYS OF AGE.



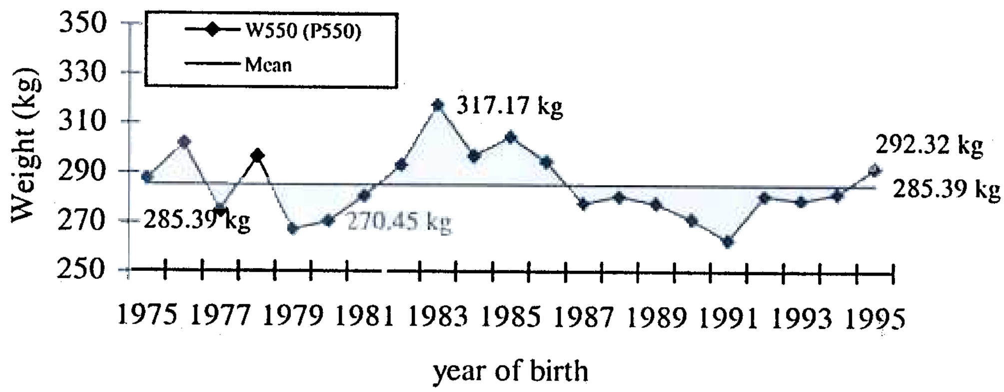
Sex of the animal accounted for 4.50, 8.50 and 9.68% of the total variation in the weights at 205, 365 and 550 days of age, respectively. The males were always heavier than the females at all three considered ages (FIGURE 7). The relative difference among the sexes presented a gradual increase with age, and the superiority of the males compared to the females was 6.33% for W205, 9.08% for W365 and 11.39% for W550. These results are in agreement with those reported by SILVA (1990), SOUZA *et al.* (1994), SOUZA and RAMOS (1995) and MASCIOLI *et al.* (1997). Sexual dimorphisms were also observed by NOBRE *et al.* (1985), ROSA *et al.* (1986), SILVA *et al.* (1987), SILVA (1990) and FERRAZ FILHO (1996). It is necessary to point out that the fastest growth of the males is partly due to their largest physiologic and hormonal activity, what leads to a greater feeding capacity (BIFFANI *et al.*, 1999a). Another reason could be some privilege given to the males due to their higher commercial value.

FIGURE 5 - EFFECT OF YEAR OF BIRTH ON WEIGHT AT 365 (W365) DAYS OF AGE.



With an average of 88.77 months, the age of the dam at calving affected significantly the weights of the animals at 205 ($P < 0.001$) and 365 ($P < 0.05$) days of ages; however, at 550 days of age there was no effect of age of cow (TABLE 1). The quadratic form of the effect of age of cow on W205 and on W365 is illustrated in FIGURES 8 and 9. For W205 there was a maximum (172.49 kg) at 96.94 months (8.08 years), while for W365 the maximum (223.87 kg) occured at 75.87 months (6.3 years) of age.

FIGURE 6 – EFFECT OF YEAR OF BIRTH ON WEIGHT AT 550 (W550) DAYS OF AGE.

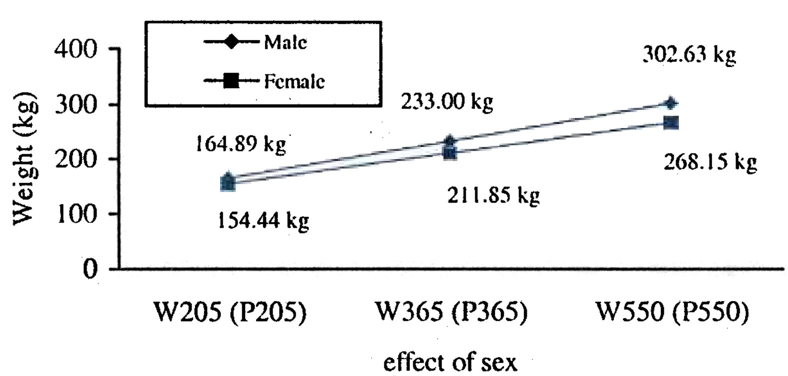


These effects of age of cow on body weight of their calves agree with those reported by SILVA (1990), MASCIOLI *et al.* (1996), FERRAZ FILHO (1996), SOUZA (1997) and BIFFANI *et al.* (1999a,b), where the youngest and the oldest cows were the ones that weaned the lightest calves.

The estimates of the genetic ($\hat{\sigma}_a^2$), residual ($\hat{\sigma}_e^2$) and phenotypic ($\hat{\sigma}_p^2$) variances and of the heritabilities ($\hat{h}^2$)for the traits studied are presented in TABLE 4.

The heritability of W205 is equals to 0.20 ± 0.03, indicating some additive genetic variation in this trait. This result is within the interval of values obtained in the revised literature. According to the summary of 31 references elaborated by OLIVEIRA (1987), in which the Nellore, Guzerá, Gir and Tabapuã breeds were included, the heritability coefficients for W205 ranged from 0.04 to 0.80, with an average of 0.26. However, most of the estimates were positioned between 0.10 and 0.30, agreeing with MORTARI (1976), who summarized 19 references.

FIGURE 7 – EFFECT OF THE SEX ON THE WEIGHTS AT 205 (W205), 365 (W365) AND 550 (W550) DAYS OF AGE.

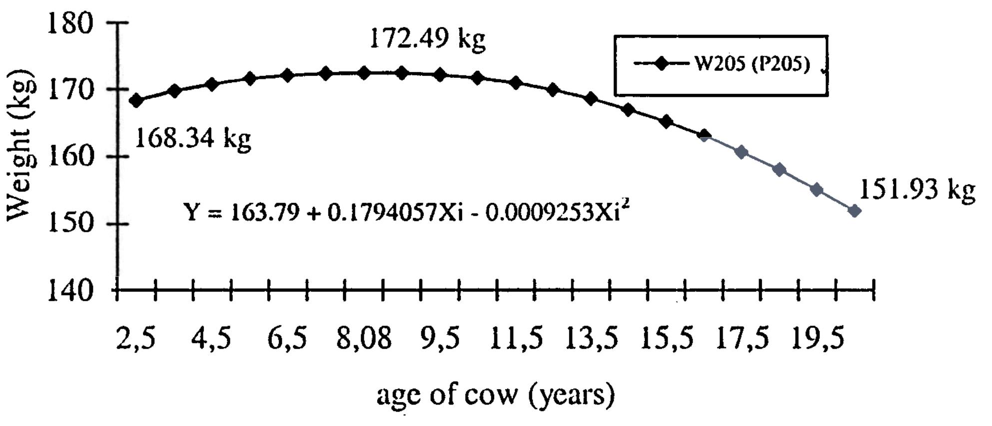


The heritability estimate for W365 is equal to 0.33 ± 0.03, indicating that there is moderate additive genetic variation for this trait in the Tabapuã breed, suggesting that it is possible to make changes in body weight at 12 months of age by mass selection. According to the summary elaborated by SILVA (1990), the estimates of heritability for weight at 12 months of age, for several breeds ranged from 0.17 (PIMENTA FILHO, 1980) to 0.83 (CARNEIRO et al. 1974), with an average of 0.45. OLIVEIRA (1987) reviewed values that ranged from 0.14 (MARIANTE, 1979 and SAMPAIO *et al.*, 1980) to 0.81 (TORRES *et al.*, 1973), with an average of 0.30.

For body weight at 550 days of age, the value found for the heritability estimate was 0.24 ± 0.03, indicating that some genetic gain can be attained by mass selection. Regarding to this weight, the review by FERRAZ FILHO (1996) showed a range from 0.09 (LÔBO *et al.*, 1993) to 0.79 (ROSA *et al.*, 1986), with an average of 0.40.

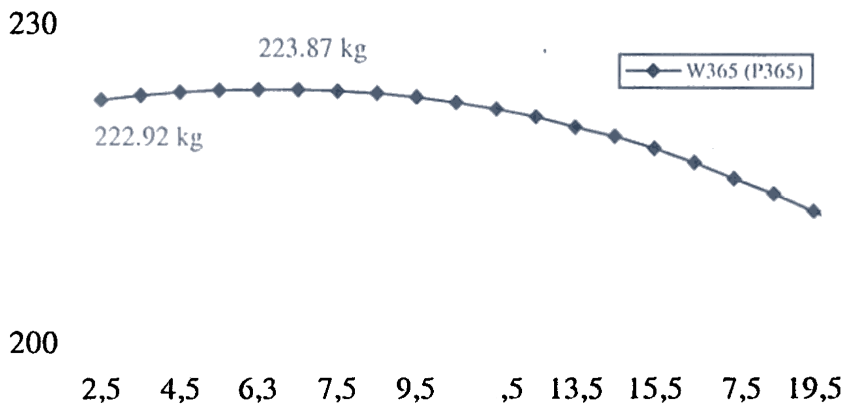
The occurrence of different values of heritability estimates for the same trait in different studies is expected. The reason for this is that such genetic parameter depends on the gene frequencies and these ones, as a result of the selection or genetic drift, vary in different ways among herds (OLIVEIRA, 1987). According to the same author, the wide range of values can be attributed also to non-appropriate methods of estimation.

FIGURE 8 – EFFECT OF AGE OF COW ON WEIGHT AT 205 (W205) DAYS OF AGE.



The values obtained in this study for the heritability estimates for the three traits are low but low standard errors, indicating good precision. Although a high number of observations has been used, with reasonable number of bulls, and high number of bull descendents, the estimates can be under or overestimated. The method employed in this study was the paternal half-sib method, which demands no interaction between sire and environment. This method also requires no selection of bulls, no preferential matings and no covariance between genotype and environment.

FIGURE 9 – EFFECT OF AGE OF COW ON WEIGHT AT 365 (W365) DAYS OF AGE



Conclusions

The significant effect of herd, year and month of birth, sex of the animal, and age of the cow at calving indicates the need of previous adjustment of the weights for these sources of non-genetic variation.

The heritability estimates for body weights of Tabapuã cattle at 205, 365 and 550 days of age, are low but suggest that mass selection can result in some genetic progress for these growth traits.

TABLE 4 – ESTIMATES OF ADDITIVE GENETIC ($\hat{\sigma}_a^2$), Residual ($\hat{\sigma}_e^2$) AND PHENOTYPIC ($\hat{\sigma}_p^2$) VARIANCES AND OF HERITABILITY ($\hat{h}^2$) FOR BODY WEIGHTS AT 205 (W205), 365 (W365) AND 550 (W550) DAYS OF AGE. 1975-1995, BRAZIL.

Weight *Peso*	$\hat{\sigma}_a^2$	$\hat{\sigma}_e^2$	$\hat{\sigma}_p^2$	$\hat{h}^2$	K
W205 *P205*	20,77	396,17	416,94	0,20 ± 0,03	40,765
W365 *P365*	69,36	768,46	837,82	0,33 ± 0,03	40,765
W550 *P550*	15,50	1828,05	1943,55	0,24 ± 0,03	40,765

K = number of calves per sire.

References

BIFFANI, S.; MARTINS FILHO, R.; GIORGETTI, A.; BOZZI, R.; LIMA, F. A.M. Fatores ambientais e genéticos sobre o crescimento ao ano e ao sobreano de bovinos Nelore, criados no Nordeste do Brasil. **Revista da Sociedade Brasileira de Zootecnia**, Viçiosa, v. 28, n. 4, p. 468-473, 1999a.

BIFFANI, S.; MARTINS FILHO, R.; MARTINI, A.; BOZZI, R.; LIMA, F. A. M. Fatores ambientais e genéticos que influenciam o desenvolvimento ponderal até o desmame de animais Nelore criados no Nordeste do Brasil. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 28, n. 4, p. 693-700, 1999b.

CARNEIRO, G.G.; MIRANDA, J.J.F.; PEREIRA, J.C.G.; TORRES, J. R. Pesos e ganhos de peso de bezerros zebus tratados durante a estação seca em três localidades de Minas Gerais. **Arquivos da Escola de Veterinária Universidade Federal de Minas Gerais**, Belo Horizonte, v. 27, n. 2, p. 189-93, 1974.

ELER, J.P.; LÔBO, R.B.; ROSA, A.N. Influência de fatores genéticos e do meio em pesos de bovinos da raça Nelore criados no Estado de São Paulo. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 18, n. 2, p. 103-111, 1989.

EUCLIDES FILHO, K. **O melhoramento genético e os cruzamentos em bovinos de corte**. Campo Grande: EMBRAPA-CNPGC, 1996. 35p. (Documentos, n. 63).

EUCLIDES FILHO, K.; NOBRE, P.R.C.; ROSA, A. N. Idade da vaca e suas interrelações com a fazenda, reprodutor e sexo do bezerro. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 20, n. 1, p. 40-46, 1991.

FERRAZ FILHO, P.B. **Análise e tendência genética de pesos em bovinos da raça Nelore Mocha no Brasil.** Jaboticabal, 1996. 163 f. Dissertação (Mestrado em Melhoramento Genético Animal) - Faculdade de Ciência Agrárias e Veterinárias de Jaboticabal, Universidade Estadual Paulista.

LEDIC, I.L.; MIRANDA, J.J.F.; PEREIRA, C. S.; FONSECA, C. G. Efeitos de meio em características ponderais em animais Tabapuã. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia,** Belo Horizonte, v. 38, n. 3, p. 359-379, 1986.

LEDIC, I.L.; ROSA, A.N.; NOBRE, P.R.C.; SILVA, L.O.C.; EUCLIDES FILHO, K.; MARIANTE, A.S. **Resultados do controle do desenvolvimento ponderal:** raça Tabapuã – 1975/1984. Campo Grande: EMBRAPA-CNPGC, 1985. 48 p. (Documento, n 29).

LÔBO, R.B.; OLIVEIRA, H.N.; MERCADANTE, M.E.Z. Estimativa de herdabilidade para característica de crescimento na raça Nelore. In: CONGRESSO NACIONAL DE GENÉTICA, 39., 1993, Caxambú. **Anais...** São Paulo: SBG, 1993. p. 390.

MARIANTE, A.S., 1979. **Growth and reproduction in Nelore cattle in Brazil: genetic parameters and effects of environmental factors.** Dissertation Abstracts International, B, 39:5673.

MARQUES, L.F.A.; MILAGRES, J.C.; CASTRO, A.C.G.; ALMEIDA E SILVA, M. Fatores de meio que influenciam o crescimento de gado Guzerá em regiões do Espírito Santo. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 12, n. 2, p. 369-88, 1983.

MARTINS, G.A.; MARTINS FILHO, R.; LÔBO, R.N.B. Fatores genéticos e de ambiente que influenciam o peso à desmama em bovinos da raça Nelore. In: REUNIÃO DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 33., 1996, Fortaleza. **Anais...** Fortaleza: SBZ, 1996. p. 181-183.

MASCIOLI, A.S.; ALENCAR, M.M.; BARBOSA, P.F.; OLIVEIRA, M.C.S.; NOVAES, A.P. Influência de fatores de meio sobre pesos de animais da raça Canchin. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 25, n. 5, p. 853-865, 1996.

MASCIOLI, A.S.; PAZ, C.C.P.; EL FARO, L. Estimativas de parâmetros genéticos e fenotípicos para características de crescimento até a desmama em bovinos da raça Canchin. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 26, n. 4, p. 709-713, 1997.

MILAGRES, J.C.; SILVA, L.O.C.; NOBRE, P.R.C.; ROSA, A.N. Influências de fatores de meio e herança sobre pesos de animais da raça Nelore no Estado de Minas gerais. **Revista da Sociedade Brasileira de Zootecnia,** Viçosa, v. 14, n. 4, p. 463-468, 1985.

MORTARI, N. **Estudo genético-quantitativo de características ponderais do período pré-desmame em gerações sucessivas de um rebanho Nelore.** Ribeirão Preto, 1976. 127 f. Tese (Mestrado) - Faculdade de Medicina, Universidade de São Paulo

NÁGERA, J.M.; PEREIRA, J.C.C.; OLIVEIRA, H.N. Efeitos genéticos e não genéticos sobre características ponderais de duas populações da raça Nelore. **Arquivos Brasileiros de Medicina Veterinária e Zootecnia**, Belo Horizonte, v. *43*, n. 1, p. 81-91, 1991.

NOBRE, P.R.C.; ROSA, A.N.; SILVA, L.O.C. Influência de fatores genéticos e de meio sobre os pesos de gado Nelore no estado da Bahia - Brasil. **Revista da Sociedade Brasileira de Zootecnia,** Viçosa, v. 14, n. 3, p. 338-57, 1985.

OLIVEIRA, J.A. **Avaliação genética de pesos e ganhos de peso do nascimento aos 365 dias de idade de bovinos da raça Guzerá.** Ilha Solteira, 1987. 167 f. Tese (Livre Docência) - Faculdade de Engenharia de Ilha Solteira, Universidade Estadual Paulista.

OLIVEIRA, J.A.; LOBO, R.B.; GONÇALVES, A.A.M. Estimativa de parâmetros genéticos e fenotípicos de peso e ganho de peso aos 365 dias de idade em um rebanho da raça Guzerá. **Boletim da Industria Animal**, Nova Odena, n. 50, v. 2, p. 119-123, 1993.

PIMENTA FILHO, E. C. **Fatores genéticos e de meio que influenciam os pesos e ganhos de pesos de animais Nelore na caatinga litorânea da Paraíba.** Viçosa, 1980. 92 f. Tese (Mestrado) - Faculdade de Medicina Veterinária, Universidade Federal de Viçosa.

ROSA, A.N.; SILVA, L.O.C.; NOBRE, P.R. C. Avaliação do desempenho de animais Nelore em controle do desenvolvimento ponderal no Estado do Mato Grosso do Sul - Brasil. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 15, n. 6, p. 515-532, 1986.

SAMPAIO, I.B.M.; PEREIRA, J.C.C.; TORRES, J.R. Heritabilidade e causas de variação de pesos ao nascer, à desmama e aos 365 dias de idade de animais da raça Gir no Estado de Minas Gerais. **Arquivos da Escola de Veterinária Universidade Federal de Minas Gerais**, Belo Horizonte, v. 32, n. 1, p. 137-141, 1980.

SAS, 1996, *Institute Inc. Statistical Analysis System Introductory Guide for Personal Computers*. Release. Cary, (NC: Sas Institute Inc.).

SILVA, L.O.C. **Tendência genética e interação genótipo x ambiente em rebanhos Nelore, criados a pasto no Brasil Central.** Viçosa, 1990. 113 f. Tese (Doutorado em Genética e Melhoramento) - Universidade Federal de Viçosa.

SILVA, L..O.C.; ROSA, A..N.; NOBRE, P.R.C.; MILAGRES, J.C.; EVANGELISTA, S.R.M. Análise de pesos de bovinos Nelore criados a pasto no Estado de São Paulo, Brasil. **Pesquisa Agropecuária Brasileira**, Brasília, v. 22, p. 1245-1256, 1987.

SOUZA, J.C. **Interação genótipo x ambiente sobre o peso ao desmame de zebuínos da raça Nelore no Brasil.** Botucatu, 1997. 122 f. Tese (Doutorado em Genética) - Universidade Estadual Paulista, 1997.

SOUZA, J.C.; BRULE, A.O.; FERRAZ FILHO, P.B.; OLIVEIRA, J.A.L.; ALENCAR, M.M. Repetibilidade dos pesos e ganho de pesos do nascimento à desmama de bezerros da raça Nelore. **Revista da Sociedade Brasileira de Zootecnia**, Viçosa, v. 23, n. 1, p. 133-139, 1994.

SOUZA, J.C.; RAMOS, A.A. Efeitos de fatores genéticos e do meio sobre os pesos de bovinos da raça Nelore. **Revista da Sociedade Brasilera de Zootecnia**, Viçosa, v. 24, n 1, p. 164-172, 1995.

SWIGER, L.A.; HARVEY, W.R.; EVERSON, D.O. The variance of intraclass correlation involving groups with one observation. **Biometrics**, Washington,v. 20, n. 4, p. 818-826, 1964.

TORRES, J.R.; CARNEIRO, C.G.; GOMMES, F.R. Heritabilidade de peso de bezerros daraça Guzerá aos 365 diasde idade. In: REUNIÃO DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 10., 1973, Porto Alegre. **Anais...** Porto Alegre: SBZ, 1973. p. 96.

TORRES, R.A.A.; SILVA, M.A.; TORRES, J.R. Fatores de meio e herança que afetam os pesos e o ganho de peso de bezerros Gir na fase de aleitamento. **Revista da Sociedade Brasilera de Zootecnia**,Viçosa, v. *8*, n. 3, p. 488-496, 1979.

Recebido para publicar: 13/07/2001
Aprovado: 10/09/2001