ENVIRONMENTAL EFFECTS ON BIRTH AND WEANING WEIGHTS OF GYR AND GUZERA CATTLE IN THE NORTHEAST OF BRAZIL

Efeitos de ambiente sobre os pesos ao nascimento e desmama de bovinos Gir e Guzerá criados no Nordeste do Brasil

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ABSTRACT

The environmental effects on growth traits of Gyr and Guzerat cattle were evaluated using data from Brazilian Zebu Cattle Association (ABCZ) collected for a 23-year period (1975-1997). Growth traits, analysed separately for each breed, were body weights at birth and weaning. A mixed model containing herd, sex, year, season or month of birth, a linear regression on dam's age and the random effect of sire nested within herd was used. Feeding level was also included in the model for weaning weight. Herd and sex significantly affected ($P < 0.001$) birth and weaning weights for both breeds. Males at birth were approximately 5% heavier than females. Male calves at weaning were 7.75 ± 2.15 kg heavier than female calves for Gyr cattle and 7.96 ± 0.75 kg for Guzerat breed. Age of dam did not affect birth weight for Gyr cattle (average age of Gyr dam was 8.7 yr). Year effect was significant for the two breeds. Models, which included month effect instead of season effect, resulted in highly significant test for month effect. Animals which received supplementation were 24.1 ± 3.9 kg and 25.2 ± 1.1 kg heavier than animals which grazed on free range for Gyr and Guzerat breeds, respectively. The results of this investigation indicate the importance of environmental effects to obtain unbiased evaluation of genetic values. It can be concluded that the definition of season period is not trivial in such situation and each case should be carefully investigated.

Key Words: Tropics, Brazil, Zebu cattle, Growth, Environment.

RESUMO

Os efeitos de ambiente sobre as características de crescimento de bovinos das raças Gir e Guzerá foram avaliados utilizando dados da Associação Brasileira dos Criadorese de Zebu (ABCZ) colhidos durante

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o período de 23 anos (1975-1997). As características de crescimento estudadas foram peso ao nascimento e ao desmame, analisadas separadamente para cada raça. Um modelo misto contendo os efeitos fixos de rebanho, sexo, ano, estação ou mês de nascimento, a regressão linear da idade da mãe ao parto e o efeito aleatório do pai dentro de rebanho foi usado. Regime alimentar também foi incluído no modelo para peso ao desmame. Os efeitos de rebanho e sexo afetaram significativamente (P<0,001) os peso ao nascimento e ao desmame para ambas as raças. Os machos pesaram cerca de 5% a mais que as fêmeas ao nascimento. Ao desmame os machos pesaram 7,75 ± 2,15kg e 7,96 ± 0,75kg a mais que as fêmeas para Gir e Guzerá, respectivamente. A idade da mãe não afetou o peso ao nascimento para a raça Gir (média de idade das mãee – 8,7 anos). O efeito de ano foi significativo para as duas raças. Modelos que incluíram o efeito de mês ao invés do efeito de estação de parto foram mais significativos. Animais que receberam suplementação foram 24,1 ± 3,9kg and 25,2 ± 1,1kg mais pesados que aqueles criados exclusivamente a pasto para as raças Gir e Guzerá, respectivamente. Estes resultados indicam a importância dos efeitos de ambiente para se obter valores genéticos não viesados. Pode ser concluído que a definição de uma estação de nascimento não é evidente e que cada caso deve ser investigado cuidadosamente.

Palavras-chave: Ambiente, Brasil, Crescimento, Gado Zebu, Trópicos.

INTRODUCTION

Since the beginning of the nineteenth century, Zebu cattle (*Bos indicus*) have played an important role as a genetic resource for beef production in Brazil. Due to adaptation to tropical and subtropical environments (Davis 1993, Payne & Hodges, 1997), these cattle have spread around the country replacing many Brazilian Creole breeds. At present, Zebu cattle represents 80% of an estimated herd of 150,000,000 animals but productivity is low, especially in the semi-arid area. Besides genetic changes, important factors need to be taken into account to improve livestock production. External influences (e.g., nutrition, disease control and herd management level) represent some of the so-called non-genetic effects that affect the phenotype of an animal and need to be adjusted to obtain effective estimates of genetic value. Especially in tropical conditions these environmental effects influence animal performance and unbiased evaluation of genetic value must start with the identification of these external factors. In tropical and sub-tropical area, breeders have less control of the environmental influence and, sometimes, do not know such e effects (Payne & Hodges, 1997).

In Brazil, Guzerat and Gyr cattle groups are quite important, especially for animal production in the northeast. Guzerat breed was developed mainly from kankrej-type Indian cattle imported to Brazil between 1881 and 1962. With good potential growth, this breed has been primarily developed for beef production but dairy "lines" have also been developed (Payne & Hodges, 1997). A history of this breed in Brazil was given by Rosa et al (1985).

According to Santiago (1967) the first major importation of Gyr from India to Brazil occurred in 1918 and despite prohibitions, importation continued up to the 1960s. Mattos et al. (1985) presented a brief history of this breed in Brazil. Gyr breed was used originally for beef production but at present the Brazilian Gyr is also used for milk production. The purpose of this study was to estimate the effects of non-genetic factors on weight traits (birth and weaning weights) of Guzerat

and Gyr cattle reared in the Northeast of Brazil.

MATERIAL AND METHODS

Data were obtained from the Brazilian Zebu Cattle Association (ABCZ). The original data contained records of 1,426 Gyr and 6,701 Guzerat calves, collected from 1975 to 1997, in two States of the Northeast of Brazil: Ceará and Piauí.

The climate of this area is typical for a dry tropical region with an average annual rainfall of 600 mm, an average temperature of 30°C and 70% relative humidity. The pattern of rainfall is quite uneven, in some years the seasonal pattern includes two main seasons, a rainy (January - June) and a dry season (July - December). In some years there is no seasonal pattern.

The management of animals is similar for all herds. Animals graze on free range, using natural pastures or in some cases cultivated ones, basically *Panicum maximun* (Elephant grass), *Sorghum vulgare* (or *saccharatum*) (Sudan grass) and *Saccharum officinarum* (Sugarcane). During long and frequent dry periods, quantity and quality of available feed decrease and a few breeders supplement their animals with concentrate or sorghum silage. In general, each breeder raise some animals in an intensive way, usually those are the ones with the most desirable breed characteristics which are sent to expositions or sold for breeding stock.

A main breeding season does not exist and calvings are spread over the year. Natural mating and artificial insemination are both used but in spite of use of artificial insemination there are little use of the same bulls across herds. Calves are usually weaned between 6 and 9 months of age.

Data were obtained from herds participating in the ABCZ performance growth program. Breeders submit to the ABCZ birth information for each animal (date and weight of birth, parents). Later the Association staffs records the weight of animals about once every three months. Weaning weights for this analyses were adjusted to 205 d of age according to the formula proposed by Lobo (1992).

To obtain a dataset of manageable size and to maximise information, a set of herds was chosen with a reasonable number of recorded birth and weaning weights. Two different datasets were created, one for each breed. Pedigree information was used to ensure that all parents were born at appropriate times before their offspring and that recorded ages agreed with dates of birth. Weights were edited to be within the range expected for the age, sex and breed of the animal. Records of progeny of sires with less than five offsprings were deleted.

After data had been selected, 1,021 birth and 814 weaning weights, between 1982 and 1991, were available for Gyr breed and 6,135 birth and 5,382 weaning weights recorded, 1976 and 1991, were available for Guzerat breed. A summary of data structure and descriptive statistics of the traits for the two breeds is presented in TABLE 1.

Statistical Analyses

A mixed model was used to evaluate the influence of each effect.

In matrix notation the fitted model was:

$$y = Xb + Zv + e$$

where y is a vector of observations, X is a matrix associated with a vector of fixed effects, b, to y, Z is an incidence matrix related to random effects, v, to y and e is a vector of residual effects, which was assumed $N \sim (0, Is^2)$.

Three different sets of fixed effects were fitted. All sets contained class effects of sex, herd, age of dam (quadratic covariate). To evaluate changes of environmental conditions over time, year and month

Table Birth and weaning weights for Gyr and Guzerat breeds in the Northeast of Brazil

	Gyr		Guzerat	
	Birth Weight	Weaning Weight	Birth Weight	Weaning Weight
Number of calves	,021	814	6,135	5,382
Number of sires	44	44	15	
Number of dams	565	501	2,47	
Mean (kg)	24.5	123.9	27.6	133.2
Standard deviation	2.5	27.6	3.6	
Coefficient of variation (%)	10.3	22.3	13	24.3

effects or year and season effects were fitted by classifying date of calving in two ways: 1) by month of birth or 2) by season of birth, rainy (January - June) and dry season (July - December).

The model for weaning weight contained an effect for feeding level: no supplementation (1) or supplementation (2).

The effect of sire nested within herd was fitted as a random effect after preliminary analyses showed that only a few number of sires were represented in more than one herd.

Least square means from these models were computed to evaluate differences due to sex and feeding level.

Restricted Maximum Likelihood (REML) was implemented using the MIXED procedure of SAS (1996).

RESULTS AND DISCUSSION

Tests of fixed effects are presented in TABLE 2 for birth weight and in TABLE 3 for weaning weight for both breeds. Least squares means by sex and feeding level and their standard errors for birth and weaning weight are shown in TABLE 4.

Birth Weight

Herd and sex significantly affected ($P < .001$) birth weights for both breeds (TABLE 2) for all of the three models. Van Bebber et al. (1997) stated that environmental conditions and management practices are likely to vary from herd to herd, which would cause the observed differences among herds.

Males were heavier than females for both breeds (TABLE 4), with a birth weight difference of approximately 5% for males, 1.08 ± 0.07 kg for Gyr and 1.25 ± 0.07 kg for Guzerat. These differences were similar to the range of 4 to 8% reported by Holland and Odde (1992) and to other reports for zebu breeds (Reynolds et al., 1980; Carvalheira et al., 1993; Ahunu et al., 1997). According to Kim et al. (1972), the physiological basis for weight differences between sexes at birth is a higher concentration of androgenic hormone in the male foetus, which would cause enhanced muscle tissue growth.

Age of dam, included as a linear and quadratic covariate, had a different pattern between the two breeds (TABLE 2). Contrary to other studies (Cundiff, 1966; Koch, 1972; Holland and Odde, 1992), age of

able 2. Tests of fixed effects for birth weight for Gyr and Guzerat breeds in the Northeast Braz

Source	Gyr				Guzerat			
	Ndf[d]	Ddf[e]	type III F	pr>F	Ndf[d]	Ddf[e]	type III F	pr>F
Model A								
Herd		42	77.57	.0001	10	35	36.40	.0001
		964	28	.0001	15	5,970	28.62	.0001
Season		964	5.96	.0148		5,970	1.56	.2124
Sex		964	82.32	.0001		5,970	273.50	.0001
age of dam (linear)		964	.02	.8803		5,970	7.33	.0068
age of dam (quadratic)		964	.02	.8984		5,970	7.24	.0071
Model B[b]								
Herd		42	63.79	.0001	0	35	37.81	.0001
Year		954	28.12	.0001	5	5,960	3.00	.0005
Month		954	7.38	.0001		5,960	27.43	.0001
Sex		954	187.15	.0001		5,960	272.26	.0001
age of dam (linear)		954	.36	.5490		5,960	7.81	.0052
age of dam (quadratic)		954	.30	5813		5,960	7.73	.0055
Model C								
Herd	1	42	219.06	.0001	10		37.36	.0001
year x month	106	868	7.86	.0001	191	5,795	4.66	.0001
Sex		868	205.95	.0001		5,795	281.24	.0001
age of dam (linear)		868		.7449		5,795	10.10	
age of dam (quadratic)		868	.06	.8104		5,795	9.96	

r-season model, [b] year-month model, [c] year x month model, [d] numerator degrees of freedom
minator degrees of freedom (McLean and Sanders, 1988)

dam did not affect birth weight for Gyr cattle. Average age of Gyr dams at birth was 8.7 yr, with only 16% of dams between 2 and 5 years of age. As stated by Holland and Odde (1992) the lowest birth weights are found in 2-year-old heifers, then the weights increase through 5 to 6 years of age and decrease when cows reach 9 to 11 years of age. Besides the high average age and the small number of young cows found in the present study, environmental factors (heat stress, limited food resources) have certainly influenced mothering ability, reducing the performance of young cows.

Ages of dam effects were significant ($P < .001$) for Guzerat breed (TABLE 2). Average age of dams was 8 years, but nearly 30 % of cows were between 2 and 6 years of age.

Year effects (Models A and B) were significant for the two breeds, reflecting changes in management practices and environmental conditions. Season of birth effects (Model A) were significant ($P < .05$) for Gyr breed but were not significant for Guzerat breed. Month of birth effects (Model B) were highly significant ($P < .001$) for both breeds.

Changes in environmental conditions over time within a herd are usually accounted for by fitting a fixed year-season effect. Particularly in tropical areas, where average annual rainfall has a bimodal distribution, seasons are formed by grouping months with similar patterns with the calving date used to assign an animal

Table 3. Tests of fixed effects for weaning weight for Gyr and Guzerat breeds in the Northeast of Brazil

Source	Gyr				Guzerat			
	Ndf[d]	Ddf[e]	Type III F	pr>F	Ndf[d]	Ddf[e]	type III F	pr>F
Model A								
Herd		42	9.46	.0037	10	132	11.96	
Year		756	17.65	.0001	15	5,219	25.00	
Season		756	28.33	.0001		5,219	1.36	
Feeding Level		756	82.58	.0001			480.69	
Sex		756	82.58	.0001		5,219	104.61	
age of dam (linear)		756	.11	.7438		5219	31.79	
age of dam (quadratic)		756	.00	.9491		5219	44.96	.0001
Model B[c]								
Herd		42		.0103	10			
		746	8.17	.0001	15	5,209	24.60	.0001
Month		746		.0001		5,209	13.95	.0001
eding Level		746	86.41	.0001		5,209	478.72	.0001
Sex		746	18.33	.0001		5,209	109.73	.0001
age of dam (linear)		746	.05	.8162		5,209	35.40	.0001
age of dam (quadratic)		746	.25	.6203		5,209	48.27	.0001
Model C								
Herd				.0046	10	131	13.11	.0001
	100	666	6.54	.0001	90	5,046	5.10	.0001
Feeding Level		666	37.58	.0001		5,046	519.13	.0001
		666	31.78	.0001		5,046	111.93	.0001
age of dam (linear)		666		.7444		5,046	30.00	.0015
age of dam (quadratic)		666		.9134		5,046	41.76	.0016

[a] year-season model, [b] year-month model, [c] year x month model [d] numerator degrees of freedom, [e] denominato degrees of freedom (McLean and Sanders, 1988)

to a particular season (Milagres et al., 1993; Khombe et al., 1995; Ahunu et al., 1997). Van Vleck (1987) pointed out that such a classification is somewhat arbitrary, because it could not reflect changing environmental conditions. A logical example related to this matter is that cows calving just one day apart may be assigned to different seasons. Hence Van Vleck (1987) suggested that seasons should be defined to short periods of time (month, week). Moreover, lost information due to the limited number of animals of the same group must be used from adjacent seasons.

The results obtained in the present report seem to agree with this theory. Models B and C which included month effects instead of season effect, resulted in highly significant test for month effect with the REML log likelihood better than did Model A.

Birth weight is the first available information for an animal and it is of economic relevance because is positively correlated with pre and post weaning growth (Lobo, 1994). The major problem associated with heavy birth weight is dystocia (Laster et al., 1973). Galina and Arthur (1989), however, reported a low incidence (2%) of difficult calving for Gyr cattle and stated that, in tropical environment, the only reports of dystocia rates greater than 10% were for European cattle. According to Koch et al. (1993), Zebu dams have lower rates of dystocia because of a combination of larger pelvic area, smaller maternal body weight and

Table 4. Least squares means ($\bar{x}$ and standard errors (SE) for sex and feeding level on body weights (kg) at birth and weaning of Gyr and Guzerat breeds in the Northeast of Brazil

	Gyr		Guzerat	
	Birth	Weaning	Birth	Weaning
Effect	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE
Sex				
F[a]	23.6 ± .09	131.2 ± 2.15	26.8 ± .18	137.5 ± 1.99
M[b]	24.7 ±	138.9 ± 2.16	28.1 ± .19	145.5 ± 2.02
Feeding Level				
1[c]		123 ± 1.8		128.8 ± 1.95
2[d]		47 ± 3.57		154.1 ± 2.14

[a] F = female; [b] M = Male; [c] 1 = no supplementation; [d] 2 = supplementation

smaller calf birth weight.

Weaning Weight

Herd effects (TABLE 3) were significant for weaning weight in Gyr ($P < .05$) and Guzerat cattle ($P < .001$), in agreement with other studies (Milagres et al., 1985, Rosa et al., 1986, and Eler et al. 1989).

Male calves were 7.75 ± 2.15 kg heavier than female calves for Gyr cattle and 7.96 ± 0.75 kg for Guzerat breed (TABLE 4). A similar difference was found in other zebu cattle by Plasse et al. (1995), Haile-Mariam and Philipsson (1996) and Martins Filho et al (1997).

A highly significant ($P < .001$) difference was found between animals that received feedlot supplementation and animals that grazed on free range (TABLE 3). Differences in least squares means for feeding level effect (level 2 vs. level 1) averaged 24.1 ± 3.9 kg and 25.2 ± 1.1 kg for Gyr and Guzerat breeds, respectively. In spite of the small number of animals that received feed supplementation, failure to account for supplementation would tend to bias in least squares estimates. These results confirm the difficulty of achieving higher body weight in tropical conditions, due mainly to inadequate nutrition based merely on native pasture.

Age of dam did not significantly affect weaning weight for Gyr cattle. These results are in agreement with Christian et al. (1965) and Carvalheira et al. (1995), but analysis has to be viewed with caution due to the small number of available observations (TABLE 1). In fact, age of dam influenced weaning weight for Guzera breed ($P < .001$), whose data set included 5,382 records (TABLE 1).

Clutter and Nielsen (1987) found that milk intake of the calf was highly correlated with 205 d weight and therefore the effect of milk production on weaning weights is probably related to milk volume rather than milk quality. Gyr cattle are used for milk production and the breeder feed the calf a small amount of milk. It would be reasonable to believe that such a practice is

one of the reasons why no difference was found among young and mature cows.

Year and season (Model A) significantly ($P < .001$) affected weaning weight for Gyr, but not for Guzerat breed. Effects of month (Models B and C) were significant for both breeds ($P < .001$), as shown in TABLE 3. There are no doubts about the influence of different periods of time (year, month of birth) on quality and quantity of forage. Calves born at the beginning of the rainy season benefit from a higher milk production provided by dams, which have access to good forages. On the contrary, cows calving late in the rainy season graze on mature and less digestible pastures, which negatively influence milk production.

Weaning weight is an important trait because it provides the breeder with information about both calves and dams. In fact, calf growth is based on its own genotype (half supplied by the dam) but also depends on milk production and mothering ability of the dam (Willham, 1963; 1972). Thus, weaning weight is a measure of both the animal own value and cow productivity. Both criteria should receive appropriate emphasis when selection choices are made.

Implications

This study, pointing out the importance of good and appropriate management practices confirmed differences among herds. Difference due to sex, with male superiority at birth and weaning for both breeds, agreed with reviewed literature. Age of dam at calving significantly affected both traits for Guzerat. Including year and month effects in the model for both traits and breeds accounted for significant changes in environmental conditions over time. However, with the fitted model including the effects of year and season, only weaning weight for Gyr breed was significantly affected by season of birth. Complete evaluation of a data set should be based on preliminary analyses identifying the distribution of the data to avoid loss of information and increase in standard errors. Animals, which received supplementary feeding, achieved higher weight at weaning. Appropriate economic analyses should be made to evaluate the effectiveness of this management system.

ACKNOWLEDGMENT

The authors gratefully acknowledge Dr. L.D. Van Vleck for the critical reading of the manuscript and Brazilian Zebu Cattle Association (ABCZ) for providing the data.

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