Parameters and genetic tendency in post-weaning growth traits in Santa Gertrudis males

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For estimating the parameters and genetic tendencies of post-weaning growth traits of Santa Gertrudis males, the performance test records of the period 1981-2010 were analyzed. Records came from the cattle breeding enterprises "Turiguanó" and "Camilo Cienfuegos", from Ciego de Ávila and Pinar del Río, respectively, as well as from the cattle breeding farm "Rancho Vallina", of Santiago de Cuba. Live weight traits were studied at the beginning of the performance test (ILW), average daily gain (ADG), weight for age (WFA) and final live weight in the performance test (FLW), at 18 months. Animals were fed natural pastures and supplemented with concentrates. The analysis was carried out through a multi-trait animal model, including as fixed effects the contemporary group (herd-year-birth trimester) and age as covariable. As random effects the direct and maternal additive genetic effects and the residual error were considered. The highest heritability estimates were of 0.21 ± 0.07 and 0.22 ± 0.07 for FLW and WFA, respectively. The genetic correlations between ADG and WFA were 0.78 ± 0.21 and between ILW and ADG 0.83 ± 0.07. The lowest correlation was between ILW and FLW (0.60). It is concluded that heritabilities for growth traits in Santa Gertrudis cattle were between medium and low. Genetic correlations were high and positive. Genetic tendencies resulted low; there was no genetic progress in traits as ADG.

Key words: *final live weight, direct and maternal effects, genetic progress*

The knowledge of the genetic parameters indicating how much of the total variability, linked to the expression of a characteristic, is due to the additive genetic variation, is essential to estimate more accurate genetic values, optimize the improvement schemes and predict the response to selection (Bittencourt *et al*. 2000).

Any selection program must be periodically checked to correct mistakes quickly. One of the ways of monitoring results is through the study of the genetic tendency in time. In this way the genetic progress attained can be verified and re-orientate or not the selection work (Ferraz *et al*. 2002).

The genetic tendencies help to understand, mainly, the selection effect through the years in production systems (Eler *et al*. 2005). This is vital, especially, if the evaluation of annual genetic trends has as objective inferring on the effectiveness of the selection programs and helping to establish a basis to justify the decisions that are taken regarding management, nutrition, health, among other aspects. The purpose of these evaluations is to correct those programs, from what results obtained suggest (Euclides *et al*. 2000).

Considering that estimates of genetic parameters in Santa Gertrudis breed and other synthetic breeds under tropical conditions are scarce, and that specifically in Santa Gertrudis there are no reports on genetic tendency, the objective of this paper was to estimate the parameters and genetic tendencies of post-weaning growth traits in Santa Gertrudis males in performance tests.

Materials and Methods

Records of performance tests in males of the Santa Gertrudis breed in the period 1981-2010 were analyzed. Data belong to the Cattle Breeding Enterprises "Turiguanó" and "Camilo Cienfuegos", as well as the cattle breeding farm "Vallina", of the provinces Ciego de Avila, Pinar del Río and Santiago de Cuba, respectively.

Data were taken from the individual control record of the animals of each one of the enterprises and of the genetic direction. The sample was constituted by 2 263 animals, offspring of 210 sires and 1 566 dams. The contemporary groups were represented by the herd, year and birth trimester combination. Each group was structured by more than five animals, with a total of 167 groups of contemporaries and 4 625 animals in the pedigree.

The traits studied were: initial live weight of the performance test (ILW), average daily gain (ADG), weight for age (WFA) and final live weight of the performance test (FLW) at 18 months. In table 1 are shown the statigraphs for these traits.

The ADG of live weight ($g.d^{-1}$) at the end of the test was calculated as follows:

$$ADG = \frac{FLW - ILW}{D\,T} * 1000$$

where:

Table 1. Statigraphs for the studied traits

Traits	Min.	Max.	($\overline{X}$)	SD	VC (%)
ILW (kg)	100	340	185.75	29.48	15.87
ADG (g.d^{-1})	200	1008	446.04	159.7	35.8
WFA (g.d^{-1})	337	1117	613.8	129.03	21.02
FLW (kg)	191	621	337.7	680.9	20.41

FLW : final live weight

ILW : initial live weight of the test

DT : days in the test

The weight for age (g) was calculated through the following expression:

$$WFA = \frac{FLW}{EF} * 1000$$

Calves included in the performance test were weighed separately in a 1 000 kg scale at the beginning of the test, approximately between 10 and 15 d after weaning. The second and third weighing were carried out close to the 12 and 18 months of age, when the test period ends.

The feeding system was based in pastures, as for example common guinea grass (*Panicum maximum*), star grass (*Cynodon nlemfluensis*), Texan grass (*Paspalum notatum*), Leucaena (*Leucaena leucocephala*) and *Glyricidia sepium*. Also, 2.5 kg of concentrates approximately were supplemented according to the availability in the enterprise.

Data analysis. Data were analyzed through the Wombat of Meyer (2007) program version 6.1 1.7601. For estimating the variance components and genetic parameters the multivariate animal model, was applied including as fixed effects the contemporary group (herd-year-birth trimester), initial age as quadratic (co)variable for initial live weight, and final age as quadratic (co) variable for final live weight. As random effects the direct and maternal genetic effects and the residual error were considered.

The statistical model used, written in dot-matrix form, was the following:

$Y_i = X_i b_i + Z_i a_i + W_i m_i + e_i$

where:

y_i = is the vector of the observations for the i-th trait from I = 1 to 4.

b_i = is the vector for the solutions of the fixed effects for the i-th trait

a_i = is the vector of the solutions for the direct additive genetic random effects of the i-th trait.

m_i = is the vector of the solutions of the maternal genetic random effects of the i-th trait.

X_i and Z_i W_i = are the design matrices of the fixed and random effects, respectively, for the i-th trait.

e_i = is the vector of the residual effects of the i-th trait

It is assumed that:

$E(y_i) = X_i b_i$; $E(a_i) = 0$; $E(m_i) = 0$; $E(e_i) = 0$ and that the assumed structure of (co)variances is:

$$\mathrm{var}\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ m_1 \\ m_2 \\ m_3 \\ m_4 \\ e_1 \\ e_2 \\ e_3 \\ e_4 \end{bmatrix} = \begin{matrix}
\sigma^2_{a_1}A & \sigma_{a_1a_2}A & \sigma_{a_1a_3}A & \sigma_{a_1a_4}A & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\sigma_{a_2a_1}A & \sigma^2_{a_2}A & \sigma_{a_2a_3}A & \sigma_{a_2a_4}A & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\sigma_{a_3a_1}A & \sigma_{a_3a_2}A & \sigma^2_{a_2}A & \sigma_{a_3a_4}A & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\sigma_{a_4a_1}A & \sigma_{a_4a_2}A & \sigma_{a_4a_3}A & \sigma^2_{a_2}A & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \sigma^2_{m_1}A & \sigma_{m_1m_2}A & \sigma_{m_1m_3}A & \sigma_{m_1m_4}A & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \sigma_{m_2m_1}A & \sigma^2_{m_2}A & \sigma_{m_2m_3}A & \sigma_{m_2m_4}A & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \sigma_{m_3m_1}A & \sigma_{m_3m_2}A & \sigma^2_{m_3}A & \sigma_{m_3m_4}A & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \sigma_{m_4m_1}A & \sigma_{m_3m_2}A & \sigma_{m_4m_3}A & \sigma^2_{m_4}A & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & & 0 & 0 & \sigma^2_{e_1}I & \sigma_{e_1e_2}I & \sigma_{e_1e_3}I & \sigma_{e_1e_4}I \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{e_2e_1}I & \sigma^2_{e_2}I & \sigma_{e_2e_3}I & \sigma_{e_2e_4}I \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{e_3e_1}I & \sigma_{e_3e_2}I & \sigma^2_{e_2}I & \sigma_{e_3e_4}I \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{e_4e_1}I & \sigma_{e_4e_2}I & \sigma_{e_4e_3}I & \sigma^2_{e_2}I
\end{matrix}$$

where σ^2_{ai} with I =I,…4 are the direct additive genetic variances for the traits 1, 2, 3 and 4

σ^2_{mi} with i = 1,…,4 are the maternal additive genetic variances

σ^2_{ei} with i = 1,…4 are the residual variances for the traits σ_{aiaj} with I = 1,…,4

j = 1,…4 are the (co)variances between the direct additive genetic effects of the traits σ_{aimj} with I = 1,…4

j = 1,…4 are the (co)variances between the direct additive genetic effects and the maternal additive genetic effects of the traits

σ^2_{ei} with i = 1,…4 are the variances of the residual effects σ_{eiej} with i = 1,…4

j = 1,…4 are the (co)variances between the residual effects

A is the relationship matrix between individuals

I is the identity matrix

Results and Discussion

Table 2 shows the estimates of variance components and genetic parameters for the different traits.

Guerra *et al*. (2001) with the beef breed Charolais obtained similar results under Cuban exploitation conditions. Regarding ILW, results of this experiment were higher than those reported by these authors (0.08) for heritability.

González (2009) found values of 0.13 ± 0.05, which are higher for this trait in Cuban Zebu cattle. According to Elzo *et al*. (2001), low heritabilities for the direct and maternal additive effects indicate that the environmental conditions are restrictive for the dam (milk production) as for the youngs (individual growth). The maternal effect for ILW had an influence of 0.10, similar to what was reported by González (2009) in Cuban Zebu cattle, to that obtained by Gutiérrez *et al*. (2006) for Asturian of the Valleys breed, in Spain, and to what was registered by Pico *et al*. (2004) in South African Brahman. This

Table 2. (Co)variance components and genetic parameters for growth traits

Variance components	Traits			
	ILW	ADG	WFA	FLW
σ^2_a	59.45	974.07	799.50	233.30
σ^2_m	44.82	175.14	25.50	3.01
σ_{am}	-41.70	-103.25	38.60	6.10
σ^2_e	379.98	4997.24	210736.00	648.91
σ^2_p	448.22	5971.31	2906.43	885.22
Genetic parameters				
h^2_a	0.12 ± 0.05	0.14 ± 0.06	0.22 ± 0.07	0.21 ± 0.07
h^2_m	0.10 ± 0.10	0.03±0.07	0.0	0.0
r_{am}	-0.93 ± 0.18	-0.25±0.10	0.27±0.06	0.23 ± 0.05

σ^2_a Additive genetic variance, σ^2_p phenotypic variance, h^2_a heritability of the direct additive effects, h^2_m heritability of the maternal additive effects, σ^2_m maternal genetic variance, σ_{am} (co) variance between the direct and maternal additive effects, σ^2_e residual variance, r_{am} genetic correlation between the direct and maternal genetic effects.

latter author reported superior results than those referred by Batalha *et al*. (2006) for Gyr in Brazil.

Better results were found for Charolais cattle in Spain by Rosales *et al*. (2004), and in Mexican Simmental by El-Saied *et al*. (2006). For the remaining traits, the maternal effect was practically zero in ADG and the rest zero. Regarding the correlation between the direct and maternal effects for ILW, it was high and negative, similar to that obtained by González (2009) in Cuban Zebu. Other authors as Espinosa *et al*. (2008), also in Zebu cattle, reported lower values than those of this paper. These negative correlations between direct and maternal effects indicate that there is an antagonism for the selection between these traits, for ILW as for ADG.

For ADG, Martínez and Pérez (2006) found a heritability value of the direct additive effects of 0.17 ± 0.05 for Criollo cattle in Colombia, higher than that obtained in this study. In the same way, González-Peña *et al*. (2007) obtained values of 0.20 ± 0.07 in Charolais cattle in Cuba. Meanwhile, Ceró (2007) in Chacuba y Guerra *et al*. (2008) in Cuban Zebu, reported values of direct heritability of 0.16, and a mean of 528.7 $g.d^{-1}$ and 503 $g.d^{-1}$ respectively, In both cases, the h^2 estimate was higher than in this study.

The heritability estimates indicate that the ADG has a low heritability value. Although the additive action of the genes of the own individual has an influence on the heritability, it receives more environmental influence due to their low heritability values.

For the case of WFA, Guerra *et al*. (2002) in beef breeds in Cuba attained similar values. However, Plasse *et al*. (2002) and Pico (2004), in Brahman cattle, in Mexico, found lower values. In Cuba, in reports on Chacuba cattle, Ceró (2007) informed values higher than 0.30 ± 0.13 and González (2009) in Cuban Zebu cattle estimated figures of 0.23. Both studies were conducted under grazing conditions, similar to those of this study. Except the estimates of Plasse *et al*. (2002), all the rest were higher or similar to those of this study.

The heritability estimate for final live weight was higher to that reported by Plasse *et al*. (2002) in Brahman cattle in Mexico. Similarly, it surpassed what was referred by Mucari and Oliveira (2003) and by Silva *et al*. (2006) in studies with Guzerat cattle in Brazil (0.10), as well as what was reported by Martínez *et al*. (2007) in studies with Black Sardo in Mexico (0.12). Similar estimates were found in Brahman cattle in Mexico, with 0.18 (Pico 2004), and superior in the Colombian breed Criollo Costeño with Horns, with 0.27 (Ossa *et al*. 2008) and in Guzerat cattle in Mexico, with 0.52 (Martínez *et al*. 2009).

Under Cuban conditions, Guerra *et al*. (2001) in the Charolais breed informed estimates of 0.25. González-Peña *et al*. (2007) obtained values of 0.21 ± 0.06. In Chacuba cattle, Ceró (2007) reported an estimate of 0.21 ± 0.12, while González (2009) obtained 0.23 in Zebu cattle. The maternal effect did not show influence on this trait, coinciding this result with González (2009) in Cuban Zebu cattle.

In the majority of the cases, results obtained by different authors for the traits studied were similar to those of this paper. This confirms that growth traits show mean heritabilities, and that can be used as selection criteria, excepting ILW, that show low heritability and considerable maternal influence. The literature show a wide variation in the heritability estimates for growth traits, especially final live weight. Results of this study are in that range, confirming that can be used as selection criteria in Santa Gertrudis.

In table 3 are set out the genetic (rg) and environmental correlations between the studied traits. The highest values of rg were for WFA and FLW. These are very close to the unit, while the lowest values were those involving ILW and FLW.

Similar estimates of genetic correlations for WFA

Table 3. Genetic correlations (rg) above the diagonal and environmental below for the growth traits of males in performance test

	ILW	*ADG*	*WFA*	*FLW*
ILW	-	0.83 ± 0.07	0.80 ± 0.12	0.60 ± 0.20
ADG	0.22 ± 0.05	-	0.78 ± 0.21	0.91 ± 0.04
WFA	0.52 ± 0.04	0.76 ± 0.03	-	0.99 ± 0
FLW	0.45± 0.04	0.78 ± 0.02	0.89 ± 0	-

and FLW obtained Ceró (2007) in Chacuba cattle and González (2009) in Zebu under similar development conditions. These values are very close to the unit, which demonstrate us the great similarity in the genetic basis of such attributes. This suggests that any of them can be used as selection criterion in males under performance test. In fact, they can be employed as at earlier ages, without affecting the expression of other trait, diminishing though the duration of the performance test.

Regarding ILW and FLW traits, results from this study were similar to that found by Ossa *et al*. (2007) who reported a correlation of 0.59 in Colombian beef cattle. González (2009) attained higher values for these traits (0.73) in Cuban Zebu cattle under similar conditions. However, for the rest of the traits studied, results of González (2009) were very similar to those obtained in this paper, where values close to the unit were found between the traits WFA and FLW.

Also in Cuban Zebu cattle, authors as Espinosa *et al*. (2008) attained values of genetic correlation of 0.62 between the traits ILW and FLW and environmental correlations of 0.51. Similar estimates for the Brahman breed were found by Plasse *et al*. (2002). In other breeds, as the Hereford, and in an Australian synthetic breed, the genetic correlation values were higher (0.95 and 0.98).

Schaeffer (1999) indicated that in the multiple trait analyses all characters are benefited to some extent. These are more useful when the difference between the genetic and the environmental correlation becomes the highest (higher than 0.5) or where a trait has a heritability far superior to the other. In this case the trait showing lower heritability is more benefited, that is the ILW.

In this paper, the genetic correlation between ILW and FLW was of 0.60 ± 0.20 and the environmental of 0.47 ± 0.04, with a difference between them of 0.13, a lower value than that reported by this author. However, it could result beneficial for the ILW study, since it shows lower heritability.

In figure 1 the genetic propensity for the trait (ILW) is presented where there is a tendency of 0.015 kg/year. This represents 0.008% of the mean, values resulting very discreet. Parra *et al* (2007) in Brahman cattle in México reached far superior results, 0.05% regarding the mean for initial live weight. Plasse *et al*. (2002) with the same breed, but in Venezuela reported values of 0.09%. Similarly, in Santa Gertrudis cattle in Brazil, Ferraz *et al*. (2000) found annual change of 0.06%, while Domínguez-Viveros *et al*. (2003) obtained for Tropicarne cattle in Mexico, a change of 0.03%.

The genetic tendency for ADG (figure 2) was of 0.0003 $g.d^{-1}$/year for 0.0006 % of the population mean, a practically zero value, demonstrating that ADG has maintained constant in the animals finishing the performance test for the evaluated period. González-Peña *et al*. (2007) obtained better results in Cuban Charolais cattle with an annual gain of 0.096%. Results of this study reflect that practically there was no genetic progress for this trait.

Respecting WFA (figure 3) it showed a tendency of 0.050 $g.d^{-1}$, representing 0.0081% of the mean. González (2009) found values of 0.6 $g.d^{-1}$, representing 0.11% of the mean of the herd, figures slightly superior to those of this paper. In other studies, Albuquerque *et al*. (2006) published summaries on bulls and cows of the beef breed Nellore. The genetic tendencies found varied between 0.15% and 0.77 % for post-weaning live weights, which are far superior to those of this investigation.

FLW showed a tendency of 0.024 kg/year (figure 4), representing 0.007% of the population mean. This result is low, above all if the statements of Smith (1985) are considered. This author indicated that the possible annual genetic gain rate is of 1 to 3 % of the population mean. In Santa Gertrudis bovines, under tropical conditions, Ferraz *et al*. (2000) reported tendencies of 0.06 % of the mean, while Ferraz *et al*. (2002) determined an annual genetic trend with 0.10% increase above the mean in Tabapua breed. In Guzerat breed, Pimenta *et al*. (2001) reported a gain of 0.276 kg annually.

In Cuba, in Charolais cattle, González-Peña *et al*. (2007) found values of 0.04 % of the herd mean, results which are superior to those of this study. Guillén *et al*. found figures of genetic tendency of 0.013 kg/year for 0.004 % of the population mean, a lower value to that of this paper.

The genetic tendency of the FLW of the animals under performance test in spite of being positive is very low. This demonstrates that the selection criteria used in the studied herd did not result in the expected genetic progress for this selection program. An important factor that could influence on this result is the poor, or almost null, selection work with the females, since they play an important function, as González-Peña *et al*. (2007) showed in an investigation for this trait in Charolais cattle. Also the low selection intensity and the closed structure of this herd for various years could

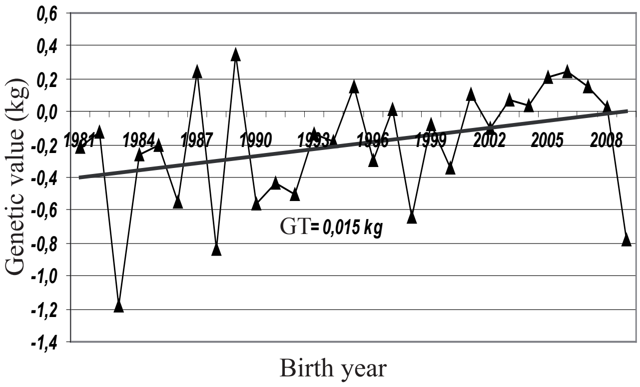

Figure 1. Genetic tendency for initial live weight

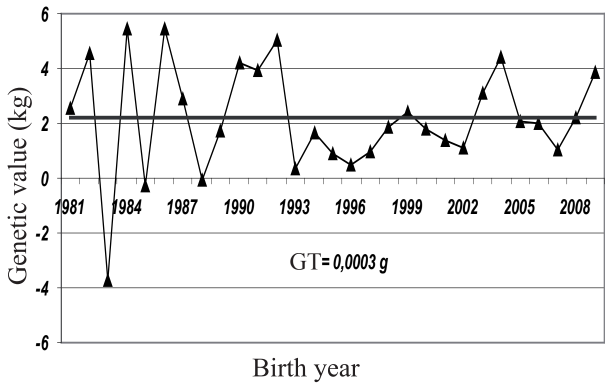

Figure 2. Genetic tendency for average daily gain in PT

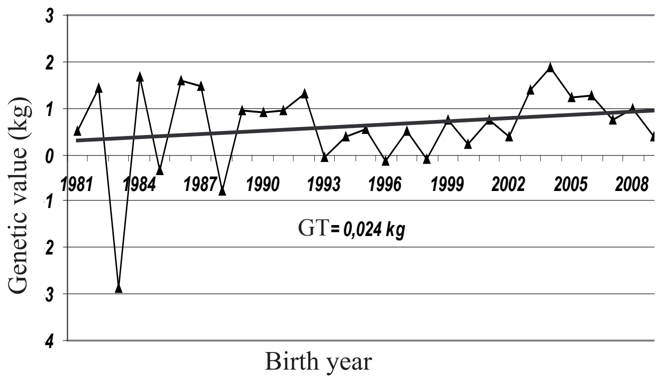

Figure 3. Genetic tendency for weight for age (WFA)

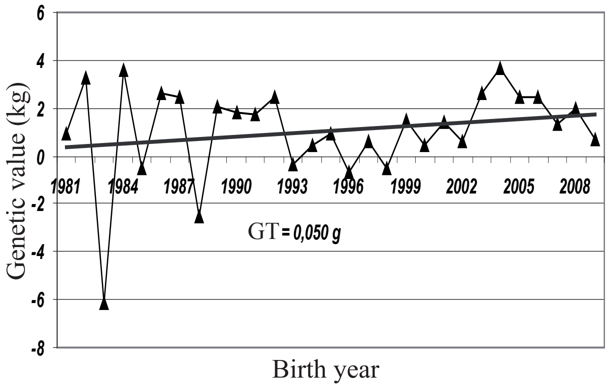

Figure 4. Genetic tendency for final live weight (FLW)

have influenced.

It is concluded that the heritability estimates for the direct and maternal effects for ILW are a constraint for the progress of this trait. The rest of the traits studied in Santa Gertrudis males can be used as selection criteria. Their heritability offers advantages for their genetic progress. The genetic correlations between the studied traits were high and positive.

It was confirmed that the final live weight and weight for age seem to be the phenotypic expression of two attributes with the same genetic basis. The initial live weight presents significant influence of the maternal effect, thus, this effect for the estimation of heritability must be always included. The improvement program has not reached the expected genetic progress for this breed.

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Received: January 21, 2013