

GENOTYPE ENVIRONMENT INTERACTION IN PERFORMANCE TESTS IN SHEEP IN CONFINEMENT AND AT PASTURE

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RESUMO

Objetivou-se com este trabalho verificar a existência de interação genótipo ambiente e o desempenho de ovinos mantidos em confinamento e a pasto. Foram utilizados oitenta e dois borregos da raça Santa Inês de 75 a 135 dias de idade. O período de adaptação foi 22 dias. Oriundos de cinco fazendas diferentes, 30 animais permaneceram 112 dias a pasto e 52 animais permaneceram 85 dias em confinamento. As características mensuradas nos animais foram ganho em peso (WG), comprimento do corpo (CC), perímetro torácico (PT), altura da anca (AA), altura do peito (AP), área de olho de lombo (REA) e espessura de gordura por ultrassom (FT), perímetro escrotal (PE), número ovos/grama de fezes (FEC) e escore corporal

(EC). Um índice (IPWG) foi criado incorporando as características medidas. O software SAS® foi utilizado para as análises estatísticas. Houve diferença entre os animais para o tipo de teste (confinamento ou pasto) para as características WG, REA, FT, PE e IPWG. Os animais em confinamento apresentaram resultados superiores aos do pasto para as características de ganho em peso e inferiores para o IPWG e PE. A idade dos animais no início do teste não mostrou influência sobre a expressão das características. Não houve evidência de interação genótipo x ambiente para animais da raça Santa Inês nas provas de ganho em peso a pasto e em confinamento para as características avaliadas.

PALAVRAS-CHAVE: área de lombo; avaliação subjetiva; espessura de gordura; índice; ultrassom.

GENOTYPE-ENVIRONMENT INTERACTION IN PERFORMANCE TESTS FOR SHEEP IN CONFINEMENT AND AT PASTURE

ABSTRACT

This study aimed to verify the existence of genotype–environment interaction and performance of Santa Inês sheep in confinement and at pasture. Eighty-two Santa Inês lambs at 75–135 days of age were used. The adaptation period lasted 22 days. Animals were from five different farms, 30 animals were kept on pasture for 112 days and 52 animals were kept in confinement for 85 days. Animals were evaluated on weight gain (WG), body length (BL), thoracic perimeter (TP), hip height (HH), breast height (BH), rib-eye area (REA) and fat thickness (FD) using ultrasound, and scrotal circumference (SC), worm load (FEC) and body condition score (CS). An

index (FI) was calculated using the measures taken. The SAS® software was used for statistical analysis. There was a statistical difference among animals for type of test (confinement or pasture) for WG, REA, FD, SP as well as FI. Measures for animals in confinement were generally higher than for animals on pasture, except for FI and SP. The age at the start of the test did not influence the expression of characteristics. There was no evidence found of a genotype–environment interaction for Santa Inês breed animals in weight gain on pasture and in confinement for the evaluated characteristics.

KEYWORDS: fat thickness; index; rib eye area; subjective evaluation; ultrasound.

INTRODUCTION

When the expression of certain genotype depends on the environment where it is evaluated this is defined as an interaction between genotype and environment (EUCLIDES FILHO, 1999). Genotypes of highly productive breeds cannot fully express their potential in environments where they are subjected to environmental stress. Environmental stress factors that can be of interest in animal production include tolerance to ticks, endoparasites, low-quality forage and highly variable nutrition in terms of quantity or quality, as well as ambient temperature (MCMANUS et al., 2009).

Regardless of the conditions under which sheep are reared, there is a need to increase profitability, maximizing the return on investment (REIS & LOBO, 1991). The establishment of an economically viable farming system in a given region requires the choice of breeds or crosses that are suited to local environmental conditions (MCMANUS et al., 2011).

Depending on the intensity of interactions between genotype and the environment, animals with potential for high yields in one environment can have different behavior in another rearing system. The animal that is considered suitable to express their genetic potential in a particular environment is not necessarily the most appropriate in production, but rather economic terms. Some animals are less suited to their environment and tend not to reproduce as efficiently as others (MARIANTE et al., 2003). Thus, less adapted individuals produce fewer offspring, altering the relative gene frequency in subsequent generations, which tends to create animals better adapted to that environment.

Research shows that the selection made in improved environments, with little or no stress factors, tends to select highly productive genotypes (MADALENA, 2007). In contrast, selection in adverse environments leads to selection of less productive, but better adapted animals. According to PERTOLDI et al. (2007), there is a tendency to associate negative responses in low quality environments and positive with environments of high quality.

The objective of this study was to verify the performance and the existence of genotype x environment interaction of Santa Ines sheep under confinement or grazing.

MATERIAL AND METHODS

Two weight gain tests were carried out with Santa Ines sheep in Sheep Management Center of the University of Brasília, Distrito Federal, Brazil. The tests were managed by a local technical committee, composed of a Technical Officer, an animal breeder, a nutritionist and a veterinarian. The animals were aged from 75 to 135 days with a maximum difference of 45 days among animals of the same group. Information on date and type of birth, birth weight and diet under which the lamb was reared were noted. The lambs were from five herds, sons of nine ewes. Of these, eight had offspring in both tests. The standards for central testing in sheep were approved at a meeting in the Ministry of Agriculture, Livestock and Supply (MAPA) in 2002, and are consistent with those used in other tests in Brazil.

In the period from December to April, Santa Ines male lambs (52) were kept in confinement and fed coast-cross hay (*Cynodon dactylon* (L.) pers.) *ad libitum*, mineral salt and 500g of concentrate / animal / day consisting of 53% ground corn, 30% soybean meal, 8.4% sunflower meal, 4.8% wheat bran and 3.8% mineral content resulting in 14% crude protein and 72% NDT, to attain an average gain of 200 g / animal / day.

In the same period, another group of Santa Ines male lambs (30) kept on pasture (*Panicum maximum* v. Tanzania) were supplemented with 150g/animal/day concentrate as above, but without the mineral, which was offered separately (*ad libitum*), to attain a daily gain of 110g/animal/day.

Before the start of the test, the technical committee evaluated the health status and possible diseases (contagious ecthyma, lice, caseous lymphadenitis). After inspection, the animals were vaccinated and dosed. The adaptation period was 22 days. The test phase lasted 85 days for confinement (n = 52) and 112 days at pasture (n = 30). During the test, animals were tested for endoparasites every 15 days (fecal egg count - FEC). Strongyloidea, Moniezia, and Strongyloides were counted. Eimerias were classified according to their occurrence (0-4).

The animals were evaluated for weight gain (WG), body length (BL), thoracic perimeter (TP), hip height (HH), breast height (PH), ribeye area (REA) and fat thickness by ultrasound (FT), scrotal circumference (SC), Eggs per gram of feces (FEC) and body condition score (CS). Before calculating the final indices, objective measures underwent a linear adjustment for age.

The score was composed of visual scores for

conformation (C), precocity (P), muscle (M), breed (BR) and angulations (A), each item contributing to 20% of the visual score, representing 6% of the final IPWG. The visual score scale ranged from one to six, where six was more desirable. An index was created by incorporating the characteristics measured and calculated as follows: IPWG (weight gain test index) = mean weight gain per day (40%) + ribeye area (15%) + scrotal circumference (10%) + fat thickness (5%) + visual score (30%).

A score of six represents an excellent animal, 5 - great 4 - good 3 - average 2 - represents a bad and 1 - worst animal. In the visual assessment of conformation (C) characteristics such as development of muscle mass and estimated total quantity of edible portion were taken into account, valuing structural aspects, including the size and characteristics of the morphofunctional harmony.

Precocity (P) was assessed by the ability or degree of early deposition of fat, seeking animals that reach the finishing point earlier. The biotype of the animal was also analyzed. The elongated type was tall with little depth of rib, and is characterized as late developer (lower scores), while the medi-linear presents animals with good depth of rib, good muscle mass, full groin combined with good body development, defining an earlier maturing animal, thereby receiving higher scores marks for this feature.

Musculature (M) was assessed by observation of specific points on the animal, such as the forearm, anterior and posterior limbs and depth of rump. The scores were given by analyzing the animals at rest and in motion. When standing, the

animals displaying the both front and behind members well separated show better developed muscle. When in movement, the muscle movement, which contract and increase in volume rhythmically, delineating the shape, differentiating muscle from fat, which has no definite shape or support. An animal with more muscle animal received higher scores.

Breed type (BR) took into consideration the official standard of the Santa Ines breed (head, hair, skin pigmentation, among others). The legs and feet were assessed for proportion, direction and joints of the anterior and posterior limbs.

Data were analyzed using SAS ® software, using the GLM, CORR and PRINCOMP procedures. The statistical model used was: $Y_{ijklm} = T_i + R_j + P_l + TR_{ij} + \beta(I_{ijl} - \bar{I}) + e_{ijklm}$ Where Y_{ijklm} is the trait measured on the animal, T_i is the fixed effect of test ($i = 1, 2$), R_j is the fixed effect of ewe ($j = 1, \dots, 14$), TR_{ij} is the fixed effect of interaction between ewe and test; P_l is the fixed effect of type of birth ($l = 1, 2$), $\beta(I_{ijl} - \bar{I})$ = covariate effect of the age at start of test and e_{ijkl} is the random error effect.

The FEC data were transformed into log (x +10) and the scores were using the square root.

RESULTS AND DISCUSSION

The traits measured had low variation (Table 1) except FEC. This was expected, as there was an adjustment period to eliminate environmental effects of the farms of origin (BIF, 1986) coupled with similar ages and weight at the start of test.

TABLE 1. Traits measured in weight gain tests in Santa Ines sheep in the Distrito Federal, Brazil

Carac.	N	Mean	SD	Min.	Max.	Carac.	N	Mean	SD	Min.	Max.
Sdea	81	519	1368	0	8200	C	79	4	0.84	3	6
Sdes	81	20	71.45	0	450	P	79	4	0.87	2	6
Mon	81	13	106	0	950	M	79	4	0.84	2	6
Eim	81	0.27	0.59	0	3	BR	79	4	1.33	1	6
WGN_I	81	0.14	0.06	0.04	0.32	A	79	4	0.7	3	6
WGN_F	79	0.13	0.03	0.08	0.2	IPWG	79	9	1.68	4.26	12.97
WGI_F	79	0.16	0.07	0.05	0.31	BL	28	64	4.52	56	72
REA	79	6	1.89	1.74	10.18	PT	28	74	5.1	64	83
FT	79	0.28	0.11	0.1	0.6	HH	28	70	4.39	62	78
SC	76	26	4.33	16	35						

Carac. Trait; N – number of animals; SD – standard deviation; Min. minimum; Max -maximum; Sdea – Strongyloidea (n); Sdes – Strongyloides(n); Mon – Moniezia(n); Eim – Eimeria(n); WGN_I – weight gain from birth to first test day (Kg/day); WGN_F – weight gain from birth to last test day (Kg/day); WGI_F – weight gain on test (Kg/dia); REA–ribeye area (cm²); FT–fat thickness (cm); PE –scrotal circumference (cm); C– conformation (scores 1-6); P – precocity (1-6); M – muscling (1-6); BR –breed type (1-6); A –legs and feet (1-6); IPWG–weight gain test index; BL – body length (cm); PT – thoracic perimeter (cm); HH – shoulder height (cm); AP – chest height (cm).

There were differences (Table 2) between the two tests for WGN_I, WGN_F, WGI_F, REA, FT, IPWG and SC ($P < 0.001$), IMT ($P < 0.05$) but no differences were detected for SDEA, SDES, Mon and visual scores (C, P, M, BR and A). The animals in confinement showed faster growth, but animals at pasture had higher PE. Sheep at pasture were older at the end of test (about two months) and, according to the testes weight of the animals, closer to puberty, though the body weight of animals in both tests were similar. According to ALVES et al. (2006), testicular growth and puberty are more related to feeding than age. In the latter experiment, all animals were raised at pasture and in the rainy season, without supplementation, which slows their development.

The rate of growth in young animals is largely a function of appetite, tissue ability to grow (bone and muscle) and body maintenance efficiency. At low levels of feed, the variation in growth rate is mainly affected by body maintenance requirements. At high levels, maintenance and growth capacity of the tissues are the main contributors (BERG & BUTTERFIELD, 1979). In Brazil, the use of crosses between specialized and adapted breeds has been used by farmers in search of more productive animals under tropical and subtropical conditions. In most developing countries located in the tropics, low reproductive performance, both in native and imported breeds, results from a combination of genetic, management and environmental factors (AGYEMANG et al., 1991).

The correlations were generally low with FEC and average between weight gain and visual scores. High correlations were found between the four size traits (DC, PT, HH and AP) and weight (WGI_F) and medium to high between size and three visual scores (C, P and M), however, when these (C, M and P) were compared with weight (WGI_F), correlations were very low (Table 3). This may mean that the person evaluating the animals unconsciously gave higher marks to larger animals (high BL, PT, HH and AP).

Correlations between measures of size (DC, PT, HH and AP) were not calculated because these were only taken on the animals kept in confinement, and these FEC had zero, preventing the calculation.

Fourteen sires were tested, having 3-11 offspring each. Eight, with 6 to 11 offspring, had their products in both tests, promoting genetic ties needed for evaluation. There were no detectable interaction between these sires and the type of test (not shown). This means that the offspring of sires with the best

performance in confinement, also performed well at pasture. Different genotypes can respond in various ways depending on the environment. The highly productive animal genotypes can express their growth potential if there is no environmental stress, while genotypes selected for survival and reproduction can fare better performance when subjected to harsh environments (PEBTOLDI et al., 2007). Environmental stress includes challenges by ticks, internal parasites, low-quality forage and highly variable nutrition in quantity or quality, as well as ambient temperature (McMANUS et al., 2010).

In both tests, the environment was reasonably favorable for animal growth, which may explain the lack of interaction. The differences in the initial weight of animals before entering the test (due to effect of type of birth, farm and age) disappeared by the time the test started, indicating that the adaptation period was adequate to remove differences due to the origin of animals (KRAUSSLICH, 1974). According to ANDERSEN et al. (1981), the adaptation period should be sufficient to allow compensatory growth and standardize the physical condition of the animals. The age of the animal has an important effect on weight during this period, which also must be used to eliminate parasites and correct the levels of vitamins and minerals in animals (ANDERSEN et al. 1981).

This study was unable to detect differences among tests, farms or type of birth for the visual scores (C, P, M, BR and A). Although they accounted for 30% in the final index (6% each), objective characteristics (WG, REA and PE) showed differences at the end of the two tests with animals raised at pasture presenting a higher rate. It should be noted that the animals on test were selected by farmers for whatever reason.

In the main component analysis, the first component showed that, in general, heavier animals were higher for all characteristics as expected (Figure 1). The second component showed animals with high gain on test, but with low REA and IPWG. The animal described by the second component is not interesting for the farmer. The first two components explained 63% of the variation during the test. Again, subjective scores (C, P, M and BR) followed size measures (BL, PT, HH and GG), except legs and feet (A) that is not related to the size of the animal. This shows the difficulty that exists in separating these measures from the size of the animal during visual evaluation.

TABLE 2. ANOVA results for traits measured in Santa Ines sheep in weight gain tests in the Distrito Federal

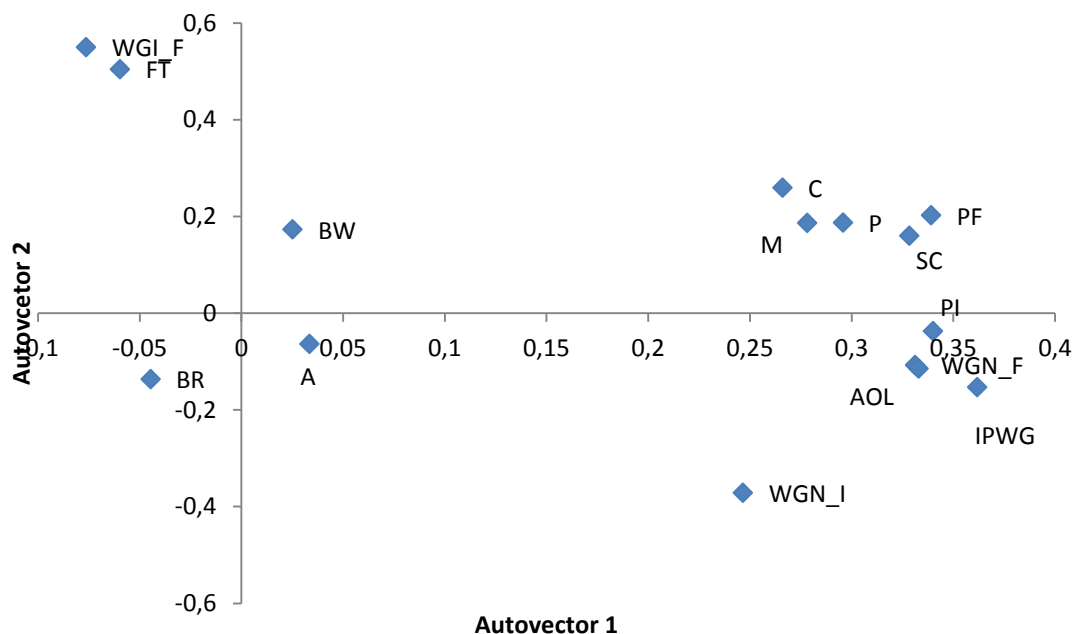
	Sdea	Sdes	Mon	Eim	WGN_I (Kg/day)	WGN_F (Kg/day)	WGI_F (Kg/day)	REA (cm ²)	FT (cm)	C	P	M	BR	A	IPWG	SC (cm)	BL (cm)	PT (cm)	HH (cm)	AP (cm)
Test	ns	ns	ns	*	***	***	***	***	***	ns	ns	ns	ns	ns	***	***	.	.	.	.
Ewe	**	***	*	ns	**	*	***	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	ns	**
Test x Ewe	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	.	.	.	.
BirthType	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Age	ns	ns	ns	ns	**	*	ns	ns	ns	ns	ns	ns	*	ns	ns	*	ns	ns	ns	ns
R ²	0.40	0.38	0.21	0.26	0.76	0.48	0.85	0.57	0.72	0.16	0.27	0.25	0.16	0.14	0.67	0.49	0.65	0.52	0.43	0.56
CV (%)	218.11	303.58	777.18	201.06	24.23	17.36	18.34	21.99	22.93	19.95	19.85	20.51	30.85	15.99	11.31	12.64	4.59	5.33	5.29	4.33
Overall Mean	519.14	19.75	12.96	0.27	0.14	0.13	0.16	6.04	0.28	4.13	4.01	3.80	4.23	4.37	9.13	26.31	64.32	73.79	69.75	70.64
Means:																				
Housed	0.00	0.00	0.00	0.00	0.08	0.11	0.23	4.44	0.40	4.00	3.71	3.54	4.25	4.29	7.45	24.52				
Pasture	824.50	31.37	20.59	0.43	0.18	0.01	0.11	6.92	0.21	4.20	4.18	3.94	4.22	4.41	10.05	27.24				

R² – coeficiente of determination; CV – coeficiente of variation; ; Sdea – Strongyloidea (n); Sdes – Strongyloides(n); Mon – Moniezia(n); Eim – Eimeria(n); WGN_I – weight gain from birth to first test day (Kg/day); WGN_F – weight gain from birth to last test day (Kg/day); WGI_F – weight gain on test (Kg/day); REA – ribeye area (cm²); FT – fat thickness (cm); SC – scrotal circumference (cm); C – conformation (scores 1-6); P – precocity (1-6); M – muscling (1-6); BR – breed type (1-6); A – legs and feet (1-6); IPWG – weight gain test index; BL – body length (cm); PT – thoracic perimeter (cm); HH – shoulder height (cm); AP – chest height (cm).

TABLE 3. Phenotypic correlations (Pearson) between traits measured in Santa Ines sheep in weight gain tests in the Distrito Federal.

	Sdea	Sdes	Mon	Eim	WGN_I	WGN_F	WGI_F	REA	FT	SC	C	P	M	BR	A	IPWG	BL	PT	HH
Sdes	0.51 ¹																		
Mon	0.00	-0.03																	
Eim	0.42	0.24	-0.06																
WGN_I	0.26	0.14	0.03	0.18															
WGN_F	0.04	0.01	-0.13	0.16	0.83														
WGI_F	-0.32	-0.21	-0.17	-0.26	-0.64	-0.24													
REA	-0.07	-0.07	-0.14	0.11	0.57	0.70	-0.32												
FT	-0.36	-0.29	-0.19	-0.25	-0.51	-0.17	0.83	-0.22											
SC	-0.19	-0.21	-0.28	0.19	0.28	0.57	0.08	0.65	0.06										
C	-0.12	-0.15	-0.15	0.13	0.17	0.44	0.21	0.37	0.11	0.59									
P	-0.17	-0.20	-0.13	0.19	0.30	0.54	0.07	0.47	0.04	0.65	0.72								
M	-0.04	-0.10	-0.11	0.19	0.30	0.53	0.12	0.46	0.05	0.57	0.62	0.65							
BR	0.07	0.09	-0.01	0.00	0.08	0.03	0.00	-0.01	-0.03	-0.21	-0.10	-0.15	-0.19						
A	0.10	0.13	-0.05	-0.03	0.10	0.05	-0.03	0.07	-0.09	0.06	0.18	-0.03	0.19	0.28					
IPWG	0.06	0.01	-0.12	0.32	0.66	0.75	-0.39	0.82	-0.36	0.69	0.56	0.62	0.59	0.16	0.28				
BL					-0.27	0.18	0.82	0.39	0.33	0.78	0.51	0.71	0.67	-0.13	0.44	0.55			
PT					-0.05	0.34	0.73	0.49	0.49	0.56	0.64	0.67	0.70	0.27	0.36	0.76	0.59		
HH					0.00	0.40	0.74	0.53	0.41	0.69	0.66	0.69	0.65	0.08	0.55	0.72	0.67	0.67	
AP					-0.09	0.32	0.74	0.51	0.36	0.65	0.56	0.64	0.65	0.14	0.56	0.71	0.68	0.65	0.95

; Sdea – Strongyloidea (n); Sdes – Strongyloides(n); Mon – Moniezia(n); Eim – Eimeria(n); WGN_I – weight gain from birth to first test day (Kg/day); WGN_F – weight gain from birth to last test day (Kg/day); WGI_F – weight gain on test (Kg/day); REA – ribeye area (cm²); FT – fat thickness (cm); SC – scrotal circumference (cm); C – conformation (scores 1-6); P – precocity (1-6); M – muscling (1-6); BR – breed type (1-6); A – legs and feet (1-6); IPWG – weight gain test index; BL – body length (cm); PT – thoracic perimeter (cm); HH – shoulder height (cm); AP – chest height (cm).¹Correlation significance level: 0.00 to <0.22 NS; 0.22 to 0.29 (P<0.05) and >0.29 (P<0.01).



GPN_I – weight gain from birth to first test day (Kg/dia); GPN_F – weight gain from birth to last test day (Kg/day); GPI_F – weight gain on test (Kg/day); AOL – ribeye area (cm²); EG – fat thickness (cm); SC – scrotal circumference (cm); C – conformation (scores 1-6); P – precocity (1-6); M – muscling (1-6); BR – breed (1-6); A – legs and feet (1-6); IPGP – weight gain test index; CC – body length (cm); PT – thoracic perimeter (cm); AA – shoulder height (cm); AP – chest height (cm).

FIGURE 1. First two autovectors measured on Santa Inês sheep on weight gain tests in the Distrito Federal, Brazil.

CONCLUSION

There was no evidence for genotype environment interaction for Santa Inês animals in weight gain tests in feedlot and pasture, showing that an animal selected in one test environment may respond well in the other. The use of subjective scores was not efficient in detecting differences in the phenotypes of animals.

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