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PHENOTYPIC AND GENETIC PARAMETER ESTIMATES OF LITTER SIZE AND BODY WEIGHTS IN GOATS

Alade, N.K., Dilala, M.A. & Abdulyekeen, A. O.
Department of Animal Science, University of Maiduguri, P.M.B.1069, Maiduguri, Borno, State.

ABSTRACT
Reproductive and growth data (birth to nine months of age) of 194 kids; progenies of 9 sires, 32 dams and from 137 kiddings were analysed for genetic parameter estimates. Heritability estimates from sire component were 0.39 (litter size), 0.47 (birth weight), 0.39 (pre-weaning gain), 0.04 (weaning weight), 0.03 (post-weaning gain) and 0.22 (9 month body weight). The corresponding values for repeatability estimates were 0.12, 0.61, 0.37, 0.52, 0.24 and 0.4. Genetic correlations between litter size and body weight ranged from -0.122 to -0.22 while the phenotypic correlations ranged from -0.118 to 0.295. Low but negative correlations were recorded between post-weaning gain and weaning weight (genetic: -0.056, phenotypic: -0.065) and between post-weaning gain and pre-weaning gain (genetic: -0.101, phenotypic: -0.042). Genetic and phenotypic correlations between 9 month body weight and other growth traits were positive. From the results of this study it can be concluded that growth and litter size can be improved by individual selection. Addition information on relatives may be required for litter size because of its relatively low repeatability. However, while 9 month body weight can be improved by selecting for other growth traits, pre-weaning and post-weaning gains are antagonistic to each other. Finally, selection for litter size may have negative effect on growth performance.

KEY WORDS: Phenotypic,Genetic, correlation, reproductive, Growth.

INTRODUCTION

Goats are known to be potential genetic resources for meat, milk, skin and fibre throughout the tropical and developing countries. They also play an important role in the socio-economic life of the people as they feature prominently in socio-cultural functions like ceremonies and religious festivities. In fact, goats play a significant role in household nutrition and food security of pastoral people. Goats are widely distributed in the tropics and subtropics as a result of the ability to adapt to a variety of environments. Additionally, in any environment where they thrive best they are noted for their multiple births up of to quadruplets though twins are mostly common. This is an important genetic characteristic of goats which varies with breed, body condition and age of the doe (Christie, 1996). Other characteristics that need to be given high priority in breeding goats are growth and development. Sometimes size is inferred from the weight but this can be misleading. Growth is the increase in weight and or size that occurs over time (i.e. age) while development is the changes that start at conception and continue up to the maturity. The time to reach maturity and market weight are both influenced by differences in growth and development. Selection is an important tool usually employed to make genetic improvement with respect to a particular trait in any specie of livestock. Any effective selection is however largely dependent on heritability of the trait and its genetic relationship with other traits of economic importance. In the semi arid region of Nigeria no information is available on genetics of growth and litter size of goats. This study is therefore carried out in other to determine the heritability and repeatability estimates of litter size and, also show the genetic and phenotypic relationship between these traits for successful breeding programmes.

MATERIALS AND METHODS

Experimental location, Climate and Vegetation

The study was conducted at the University of Maiduguri Teaching and Research Farm, Maiduguri. Maiduguri is located within the Sahelian (Semi Arid) region of West Africa on latitude 11.38^0 North and 37.17^0 East of the equator at an altitude of 354m above sea level. The temperature of the area ranges from 24.0^oC to $40.7\,^oC$. The Sahel is a region of steppes with thorny species. There are widely spread perennial grasses; usually less than 80cm high. Annuals are often abundant. The xerophitic (adaptive to dryness) natives of the graminae are quite marked. Trees are mainly thorny Acacia with some organs transformed into thorns.

Animal Management

The management was generally semi intensive. Animals were allowed to graze twice a day: morning (8.00am to 12.00pm) and evening (2.00pm to 5.00pm). Species of plants in the grazing area included *Cassia obtusifolia, Striga asiatica, Cyperus dactylic, Digitaeria ternatta, Cyperus esculentus, Trichodesma zeylanacum, Boerhavia diffusa, Acalypha segatalis and Leucas martinicensis.* Availability of grasses is seasonal. They are available during rainy season but dry up during the dry season. However, as the dry season sets in, the left over of the farms become a rich source of feed to the animals. Supplements in form of hay (adlibitum), cowpea husk and wheat offal (1:10) were offered during the periods of advanced pregnancy, lactation, weaning and dry season.

To ensure good health, animals were routinely treated against endoparasites and ectoparasites using ivomec. At the same time they were injected with broad spectrum antibiotics (Oxytetracycline L.A.). These operations were usually carried out before and after the rains. Anytime stress was suspected the animals were offered multivitamins (injectable).

DATA COLLECTION AND ANALYSIS

At the end of the study, which lasted 3½ years, 194 kids progeny of 9 sires and 32 dam were produced from 137 kiddings. Each kid was weighed at birth and then monthly up to nine months of age. Body weights were obtained using a hanging spring balance.

Prior to entry into the computer and after printing out, the data were crosschecked for possible duplication and omissions. The genetic parameters their standard errors were estimated using the maximum likelihood computer programme of PC-2 (Harvey, 1990) after adjustment of the data for environmental factors such as effect of breed, sex, year of birth, parity and season of birth.

Heritability ($h^2_{(s)}$) was estimated from sire component according to Becker (1984) as follows:

$$h^2_{(s)} = \frac{4\sigma^2 s}{\sigma^2 s + \sigma^2 d + \sigma^2 w}$$

Genetic (r_G) and phenotypic (r_P) correlations between traits were estimated from variance and covariance components using the following formulae (Becker, 1984).

Genetic correlation:

$$r_G = \frac{\sigma^2 s_{XY}}{\sqrt{\sigma^2 s_{XX} \times \sigma^2 s_{YY}}}$$

Phenotypic Correlations:

$$r_P = \frac{\sigma^2 P_{XY}}{\sqrt{\sigma^2 P_{XX} \times \sigma^2 P_{YY}}}$$

Repeatability (R) coefficients were estimated using the expression:

$$R = \frac{\sigma^2 B}{\sigma^2 B + \sigma^2 W}$$

Where:

$\sigma^2 s$ = sire variance component
$\sigma^2 d$ = dam variance component
$\sigma^2 w$= error variance component
$\sigma^2 s_{xy}$ = sire covariance of traits x and y
$\sigma^2 s_{xx}$= sire variance of trait x
$\sigma^2 s_{yy}$= sire variance of trait y
$\sigma^2 p_{xy}$= phenotypic covariance of traits x and y
$\sigma^2 p_{xx}$= phenotypic variance of trait x
$\sigma^2 p_{yy}$ = phenotypic variance of trait y
$\sigma^2 B$ = Variance component due to differences between individuals
$\sigma^2 W$ =Variance component due to differences within individuals

RESULTS AND DISCUSSION

Heritability

The heritability estimate for litter size and different growth traits are presented in Table 1. Heritability of litter size recorded was 0.39. This is similar to 0.35 reported by Odubote (1996) in West African Dwarf goats. It is however higher than values reported by Odubote (1992), Neopane (1997) and Neopane (2000) in different breeds of goats. Differences in heritability estimates are as a result of differences in methods of estimation and data size. Large heritable differences in litter size are an indication of positive response to individual selection. However, selection for litter size must be done with caution because incidence of large litter may jeopardize the survival of kids (due to low birth weight) and it may lead to dystocia in does and lengthened kid intervals.

Heritability estimates recorded for birth weight (0.47) is lower than most of tne estimates in the literature (Al-Shorepy, *et al.,* 2002; Portolana *et al.,* 2002 and Kosum, *et al.,* 2004), though similar to 0.43 reported by Hongping (2007) and lower than 0.68 reported by Mourad and Anous (1998) for Boer goats and Common African and Alpine goats, respectively. Preweaning weight gain's heritability estimate obtained in this study (0.39) is higher than 0.26 reported by Schoeman *et al.* (1997) but lower than 0.52 reported by Concepta *et al.* (2008). Weaning weight was poorly heritable with 0.04 heritability; an estimate that compares well with 0.06 and 0.09 reported by Taskin *et al.* (2000) and Das (1993). Although postweaning weight gain was poorly heritable (0.03), 0.22 recorded as estimate for 9month body weight is similar to 0.19 and 0.23 recorded by Kumar *et al.* (1994) and Roy *et al.* (1997), respectively. Since individual selection is based on the value of heritability estimate appreciable response is expected through direct selection for birth weight, preweaning weight gain, postweaning weight gains

TABLE 1: Heritability and repeatability estimates (±SE) of litter size and body weights in Goats.

Variable	Heritability Estimate	Repeatability Estimate
Litter size	0.39±0.09	0.12±0.06
Birth weight	0.47±0.12	0.61±O.15
Preweaning weight	0.39±0.08	0.37±0.11
Weaning weight	0.04±0.01	0.52±0.12
Postweaning gain	0.03±0.01	0.24±0.08
9 month body weight	0.22±0.06	0.40±0.04

Repeatability of litter size and growth traits are also shown on Table 1. Estimate recorded for litter size is lower than 0.33 reported by Odubote (1992) for West African Dwarf goats in a humid tropical environment, though similar values were recorded by Boujenane *et al.* (1991) and Abegaz *et al* (2002) in different breeds of sheep. Low repeatability of litter size implies that assessment of prolificacy or culling of unproductive animals based on individual litter size may not yield desired results. Rather, additional information on the performance of female relatives and management practices aimed at standardizing all environmental problems known to affect litter size should be considered.

Repeatabilities of growth traits (Table 1) are higher than the corresponding heritability estimates. This is in agreement with the theory that repeatability sets the upper limit to heritability estimates. Most of the estimates are higher than values in the literature (Forgaty *et al.*, 1985; Odubote and Akinokun, 1992 and Das *et al.*, 1996); though values for prewaning weight gain (0.37) and postweaning weight gain (0.17) are similar to corresponding values 0f 0.37 and 0.17 reported by Said *et al.* (1999) and Das *et al.* (1996), respectively. As a result of the high repeatability, maternal influence can be regarded as an important source of variation in growth performance of kids. Early selection of animals based on single records can therefore be applied in other to increase growth performance in a herd.

Correlation between litter size and growth traits

Genetic and phenotypic correlations between litter size and growth traits are shown in Table 2. The correlations were all negative ranging from -0.122 to -0.251. Litter size and Birth weight had the highest negative correlation while the lowest was recorded for 9month weight and litter size which incidentally is similar to what was recorded for preweaning weight gain and litter size. Though these results fall within -0.23 to 0.09 reported by Hanford *et al.* (2002) in sheep, Safari *et al.* (2005) reported a positive between weaning weight and litter size. The negative correlations were expected since large litter size had been shown to have negative effect on body weights of goats (Alade *et al.*, 2008).The phenotypic correlations between litter size and growth traits also ranged from -0.295 (litter size and birth weight) to -0.118 (litter size and preweaning/post weaning weight gain). In the literature both negative and positive genetic correlation coefficients between litter size and growth traits had been reported (Forgarty *et al.*, 1985; Al Shorepy and Notter, 1996; Bromley *et al.*, 2001). According to Bradford (2009), variability among estimates depends on environment. The relationship may be negative in harsh environments especially where feed is scarce or poor in quality or where animals are subjected to extreme temperatures or serious disease and parasite challenges. Therefore, increased litter size should not be a priority where such conditions prevail.

TABLE 2: Genetic (Below diagonal) and Phenotypic (Above diagonal) correlation between litter size and body weights in Goats.

	BW (9 month)	BWT	POST	LS	WW	PRE
BW (9 Month)		0.398	0.736	-0.195	0.634	0.621
BWT	0.461		0.022	-0.295	0.562	0.442
POST	0.591	0.011		-0.118	-0.056	-0.065
LS	-0.122	-0.251	-0.222			-0.118
WW	0.513	0.366	0.101	-0.151		0.911
PRE	0.692	0.51	-0.042	-0.123	0.811	

BW (9 month)- Body weight at 9 month, BWT- Birth weight, POST-Post weaning gain, LS-Litter size, WW-Weaning weight, PRE-Pre weaning gain.

Correlation between growth traits

Generally both the genetic and phenotypic correlations between growth traits were high and positive (Table 2). Exceptions were negative correlations between weaning weight and both preweaning and postweaning weight gains. Preweaning and postweaning gains also had negative correlation coefficient while coreelation between birth weight and postweaning weight was low though positive. Al-Shorepy *et al.* (2002), Neopane (2000) and Concepta *et al.* (2008) also confirmed that genetic and phenotypic correlations between growth traits were positive and medium to high. In essence, this is an indication that selection for any of these growth traits would have a considerable positive impart on others. Efforts should however be concentrated on those with high heritability, which incidentally are expressed in early in life. While selecting for increased birth weight care must be taken to guide against dystocia related problems.

Positive correlations between birth weight, preweaning weight gain and weaning weight is an indication that a heavy goat had a fast growth during the preweaning stage which resulted to heavy weaning weight. However, the negative correlation which preweaning weight gain and weaning weight had with postweaning weight gain is an indication that a faster preweaning growth rate and heavier weaning weight, which can be attributed to maternal effect, tended to be followed by slower postweaning growth.

CONCLUSION

This study indicated that a high genetic progress in growth rate can be achieved through direct selection in goats due to high heritability and repeatability estimates. However, to improve litter size additional information on records of relatives and improved management practices are required. Indirect positive response is also expected in other growth traits when any is selected with the exemption of preweaning and post weaning weight gains that were negatively correlated. Finally, selection for litter size may have a negative effect on growth performance.

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