# Phenotypic and genetic parameters of body weights of blackbelly sheep

**MANJELI Y., TCHOUMBOUE J., NJWE R. M.**
Faculty of Agronomy and Agricultural Sciences, Department of Animal Production P.O Box 222 Dschang – CAMEROON

## ABSTRACT

Eight years data (1989 – 1998) on Blackbelly sheep from University of Dschang Animal Farm totalling 1035 records were analysed for phenotypic and genetic parameters of body weights from birth to one year of age. Birth and weaning weights (90 days) averaged 1.79 ± 0.02 kg and 6.26 ± 0.02 kg, respectively. Body weights at six months and one year of age averaged 9.13 ± 0.15 kg and 14.48 ± 0.16 kg, respectively. Year of birth, sex of lamb and type of birth significantly ($P < 0.01$) affected birth weight, weaning weight and body weight at six months and one year of age. Season of birth significantly affected birth and weaning weights ($P < 0.05$) as well as body weights at six months and one year of age ($P < 0.01$). Age of dam significantly ($p < 0.01$) affected birth and weaning weights. Heritabilities of birth, weaning, six month and one year weights adjusted for non-genetic factors and from paternal half-sib analyses were : 0.34 ± 0.12, 0.35 ± 0.14, 0.38 ± 0.19 and 0.45 ± 0.20, respectively. Genetic correlations for birth weight with later weights were low and positive. The high phenotypic and genetic correlations between weaning and six month weights (0.56 and 0.68, respectively) indicated that weaning and six month weights were better selection criteria for genetic improvement of market weights in Blackbelly sheep than birth and one year weights.

**Key words** : Body weights, heritability, correlations, Blackbelly sheep, Cameroon.

## RESUME

Un total de 1035 données obtenues sur 8 années de recherche (1989 – 1998) sur le mouton Blackbelly de la Ferme d'Application et de Recherche de l'Université de Dschang, a été analysé pour les paramètres phénotypiques et génétiques des performances pondérales de la naissance à un an d'âge. Les poids à la naissance, au sevrage (90 jours), à six mois et à un an ont été respectivement de 1,79 ± 0,02 kg, 6,26 ± 0,02 kg, 9,13 ± 0,15 kg et 14,48 ± 0,16 kg en moyenne et ont été significativement influencés ($P < 0,01$) par l'année de naissance, le sexe et le type de naissance. La saison de naissance ont significativement influencé les poids à la naissance, au sevrage, à six mois et à un an ($P < 0,05$). Les poids à la naissance et au sevrage étaient significativement influencés par l'âge des mères. L'héritabilité du poids à la naissance, du poids au sevrage, du poids corporel à 6 mois et à 1 an estimées à partir de l'analyse des corrélations entre les demi-frères paternels ont été respectivement de 0,34 ± 0,12, 0,35 ±0,14, 0,38 ± 0,19 et 0,45 ± 0,20. Les corrélations génétiques entre les poids corporels à la naissance et les poids ultérieurs ont été faibles et positives. Les valeurs élevées des corrélations phénotypiques et génétiques entre le poids au sevrage et le poids corporel à six mois d'âge respectivement 0,56 et 0,68 ont montré que le poids au sevrage et le poids à six mois sont les meilleurs critères de sélection pour l'amélioration génétique des performances pondérales chez le mouton Blackbelly en comparaison avec le poids à la naissance et le poids à un an d'âge.

**Mots clés :** Poids corporel, héritabilité, corrélations, mouton Blackbelly, Cameroun.

## INTRODUCTION

Small ruminants in Sub-Saharan Africa, like all livestock in the continent, evolved to survive in harsh environments. Hence, most African breeds even under ideal conditions, are not as productive as temperate ones. The challenge in Africa is how to improve production traits of the indigenous breeds without losing their capacity to survive in harsh environments. (Wilson, 1989).

This improvement can be approached through selective breeding utilising the variability within a population to upgrade that population or through crossbreeding with introduction of genetic material from outside. However in the tropics, breeding policies generally aim to upgrade local breeds by crossbreeding with either temperate or tropical exotic breeds (Lavaray and Gore, 1987). This is due to easy availability of apparently superior stock from elsewhere or to difficulties in running field-based performance recording (Das *et al.*, 1996).

Considering the impressive results that have been achieved by selection in the temperate breeds, there should also be good prospects for improvement by selection in the tropics. For such genetic improvement, heritability, genetic and phenotypic correlations are needed. Information on heritabilities is essential for planning efficient breeding programmes and for predicting response to selection. Phenotypic correlation among traits, provided they are partly genetic, may enhance the effectiveness of selection for overall merit. Correlation might also be utilised to predict performance of traits difficult to measure or expressed late in life. In Cameroon, Blackbelly sheep are kept mainly for meat production. Body weights are among the most economically important traits associated with growth and are easily measured traits. Estimates of phenotypic and genotypic parameters in sheep are scarce in Cameroon.

The purpose of this study was to estimate phenotypic and genotypic parameters of body weights in a flock of Blackbelly sheep at birth, weaning, six and twelve months of age.

## MATERIALS AND METHODS

The study was carried out at the University of Dschang Animal Research Station situated within the Sudano-Guinean zone of Cameroon over the years 1989 to 1998. The region is approximately 5°30′ – 5°50′ LN and 10°50′ – 10°10′ LE at an altitude of about 1400 meters. The mean annual temperature is 20°C with a minimum of about 14°C and a maximum of about 30°C. The annual rainfall is about 2000 mm, falling during one rainy season (March to November).

The history and management of the flock have been reported elsewhere (Manjeli *et al.*, 1991, 1995). Basically, Blackbelly is abundant in the forest zones of Cameroon where it represents 35 % of sheep. The body is covered with hair which range in colour from light brown to dark red. Animals have blackbellies, with black points on the face and legs. The face sometimes has two whitish lines running down from the forehead to the nose.

Animals were allowed to graze on pastures dominated with *Brachiaria sp.* and *Stylosanthes sp.* from 0800 to 1700 hours and housed indoors at night. Varying quantities of feed supplementation (cotton seed cake and brewer's dry grain) were given to pregnant or ewes with lambs at foot when available. The health care package included dipping, deworming and annual vaccination against "peste des petits ruminants "( PPR). Animals were treated for pneumonia and diarrhoea when infection occurred. Mating was controlled and inbreeding was minimised in the herd. Lambs were ear-tagged soon after birth and left to suckle their dams during grazing until 90 days of age. Sex, type of birth, month and year of birth were recorded within 24 hours of lambing. Lambs were separated by sex at weaning into different weaner flocks. They were weighed at birth, then every week until one year.

Body weights of 1035 lambs, the progeny of 28 rams, were available at birth, weaning (3 months), six months and one year.

The analyses were carried out using the General Linear Model (GLM) procedure of SAS (1987).

The linear model was as follows :

$$Y_{ijkimno} = M + a_i + b_{ij} + s_k + t_l + p_m + c_n + d_q + e_{ijklmnqo}$$

Where,

$Y_{ijklmnqo}$ = weight at a particular age of the $o^{th}$ individual of the $k^{th}$ sex out of $j^{th}$ dam of $m^{th}$ age of $i^{th}$ sire of $l^{th}$ type of birth from $q^{th}$ season and $n^{th}$ year,

M = overall mean,

$a_i$ = random effect of the $i^{th}$ sire ( i = 1,...,8),

$b_{ij}$ = random effect of the $j^{th}$ dam within $i^{th}$ sire,

$s_k$ = fixed effect of $k^{th}$ sex of lambs (1 = male, 2 = female),

$t_l$ = fixed effect of the $l^{th}$ type of birth (1 = single, 2 = twins, 3 = triplets ),

$p_m$ = fixed effect of $m^{th}$ age of dam (m =1, ..., 6),
$c_n$ = fixed effect of $n^{th}$ year of birth,
$d_q$ = fixed effect of $q^{th}$ season of birth, and
$e_{ijklmnqo}$ = residual error.

Heritability, phenotypic and genotypic correlation estimates were computed using the method of paternal half-sib analysis (Henderson, 1953). Standard error of the heritability estimates were calculated as suggested by Falconer (1960).

## RESULTS AND DISCUSSION

### Body weights

Birth and weaning weights were highly affected ($P < 0.01$) by year of birth, sex of lamb and age of dam at lambing ($P < 0.01$), season and type of birth ($P < 0.05$) (Table 1). Differences due to these factors on pre-weaning weights have also been reported by various researchers for various breeds (Fall *et al.*, 1981; Rajab *et al.*,

**Table I** : Least- squares means of body weights (kg) of Blackbelly lambs at various ages in Cameroon.

| Factor | Birth | | | Weaning | | | Six months | | | One year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | SE | N | Mean | SE | N | Mean | SE | N | Mean | SE |
| Overall | 869 | 1.79 | 0.02 | 745 | 6.26 | 0.02 | 737 | 9.13 | 0.15 | 642 | 14.48 | 0.26 |
| Year of Birth | | ** | | | ** | | | ** | | | ** | |
| 1989 | 36 | 1.80 | 0.08 | 27 | 5.77 | 0.07 | 29 | 8.40 | 0.48 | 23 | 13.71 | 0.89 |
| 1990 | 64 | 1.92 | 0.05 | 57 | 6.02 | 0.06 | 59 | 8.57 | 0.34 | 48 | 15.49 | 0.67 |
| 1991 | 96 | 1.72 | 0.05 | 80 | 5.41 | 0.04 | 82 | 7.59 | 0.30 | 72 | 14.66 | 0.54 |
| 1992 | 137 | 1.94 | 0.04 | 124 | 6.10 | 0.04 | 126 | 9.60 | 0.27 | 116 | 15.61 | 0.54 |
| 1993 | 189 | 1.88 | 0.04 | 151 | 6.34 | 0.05 | 152 | 10.27 | 0.27 | 145 | 16.62 | 0.42 |
| 1994 | 190 | 1.73 | 0.04 | 180 | 7.01 | 0.06 | 172 | 9.17 | 0.25 | 168 | 14.31 | 0.52 |
| 1995 | 125 | 1.74 | 0.05 | 101 | 5.85 | 0.04 | 94 | 8.80 | 0.32 | 52 | 13.66 | 0.82 |
| 1996 | 32 | 1.89 | 0.08 | 25 | 6.11 | 0.08 | 23 | 11.79 | 0.49 | 18 | 16.21 | 0.83 |
| Season of birth | | * | | | * | | | ** | | | ** | |
| Rainy | 448 | 1.87 | 0.02 | 382 | 5.92 | 0.02 | 377 | 9.24 | 0.23 | 341 | 15.32 | 0.29 |
| Dry | 421 | 1.71 | 0.02 | 363 | 6.60 | 0.02 | 360 | 8.06 | 0.23 | 301 | 13.65 | 0.41 |
| Sex of Lamb | | ** | | | ** | | | ** | | | ** | |
| Female | 473 | 1.69 | 0.02 | 382 | 6.13 | 0.02 | 383 | 8.57 | 0.22 | 319 | 13.32 | 0.29 |
| Male | 396 | 1.89 | 0.02 | 356 | 6.40 | 0.02 | 354 | 9.69 | 0.23 | 323 | 15.74 | 0.29 |
| Type of Birth | | ** | | | ** | | | ** | | | ** | |
| Single | 196 | 1.96 | 0.02 | 190 | 6.53 | 0.03 | 188 | 9.78 | 0.25 | 179 | 15.06 | 0.46 |
| Twin | 579 | 1.75 | 0.02 | 468 | 6.13 | 0.02 | 450 | 9.03 | 0.18 | 430 | 14.05 | 0.40 |
| Triplet | 94 | 1.66 | 0.06 | 87 | 5.62 | 0.02 | 59 | 8.59 | 0.34 | 32 | 13.89 | 0.61 |
| Age of Dam (years) | | ** | | | ** | | | * | | | | |
| < 2 | 107 | 1.67 | 0.06 | 99 | 5.12 | 0.06 | 97 | 10.89 | 0.30 | 84 | 11.47 | 0.61 |
| 2 – 3 | 118 | 1.70 | 0.05 | 116 | 5.14 | 0.05 | 114 | 8.15 | 0.30 | 97 | 14.29 | 0.54 |
| 3 – 4 | 243 | 1.81 | 0.04 | 201 | 5.96 | 0.04 | 200 | 8.11 | 0.18 | 173 | 14.88 | 0.50 |
| 4 – 5 | 152 | 1.83 | 0.05 | 123 | 6.14 | 0.05 | 122 | 8.13 | 0.27 | 105 | 15.10 | 0.50 |
| 5 – 6 | 118 | 1.85 | 0.05 | 105 | 6.24 | 0.06 | 104 | 9.22 | 0.32 | 92 | 15.67 | 0.61 |
| 6 + | 110 | 1.89 | 0.05 | 101 | 7.16 | 0.06 | 100 | 9.14 | 0.30 | 91 | 15.48 | 0.57 |

* $p < 0.05$
** $p < 0.01$

1992; Bathaei and Leroy, 1994; Ebangi *et al.*, 1996). Pre-weaning growth of lambs is largely a function of mothering ability of the dam. Thus, prior to weaning, lambs depend mainly on dam's milk as food. The production of which is directly related to year to year variation in pastures and supplementary feed available. This variation, associated with nutritional problems, climatic stress, herdsman skill or probable changes in the genetic make-up of the flock, influence birth weight through its effects to the dam's uterine environment mostly in late gestation months or to the amount of milk available to the unweaned lambs (Ebangi *et al.*, 1996). Six months and one year weights were affected ($p < 0.01$) by season of birth. Similar results have been reported by Wilson (1987). In the post weaning period, the pronounced effect of season could be explained by the amount of annual rainfall which in turn influences the quality and quantity of pasture available to the weaned lambs. In yearling weights, age of dam was found to have non significant effect. This showed that mothering ability of lambs had carried over effect up to six months of age. From this study, it appeared that type of birth and sex of lamb significantly influenced body weights at different ages while age of dam affected weight of lamb up to six months. The results suggested that these factors should always be adjusted for in estimating genetic and phenotypic parameters or when evaluating breeding values.

**Genetic and phenotypic parameters.**

The genetic and phenotypic correlations along with heritability for weight at birth, weaning, six months and one year are presented in Table 2. The heritability estimate of birth weight in the present study (0.34 ± 0.14) was comparable to the estimate of 0.35 reported by Bathaei and Leroy (1981) on the Djallonke sheep breed, lower than the values of 0.45 observed by Ebangi *et al.* (1996) on the Fulbe sheep in Cameroon, but higher than estimates reported by Chopra and Acharya (1971) for Chios and Kiroro (1994) for Doper breed (0.10 and 0.13), respectively. The heritability estimate of weaning weight (0.35 ± 0.14) was similar to the estimate of Siregar (1983). It was lower than the values obtained by Bathaei and Leroy (1994) and Cho *et al.* (1988). The estimate was however higher than the value presented by Chopra and Acharya (1971). Six month weight estimate of heritability (0.38 ± 0.19) was comparable to the value of 0.37 reported by Chopra and Acharya (1971). The heritability estimate of one year weight (0.45 ± 0.20) fell within the range of heritability estimates of 0.41 to 0.55 obtained by Chopra and Acharya (1971). It was clear from the present and other results that post weaning growth generally had higher heritability estimates than preweaning growth. This would indicate that environmental factors, in relation to additive genetic factors, had more influence on early lamb growth than on growth after weaning. This could be attributed to the mothering ability associated with lamb growth performance early in life. High maternal influence has a tendency to increase the component of environmental variance to the lamb, thereby lowering heritability estimates (Thrift *et al.*, 1973). Differences observed between estimates of heritabilities (preweaning or postweaning growth) could, however, result from many factors such as: method of estimation, sample size, breed type, and genotype x environmental interaction. Moreover, the heritability estimates reported here indicated that genetic improvement of weight at birth, weaning, six months and one year could be achieved through selection.

**Table 2 :** Heritabilities, genetic and phenotypic correlations among weights at various ages of Blackbelly lambs in Cameroon.

| Trait | Birth | Weaning | Six months | One year |
|---|---|---|---|---|
| Birth | 0.34 ± 0.12 | 0.38 ± 0.28 | 0.22 ± 0.22 | 0.18 ± 0.20 |
| Weaning | 0.43 ± 0.06 | 0.35 ± 0.14 | 0.68 ± 0.05 | 0.49 ± 0.06 |
| Six months | 0.32 ± 0.06 | 0.56 ± 0.06 | 0.38 ± 0.19 | 0.66 ± 0.05 |
| One year | 0.28 ± 0.06 | 0.23 ± 0.06 | 0.47 ± 0.06 | 0.45 ± 0.20 |

Genetic correlations above diagonal, phenotypic below, heritabilities on diagonal.

**Genetic correlations**

The estimates of genetic correlation among birth, weaning, six months and one year weights are given in Table 2. Genetic correlations of birth weight with weaning, six months and one year weights (0.38 ± 0.28, 0.22 ± 0.22 and 0.18 ± 0.20, respectively) were low, positive and non significant. Bathaei and Leroy (1994) reported significant, positive and high correlation between birth and weaning weights (0.45 ± 0.17). Chopra and Acharya (1971) obtained small and negative genetic correlations of birth weight with weaning, six months and yearling weights. The low negative genetic correlations could be explained by heritabilities of postweaning period being higher than those observed during the preweaning period. Genetic correlations between weaning and six months (0.86 ± 0.05), weaning to one year (0.49 ± 0.06) and six months to one year (0.66 ± 0.05) were high and positive, suggesting that body weight of lamb at six months of age could be the best selection criterion as compared to weaning weight, as is often practised. Six months weight is much less influenced by maternal effects which tend to obscure the direct additive genetic effects for growth. For this reason, Das *et al.* (1994) suggested that selection for weight at later ages would be expected to lead to increase yearling weights which is desirable for meat animals though it may be associated with increased maintenance costs for breeding animals.

**Phenotypic correlations**

Phenotypic correlations among birth, weaning, six months and one year weight of lambs are presented in Table 2. Phenotypic correlations between body weights were all positive and significant ($P < 0.05$). The estimate of 0.43 ± 0.06 between birth weight and weaning weight observed in this study was lower than the value of 0.55 reported by Bathaei and Leroy (1994). Lower estimate was found by Chopra and Acharya (1971). The phenotypic correlations of weaning weights with six months and one year weights were large and significant ($p < 0.01$). Chopra and Acharya (1971) reported positive and significant correlations between weaning and body weight at six months and one year or between six months and one year weights. The high phenotypic and genetic correlations between weaning and six month or one year weights showed that weight at six months is a better selection criterion for genetic improvement of body weights in Blackbelly sheep than birth, weaning and one year weights. Six month weight is less influenced by maternal effects than the weaning weights and is associated with lower maintenance costs for breeding animals than yearling weight.

## CONCLUSION

The present study showed that environmental factors such as sex of lamb, type of birth, age of dam and year of birth significantly affected body weights of lambs at birth, weaning, six months and one year. These factors should therefore be adjusted for in estimating genetic and phenotypic parameters or when evaluation breeding values. Heritability estimates of body weights at birth, weaning, six months and one year were medium and positive with a tendency to increase from birth to one year. This indicated that genetic improvement of weight at birth, weaning, six months and one year of age could be achieved through selection. Weaning weight, with large phenotypic and genetic correlation with six months and one year weights would provide good selection criterion for improving market weights of Blackbelly sheep. However, because of maternal ability associated with weaning weights, it might be advantageous to use six months as best selection criterion since it is less influenced by maternal effects and, as such, it has higher heritability than weaning weight. Thus, selection for weights at six months would lead to increase in yearling weights which are desirable for meat animals.

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