yan un mayor número de poblaciones de este nematodo. También, es importante considerar estos antecedentes al escoger alguna población de *M. exigua* para realizar trabajos de selección de material de *Coffea* resistente a esta especie.

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Relationships Between Size, Conformation and Reproductive Traits in West African Dwarf Ewes[1]

C. Tizikara, O. Chiboka**

ABSTRACT

Linear body measurements taken on 137 ewes showed that heart girth and abdominal girthline are significantly ($P < 0.01$) related to ewe live weight, hence size. Lambing data collected on 65 ewes showed that heavier and larger –sized animals produce either larger or more lambs than lighter ones. High birth weights and total lamb weight carried to term are limited by uterine capacity, which is determined ultimately by body size. High weights also appear significantly associated with more pronounced topline curvature, which is conducive to greater depreciation in ewe value.

Data from 28 lactating ewes showed that lambing and rearing twin lambs gave better ($P < 0.01$) productivity indices and led to higher ($P < 0.05$) milk yield than rearing single lambs. Ewes appear to lactate according to their potential and in response to the demands of their offspring. Single lambs grew significantly ($P < 0.05$) faster than twins up to 28 days postpartum, but not thereafter. They gained more weight until weaning, although they were taking in less milk than twins during suckling periods. Lamb growth rate and milk production were positively ($P < 0.05$) related to lactational weight loss. While the number of lambs born had a significant ($P < 0.05$) effect upon milk production, it showed no significant ($P < 0.05$) effect on lactational weight loss.

COMPENDIO

Las medidas lineares del cuerpo tomadas en 137 ovejas indicaron que la circunferencia del corazón y las dimensiones del abdomen significativamente relacionadas ($P < 0.01$) con el peso vivo y con el tamaño de la oveja. Datos obtenidos con 65 ovejas mostraron que los animales más pesados y más grandes producen crías grandes o más corderos que los animales más livianos. Los pesos más altos al nacer y el peso total de las ovejas hasta parición están limitados por la capacidad uterina la cual, a su vez, es dependiente del tamaño corporal de la oveja madre. Cuando ocurren los pesos más altos, aparecen significativamente asociados con una mayor curvatura de la parte superior del cuerpo de la oveja madre lo cual reduce el valor de ésta en el mercado. Datos obtenidos de 28 ovejas lactantes mostraron que la cría de corderos gemelos dio mayores índices de productividad ($P < 0.01$) y condujo a mayores rendimientos de leche ($P < 0.05$) que la crianza de corderos únicos. Pareciera que las ovejas tienden a lactar de acuerdo a su potencial genético y a las demandas de sus crías. Los corderos únicos crecieron significativamente ($P < 0.05$) más rápido que los gemelos hasta los 28 días pero no después de ese lapso. Esos corderos alcanzaron mayor peso al destete aunque tomaron menos leche que los gemelos en cualquier período de la lactancia. La tasa de crecimiento de los corderos y la producción de leche estaban positivamente ($P < 0.05$) relacionadas con la pérdida de peso causada por la lactancia. Aún cuando el número de corderos nacidos mostró un efecto significativo ($P < 0.05$) sobre la producción de leche, no mostró ningún efecto significativo ($P < 0.05$) sobre la pérdida de peso causada por la lactancia.

INTRODUCTION

Body conformation has proved controversial in the evaluation of livestock. Although external linear measurements of sheep have attracted attention for some time as possible predictors of body weight and carcass yield, their practical utility is limited. Studies with cattle (30) have indicated that there is a general agreement that type (conformation) and production go together when applied to a large number of animals, but are not necessarily associated when individual animals are considered.

From observations of the conformation of West African Dwarf (WAD) ewes, it was hypothesised that the extent of topline curvature (TLC) could indicate the level of strain and consequent ewe depreciation arising from weight load in the abdominal chamber. This experiment was planned to provide a basis for broader research (24) on the productivity of WAD ewes and the biological limitations to improved productivity through breeding procedures.

MATERIALS AND METHODS

Data Preparation

In the month of October 1983, the live weight and body measurements of 137 nulli- and polyparous ewes were taken at the University of Ife Teaching and Research Farm. Heart girth (HG) and abdominal girthline (AGL) were measured (in cm) as body circumference immediately behind the forelegs

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and at the junction of the skin fold from the hind legs and the hind flank, respectively. Topline curvature (TLC), in mm, was determined as the distance to the skin from the base of a board placed along the vertebral column, the reading being taken at a point of greatest depth between the base of the base of the horizontal board and the skin. Lambing data (January 1981 – October 1983) for 65 ewes that had last lambed within the rainy season (April – October 1983) were retrieved from the farm records. Twenty-eight of the ewes which had lambed in October, together with their lambs, were used to assess five-hour milk production (5MP); daily milk production (DMP); fortnightly milk production (FMP); lactational weight changes (LWC); and lamb average fortnightly weight gain (AFG) as affected by the stage of lactation postpartum (SLP). The lambing data were used to calculate average number of lambs born (ALB), ewe parity (PAR), average birth weight (ABW) and lamb weight born (LWB).

Five-hour milk production was measured using the following lamb weight change procedures. Once every fortnight, ewes were weighed at 7:00 and their lambs separated. The ewes were sent to pasture while the lambs were kept in a pen without water or feed. Five hours later, the lambs were weighed and put to their dams to suckle for one hour, after which they were re-weighed and their weight change recorded as the amount of milk extracted every five hours. The five-hour time interval was chosen on the basis of the evidence on lambs' suckling behaviour described by Mount (19). It was assumed that since lambs were largely dependent on milk for their nutrition, and the since feed and water were not provided overnight nor during the five hours prior to the weighing, faecal and urinary losses within one hour would not be large enough to account for a significant loss in weight.

Data Analysis and Presentation

Non-linear regression analyses were carried out to establish prediction equations for ewe live weight (ELW) using either HG or AGL. Multiple linear regression analyses were also conducted to get predictive equations for TLC, and LWC using discrete variables. The significance of each of the independent factors was determined by partial regression analysis. The other results and comparisons were presented either in the form of graphs or tables of means, with significant differences being determined by either the Least Significant Difference (LSD) or Duncan's New Multiple Range Test (MRT). All statistical procedures were as outlined by Steel and Torrie (22).

RESULTS

The curvilinear relationship between ELW and HG or AGL is confirmed by the significance ($P < 0.01$) of fitting second-degree polynomial curves (Table 1). Topline curvature was significantly related to both LWB and PAR ($R = 0.320$, $P < 0.05$) but not to PAR alone. Lactational weight changes, which were negative, were significantly related to AFG and FMP either alone or combined. Fig. 1 shows the nature of the response of LWB and ABW to ALB computed for all the parities considered. There is a proportionately larger increase in LWB than the corresponding decrease in ABW as ALB improves, until two lambs, when LWB tends to level off while ABW falls at a faster rate. The number of lambs born and LWB seem to improve with parity, while ABW shows an initial decline but also starts increasing after the third parity. Ewe liveweight increased with PAR and therefore had compounded effects on ALB, LWB and ABW with PAR (Fig. 2)

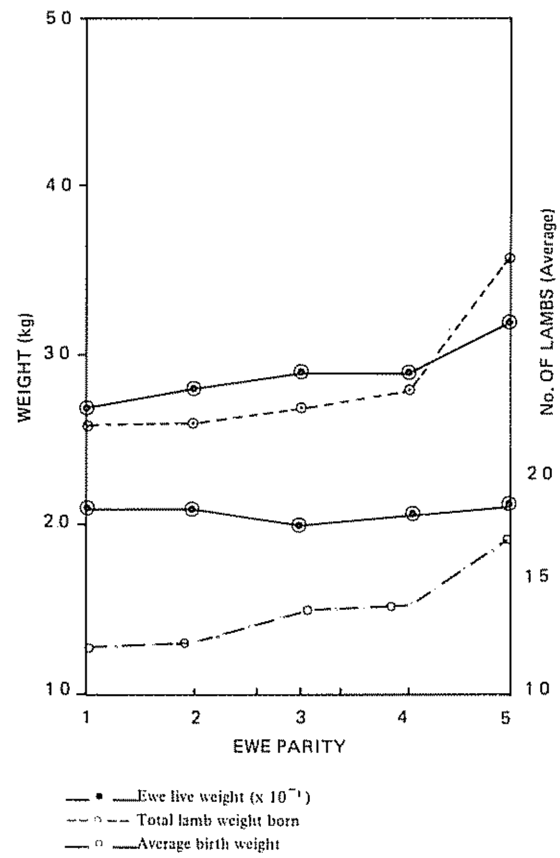

Fig. 1. Relationship between number of lambs born and lamb weights.

Table 1. Mean Squares of the ANOVA of multiple and partial regressions involving body measurements and some reproductive traits.

Regression Equation	n	X_1 and X_2	X_1	X_2	R
ELW $= 19.71 - 0.73$ HG $+ 0.11$ HG^2	137	2 970.61**	6 154.45**	213.24**	0.918**
ELW $= 18.54 + 0.45$ AGL $+ 0.002$ GL^2	137	2 826.67**	5 520.56**	132.78**	0.895**
TLC $= 2.40 + 2.794$ PAR $+ 2.191$ LWB	65	256.15*	285.16NS	367.19*	0.320*
LWC $= 2.90 + 0.684$ AFG $+ 0.021$ FMP	66	29.27**	58.54**	112.03**	0.572**

* P < 0.05.
** P < 0.01.
NS P < 0.05.

Table 2. Effect of litter size and stage of lactation post-partum on five-four milk production, lactational weight changes and fortnightly weight gain of lambs.

Stage of lactation (Days)	Single	Twins	Overall
(a) 5-hour milk production (5MP)			
0–14	0.15 ± 0.11[a]	0.33 ± 0.19[b]	0.23 ± 0.17
15–28	0.24 ± 0.17[a]	0.53 ± 0.16[c]	0.32 ± 0.21
29–42	0.22 ± 0.23[a]	0.51 ± 0.14[c]	0.31 ± 0.24
(b) Lactational weight change (LWC)			
0–14	−0.76 ± 1.05[d]	−0.37 ± 0.89[d]	−0.58 ± 0.97
15–28	−1.14 ± 2.10[d]	−1.33 ± 1.94[d]	−0.89 ± 0.93
29–42	−0.37 ± 1.44[d]	−1.27 ± 1.81[d]	−0.62 ± 1.57
(c) Average Fortnightly Gain (AFG)			
0–14	1.93 ± 0.54[e]	1.25 ± 0.37[f]	1.49 ± 0.54
15–28	1.78 ± 1.07[e]	1.10 ± 0.54[f]	1.48 ± 0.93
29–42	1.34 ± 0.72[e]	0.86 ± 0.66[ef]	1.14 ± 0.73
43–98	1.41 ± 0.35[e]	1.06 ± 0.27[ef]	1.23 ± 0.31

Means with the same superscript in the same row or column show no significant difference (P > 0.05).

Table 3. Some reproductive characteristics of West African Dwarf ewes as affected by litter size.

Trait	Single[a]	Twins[b]	Overall
Ewe weight at lambing (kg)	28.36 ± 3.89	29.82 ± 5.85	28.98 ± 4.78
Lamb birth weight (kg)	2.29 ± 0.44	2.08 ± 0.27	2.19 ± 0.35
Lamb mass born/ewe (kg)	2.29 ± 0.44	4.16 ± 0.54	3.23 ± 0.49
Lamb weaning weight (kg)	13.14 ± 2.17	9.83 ± 1.22	11.97 ± 2.53
Lamb mass weaned/ewe (kg)	13.14 ± 2.17	19.66 ± 2.44	16.40 ± 2.31
Daily milk production (kg)	0.98 ± 0.17	2.19 ± 0.16	1.38 ± 0.21
Type of birth (%)	55.17	44.83	
Lamb proportion at birth (%)	37.21	62.79	
Lamb survival rates	1.00	0.70	0.81

Data used were collected from 28 ewes with 41 lambs at lambing (33 at weaning).

a, b, – mean values for singles and twins were significantly different for all traits (P < 0.05).

Table 4. Productivity indices for West African Dwarf ewes as affected by litter size.

Index (%)[a]	Single[b]	Twins[c]	Overall
Ewe Index 1	8.08	6.98	7.56
Ewe Index 2	75.08	130.82	104.19
Ewe Index 3	46.33	65.93	56.59
Ewe Index 4	106.92	154.07	131.30
FPI*	29.81	52.99	82.80

a Data in Table 3 was used to derive the indices as indicated below:

$$\text{Ewe Index 1} = \frac{\text{Lamb birth weight}}{\text{Ewe weight at lambing}} \times 100$$

$$\text{Ewe Index 2} = \frac{\text{Lamb weight born per ewe}}{\text{Expected weight}} \times 100$$

$$\text{Ewe Index 3} = \frac{\text{Lamb weight weaned}}{\text{Ewe weight at lambing}} \times 100$$

$$\text{Ewe Index 4} = \frac{\text{Lamb weight weaned}}{\text{Ewe metabolic body weight}} \times 100$$

Flock Productivity Index (FPI) =

$$\frac{\left(\begin{matrix}\text{Singles}\\\text{born}\end{matrix} \times \begin{matrix}\text{Survival}\\\text{rate}\end{matrix} \times \begin{matrix}\text{Weight}\\\text{weaned}\end{matrix}\right) + \left(\begin{matrix}\text{Twins}\\\text{born}\end{matrix} \times \begin{matrix}\text{Survival}\\\text{rate}\end{matrix} \times \begin{matrix}\text{Weight}\\\text{weaned}\end{matrix}\right)}{\text{Total lambs born} \times \text{Overall weaning weight}}$$

b, c – mean values for singles and twins were significantly ($P < 0.01$) different.

* Figures give the proportionate contribution to overall flock productivity index of twin and single lambs.

Ewes that nursed twins (Table 2a) produced significantly ($P < 0.05$) more milk than those nursing single lambs. Lactational weight changes by the ewes (Table 2b) were not significantly ($P < 0.05$) affected by either the stage of lactation up to 6 weeks or the number of lambs nursed. Single lambs grew significantly faster ($P < 0.05$) than twins in the first four weeks, but not ($P < 0.05$) thereafter (Table 2c). Stage of lactation did not significantly ($P < 0.05$) affect fortnightly gain in either singles or twins. Single lambs had significantly ($P < 0.05$) higher birth weights, weaning weights and survival rates than twins (Table 3). Ewes that gave birth to twins were significantly ($P < 0.05$) heavier than those that gave birth to singles and were also superior in terms of lamb weight born and weaned as well as in daily milk production. Multiple births, although they accounted for a smaller proportion of the total births, contributed a significantly ($P < 0.05$) higher proportion to the total lamb population at birth and also at weaning, despite the lower survival rates of twins. The productivity indices shown in Table 4 further indicate the superiority of the more prolific ewes when evaluated individually or on basis of their proportionate contribution to flock productivity.

DISCUSSION

The high correlation between HG and ELW ($R = 0.918$) is in agreement with reports on the same breed of sheep, locally known as Djallonke, in Senegal (10). They noted that heart girth is widely recognised as the most satisfactory single linear measurement for estimating live weight in livestock. As expected, AGL followed the same trend as HG in relation to ELW, but with a wider variation attributable to the effects of gut fill and uterine contents during pregnancy. The use of physical measurements in predicting liveweight is well discussed by Kandasamy and Gupta (12) and in selection by Tizika *et al.* (26).

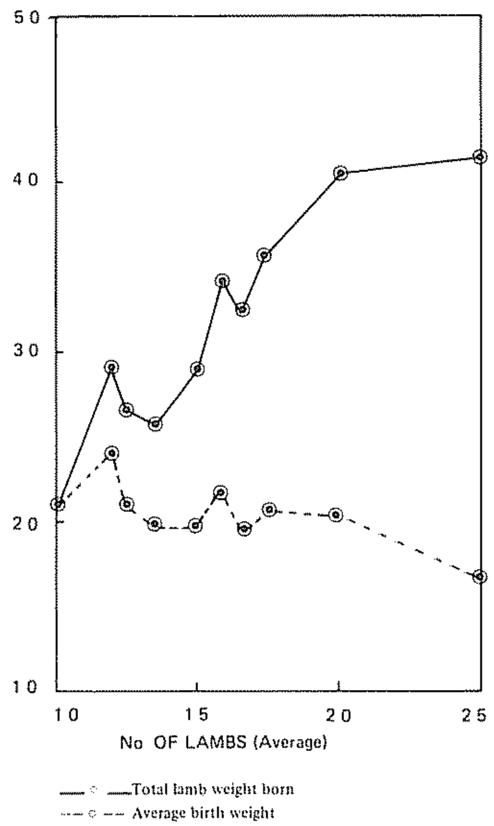

Fig. 2. Relationship between parity, number of lambs born and ewe and lamb weights.

Abdominal girthline depends not only on animal size but also on size and content of the gut and uterus. It is possible that where these form a significantly high proportion of the ELW, they may generate a pull on the backline and cause it to curve in. This is suggested by the relationship between TLC, LWB and PAR. Land (15) noted that the production of more lambs per ewe per year may cause higher ewe depreciation. Changes in TLC with parity and relative to LWB may indicate such depreciation. ILCA (11) noted that up to 40% of ewe live weight might be lambs and placenta when near to term; hence the consequences of the stress on the ewe need to be considered and minimised in managing prolitic breeds of sheep. However, given the low significance ($P < 0.05$) of the correlation coefficient from the analysis involving TLC, LWB and PAR and the non-significance ($P < 0.05$) of the partial regression between TLC and PAR, it would appear that the average WAD ewe possesses a size and carries a weight (conceptus and feed) that enables it to maintain its shape and conformation. This suggests a high level of evolutionary adaptation as earlier reviewed (28). It has favoured the development of small-sized animals, possible with limited uterine capacity, in itself a serious limitation to the number and birth weight of lambs. This size limitation is apparently a common feature of most tropical livestock (5, 6 23).

The increases in ALB and LWB with PAR are consistent with the observation that higher parity animals are frequently heavier and thus bound to have higher reproductive efficiencies and productivity. A linear relationship exists between the log of total weight of newborn young and log of maternal weight (8, 17). The weight of the young carried (N, in grams) can be predicted from the mother's weight (M, in grams) by the formula, $N = 0.5408M^{0.8323}$ (17). Individual birth weight, for its part (14), as a proportion, is independent of maternal weight, varying around an average of 5% (range 3 – 10%). With lower maternal weights, once 5% of the maternal weight is greater than $0.54M^{0.83}$, multiple births may be favoured.

The experimental evidence presented in Table 4 clearly indicates that the average WAD ewe is producing at expected levels. Indices 1 and 2, for example, suggest that the WAD ewe has adequate uterine capacity for the production of one lamb only and that those that give birth to twins exceed the expected by 30%. Increasing the number of fetuses beyond two (which also already exceeds average ewe capacity), or birth weight beyond the calculated N value of 3.02 ± 0.41 kg, may prove disadvantageous because of increased lamb mortality. According to Land (14), mortality tends to increase when individual birth weight exceeds 10% of the maternal weight due to difficulties at parturition (dystocia) and when it is below 3% due to neonatal morbidity. Birth weight is therefore restricted by the ability of the fetus of grow fast enough to be above 3% and sufficiently slowly for it to be less than around 10% of maternal weight. The values were 8.08% for singles and 6.98% for twins in the experimental ewes (Table 4), both of which are well above the 5% average.

As in the present study, other investigators have agreed that maximum daily milk production in ewes is attained during the first month of lactation, especially 15 – 20 days post-partum (1, 7, 13). Yield was significantly affected by type of birth and/or number of lambs reared. Similar results were obtained with other breeds (2, 4, 7, 13). The increase in milk production has been attributed to higher oxytocin levels resulting from greater udder stimulus in multiple-suckled ewes. The greater udder stimulus may also ensure increased prolactin production to maintain mammary gland integrity, since it was noted (18, 20) that a wave of cell division occurs in mammary gland tissue towards the end of gestation and into the early stages of lactation.

These would explain why significantly ($P < 0.05$) more milk was produced in the later stages of lactation than in the first two weeks (which could be taken as a period of adjustment) with ewes that produced and nursed twins. Further, since natural selection would favour the birth of more lambs by heavier animals (3, 8), it is possible that animals that gave birth to twins either were in a better condition or also had the potential to produce more milk. Ehoche and Buvanendran (9) noted that in Red Sokoto goats, does which produced twins were heavier (23.7 ± 0.51 vs. 20.8 ± 0.71 kg) and produced 20% more milk than those that produced singles. They held the opinion that body weight may influence milk yield more significantly than the number of kids nursed.

Increase in milk production is known to enhance lamb growth (13) and it is therefore not suprising to note that growth rate was not significantly different between singles and twins from 29 to 98 days, given the greater increase in milk production by ewes suckling twin lambs. As suggested for goats (9), the slower growth rate of twins may be attributed to the weight disadvantage they had at birth and diminished nutritional supply **in utero**. Milk production and actual weaning mass (16, 29) provide conclusive proof with regard to animal efficiency. The WAD ewe therefore appears to be an efficient producer and could be more so if it were selected for twinning ability and higher milk yield, either directly or indirectly by selecting heavier and larger animals.

Lactational weight loss was significantly ($P < 0.01$) related to FMP and AFG. However, the two factors accounted for 32.7% of the observed weight loss (Table 1), indicating that other factors (not considered in this study) affected the LWC more strongly. Orji and Steinbach (21) reported that WAD ewes lost about 0.13 kg of their weight per week, with greater losses noted within the first seven weeks of lactation. In the present study, the ewes lost weight at a rate of 0.18 kg per week during the first six weeks of lactation.

In conclusion, it is clearly understood that body size is correlated with live body weight and productivity of ewes. Excessive weight load in the abdominal cavity may significantly reduce lifetime productivity (longevity) through greater ewe depreciation, as shown by the effect of the load on topline curvature (24, 25, 27). The improvement of the West African Dwarf sheep could be achieved not through overburdening the resource of the individual animals, but rather through the selection of those that show superior performance, especially with regard to twinning and suckling ability.

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