ESTIMATE OF GENETIC AND PHENOTYPIC PARAMETERS FOR LITTER SIZE AND WEANING WEIGHT IN YANKASA SHEEP.

M.E. OLAYEMI; O.A. OSINOWO¹; N. I. DIM² AND L.O. EDUVIE

National Animal Production Research Institute, Ahmadu Bello University P.M.B. 1096, Shika,

Received 3 February, 1996, Accepted 5 May, 1997

ABSTRACT

Data on 964 and 1150 weaning weight and litter size records respectively, collected over a 10-year period on Yankasa Sheep breeding project at the National Animal Production Research Institute (N.A.P.R.I.), Zaria, were used in this study. The analysis was for estimation of genetic and phenotypic parameters for litter size and weaning weight in Yankasa sheep. Estimates of heritability for litter size and weaning weight were obtained from paternal half sib intraclass correlation. The genetic and phenotypic relationship between the litter size and weaning weight were estimated from the covariance and variance components of the two traits. Least squares means of 1.18 ± 0.02 and 10.67 ± 0.11 were obtained for litter size and weaning weight, respectively. Heritability (h^2) estimates of 0.18 ± 0.07 and 0.63 ± 0.01 were obtained, respectively, for litter size and weaning weight. Genetic and phenotypic correlations of -0.83 ± 0.052 and 0.23 ± 0.094 respectively, were obtained, between weaning weight and litter size.

Key words: Genetic, Phenotypic, correlations, litter size, weaning weight heritability

INTRODUCTION

The genetic improvement of a trait is, to a very large extent, dependent on its heritability and genetic correlations with other traits of economic importance, which selection pressure may be applied. Thus, for efficient planning of breeding programmes and prediction of response to selection there is a need to obtain estimates of heritabilities on traits of interest. Also, genetic and phenotypic

correlations are essential in predicting indirect responses to selection and for determining the optimum weighting and expected response to selection in a multiple trait selection programme (Falconer, 1989; Inyagala, *et al* 1992).

Estimates of genetic and phenotypic parameters in sheep for litter size and weaning weight have been extensively reported. Reported estimates vary, depending on breed type and procedure of estimation, Balogun *et al.* (1993) reported a least squares mean of 1.22 ± 0.010 for litter size in Yankasa sheep, while Adu *et al.* (1985) reported a value of 1.17 for Balami sheep. From paternal halfsib analysis, Osinowo *et al.* (1993) reported heritability estimated of 0.11 and 0.66 for litter size and weaning weight respectively. In Galway ewes heritability estimates of 0.18 and 0.25 were reported for litter size and weaning weight respectively (O'Ferral, 1976). from daughter-dam regression analysis an heritability estimates of 0.06 was reported for litter size (Eikje, 1975). From Bradford's (1972) review of several other works, he concluded that heritability estimate for litter size was quite low and probably not higher than 0.15. But, Turner (1969) reported that estimates of heritability for litter size was ranged between 0.04 and 0.40. The reports of a 2-way selection for weaning weight in Merino sheep showed that a positive correlation existed between the selection criterion and multiple birth (Patire, 1965). A genetic correlation of 0.44 ± 0.11 between adult body weight and lambs born per ewe lambing was reported by Purser (1965), while Atkins (1986) reported a higher figure of 0.66 ± 0.18 for the same trait.

The aim of this study, therefore, was to estimate heritabilities for litter size and weaning weight, and the genetic and phenotypic correlations between these traits in

¹ Present Address: College of Animal Science and Livestock Production, University of Agriculture, Abeokuta, Nigeria

² Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria.

Yankasa sheep. This is with a view to evaluating if direct selection for one of the traits will influence the other.

MATERIALS AND METHODS

The data used consisted of 964 and 1150 records of weaning weight and lambing, respectively, in a flock of Yankasa sheep. The data were collected over 10 years from the Yankasa sheep flock of National Animal Production Research Institute (N.A.P.R.I.). Ahmadu Bello University, Zaria.

The animals were reared under semi-intensive system of management. Grazing on improved pastures of *Andropogon gayanus*, *Panicum maximum*, *Hyparrhenia rufa*, *Digitaria smutsii* and *Stylosanthes spp* and *Bracharia decumbens* was the practice, this occurred between 09.00 and 18.00 hours daily. Prior to grazing, the animals were supplemented with concentrate ration consisting of about 15-17% CP, at 300g/head/day. During the dry season the animals were fed the above forage hays at 1-2% of body weight in addition to grazing and supplementation. Water and mineral salt licks were provided *ad libitum*. Animals were routinely controlled for ecto- and endo-parasites.

Litter size was defined as the number of lambs born per parturition and weaning weight was taken to be the 90-day age adjusted weight. Adjustments for fixed effects on litter size and weaning weight were achieved by including them in the model. Estimates of h^2 for litter size and weaning weight, and genetic and phenotypic correlations between these traits were obtained, using Harvey (1990). In the mixed model least square and maximum likelihood computer programme.

The statistical models used to relate weaning weight and litter size with independent variables were as follows.

$$Y_{ijklm} = U + a_i + S_j + Y_k + P_1 + e_{ijklmn} \text{ and}$$

$$W_{ijklmno} = U + a_i + S_j + Y_k + P_1 + X_m + L_n + e_{ijklmno}$$

where, Y_{ijklmn} = single observation on litter size

$W_{ijklmno}$ = single observation on weaning weight

U = overall mean for the trait of interest

a_i = effect of the i th sire ($i = 1, \dots, 92$ for weaning weight and $i = 1, \dots, 251$ for litter size) assumed random, $N(0, \text{var})$

S_j = effect of the j th season of birth ($j = 1, 2, 3, 4$)

Y_k = effect of the k th year of birth ($k = 1, \dots, 10$)

P_1 = effect of the 1st parity ($1 = 1, \dots, 6$)

X_m = effect of the m th sex ($m = \text{male, female}$)

L_n = effect of the n th litter size ($1, 2$)

e_{ijklmn} = random error associated with a single litter size, assumed $N(0, \text{var})$

e_{ijklmn} = random error associated with a single weaning weight, assumed $N(0, \text{var})$

Heritabilities were estimated from paternal half-sib intrasire correlation analysis using estimated variance components between and within sires as follows:

$$h^2 = (4 \cdot \text{var}_s) / (\text{Var}_s + \text{var}_w)$$

Where h^2 = heritability estimate

Var_s = sire variance component

Var_w = variance of records within sires

The genetic and phenotypic correlations were estimated from the variance and covariance components between the traits under study, using the following formulae:

$$r_G = (\text{Cov}_s(xy)) / \sqrt{\text{Var}_s(x) \text{Var}_s(y)}$$

$$r_P = (\text{Cov}_w(xy) + \text{Cov}_s(xy)) / \sqrt{(\text{Var}_w(x) + \text{Var}_s(x)) (\text{Var}_w(y) + \text{Var}_s(y))}$$

Where,

r_G = Genetic correlation

r_P = phenotypic correlation

Cov_s = estimated sire covariance component

cov_w = error covariance component

X = litter size

Y = weaning weight

RESULTS AND DISCUSSION

The analysis of variance and heritability estimates for weaning weight and litter size are shown on Tables 1 and 2, respectively.

TABLE 1. ANALYSIS OF VARIANCE AND HERITABILITY ESTIMATE FOR WEANING WEIGHT

Sources of variation	DF	SS	MS	Var. Components
Between sires	92	1698.16	18.46	1.26
Residual	871	5863.48	6.73	6.73
Heritability	$= (4\sigma_s^2)/(\sigma_s^2 + \sigma_w^2)$ $= (4 * 1.26)/(1.26 + 6.73)$ $= 0.63$			

TABLE 2. ANALYSIS OF VARIANCE AND HERITABILITY ESTIMATE FOR LITTER SIZE

Sources of variation	DF	SS	MS	Var. Components
Between sires	251	161.61	0.64	0.01
Residual	898	195.14	0.22	0.22
Heritability	$= (4\sigma_s^2)/(\sigma_s^2 + \sigma_w^2)$ $= (4 * 0.01)/(0.01 + 0.22)$ $= 0.18$			

Hertability estimates of 0.18 ± 0.07 and 0.63 ± 0.01 were obtained for litter size and weaning weight, respectively.

This estimated h^2 of 0.18 for litter size was of same magnitude with that reported by Shrestha and Heaney(1990) and O'Ferral (1976) for the same trait. Heritability of similar magnitude was reported for both the flock of Chun forest adult ewes (Forrest and Bichard, 1974) and Australian Merinos (Atkins, 1990). It is, however, lower than 0.21 obtained for American Rambouillet and crossbred ewes of mixed ages (Vakil *et al.*, 1968), but within the range of 0.10 and 0.23 (Baker and Stein, 1986). The h^2 estimate of 0.63 ± 0.01 for weight at weaning was in close agreement with an estimate of 0.66 (Osinowo *et al.* 1993), but was higher than the estimates of 0.30 for 2-year old Galway ewes (O'Ferral, 1976) and 0.18 for Dorper sheep (Inyagala, 1992).

The high magnitude of heritability estimated for weaning weight and the possibility of measuring it in both sexes before sexual maturity makes individual (mass) selection to be the method of choice for selecting for this trait. The higher the heritability the greater the potential for mass selection (Willis, 1991). The expected genetic gain for weaning weight will be high, because, it is expected that maximum gian will result

when the heritability and selection differential are high and generation interval is low. For litter size, with a low magnitude of heritability, a low genetic of the phenotypic variance.

Estimates of Y_G and Y_p between litter size and weaning weight are -0.083 ± 0.052 and 0.23 ± 0.094 , respectively. Litter size and weaning weight were negatively and lowly genetically correlated ($Y_G = -0.083 \pm 0.052$) and was not statistically significant ($P > 0.001$). This Y_G suggest that the two traits might be genetically independent. The phenotypic correlation ($r_p = 0.23 \pm 0.094$) was positive and significant ($P > 0.001$), which probably indicates that the weaning weight decreases with increase in litter size.

The estimated Y_G between weaning weight and litter size in this study is in agreement with the Y_G of -0.11 for Norwegian sheep (Baker and Stein, 1986). Also reported were r_G of -0.02 and Y_p of 0.13 (Young *et al.*, 1985). Similarly, Dzakuma *et al.* (1978) reported estimates of Y_G and Y_p of -0.06 and 0.21, respectively, which agree with the estimated correlations in this study. The observed negative and low genetic correlation suggests that most of the genes influencing litter size and weanning weight are different (Swigger, 1961). While the positive and significant phenotypic correlation between the traits

shows that an increase in litter size will be phenotypically associated with a reduction in weight at weaning

It can be concluded that improvement in litter size or weaning weight cannot be pursued through indirect selection for either of the traits, in view of the results of this and other studies which indicate independence of the genes governing the two characters. Also, due to the high magnitude of heritability estimate for weaning weight mass selection method should be practised, while, for litter size with a very low magnitude of heritability half-sibling selection will be the most appropriate method of selection

ACKNOWLEDGEMENT

The authors wish to express their sincere appreciation to the field and technical staff of the Small Ruminant Research Programme and the Director of N.A.P.R.I. for approving the publication of this work.

REFERENCES

- ADU, I.F.; TAIWO, B.B.A. AND BUVANENDRAN, V. (1985). Reproductive and lamb growth performance of Balami and Dorset Sudanese sheep in the sahelo-sudan savana zone of Nigeria. *Journal of Animal Production Research* 5(1): 67-76.
- ATKINS, K.D. (1965). A genetic analysis of the components of live time productivity in Scottish Blackface sheep. *Animal Production*. 43: 405 - 419.
- ATKINS, K.D. (1990). Incorporating parameters for life time productivity into breeding objectives for sheep. 4th World Congress on Genetics Applied to Livestock Production. pp. 17-25.
- BAKER, R.L. AND STEIN, T.A. Components of genetic variation for litter size and lamb survival in sheep. 3rd World Congress Genetics Applied to Livestock Production. pp.XI: 84-89
- BALOGUN, R.O. OLAYEMI, M.E. AND OSINOWO, O.A. (1993). Environmental factors affecting weaning weight and litter size in Yankasa sheep. *Nigerian Journal of Animal Production*.
- BRADFORD, G.E. (1972). Genetic control of litter size in sheep. *Journal of Reproductive Fertility* (supplement) 15: 23-41
- DZAKUMA, J.M.; NEILSEN, M.K. AND DOANE, T.H. (1978). Genetic and phenotypic parameters for growth and wool traits in Hampshire sheep. *Journal of Animal Science* 47(5): 1014-1021.
- EIKJE, E.D. (1975). Studies of Sheep production records, VII Genetic, phenotypic and environmental parameters for production traits of ewes. *Acta. Agric. Scand.* 242-252.
- FALCONER, D.S. (1989). Introduction to quantitative genetics. 3rd edition. Longman, London and New York. 438pp.
- FORREST, P.A. and BICHARD M. (1974). Analysis of production records from a lowland sheep flock. *Animal Production* 19: 33-45.
- HARVEY, R.W. (1990). Mixed model Least Squares and maximum Likelihood Computer Programme. PL2. Ohio State University.
- INYAGALA, B.A.O.; Rege, J.E.O. AND ITULYA, S. (1992). Growth traits of the Dorper sheep. II. Genetic and phenotypic parameters. Small ruminant research and development in Africa. In Proceedings of the first Biennial Conference of the African Small Ruminant Research Network. IRAD, Nairobi. Kenya, 10-14 December, 1990, ILCA. (eds) S.H.B. Lebbie. and L. Reynolds pp 517-525
- O'FERRAL, G.J.M. (1976). Phenotypic and genetic parameters of productivity in Galway ewes. *Animal Production* on 23:295-304.
- OSINOWO, O.A.; ABUKAKAR, B.Y. AND TRIMNELL, A.R. (1993). Genetic and phenotypic relationships between gestation length, litter size and litter birth weight in Yankasa sheep. *Animal Reproduction Science*, 34: 111-118.
- PATTE, W.A. (1965). Selection for weaning weight in Merino sheep. I Divergent response to selection. *Australian Journal of Experimental Agriculture and Animal Husbandry* 5:353.
- PURSER, A.F. (1965). Repeatability and heritability in hill sheep. *Animal Production* 7:75-82.
- SHRESTHA, J.N.B. AND HEANEY, D.P. (1990). Genetic basis of variation in reproductive performance. 2. Genetic correlation between gestation length and prolificacy in sheep. *Animal Reproduction Science* 23: 305-317.
- SWIGGER, L.A. (1961). Genetic and environmental influences on gain of beef cattle during various periods of life. *Journal of Animal Science* 20:185-189
- TURNER, H.N. (1969). Genetic improvement of reproductive rate in sheep. *Animal Breeding Abstract* 37: 547-563.
- VAKIL, D.V.; BOTKIN, M.P. AND ROEHRKASSE, G.P. (1968). Influence of hereditary and environmental factors on twinning in sheep. *Journal of Heridity* 52. 253-259.
- WILLIS, M.B. (1991). Dalson's Introduction to practical animal breeding. 3rd edition, Blackwell Scientific Publications, London. pp. 61-74.
- YOUNG, I.D.; DICKERSON, G.E. AND FORGARTH N.M. (1985). Evaluation and utilization of Finn sheep In Genetics of Reproduction in sheep. (Eds) R.B. Lanc and D.W Robinson, Butterworths, London.