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PRELIMINARY RESULTS ON THE INHERITANCE OF EARLY LAMB GROWTH AS AN INDICATOR FOR MILK PRODUCTION IN MERINO SHEEP?

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SUMMARY

The inheritance of early growth rate of the litter from birth to 30 days of age was investigated as an indirect trait for milk production of the dam in a medium type Merino flock in a production system where ewes were mated over a 35 day period. Body weight at marking was used to calculate a standardised cumulative weight gain for each litter to an average age of 30 days. The standardised 30 day weight gain had a low heritability (0.17 ± 0.04). It was also genetically positively correlated with hogget body weight (r_g = 0.38 ± 0.09). The genetic correlations of 30 day weight gain with clean fleece weight, fibre diameter and staple strength at hogget age, did not differ significantly from zero. It was suggested that the heritability may be higher in a production system where artificial insemination is generally used, as lamb age would be less variable in such a system. These results indicate that it should be possible to develop an indirect breeding value for milk production in Merino sheep.

INTRODUCTION

Milk production is crucial for lamb survival and early lamb growth. Four different measurement techniques have been developed to measure milk production, i.e. (i) use of exogenous oxytocin and directly milking the ewe, (ii) weighing the lamb before and after suckling, (iii) measuring water turnover rate using tritiated water, and (iv) using lamb weight gain as an indirect estimate of milk yield (Geenty 2010). However, it is difficult and expensive to measure milk production using methods (i) to (iii) on individual sheep. Afolayan *et al.* (2009) measured milk production in crossbred meat sire x Merino ewes and estimated the genetic correlations between milk production and average lamb weaning weight in the litter and reported a genetic correlation of 0.44. Geenty (1979) found that the phenotypic correlation between milk production of the dam and the early growth rate of their lambs varies between 0.22 to 0.76 in different meat breeds and their crosses. This implies that early growth rate of the lamb(s) may qualify as a potential indicator trait of milk production for the dam. However, very little information is available on early weight gain prior to the lamb starting to consume solids and this could be affected by age of the dam, litter size, sex of the lambs, and age of the lamb(s) when first weighing occurs at marking. Snyman *et al.* (2016) published genetic parameters of milk production using the oxytocin method where milk production was measured at 3 and 12 weeks of lactation. They found high genetic correlations between milk production and the maternal effect of early body weight. Thus early growth rate of the lamb can be used as an indicator of milk production in the dam. This study investigates the inheritance of early growth rate up to 30 days of age of the lamb as a trait of the dam, and its genetic relationship with body weight, wool production and fibre traits of the dam at hogget age.

MATERIAL AND METHODS

The Australian Wool Innovation Breech strike flock of the Department of Agriculture and Food Western Australia was used in this study (Greeff *et al*. 2014). Ewes were naturally mated in single sire groups over a 35 day period. Maternal pedigree, birth weight, litter size, birth date and sex of the lambs were recorded at birth during July/August. Marking weight was recorded at an average

age of 30 days of age on 1954 lambs that were born in 2014, 2015 and 2016 from 954 dams mated to 143 sires. Weight gain from birth to marking for the litter was standardised by calculating the daily rate of gain from birth to first weighing and predicting the total litter weight at 30 days of age.

Wool production and fibre traits produced over a 12 month growth period and the body weights were recorded on the dams and their contemporaries at approximately 18 months of age. This dataset consisted of 7956 sheep that were the progeny of 194 sires mated to 3120 dams that were between 2 and 8 years of age. All flystrike information was available on each sheep.

STATISTICAL ANALYSIS

ASREML (Gilmour *et al.* 2009) was used to analyse the data. A univariate analysis was carried out to obtain estimates of the heritability of weight gain of the litter up to 30 days of age as a trait of the dam. A repeatability model was fitted to the data with dam as random genetic effect, and also fitting dam as a permanent maternal environmental effect. An animal model was fitted for wool yield and the fibre traits and body weight at hogget age (see Table 1). Year of birth (2014-2016), age of the dam (2-8 years), and year of observation were fitted as fixed effects for the 30 day weight gain trait. For the wool, fibre and body weight traits at hogget age, year of birth (2006 to 2014), birth status (single or multiple), sex (male or female), and whether the animal was struck by blowflies were fitted as fixed effects. Sex was confounded with management group as males and females were managed in separate groups. All two way interactions were initially fitted for both models. Statistically non-significant factors (P>0.05) were dropped from the final model. This was followed by a bivariate analysis to obtain genetic covariances to estimate the genetic correlations between 30-day-weight gain as a trait of the dam and her production traits at hogget age

RESULTS AND DISCUSSION

Table 1 shows that the average and standard deviation for the different traits in this study. The averages of the wool and fibre traits in this Merino flock shows that this flock is representative of a typical medium wool type in Western Australia (Greeff and Cox 2006). The weight gained from birth to 30 days of age was on average 10.5kg. Year of birth of the ewe, year of measurement, age of the ewe were significant (P<0.01) environmental effects of 30 day weight gain.

Table 1. Number of records, raw means and standard deviation (SD) of the different traits

Trait	Abbreviation	n	Mean	SD
30 day weight gain (kg)	30d_WT	1954	10.5	3.85
Greasy fleece weight (kg)	GFW	7965	3.87	0.83
Yield (%)	Yld	7956	70.9	4.23
Clean fleece weight (kg)	CFW	7965	2.74	0.61
Fibre diameter (micron)	FD	7965	19.2	1.59
Coefficient of variation of Fibre diameter (%)	FDCV	7956	20.5	2.42
Fibre curvature (deg)	CUR	7965	93.7	11.1
Standard deviation of CUR	SDCUR	7965	55.7	6.08
Staple strength (N/Ktex)	SS	7953	26.0	10.83
Hogget body weight (kg)	HWT	7952	47.9	17.0

Significant effects (P<0.05) of fixed effects were observed on various traits, as follows:

Year of birth of the ewe: GFW, CUR, FD, FDCV, SS, YLD and HWT.

Age of the dam: GFW, CFW and FD.
Sex of the lamb: GFW, FDCV, SS, Yld, FD and HWT.
Birth status: GFW and CFW.
Flystrike: GFW, CFW and HWT.
A year of birth by sex interaction was also significant for GFW, CUR, FDCV, SS, CFW, GFW, YLD, FD and HWT.

Table 2 shows that the heritability estimates found in this study for body weight and the wool traits at hogget age are very similar to that which has been widely reported in the literature (Safari *et al.* 2005).

A low heritability of 0.17 (± 0.04) was found for weight gain to 30 days of age as a trait of the dam. The permanent maternal environmental component effect explained an additional 8.4% (± 4.9) of the phenotypic variation in 30-day weight gain.

Standardised 30-day weight gain was also genetically positively correlated (0.38 ± 0.09) with the dam's body weight at hogget age. For the wool traits, fibre curvature and clean yield had a small but significant positive (0.18 ± 0.09) and negative genetic correlation (-0.18 ± 0.09) with 30-day weight gain, respectively. None of the other wool production traits (clean fleece weight, fibre diameter and staple strength) showed a significant relationship with 30-day body weight.

Table 2. The phenotypic variation (Vp), heritability (h^2) of 30 day weight gain of the litter as a trait of the dam and her production traits at hogget age, and the genetic correlations (r_g) between 30 day weight gain of the litter and the production traits at hogget age.

Trait	Vp	h^2	SE	r_g (30 day weight gain and trait)	SE
30 day weight gain	13.7	0.17	0.04		
GFW	0.40	0.46	0.02	0.23	0.09
CFW (kg)	0.22	0.47	0.02	0.15	0.09
YLD (%)	15.1	0.64	0.02	-0.18	0.08
FD (micron)	2.02	0.62	0.02	0.06	0.08
FDCV (%)	5.47	0.38	0.02	0.03	0.09
CUR (deg)	112	0.65	0.02	0.18	0.08
CURVSD (deg)	33	0.63	0.02	0.10	0.08
SS (N/Ktex)	67	0.52	0.02	-0.17	0.10
HWT (kg)	118	0.42	0.02	0.38	0.09

CONCLUSIONS

Standardised 30-day weight gain was lowly heritable (0.17 ± 0.04) in a naturally mating Merino flock. However, it is not surprising that the heritability estimate is relatively low, considering the large variation that exists in lamb age at marking due to the long lambing period. Furthermore, ewes with singletons and ewes with lambs younger than 30 days of age would not be adequately challenged to express their full milk production potential. Thus, as expected this estimate is lower than that of directly measured milk production of 0.32 (Barillet and Boichard 1987) in Lacaune sheep. Snyman *et al.* (2016) reported that the heritability of milk production using the oxytocin method was 0.02 (Grootfontein Merino), 0.21 (Afrino), 0.10 (Cradock Merino) and 0.29 (Elsenburg Merino) in four different flocks. They also found relatively high genetic correlations (Afrino, 0.76; Elsenburg Merino – not reported; Cradock Merino 0.83; Grootfontein Merino 0.62) between directly measured milk production and early growth rate up to 42 days of age in the four flocks. The heritability of this study agree well with the results of Snyman *et al.* (2016) which indicates that there may be opportunities to improve milk production indirectly by selecting on early growth rate.

No unfavourable genetic relationships were found between early weight gain and any of the wool production traits. Further research is necessary to estimate the heritability of the trait especially in a flock that predominantly uses artificial insemination, where the age of the lambs at marking is less variable than in a naturally mated flock. Various options should be evaluated to identify an optimum age when lambs should be weighed to obtain a more accurate indirect measurement of milk production as older and bigger lambs will challenge the dam more to obtain a better indication of her milk production potential. It may offer opportunities to select indirectly for milk production in sheep.

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