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GENETIC PARAMETERS ASSOCIATED WITH ADULT EWE LIVEWEIGHT AND BODY CONDITION

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SUMMARY

Adult liveweight (LW) and body condition score (BCS) are poorly recorded traits in ram breeding flocks. Despite this, ewe LW as an indirect measurement of dam feed intake is included as a cost in models of the efficiency of a breeding ewe flock. In the absence of better information, liveweight is usually predicted from weights taken early in the animal's life well before maximum weight is reached. Body condition is usually not accounted for.

Expression of both traits occurs when ewes have already entered the breeding flock. In order to improve prediction of breeding values and to incorporate these into indexes, it is necessary to have accurate phenotype and genetic parameter data measured in mature animals.

Adult LW and BCS were measured, in intensively recorded flocks in New Zealand, at four different times during the production year (mating, scanning, pre-lambing and weaning). Preliminary results indicate that adult LW was highly heritable (0.57 – 0.66) with a repeatability of 0.66 - 0.70. BCS had a heritability of 0.21 - 0.30 with a repeatability of 0.27 – 0.41. Genetic correlations between LW and BCS were between 0.58 and 0.75, while phenotypic correlations were between 0.53 and 0.65. Both the genetic and phenotypic correlation rankings remained constant at each measurement.

By recording adult LW and BCS and using this information appropriately in selection indexes, sheep breeders may have an opportunity to improve flock efficency.

INTRODUCTION

A recent increase in converting sheep farms to dairy units has changed New Zealand's land use distribution, putting pressure on both the area and quality of land devoted to sheep, and the number of animals farmed. In light of this, the New Zealand sheep industry has targeted 'ewe efficiency' as a means of maximising productivity.

Ewe efficiency is a complex amalgam of individual component traits in the animals, and how their expression is influenced by environment and farm management decisions. Individual farmers have different opinions on efficiency, depending on their selection goals and the traits they choose to place their major emphasis on. When we asked a group of more than 100 ram breeders their perceptions of ewe efficiency, the replies identified 24 different issues as "the most important factor influencing ewe efficiency". Of these, ewe bodyweight/size ranked as the most important trait affecting efficiency, and was the 2nd highest ranked trait (after lamb survival) that breeders "would most like to influence on their property" (Shackell unpublished).

Sise *et al.* (2009) used a deterministic, financially based model to estimate the contribution of adult weight as one of eight traits in a (per ewe) efficiency equation on different farm types. Ewe mature liveweight (LW) had a negative 5-20% effect on the variation in efficiency. Heavier ewes cost more to feed, and the cost of maintaining and replacing large ewes exceeded their additional cull value at slaughter. The perception of breeders and the contribution of ewe liveweight to productivity indicate a need for a better understanding of LW.

Another potential indicator of a ewe's efficiency is body condition score (BCS). This reflects her ability to maintain herself, grow her lamb(s) and recover from pregnancy and lactation before the start of the next annual production cycle.

It is a simple matter to measure LW and BCS at the same time. However, mature LW and BCS are not routinely recorded in the NZ ram breeding industry. In selection indexes, adult liveweight is at best predicted from liveweight at 18 months of age (LW18), and at worst from weaning weight. Although the genetic correlation between adult weight and LW18 is high, the accuracy of selection indexes that incorporate LW and/or BCS could be improved by measuring these traits in mature animals.

In order to test the hypothesis that both LW and BCS are heritable and may be genetically correlated, we measured these traits on intensively recorded breeding flocks.

MATERIALS AND METHODS

Flocks. This study analysed data from 19 intensively recorded flocks on properties located throughout New Zealand, with a bias to the southern South Island. All flocks were recorded on the Sheep Improvement Limited (SIL) database. Both traditional and composite breeds were represented, and flock size ranged from 58 to 1590 animals. In 2009, LW and BCS were recorded at Mating, Scanning and Weaning in 10 intensively studied flocks. In 3 of the flocks an additional record was taken prior to lambing. Data were only recorded at Mating in the other 9 flocks

Body Condition. BCS was assesed based on the 0-5 scale described by Suiter (1994), slightly modified to include half scores. Within flock, and where possible between flocks, assessments were performed by the same operator. BCS was measured at the same time as recording of LW.

Genetic analysis model. Pedigree information and all data recorded up to weaning were obtained from SIL for the 19 flocks, for lambs born in the years 1995 – 2009. This file was used to create a dam file, with ewe traits calculated from individual lamb records. Litters which included embryo transfer, fostered or hand-reared lambs were identified and excluded for all ewe traits. Litter survival and proportion of ram lambs in the litter at birth and also surviving to weaning were derived from litter totals. Repeated lifetime ewe traits (pregnancy scan rate, number of lambs born, number of lambs weaned, plus BCS and LW at mating, pregnancy scanning, pre-lambing and weaning) were used in the analysis. The BCS and LW data were not available for every period in every flock. The final ewe lifetime file contained 147,824 records. The ewe's own weaning weight (WWT) and LW at 18 months of age (LW18) were used in multivariate ASREML runs with each of the LW traits in turn to account for selection and culling. Farm and Year were included as fixed effects to account for variation in climate and management.

Genetic parameters and genetic correlations for ewe LW, and BCS at mating (LWMate; BCSMate), scanning (LWScan; BCSScan), pre-lambing (LWLamb; BCSLamb) and weaning (LWWean; BCSWean) were calculated by ASREML. In addition, genetic correlations with LW and BCS were calculated for litter weight at birth and weaning.

RESULTS AND DISCUSSION

Liveweight. The average WWT of the ewes in the analysis was 27.2 ± 3.0 kg with a direct heritability of 0.23 ± 0.03. Adult liveweights were highly heritable (0.57-0.66) with repeatabilities of 0.66 - 0.72 (see Table 1). These data are similar to adult liveweight heritabilities reported by Clarke *et al.* (2000). Mean LW at mating was 68.5 ± 6.8 kg and increased up to lambing and then dropped back to 67.6 ± 8.0 kg at weaning. Adult LWs at mating were approximately 6kg heavier that those at 18 months of age (LW18). LWLamb was corrected for lambing date and littersize, but no corrections were made for fleeceweight to any LW measurements.

Table 1: Genetic parameters for LWs,: Heritability (h^2), and the genetic correlation (r_g) and phenotypic correlation (r_p) with LW18. The population mean, residual standard deviations (rsd) and repeatability are also shown

Trait	h^2	r_g	r_p	Mean ± rsd	repeatability
WWT	**0.23 ± 0.03**			27.2 ± 3.0	-
LW18	**0.76 ± 0.01**	0.73 ± 0.04	0.41 ± 0.01	62.1 ± 6.0	-
LWMate	**0.66 ± 0.01**	0.97 ± 0.01	0.75 ± 0.01	68.5 ± 6.8	0.66 ± 0.01
LWScan	**0.62 ± 0.02**	0.95 ± 0.01	0.71 ± 0.01	71.1 ± 6.9	0.69 ± 0.01
LWLamb	**0.64 ± 0.04**	0.91 ± 0.03	0.63 ± 0.02	79.3 ± 8.2	na
LWWean	**0.57 ± 0.02**	0.91 ± 0.01	0.63 ± 0.01	67.6 ± 8.0	0.70 ± 0.01

Currently, adult weights are usually estimated from earlier weights, sometimes as early as weaning. Rapid early growth rate is correlated with higher mature body size. Clarke *et al*. (2000), noted that restricting ewe LW greatly reduced the contribution of growth to a selection index for economic progress. Although the genetic correlation between adult weight and LW18 (a frequently used predictor trait) was high, it may be worthwhile to measure adult LW routinely to identify animals which produce well while maintaining low LW, especially in flocks where a weight prior to LW18 is used to predict adult weight. In this study, each birth year cohort did not reach maximum avaerage LW until 2½ - 3½ years of age (data not presented).

It is generally accepted that liveweight positively influences intake, which in turn is used to estimate feed cost in economic models (Sise *et al*. 2009). Young (2005), noted that while larger ewes have higher fecundity, selection indexes that incorporate number of lambs born and mature ewe LW may compensate for any loss in lambing rate that might occur by limiting body size. This would allow scope to select for efficiency by decreasing adult ewe size. To achieve this requires regular recording of adult LW.

Body Condition. Mean BCS was highest at mating (Table 2). This was expected, as it is a routine management target to have ewes at a 'optimum' condition when they are put to the ram. Mean BCS was lowest prior to lambing. At this time of year, the ewe must maintain herself and the lamb(s) that she is carrying. In the majority of flocks, BCS at weaning was better than expected. There was considerable interest in this result among the breeders, who invariably expected their ewes to have lost condition at weaning.

Table 2: Genetic parameters for BCS, Heritability (h^2) in bold; phenotypic correlations (r_p)above the diagonal and genetic correlations (r_g) below the diagonal. The population mean, residual standard deviations (rsd) and repeatability are also shown

	BCSMate	BCSScan	BCSLamb	BCSWean	Mean (rsd)	repeatability
BCSMate	**0.28** ± 0.02	0.52 ± 0.01	0.39 ± 0.01	0.37 ± 0.01	2.9 (0.6)	0.30 ± 0.01
BCSScan	0.81 ± 0.03	**0.30 ± 0.02**	0.48 ± 0.01	0.41 ± 0.01	2.8 (0.6)	0.39 ± 0.01
BCSLamb	0.84 ± 0.04	0.91 ± 0.03	**0.21 ± 0.02**	0.40 ± 0.01	2.6 (0.6)	0.27 ± 0.02
BCSWean	0.87 ± 0.03	0.76 ± 0.04	0.74 ± 0.05	**0.21 ± 0.02**	2.7 (0.7)	0.41 ± 0.01

The heritability of BCS was 0.2 - 0.3 with a repeatability of 0.27 – 0.41. These heritabilities are promising for a subjectively scored trait, and indicate that genetic gain could be made by selecting for BCS. Davis *et al*. (1983) showed that as litter size increased, the proportion of ewes carrying triplets also increased. Recently, it has been shown that triplet bearing ewes with a high BCS at weaning, have lower litter weaning weights than ewes with low to medium BCS (Mathias-Davis *et.al*. 2011). This suggests that these animals may be less efficient as they are diverting energy into themselves at a cost to their lambs.

Correlation between LW and BCS. Genetic and phenotypic correlations between LW and BCS at each of the four recording periods were also calculated (see Table 3). The genetic correlation between LW and BCS ranged from 0.58 ± 0.08 to 0.75 ± 0.03. The phenotypic correlation between LW and BCS ranged from 0.53 ± 0.02 to 0.65 ± 0.01. Both maintained their relative ranks at each recording period, and were lowest at pre-lambing and highest at weaning. In this population, adult weight at mating increased by 7.05 ± 0.16 kg per unit BCS.

Table 3: Correlations between LW and BCS

Correlation	Mating	Scanning	Lambing	Weaning
genetic	0.62 ± 0.03	0.61 ± 0.03	0.58 ± 0.08	0.75 ± 0.03
phenotypic	0.55 ± 0.01	0.54 ± 0.01	0.53 ± 0.02	0.65 ± 0.01

Mating weight and BCS in relation to weight of lambs born and weaned. We also estimated genetic correlations between LW and BCS, and weight of lambs born and weaned (data not presented). The genetic correlations between LW and BCS at mating and weight of lambs born were 0.34 ± 0.06 and 0.31 ± 0.02 respectively, confirming that heavier ewes bear and wean heavier litters. The corresponding genetic correlations with weight of lambs weaned were 0.28 ± 0.06 and -0.07 ± 0.06, confirming the observation of Mathias-Davis *et. al.* (2011) that high BCS is associated with lower litter weaning weight.

CONCLUSIONS

Selection for high lambing performance and lamb weaning weights without increasing adult ewe liveweight will lift efficiency by limiting input costs and increasinging outputs. Adding BCS as a selection trait may improve efficency even further. However, this will require the use of recorded, rather than predictive, traits. Ram breeders have an opportunity to improve efficiency by recording adult ewe LW and BCS for inclusion in appropriate selection indexes. Including LW and BCS in Whole Genome Selection indexes would provide an earlier selection pressure advantage.

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