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Effect of selection for fleece weight on liveweight, reproductive performance and wool characteristics in mixed age Romney ewes

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ABSTRACT

This paper presents the analysis of 3525 annual production records of mixed age Romney ewes in a fleece weight selected (HF) or control (RC) flock over 11 years. HF ewes were significantly ($P<0.001$) heavier than RC ewes for autumn live weight (8%), winter live weight (9%), spring live weight (7%), greasy fleece weight (20%) and clean fleece weight (19%). Small but significant ($P<0.01$) flock differences were found for fibre diameter and yellowness. HF fleeces were coarser and more yellow than RC fleeces. HF ewes were significantly ($P<0.01$) higher than RC for ovulation rate (1.80 vs 1.73 SED 0.03), number of lambs born/ewes lambed (1.63 vs 1.56 SED 0.02), and number of multiple births/ewes lambed (60% vs 54% SED 2%), but lower ($P<0.01$) for number of lambs weaned/lambs born (0.84 vs 0.88 SED 0.01). The results indicate that single trait selection for fleece weight enhances greasy and clean fleece weights, live weight and ovulation rate, with an associated increase in FD and yellowness of their fleeces.

Keywords: Romney; fleece weight; selection; ovulation rate; fibre diameter.

INTRODUCTION

Crossbred sheep dominate wool production volume and value in New Zealand. Wool weight as a selection criterion in crossbred wool has been reviewed extensively (Wickham, 1966; Wickham and Bigham, 1976; Wickham and McPherson, 1985). Although earlier studies have emphasised selection for fleece weight, quality traits are becoming increasingly important. More recently, wool characteristics, as well as production traits, have been investigated for a flock screened from industry Romney flocks and subsequently selected for high fleece weight. Hawker and Littlejohn (1986) analysed two-tooth production and wool characteristics of the screened ewes. The hogget production performance and progress in this flock and its control flock have been reported (Hawker *et al*., 1988; Wuliji *et al*., 1991; Wuliji *et al*., 1998), showing that single trait selection for fleece weight increased hogget fleece weight by 24% and hogget live weight by 8%. However, there is little information on the retention of these genetic advantages in adults, and the associated effect on reproductive and wool traits. We present live weight, reproduction performance, fleece weight and wool characteristics responses in fleece weight selected mixed-age Romney ewes for 11 production years (between 1985 and 1995).

MATERIALS AND METHODS

Animal management

The source, management and selection criteria for the flocks under study have been described previously (Wuliji *et al*., 1991; Wuliji *et al*., 1992). Selected high fleece weight (HF) and random control (RC) mixed-age ewes were managed together except during mating and lambing. Ewes were grazed on AgResearch Woodlands Research Station at an average stocking rate of 17 ewes/ha on predominantly rye grass/white clover pastures. Each year ewes were joined with rams for two oestrus cycles (35 days) in single sire groups in April and lambed in these groups in September. Ewes were shorn in early December and culling and replacements were made in the following January, when 16 month old ewes were also shorn (two-tooth shear). Routine husbandry practices, such as drenching, dipping and vaccination were carried out simultaneously for all animals in both flocks.

Recording and measurements

The data presented in this report consist of 3525 records, of which 2380 were from HF and 1145 were from RC ewes, collected between 1985 and 1995. The live weights were recorded at pre-joining in April (autumn live weight - ALW), in July (winter live weight - WLW) and in December prior to shearing (spring live weight - SLW). Greasy fleece weight (GF), yield (%), clean fleece weight (CF), fibre diameter (FD), FD coefficient of variation (FDcv), wool brightness (Y) and yellowness (Y-Z) of ewes were measured. Fleece weights of two-year-olds were adjusted to a 12-month growing period. Reproductive performance was measured as ovulation rate (OR), number of lambs born/ewes joined (LBEJ), number of lambs born/ewes lambed (LBEL), number of ewes with multiple births/ewes lambed (NEMB), number of lambs weaned/lambs born (LWLB), number of lambs weaned/ewes lambed (LWEL), and number of lambs weaned/ewes joined (LWEJ). The OR was determined by laparoscopic counting of corpora lutea in each ewe after one cycle of mating (Davis *et al*., 1987).

Statistical analysis

The data were analysed by residual maximum likelihood with ewe as a random effect and fixed effects of year, flock and age of ewe, with older ewe classes (6 and above) combined. When checking first order interactions for significance, a significant year x age interaction was found for some traits. Although this interaction could be largely accounted for by a year of birth effect, this was not included as a fixed effect, since it caused partial confounding with other effects, particularly age and year. Least squares means were calculated using subclass numbers as weights. Repeatability was calculated as the ewe variance divided by the sum of the ewe and residual variances. Correlations were calculated on data adjusted for the above fixed effects and year of birth. Unless stated, a 5% significance level is assumed.

RESULTS

Flock mean reproduction performances are shown in Table 1. The OR, LBEL and NEMB of ewes was significantly (P<0.01) higher for HF than for RC, but LWLB was significantly (P<0.01) lower. No difference was found for LBEJ, LWEL or LWEJ.

TABLE 1: Least square means of reproductive performance in HF and RC ewes

	N	OR	LBEJ	LBEL	NEMB	LWEL	LWEJ	LWLB
RC	1145	1.73	1.38	1.56	0.54	1.35	1.17	0.88
HF	2380	1.80	1.43	1.63	0.60	1.35	1.16	0.84
SED		0.03^{**}	0.03	0.02^{**}	0.02^{**}	0.03	0.03	0.01^{**}

**: P< 0.01; OR: ovulation rate; LBEJ: lambs born/ewe joined; LBEL: lambs born/ewe lambed; NEMB: number of ewes gave multiple births/ ewe lambed; LWEL: lamb weaned/ewe lambed; LWEJ: lambs weaned/ ewe joined.

Flock means of live weights, fleece weights and wool characteristics are shown in Table 2. HF was significantly (P<0.01) higher than RC for all live weights and fleece weights and for FD and yellowness.

TABLE 2: Least square means of live weights, fleece weights and wool characteristics in HF and RC ewes

	ALW (kg)	WLW (kg)	SLW (kg)	GF (kg)	CF (kg)	Yield (%)	FD (µm)	FDcv (%)	Y	Y-Z
RC	58.0	57.5	58.1	3.82	3.03	78.3	39.3	26.4	61.6	4.6
HF	62.8	62.8	62.3	4.61	3.59	78.6	40.3	25.9	61.4	5.4
SED	0.4^{***}	0.4^{***}	0.4^{***}	0.03^{***}	0.06^{***}	0.4^{ns}	0.3^{**}	0.3^{ns}	0.2^{ns}	0.2^{***}

**:P<0.01; ***:P<0.001; ALW: autumn live weight; WLW: winter live weight; SLW: spring live weight; GF: greasy fleece weight; CF: clean fleece weight; FD: fibre diameter; FDcv: FD coefficient of variation; Y: brightness; Y-Z: yellowness.

The mean reproductive performances by ewe age groups and their repeatabilities are shown in Table 3. The OR, LBEJ, LBEL and NEMB significantly increased with age up to 4 years old while LWEL, LWLB and LWEJ were significantly higher for 3 and 4 than 2 year olds. Repeatability of OR was moderate while all other reproductive measurements gave low estimates (7 to 15%).

TABLE 3: Least square means of reproductive performance measured by age groups and reapeatability.

Age	N	OR	LBEJ	LBEL	NEMB	LWEL	LWEJ	LWLB
2	1194	1.70^{a}	1.31^{a}	1.48^{a}	0.47^{a}	1.23^{a}	1.07^{a}	0.84^{ab}
3	940	1.76^{b}	1.42^{b}	1.63^{b}	0.61^{b}	1.43^{c}	1.22^{b}	0.88^{c}
4	635	1.86^{cd}	1.52^{c}	1.71^{c}	0.68^{c}	1.44^{c}	1.25^{b}	0.86^{bc}
5	415	1.91^{d}	1.54^{c}	1.70^{bc}	0.64^{bc}	1.43^{bc}	1.27^{b}	0.86^{abc}
6+	341	1.81^{bc}	1.40^{ab}	1.67^{bc}	0.63^{bc}	1.33^{b}	1.07^{a}	0.81^{a}
SED		0.04	0.04	0.04	0.03	0.04	0.05	0.02
Rep %	-	21.1	14.7	13.2	13.4	7.3	12.9	6.5
SE	-	2.1	2	1.9	1.9	1.9	2	2.1

^{abcd}: Means with different superscripts differ significantly at P<0.05; OR: ovulation rate; LBEJ: lambs born/ewe joined; LBEL: lambs born ewe lambed; NEMB: number of ewes with multiple births/ewes lambed; LWEL: lamb weaned/ewe lambed; LWEJ: lambs weaned/ewe lambed; Rep%: repeatability.

Mean live weight, fleece weight and wool characteristics of the age groups and their repeatabilities are shown in Table 4. Live weights and FD significantly increased with age up to 4 years old, but decreased from 5 to 6 year olds. GF and CF increased significantly from 2 to 3 years old, but decreased thereafter. Yield significantly decreased with age from 3 years old. FDcv was significantly higher in 2 year olds than in other age groups. Two year olds had significantly higher Y and lower Y-Z than other age groups. Repeatability of live weight, fleece weight, FD and FDcv were high (63 to 74%) while yield and colours were moderately repeatable (22 to 36%).

TABLE 4: Least square means and repeatability of live weights, fleece weights and wool characteristics measured by age groups

Age	ALW (kg)	WLW (kg)	SLW (kg)	GF^{1} (kg)	CF^{1} (kg)	Yield (%)	FD (µm)	FDcv (%)	Y	Y-Z
2	57.9^{a}	55.4^{a}	57.6^{a}	4.31^{b}	3.28^{b}	79.2^{d}	39.1^{a}	27.1^{b}	62.2^{c}	4.6^{a}
3	60.9^{b}	62.0^{b}	61.9^{b}	4.55^{d}	3.64^{d}	79.2^{d}	40.0^{b}	25.7^{a}	61.1^{ab}	5.4^{b}
4	63.9^{c}	64.9^{c}	63.3^{c}	4.43^{c}	3.54^{c}	78.3^{c}	40.7^{c}	25.4^{a}	61.4^{b}	5.2^{b}
5	65.0^{d}	65.9^{d}	63.9^{c}	4.28^{b}	3.35^{b}	77.4^{b}	40.7^{c}	25.7^{a}	61.3^{b}	5.2^{b}
6+	64.1^{c}	64.5^{c}	61.6^{b}	3.91^{a}	3.12^{a}	76.6^{a}	40.1^{b}	25.5^{a}	60.7^{a}	5.5^{b}
SED	0.3	0.3	0.3	0.03	0.04	0.4	0.2	0.2	0.2	0.2
Rep %	71.0	74.2	64.2	64.7	63.4	35.5	70.1	68.5	22.3	32.5
SE	1.2	1.2	1.5	1.5	2.8	3.6	2.3	2.4	3.6	3.6

^{abcde}: Means with different superscript differed significantly at P<0.05; ^{1}: 2 year olds had 10.5 months fleece growth which was adjusted to a 12 month period; ALW: autumn live weight; WLW: winter live weight; SLW: spring live weight; GF: greasy fleece weight; CF: clean fleece weight; FD: fibre diameter; FDcv: FD coefficient of variation; Y: brightness; Y-Z: yellowness; Rep%: repeatability.

Correlation coefficients among fleece weight and wool characteristics are shown in Table 5. Clean fleece weight was correlated significantly (P<0.001) with yield, FD, FDcv (negatively) and yellowness; yield correlated significantly (P<0.01) with FDcv, Y (both negatively) and Y-Z although the values were low; and Y and Y-Z were highly but negatively correlated.

TABLE 5: Pearson's correlation coefficients in fleece weight and wool characteristics

	GF	Yield	FD	FDcv	Y	Y-Z
CF	0.93***	0.33***	0.36***	-0.18***	-0.02	0.27***
Yield			0.05	-0.12***	-0.11***	0.09**
FD				-0.26***	0.06*	0.12***
FDcv					0.05	-0.04
Y						-0.43*

*:P<0.05; **:P<0.01; ***:P<0.001; GF: greasy fleece weight; CF: clean fleece weight; FD: fibre diameter; FDcv: FD coefficient of variation; Y: brightness; Y-Z: yellowness.

DISCUSSION

The reproduction and lambing performance differences between selected and control flocks and age groups in this study generally agree with previous investigations in Romneys (Kelly *et al.,* 1978; Baker *et al.,* 1979; Davis *et al.,* 1987; Wuliji *et al*., 1992). The higher OR in HF compared with RC can be attributed to their higher live weight (Kelly and Johnstone, 1982). This study has shown that the reproductive performances achieved in the HF breeding flock at Woodlands are comparable to or exceed those of Romney strains selected for reproductive performances or in group breeding schemes summarised by Baker *et al.,* (1987). The one reproductive trait (LWLB) where HF fared poorer than RC is not fully explained, there is a possible indication that HF ewes partition a higher proportion of their nutrition to fleece growth than milk production, compared with RC ewes. Lower survival for multiple-birth lambs would also contribute to this result.

Hight and Jury (1970) noted that age differences resulted in changes in the percentage of ewes lambing, lamb survival to weaning and particularly in the proportion of multiple births. Production traits increased from 2 to 3 years old. Thereafter fleece production dropped, despite some further increases in live weight and FD with age. Fleece production had dropped to 2 year old levels by the time ewes were 5 years old. The fleece weight changes of age show an age gradient difference that is comparable, after adjustment for the 2 year olds' wool growth periods, to a Romney flock studied earlier in Canterbury (Wright and Stevens, 1953) and on hill country farms in the North Island studying long wool breeds such as Coopworth, Perendale, Cheviot and Romney cross (Bigham *et al.,* 1978).

Liveweights and fleece weights analysed in these flocks are similar to previous studies in crossbreds (Wright and Stevens, 1953; Bigham *et al.*, 1978). Although the difference was small (1.0µm), FD was significantly coarser for HF than RC ewes, which is consistent with the analysis of hogget data from these flocks (Wuliji *et al.*, 1998). The relative magnitudes of differences between HF and RC for GF, CF and FD are very similar to those reported for hoggets by Wuliji *et al.,* (1998) indicating that the selection advantage in ewe hoggets is sustained through to adult performance. It has also been shown that the HF flock grew more wool in winter compared with RC resulting in a less seasonal wool growth pattern (Wuliji *et al*., 1995). The lower FDcv in HF indicates that fleeces possess more uniformity than RC, and consequently it would produce a better length and strength in fibre processing. Although there was no difference in brightness, HF fleeces showed yellower than RC, which also agreed with the tendency in Romney sheep for fleece weight selection (Hawker *et al*., 1988; Wuliji *et al*., 1998). Overall, these results suggest that selection for fleece weight in long wool sheep is generally positively associated with liveweight and reproductive performance traits.

CONCLUSIONS

The fleece weight selection trial at Woodlands has demonstrated that selection on fleece weight will increase fleece weight, ovulation and multiple birth rate, live weight, fibre diameter and Y-Z with little effect on other wool characteristics. As fleece weight is highly associated with other major productive traits, namely ovulation rate, lambs born/ ewe lambed rate and live weight, there will be indirect gains in these traits with selection for fleece weight in long wool sheep. However further improvement in wool quality traits such as fibre diameter and colour would enhance crossbred wool profitability in the future.

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REFERENCES

Baker, R.L.; Clarke, J.N.; Carter, A.H.; Diprose, G.D. 1979. Genetic and phenotypic parameters in New Zealand Romney sheep. 1. Body weights, fleece weights , and oestrous activity. *New Zealand Journal of Agricultural Research* **22:** 9-21.

Baker, R.L.; Clarke, J.N.; Meyer, H.H.; Harvey, T.G.; Bigham, M.L. 1987. Genetic variation among six strains of Romneys and Border Leicester and Coopworth crosses. *Proceedings of the New Zealand Society of Animal Production* **47:** 101-105.

Bigham, M.L.; Sumner, R.M.W.; Dalton, D.C. 1978. Wool production of different breeds of mixed-age ewes on hill country. *New Zealand Journal of Agricultural Research* **21:** 119-126.

Davis, G.H.; McEwan, J.C.; Howarth, M.V.; Kelly, R.W.; Paterson, A.T. 1987. Reproductive performance of progeny of prolific Romney, Coopworth and Perendale sheep. *Proceedings of the New Zealand Society of Animal Production* **47:** 89-91.

Hawker, H.; Dodds, K.G.; Andrews, R.N.; McEwan, J.C. 1988. Production and characteristics of wool from the hogget progeny of sheep intensively screened for fleece weight. *Proceedings of the New Zealand Society of Animal Production* **48:** 207-212.

Hawker, H.; Littlejohn, R.P. 1986. Live weights, fleece weights and wool characteristics of screened high fleece weight and randomly selected Romney ewe hoggets. *Proceedings of the New Zealand Society of Animal Production* **46:** 219-223.

Hight, G.K.; Jury, K.E. 1970. Hill country sheep production. I. The influence of age, flock, and year on some components of reproduction rate in Romney and Border Leicester X Romney ewes. *New Zealand Journal of Agriculture and Research* **13:** 641-659.

Kelly, R.W.; Allison, A.J.; Johnstone, P.D. 1978. A system of identifying factors limiting the reproductive performance of commercial sheep flocks. *Proceedings of the New Zealand Society of Animal Production* **38:** 80-89.

Kelly, R.W.; Johnstone, P.D. 1982. Reproductive performance of commercial sheep flocks in South Island districts. 2. Relationships between ovulation rate, liveweight, mating, and lambing performances. *New Zealand Journal of Agricultural Research* **25:** 519-523.

Wickham, G.A. 1966. What emphasis should be placed on wool characters when selecting sheep? *Sheepfarming annual: 95-103.*

Wickham, G.A.; Bigham, M .L. 1976. Growing more and better wool. *Proceedings of the Ruakura Farmers' Conference* **28:** 18-21.

Wickham, G.A.; McPherson, A.W. 1985. A review of the importance of wool traits as genetic improvement objectives and selection criteria for New Zealand Romney sheep. *Proceedings of the New Zealand Society of Animal Production* **45:** 203-208.

Wright, G.M.; Stevens, P.G. 1953. Lifetime wool production and breeding performance of Romney Marsh and Corriedale ewes. *New Zealand Journal of Science and Technology* **34:** 431-435.

Wuliji, T.; Dodds, K.G.; Andrews, R.N.; Wheeler, R. 1991. Responses in production and wool characteristics of Romney sheep selected for high fleece weight. *Proceedings of the Australian Association of Animal Breeding and Genetics* **9:** 331-334.

Wuliji, T.; Dodds, K.G.; Andrews, R.N.; Turner, P.; Wheeler, R. 1992. Reproduction performance and liveweight in Romney sheep selected for fleece weight and a control flock. *Proceedings of the New Zealand Society of Animal Production* **52:** 237-240.

Wuliji, T.; Weatherall, I.L.; Andrews, R.N.; Dodds, K.G.; Turner, P.; Wheeler, R. 1995. Effect of selection for wool growth on seasonal patterns of yield, fibre diameter, and colour in Romney lines. *Australian Journal of Experimental Agriculture* **35:** 27-31.

Wuliji, T.; Dodds, K.G.; Andrews, R.N.; Turner, P.R.; Wheeler, R. 1998. Responses to fleece weight selection and heritability estimates of wool characteristics in Romney sheep. *Wool Technology and Sheep Breeding* **46:** 250-254.