A comparison of the ewe reproductive performance of Romney ewes bred to Romney or Wiltshire rams and the growth of their progeny to weaning

RA Corner-Thomas[a]*, AL Ridler[a], PR Kenyon[a], HT Blair[a] and ST Morris[a]

[a]*School of Agriculture and Environment, Massey University, Palmerston North, New Zealand.*

**Corresponding author.* Email: r.corner@massey.ac.nz

Abstract

This study reports the results of the first cross breeding of Romney ewes with Wiltshire rams as part of a grading-up transition. Romney mixed-age ewes were bred to either Romney (n=200) or Wiltshire rams (n=349) in March 2020. Ewe breeding pattern (cycle bred), reproductive performance (pregnancy and fecundity rates) and lambing performance (lambing rate, lamb birth and weaning live weight and lamb survival) were recorded. The reproductive performance of ewes bred to either Romney or Wiltshire rams showed few differences. There were no differences (P>0.05) in pregnancy, fecundity or lambing rates of ewes bred to either Romney or Wiltshire rams although minor differences (P<0.05) in the breeding pattern were observed. Lamb live weights at birth and in mid-lactation did not differ (P>0.05) among single, twin and triplet lambs sired by either Romney or Wiltshire rams, however at weaning Romney-sired triplet lambs were heavier than Wiltshire triplets (P<0.05). At weaning, a small percentage (1.6%) of Wiltshire lambs showed early signs of fleece shedding. Combined, these results suggest that in this flock there was little impact of introducing Wiltshire rams to a mixed-age Romney ewe flock on ewe reproductive performance and the growth of the F_1 progeny to weaning.

Keywords: Wiltshire; Romney; reproduction; growth; shedding

Introduction

The New Zealand sheep industry was founded on the production of wool, exports accounting for more than a third of New Zealand's export earnings (Easton 2010) until 1882 when the first shipment of refrigerated sheep meat allowed the export of meat to the United Kingdom (Cottle 2010). Since the late 1980s, however, the percentage of export earnings attributed to wool has decreased from approximately 13% to 3% in the mid 2000s (Easton 2010). In the 2018-19 survey, the Beef + Lamb Economic Service reported that wool contributed an average of 3% to the farm income of New Zealand sheep and beef farms.

In New Zealand, the majority of sheep are dual purpose producing both meat and wool (Beef + Lamb NZ 2020). Blair (2011) estimated that 59% of farms had Romney-based breeds which have been reported to produce fleeces with a fibre diameter of between 33 and 37 µm (Morris et al. 1996). Currently, 90% of the wool produced in New Zealand is classed as coarse or >30 µm (Beef + Lamb New Zealand 2021a; Simm 1998). Over the last five years the price paid for clean coarse wool has decreased from $6.14/kg in 2016 to $1.88/kg in January 2021 (JDJL Limited 2021). At this price farmers are not able to recover the costs of shearing and as a result, are investigating alternative options (Beef + Lamb New Zealand 2021b).

One option for farmers to reduce the impact of low wool prices on farm income is to introduce of a self-shedding breed such as the Wiltshire into the flock, to eliminate the need for shearing (Slee 1959). The Wiltshire breed in New Zealand originated from four Wiltshire Horn x Poll Dorset first cross ewes and a Wiltshire Horn ram imported from Australia in 1972, from which a stabilised polled Wiltshire breed was established (Morrison 2010). The heritability of fleece shedding in the New Zealand Wiltshire sheep has been reported to be high at 0.52 (Johnson et al. 2007). Due to this high heritability, a low-cost and medium-term strategy to transition to a Wiltshire flock is by using a grading-up approach (Slee 1959). Grading up involves continued use of Wiltshire rams across an existing ewe flock and the selection of replacement ewe lambs for greater shedding (Nicholas 2009). It has been predicted that this transition to a shedding flock would take three to four generations (Nicholas 2009; Slee 1959). Farrell et al. (2020) predicted that grading up from a Romney-based flock to a fully shedding Wiltshire flock could be achieved within 15 years, with shearing expenses eliminated after seven years. In addition, they predicted that once the flock had reached the desired final cross of 7/8Wiltshire the income from the sheep enterprise would be greater than that of the base Romney flock. The model, however, had limitations as data on shedding sheep in New Zealand were scarce, which may have reduced the accuracy of the model predictions. This study was designed, therefore, to determine the reproductive performance of Romney ewes bred to Wiltshire rams and the growth and shedding of the F_1 progeny of a flock in the first year of a grading-up transition.

Materials and methods

The study was conducted at Massey University's Riverside farm located 10km north of Masterton on the east coast of the North Island of New Zealand (40°50'31"S 175°37'04"E). In March 2020, Romney ewes (n=549) were bred to either Romney (n=200 ewes) or Wiltshire rams (n=349 ewes). The ram to ewe ratio used was in excess of the industry recommendation of 1:100 (Geenty, 2017) at 1:66 for the Romney rams and 1:87 for the Wiltshire rams. All rams were fitted with a mating harness and crayon to identify ewes that had been bred during the first or second oestrous cycles. Breeding began on the 25th of March (pregnancy day 1; P1) and rams remained with the ewes for two oestrous cycles (a total of 34 days) until the 28th of April (P35). The ram-harness crayon colour was changed at P18 and the presence of colour marks on the rump of the ewes was recorded at P35. After rams were removed, all ewes were managed as a single mob throughout pregnancy and until lambing. Pregnancy diagnosis was conducted 107 days after the start of breeding (P107). Pregnancy status (pregnant/non-pregnant) and the number of fetuses (0, 1, 2, or 3) was determined using transabdominal ultrasound conducted by a commercial operator. Ewes were weighed prior to breeding (P1), at ram removal (P35), pregnancy diagnosis (P107), in mid-lactation (Day 52 of lactation; L52) and at weaning (L108). Ewe body condition was scored on a scale from 1 to 5 as described by Jefferies (1961) at weighing events conducted on P1, P107, L52 and L108.

One week prior to the expected start of lambing, ewes were randomly allocated to one of 16 lambing paddocks at a density of 10 to 12 ewes per hectare. Each lambing paddock had a mix of pregnancy ranks (single, twin or triplet) and ewes bred to either Romney or Wiltshire rams. The lambing period began on the 11th of August (L1) with the final lamb born on L51. Lambs were ear tagged within 24 hours of birth and had their weight, birth rank and sex recorded. At L52, all lambs born prior to L47 were tail docked and ram lambs were ear marked and made short-scrotum using an elastrator and a rubber ring (Elastrator ring, Heiniger, New Zealand). The single ewe lamb born after L47 was weighed but not tail docked. Ewe and lamb live weights were recorded mid-lactation (L51) and at weaning (L108).

At weaning (L108; 26th November 2020) short-scrotum ram lambs were weighed and separated from ewe lambs and removed from the study. Of the 438 ewe lambs present at weaning, 374 (Wiltshire sired n=243 and Romney sired n=128) were retained as replacement animals. Fleece shedding scores were conducted on all the replacement ewe lambs sired by Wiltshire rams (n=243) and a random sample of Romney-sired ewe lambs (n=19). The shedding score (0 to 5: no shedding to full shedding) was conducted as per the method of Johnson et al. (2007) and O'Connell et al. (2012).

Statistical analysis

All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, USA). Analyses of ewe reproductive performance (cycle marked (first, second, both cycles or not marked), fertility (pregnant / non pregnant), fecundity (number of fetuses), lambing (lambed / not lambed), ewe body condition score (BCS), and lamb survival to weaning (lived / died) were analysed using generalised models which included the fixed effect of sire breed. Models of variables with two outcomes (fertility, lambing and lamb survival) used a binomial distribution and logit transformation whereas models with ordinal outcomes (cycle, fecundity) used a Poisson distribution. Ewe BCS was analysed using a generalised model that allowed for repeated measures which included the fixed effects of day (P1, P107, L52 and L108) and sire breed (Romney or Wiltshire) and their two-way interaction. Means were back-transformed using a logit transformation and presented as the back-transformed mean with the 95% confidence interval in parentheses.

Analyses of ewe and lamb live weight were conducted using the mixed procedure allowing for repeated measures. The model for ewe live weight included the fixed effects of day and sire breed and their two-way interaction. The model for lamb live weight included the fixed effect of day of lactation (L0, L52 or L107), sire breed, birth rank (1, 2 or 3) and sex of the lamb (ewe or short scrotum) and the three-way interaction of day by sire breed by birth rank. Lamb growth rates from birth to weaning were analysed using a mixed model that included the fixed effect of sire breed and included lamb birth weight as a covariate. Results are presented as the mean and standard error of the mean.

The frequency of ewe lamb fleece shedding scores could not be statistically analysed since all ewe lambs in the subsample sired by Romney rams had a score of 0. A summary of the frequency of shedding scores have been reported.

Results

Ewe live weight and body condition score

Ewe live weight and BCS did not differ (P>0.05) among ewes bred to Romney or Wiltshire rams throughout the study (Table 1). During pregnancy, ewe live weights and BCS increased to the time of pregnancy diagnosis (P107)

Table 1 Ewe live weight (kg; mean ± SEM) and body condition score (BCS, mean with 95% confidence interval in parentheses)) of ewes bred to either Romney or Wiltshire rams at mating (pregnancy day 1; P1), ram removal (P35), pregnancy diagnosis (PD; P107), mid-lactation (lactation day 51; L52) and weaning (L108)

	Sire breed			
Weighing event	n	Romney	n	Wiltshire
Live weight (kg)				
Pre-breeding (P1)	184	67.7 ± 0.5 ^{ab}	328	66.6 ± 0.4 ^{a}
Ram out (P35)	184	67.2 ± 0.5 ^{a}	328	66.5 ± 0.4 ^{a}
PD (P107)	184	69.5 ± 0.5 ^{cd}	328	68.9 ± 0.4 ^{bc}
Mid-lactation (L52)	184	67.0 ± 0.5 ^{a}	331	66.7 ± 0.4 ^{a}
Weaning (L108)	169	70.2 ± 0.5 ^{d}	298	69.8 ± 0.4 ^{cd}
BCS				
Mating (P1)	184	2.65 (2.59 - 2.72) ^{b}	328	2.72 (2.57 - 2.87) ^{bc}
Ram out (P35)	184	2.90 (2.82 - 2.97) ^{d}	328	2.91 (2.85 - 2.98) ^{d}
PD (P107)	184	2.31 (2.23 - 2.39) ^{a}	331	2.37 (2.30 - 2.44) ^{a}
Mid-lactation (L52)	169	2.58 (2.48 - 2.68) ^{b}	298	2.66 (2.58 - 2.73) ^{bc}

^{abcd} within each variable (live weight and BCS) means with different superscripts are significantly different P<0.05

Ewe reproductive performance

Table 2 Reproductive performance (percentage with 95% confidence interval in parentheses) of ewes bred to Romney or Wiltshire rams including cycle marked by the ram (first, second, returned to service or not marked;)), diagnosed with single, twin or triplet fetuses, fertility rate (ewes pregnant per ewe presented for breeding), fecundity rate (fetuses per 100 ewes presented for breeding), lambing rate (lambs born per ewe presented for breeding) and percentage of ewes lambed (had lambing record).

	Ram breed			
	n	Romney	n	Wiltshire
Cycle marked by ram				
First (%)	159	81.5 (75.5 - 86.4) [a]	302	88.8 (85 - 91.8) [b]
Second (%)	25	12.8 (8.8 - 18.3)	26	7.6 (5.3 - 11)
Returned to service (%)	0	0 (0 - 0)	14	4.1 (2.5 - 6.8)
Not marked (%)	11	5.6 (3.2 - 9.9)	12	3.5 (2.0 - 6.1)
Reproductive performance				
Single (%)	50	25.6 (20 - 32.2)	90	26.5 (22.1 - 31.4)
Twin (%)	141	72.3 (65.6 - 78.1)	239	70.3 (65.2 - 74.9)
Triplet (%)	4	2.1 (0.8 - 5.3)	11	3.2 (1.8 - 5.7)
Fertility rate (%) *	195	100	340	100
Fecundity rate (%)	195	176.4 (158.7 - 196.1)	340	176.8 (163.2 - 191.5)
Lambing rate (%)	194	176.3 (158.6 - 196.0)	331	175.2 (161.5 - 190.1)
Ewes lambed (%)	193	99.0 (96.0 - 99.7)	326	95.9 (93.2 - 97.6)

[abcd] means with different superscripts are significantly different P<0.05
* Statistical analysis was not conducted as all ewes were diagnosed as pregnant

and decreased after lambing, reaching their lowest value at mid-lactation, and then increased to the time of weaning.

A greater percentage (P>0.05) of ewes that were bred to Wiltshire rams were marked with the mating-harness crayon in the first 17-day oestrous cycle compared with ewes bred to Romney rams (Table 2). There was a tendency (P=0.052) for a lower percentage of the Wiltshire-bred ewes to be bred in the second cycle. The percentage of ewes that were marked by the ram in both cycles (returned to service) or that were not marked by the ram did not differ between ram breeds (P<0.05).

At pregnancy diagnosis, all ewes (100%) bred to either the Romney or Wiltshire rams were diagnosed as pregnant (Table 2). There were no differences in the percentage of ewes diagnosed as single-, twin- or triplet-bearing among ewes bred to either Romney or Wiltshire rams and, therefore, no difference in the fecundity rate (P>0.05). The percentage of ewes that had lambing records was similar between ewes bred to either Romney or Wiltshire rams (P>0.05).

Lamb live weight, growth and survival

Lamb live weights at birth and mid lactation were greater (P<0.05) for single-born lambs than for twin and triplets, which did not differ (P>0.05, Table 3). At weaning, Romney-sired single lambs were heavier (P<0.05) than either twin or triplet lambs, however, among Wiltshire-sired lambs, singles were heavier than twins which in turn were heavier than triplets (P<0.05).

At birth and mid-lactation, the live weights of single, twin and triplet lambs sired by either Romney or Wiltshire rams did not differ (P>0.05, Table 3). At weaning, however, triplets sired by Romney rams were heavier (P<0.05) than those sired by Wiltshire rams.

For both Romney- and Wiltshire-sired lambs, liveweight gains from birth to weaning were greater (P<0.05) for singles than for twin or triplets, which did not differ (P>0.05, Table 32). The liveweight gain of single lambs was greater for Wiltshire-sired lambs than for Romney (P<0.05). Twin and triplet lambs had similar live weight gains regardless of the breed of their sire (P>0.05).

Lamb survival rates to weaning did not differ (P>0.05) among Romney 84.2% (79.9–87.7%) and Wiltshire sired lambs 87.2% (84.1–89.7%). The survival of triplet lambs (72.5% (52.9–86.0%)) was lower (P<0.05) than that of single and twin lambs which did not differ (81.7% (74.1–87.4%) *vs.* 87.6 (84.9–89.8%); P>0.05). Ewe lambs tended (P=0.08) to have greater survival rates than did ram lambs (87.7 (84.2–90.5%) *vs.* 83.5 (79.8–86.7%), respectively)).

Lamb shedding scores

At weaning, four Wiltshire-sired ewe lambs (1.6%) of the 243 scored showed signs of wool shedding particularly on the neck. All four lambs were scored 1 on the scale of 0

Table 3 Live weight (kg; mean ± SEM) of single, twin and triplet lambs sired by either Romney or Wiltshire rams at birth (L0), mid-lactation (L52) and weaning (L107) and liveweight gain (g/day) from birth to weaning

		Live weight (kg)						Liveweight gain (g/day)
Sire breed	Birth rank	n	L0	n	L52	n	L107	L0 to 107
Romney	Single	49	6.2 ± 0.4[b]	39	18.0 ± 0.4[d]	38	31.9 ± 0.5[g]	277.4 ± 6.5[b]
	Twin	287	5.2 ± 0.2[a]	251	14.2 ± 0.2[c]	246	28.0 ± 0.2[f]	251.4 ± 2.5[a]
	Triplet	12	4.3 ± 0.8[a]	10	15.1 ± 0.9[c]	10	28.6 ± 0.9[f]	251.8 ± 12.5[a]
Wiltshire	Single	92	6.1 ± 0.3[b]	80	17.4 ± 0.3[d]	80	32.4 ± 0.3[g]	296.6 ± 4.5[c]
	Twin	444	5.2 ± 0.1[a]	397	14.1 ± 0.1[c]	395	28.4 ± 0.1[f]	255.5 ± 2.0[a]
	Triplet	30	4.3 ± 0.5[a]	19	13.4 ± 0.6[c]	18	26.6 ± 0.7[e]	241.6 ± 9.3[a]

[abcdef] means with different superscripts are significantly different P<0.05

to 5. The four ewe lambs that were scored 1 were twin-born and were 91 (n=1), 93 (n=1) and 100 days of age (n=2). The age range of all the progeny born in the study ranged from 57 to 107 days. All of the subsample of Romney-sired ewe lambs were scored 0.

Discussion

The reproductive performance of Romney ewes bred to Wiltshire rams showed few differences to those bred to Romney rams. The breeding pattern showed that, although there were more ewes marked by Wiltshire rams in the first oestrous cycle compared to Romney rams, there was no difference in pregnancy and fecundity rates at pregnancy diagnosis. The pregnancy scanning percentage of the Romney flock at Riverside farm has been reported to range between 170 and 190% (Kenyon et al. 2011; Pettigrew et al. 2020; Ramírez-Restrepo et al. 2005). Given the high fecundity rate reported for ewes at Riverside farm, the low ram-to-ewe ratio and the use of teams of rams it was not expected that there would be any difference in the fecundity of Romney ewes bred to Wiltshire or Romney rams.

The live weights of lambs in the current study did not differ among lambs sired by Romney or Wiltshire rams except at weaning (L108) when triplet-born lambs sired by a Wiltshire ram were lighter than their counterparts sired by a Romney ram. Few data have been published on the live weight of Wiltshire lambs. Sumner et al. (2012) reported that Wiltshire lambs had a mean birth weight of 4.3 kg and at weaning weight of 25.1 kg, which was lighter than in the current study. Scobie et al. (2016), however, reported similar lamb weaning weights for lambs born to a line of Wiltshire sheep selected for increased fleece weight, but lower live weights for those born to the decreased-fleece-weight line. Lamb liveweight gains from birth to weaning showed that, although there were no differences in the weaning weight of single lambs sired by Wiltshire or Romney rams, there was a 19 g/day greater growth rate for the progeny of the Wiltshire rams.

Lamb survival in the current study was similar for lambs sired by Wiltshire and Romney rams. Survival rates were greater than those reported by Sumner et al (2012) but were within the range reported for studies using Romney ewes at Riverside farm (Kenyon et al. 2011; Pettigrew et al. 2020). As would be expected, the survival of triplet lambs was lower than that of single and twin lambs, however, in the current study the survival of single and twin lambs was similar. The survival rates in the current study were lower for single lambs than previously reported but similar for twin and triplet lambs (Morris & Kenyon 2004; Pettigrew et al. 2020).

At weaning in late-November, very few lambs sired by Wiltshire rams showed signs of fleece shedding. This is perhaps not surprising as O’Connell et al. (2012) concluded that shedding was best observed in Wiltshire lambs during January compared with December. Shedding is driven primarily by day length which influences prolactin concentrations (O’Connell et al. 2012; Pearson et al. 1996). O’Connell et al. (2012) also observed that among Wiltshire lambs, shedding scores were greater for singles than for twins which in turn were greater than for triplets. They also reported that older lambs had greater shedding scores than did younger lambs. Slee (1959) reported that adult F_1 Wiltshire x Blackface animals showed a range of shedding scores from 0 (no shedding) to 5 (90 to 100% of the body area shed), therefore, there is potential for the progeny in the current study to show fleece shedding as they age. Further observations are required as the lambs age before firm conclusions can be drawn.

Conclusion

The results of this study suggest that for the flock investigated, there was little effect of introducing Wiltshire rams on the reproductive performance of Romney ewes and their progeny. Further studies are required to determine the variability among flocks before firm conclusions can be made. Lambs showed few signs of wool shedding, however, given that the observation was conducted a month prior to the longest day there had been little opportunity for the influence of the longer day lengths to have an effect.

Acknowledgements

This research was funded by the L A Alexander Trust, Sydney Campbell Trust and the Massey Foundation.

References

Beef + Lamb New Zealand 2021a. Wool exports by month 2019 to 2020. Retrieved 20 April 2021, from https://beeflambnz.com/data-tools/wool

Beef + Lamb New Zealand 2021b. Benchmark your farm. Retrieved 20 April 2021, from https://beeflambnz.com/data-tools/benchmark-your-farm

Beef + Lamb NZ 2020. Compendium of New Zealand Farm Facts. Wellington, New Zealand, Beef + Lamb New Zealand. 44th Ed. 28 p.

Blair H 2011. Ram breeding in New Zealand two decades after the introduction of exotic sheep breeds. Proceedings of the Association for the Advancement of Animal Breeding and Genetics 19: 407-410.

Cottle DJ 2010. International Sheep and Wool Handbook. Nottingham University Press. Nottingham, United Kingdom.

Easton B 2010. Wool, meat and butter exports, 1853–2000. Retrieved 20 April 2021 http://www.TeAra.govt.nz/en/graph/24323/wool-meat-and-butter-exports-1853-2000

Farrell LJ, Morris ST, Kenyon PR, Tozer PR 2020. Modelling a transition from purebred Romney to fully shedding Wiltshire–Romney crossbred. Animals 10: 2066.

Geenty K 2017. Making every mating count. Wellington, New Zealand, Beef + Lamb New Zealand. 94 p.

JDJL Limited 2021. Wool indicator prices. Retrieved 21/01/2021 2021, from http://www.interest.co.nz/Charts/Rural/Lamb%20Y

Jefferies BC 1961. Body condition scoring and its use in management. Tasmanian Journal of Agriculture 32: 19-21.

Johnson P, O'Connell D, Dodds K, Sumner R, Mcewan J, Pearson A 2007. Wool shedding as a trait for genetic improvement using marker assisted selection? Proceedings of the Association for the Advancement of Animal Breeding and Genetics. PP 541-544.

Kenyon PR, Maloney SK, Blache D 2014. Review of sheep body condition in relation to production characteristics. New Zealand Journal of Agricultural Research 57: 38-64.

Kenyon PR, Van der Linden DS, West DM, Morris ST 2011. The effect of breeding hoggets on lifetime performance. New Zealand Journal of Agricultural Research 54: 321-330.

Morris CA, Johnson DL, Sumner RMW, Hight GK, Dobbie JL, Jones KR, Wrigglesworth AL, Hickey SM 1996. Single trait selection for yearling fleece weight or liveweight in romney sheep – correlated responses in liveweight, fleece traits, and ewe reproduction. New Zealand Journal of Agricultural Research 39: 95-106.

Morris ST, Kenyon PR 2004. The effect of litter size and sward height on ewe and lamb performance. New Zealand Journal of Agricultural Research 47: 275-286.

Morrison J 2010 August 2010. Treasure diversity. Rare Breeds NewZ: 7-10.

Nicholas FW 2009. Introduction to Veterinary Genetics, John Wiley & Sons.

O'Connell D, Scobie D, Hickey S, Sumner R, Pearson A 2012. Selection for yearling fleece weight and its effect on fleece shedding in New Zealand wiltshire sheep. Animal Production Science 52: 456-462.

Pearson A, Parry A, Ashby M, Choy V, Wildermoth J, Craven A 1996. Inhibitory effect of increased photoperiod on wool follicle growth. Journal of Endocrinology 148: 157-166.

Pettigrew EJ, Hickson RE, Blair HT, Griffiths KJ, Ridler AL, Morris ST, Kenyon PR 2020. Differences in lamb production between ewe lambs and mature ewes. New Zealand Journal of Agricultural Research: 1-14.

Ramírez-Restrepo CA, Barry TN, Pomroy WE, López-Villalobos N, Mcnabb WC, Kemp PD 2005. Use of lotus corniculatus containing condensed tannins to increase summer lamb growth under commercial dryland farming conditions with minimal anthelmintic drench input. Animal Feed Science and Technology 122: 197-217.

Scobie D, O'Connell D, Noble A, Greer AW 2016. The influence of previous reproduction on subsequent fertility in multiparous ewes. Proceedings of the New Zealand Society of Animal Production 76: 155-158.

Simm G 1998. Genetic improvement of cattle and sheep, Farming press, Miller freeman UK Ltd, Ipswich, United Kingdom. 433 pp.

Slee J 1959. Fleece shedding, staple length and fleece weight in experimental Wiltshire horn-Scottish blackface sheep crosses. The Journal of Agricultural Science 53: 209-223.

Sumner RMW, Scobie DR, O'Connell D, Henderson HV 2012. Relative performance of Wiltshire and Perendale sheep. Proceedings of the New Zealand Society of Animal Production. 72: 28-34.