The influence of hogget liveweight change during their first lactation on pregnancy rates at the subsequent breeding period

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Abstract

Breeding ewe lambs can have a negative effect on subsequent two-tooth breeding weights which may impact on subsequent reproductive rates. The impact of ewe lamb breeding can be alleviated by providing ewes with forages with high nutritive value such as lucerne or a herb mix such as chicory, plantain, red clover and white clover. In a study conducted over two breeding seasons ewe lambs were offered a ryegrass and white clover pasture, a herb mix or lucerne from one week prior to the expected start of lambing until weaning. The impact liveweight change during lactation, and from weaning until breeding as a two-tooth, on pregnancy and fecundity rates was examined.

Keywords: ewe lamb; live weight; body condition score; scanning percentage; lambing percentage

Introduction

One of the limitations of breeding ewe lambs is the potential for a negative impact on two-tooth breeding live weight (Kenyon et al. 2014b). Ewe lambs that do not gain sufficient live weight prior to the weaning of their first lamb can display poor two-tooth reproductive performance (Kenyon et al. 2008). In recent years there has been growing interest in alternative forages as a means of improving the growth of hoggets during lactation (Tozer et al. 2011; Corner-Thomas et al. 2014). Species examined include lucerne and herb-legume mixes such as a combination of chicory, plantain with red and white clover. These alternative forages have been reported to improve the growth rate of lambs both pre- and post-weaning (Golding et al. 2008; Kemp et al. 2014) and increase ewe lactation performance (Rattray et al. 1982; Kenyon et al. 2010; Hutton et al. 2011). Therefore, it is possible that the use of these alternative forages in lactation may not only improve the live weight of lambs born to hoggets but also the live weight of the young dam at her re-breeding as a two-tooth. If this was found to be the case it is hypothesised that greater reproductive performance would be observed.

Methods

The present studies were conducted at Massey University's Riverside farm, 10 km north of Masterton on the eastern coast of the North Island of New Zealand (40°50'S,175°38'E) in 2012 and 2013 with the approval of the Massey University Animal Ethics Committee. Details of these studies to weaning have previously been described by Corner-Thomas et al. (2014).

Study design - 2012

Single-bearing ewe lambs (n = 301) were allocated to one of the three *ad libitum* herbage feeding treatments prior to lambing (14 September 2012 an average of 23 days prior to lambing; 218 days prior to their two-tooth breeding $D_{-218;}$) until the weaning of their lambs (15 December 2012; D_{-126}). Ewes were balanced by lamb live weights across feeding treatments at D_{-218}. The areas available for each treatment were as follows: 7.5 ha of pasture (mix of ryegrass [*Lolium perenne*] and white clover [*Trifolium repens*]), 11.7 ha herb-mix (mix of chicory [*Cichorium intybus*], plantain [*Plantago lanceolata*], red clover [*Trifolium pratense*] and white clover [*Trifolium repens*]) and 5.5 ha of lucerne (pure lucerne sward [Medicago sativa]). The number of hoggets per hectare was 10, 16 and 16 for the pasture, herb-mix and lucerne treatments, respectively. These stocking rates resulted in 76 hoggets being allocated to pasture, 138 to herb-mix and 87 to lucerne.

Hoggets and their lambs were monitored throughout the lactation (D_{-218} to D_{-126}). In an extension to the earlier study (Corner-Thomas et al. 2014) ewes were monitored during the period after weaning of their first lamb (D_{-126}) until pregnancy diagnosis after breeding as a two-tooth (D82). In this post-weaning period all treatments were merged and managed as a single mob under commercial farming conditions on ryegrass pastures. At D0, for 34 days, ewes were bred as a single group with rams fitted with mating harnesses at a ratio of 1:100 rams to ewes. The mating harness crayon colour was changed after 17 days to allow the identification of ewes bred in the first and second oestrous cycles. Ewes continued to be managed as a single group until pregnancy diagnosis which was conducted 82 days after the start of the breeding period (D_{82}). Hogget live weights and body condition scores (BCS, Jefferies 1961; Kenyon et al. 2014a) were recorded at the start of the lactation period (D_{-218}), weaning of lambs (D_{-126}), start of the re-breeding period (D_0) and pregnancy diagnosis (D_{82}).

Study design 2013

In 2013, a similar procedure to that undertaken in 2012 was undertaken with 195 singleton-bearing ewe lambs (Corner-Thomas et al. 2014). The feeding treatments began on D_{-202} (on average 20 days prior to lambing) and were completed at the weaning of their lambs on D_{-113}. In total, 7.5, 4.0 and 5.5 ha of the pasture, herb-mix and lucerne treatments were used. The stocking rates were 10, 16 and 10 ewes/ha for the pasture, herb-mix and lucerne treatments, respectively. This resulted in 74 ewes being allocated to the pasture treatment, 62 to the herb-mix and 55 to the lucerne. Ewe-lamb live weights and BCS were recorded at the start of the feeding period (D_{-202}), weaning of lambs (D_{-113}), start of the breeding period (D_0) and pregnancy diagnosis (D_{98}). As in 2012, all ewes were managed as a single mob after the completion of the feeding treatments (D_{-113} onwards; the period after that described by Corner-Thomas et al. 2014). Ewes were bred as a single mob for 34 days with rams fitted with mating harnesses at a ram to ewe ratio of 1:100.

Statistical analyses

Statistical analyses were conducted on data collected from ewes present at pregnancy diagnosis (n = 280 in 2012 and n = 172 in 2013). Ewe lambs were excluded from the analyses if they died during the study (2012 n=2; 2013 n= 4) or were not present at pregnancy diagnosis (2012 n=10; 2013 n=15). The analyses, therefore, included 72 hoggets offered pasture, 126 offered the herb-mix and 82 offered lucerne in 2012 and 69, 53 and 50 in each treatment in 2013, respectively.

Ewe live weight and body condition-score records at D_{-218} in 2012 and D_{-202} (pre-lambing) in 2013 were combined and labelled D_{-210}. Similarly records collected on D_{-126} in 2012 and D_{-113} in 2013 (at weaning of their lambs) were combined and labelled D_{-110}. Data collected at D_0 (re-breeding) in 2012 and 2013 were combined as were data collected at pregnancy diagnosis (D_{82} and D_{98} and were labelled D_{90}). Ewe liveweight change per day (g/day) was calculated for each ewe during the periods from D_{-210} to D_{-110} and D_{-110} to D_0. In addition, the total change in ewe BCS was calculated for the same periods.

Data were analysed using the Statistical Analysis System (SAS version 9.4, SAS institute Inc., Cary, NC, USA, 2001). Ewe live weights from D_{-210} until D_{90} and average daily liveweight change (D_{-210} to D_{-110} and D_{-110} to D_0) were analysed using a linear model in the MIXED procedure with treatment fitted as a fixed effect. BCS from D_{-210} until D_{90} and BCS change (D_{-210} to D_{-110} and D_{-110} to D_0) were analysed using a general model in the GENMOD procedure with treatment fitted as a fixed effect with a Poisson distribution and a logit transformation. The oestrous cycle in which a ewe was bred was analysed as a binomial trait using a logistic regression model with the GENMOD procedure and treatment considered as a fixed effect. The number of fetuses that a ewe was diagnosed with (D_{90}) was analysed with the GENMOD procedure using a Poisson distribution and logit transformation.

The influence of ewe liveweight change from D_{-210} to D_{-110} (-8 to +467 g/day) and D_{-110} to D_0 (-248 to +52 g/day) and BCS change during the same periods (-1 to +2 and -2 to +1 unit change, respectively) on the probability of a ewe being bred in the first oestrous cycle, diagnosed pregnant and diagnosed as bearing multiple fetuses was analysed using the LOGISTIC procedure. The models contained the fixed effect of treatment in addition to the covariate of live weight or BCS at D_{-210} for the model of liveweight change and BCS change, respectively.

Table 1 The effect of feeding treatment (Herb-mix, Lucerne and Ryegrass pasture) on ewe live weight (kg), body condition score (BCS), liveweight change (g/day) and body condition score gain (BCS/period) (mean ± s.e.m.)

		Treatment		
	n	Herb-mix	Lucerne	Ryegrass pasture
Ewe lamb live weight at D_{-210}	448	59.3 ± 0.3	59.9 ± 0.4	59.7 ± 0.4
Ewe lamb live weight at D_{-110}	447	80.2 ± 0.5 ^{c}	78.7 ± 0.6 ^{b}	67.2 ± 0.6 ^{a}
Ewe lamb live weight at D_0	448	69.1 ± 0.4 ^{b}	68.8 ± 0.4 ^{b}	62.2 ± 0.4 ^{a}
Ewe lamb live weight at D_{90}	442	62.3 ± 0.4 ^{b}	62.2 ± 0.5 ^{b}	57.3 ± 0.5 ^{a}
Ewe lamb liveweight change D_{-210} to D_{-110}	443	228 ± 5 ^{c}	209 ± 6 ^{b}	83 ± 6 ^{a}
Ewe lamb liveweight change D_{-110} to D_0	443	-91 ± 3 ^{a}	-80 ± 3 ^{b}	-46 ± 3 ^{c}
Ewe lamb liveweight change at D_0 to D_{90}	439	-81 ± 6 ^{a}	-71 ± 7 ^{a}	-54 ± 7 ^{b}
Ewe lamb BCS at D_{-210}	450	3.25 (2.99 - 3.53)	3.31 (3.01 - 3.63)	3.26 (2.97 - 3.58)
Ewe lamb BCS at D_{-110}	447	4.05 (3.76 - 4.36) ^{b}	3.85 (3.52 - 4.20) ^{b}	3.15 (2.86 - 3.46) ^{a}
Ewe lamb BCS at D_0	450	3.50 (3.24 - 3.79)	3.51 (3.20 - 3.84)	3.19 ($2._{90}$ - 3.50)
Ewe lamb BCS at D_{90}	449	3.32 (3.06 - 3.60)	3.35 (3.05 - 3.68)	3.05 (2.78 - 3.36)
Ewe lamb BCS change D_{-210} to D_{-110}	445	0.777 ± 0.032 ^{c}	0.551 ± 0.037 ^{b}	-0.134 ± 0.036 ^{a}
Ewe lamb BCS change D_{-110} to D_0	445	-0.546 ± 0.033 ^{a}	-0.337 ± 0.039 ^{b}	0.041 ± 0.038 ^{c}
Ewe lamb BCS change D_0 to D_{90}	449	-0.181 ± 0.033	-0.167 ± 0.038	-0.11 ± 0.037
Bred in first oestrous cycle (%)	450	84.4 (78.3 – 89.0)	84.1 (76.8 - 89.4)	77.7 (70.0 - 83.9)
Diagnosed pregnant (%)	452	97.2 (93.5 - 98.8)	97.0 (92.2 - 98.9)	97.9 (93.6 - 99.3)
Number of fetuses per ewe bred	452	1.82 (1.63 - 2.03)	1.79 (1.57 - 2.04)	1.72 (1.51 - 1.95)

^{abc} within rows superscripts that differ indicate that means are significantly different amongst treatments (P<0.05)

Results and discussion

Effect of feeding treatment on ewe live weight, BCS and reproductive performance

At the completion of the feeding treatments (D_{-110}) ewe live weights differed such that herb-mix ewes were heavier than lucerne ewes which were heavier than Pasture ewes ($P<0.05$; Table 1). For the remainder of the study period (D_0, to D_{90}) ewes offered either herb-mix or lucerne were heavier than ewes offered Pasture ($P<0.05$). At D_{-110} the BCS of herb-mix and lucerne ewes was greater than pasture ewes but no differences were observed between treatments at either D_0 or D_{90} ($P<0.05$; Table 1). Ewe feeding treatment in lactation had no effect on the percentage of ewes breed in the first cycle, the percentage of ewes diagnosed pregnant or the number of fetuses per ewe bred ($P>0.05$; Table 1). This lack of an effect of feeding treatment on ewe two-tooth reproduction may have been a result of ewe live weights and BCS being within the optimum range. Previous studies suggest that poor reproductive performance of two-tooth ewes does not occur unless their live weights are below 45 kg and BCS below 2 (Kenyon et al. 2004; Corner et al. 2013).

Effect of liveweight change on ewe reproductive performance

Hogget liveweight change during lactation (D_{-210} to D_{-110}), influenced the probability that a ewe would be bred in the first oestrous cycle ($P<0.05$; Table 2). For every 1 g/day increase in ewe liveweight change during lactation the odds of a ewe being bred in the first cycle increased by a factor of 1.005 (odds ratio 1.005, 95% confidence interval 1.001 – 1.009). For example the percentage of ewes with a growth rate of 200 g/day that were bred in the first cycle was 83.8% whereas for ewes with a gain of 300 g/day the percentage was 88.4%. This finding is in agreement with Kenyon et al. (2004) who reported that the live weight of ewes that were bred only in the second oestrous cycle was lower than that of ewes bred only in the first cycle. In addition, Doney et al. (1982) reported that lighter ewes had a later onset of seasonal oestrous. There was, however, no effect of liveweight change during lactation on the proportion of ewes diagnosed pregnant or diagnosed with multiple fetuses (Table 2). Therefore, in terms of potential on-farm production, this would seem to be of little consequence to farmers.

In the post-weaning period (D_{-110} to D_0), ewes in all three treatments lost live weight and body condition, particularly in the herb-mix and lucerne treatments, due to the dry summer conditions experienced (Table 1). Interestingly, this liveweight change from weaning to two-tooth breeding had no effect on any of the measured indices of reproductive performance ($P>0.05$; Table 2). Knight et al. (1983) reported that Romney ewes between 3 and 5 years of age that lost 8 to 10 kg prior to breeding in April had fewer oestruses than ewes that gained 3 kg during the same period. In the present study, the absolute loss of live weight between weaning and re-breeding was of the same magnitude as that reported by Knight et al. (1983). However, Smeaton et al. (1982) reported that live weight at oestrus itself rather than live weight gains prior to oestrus influenced ovulation rates in two-tooth ewes. It is possible, therefore, that the lack of an effect on reproductive performance may have been due to ewe live weight at breeding remaining within the optimal range.

Ewe lamb BCS change on ewe reproductive performance

Body condition score changes in the period between weaning and two-tooth breeding did not affect pregnancy rates but had a positive effect on the percentage of ewes diagnosed with multiple fetuses. For every 1-unit increase in BCS post-weaning, the odds of being diagnosed with multiple fetuses increased by 2.1 times (odds ratio 2.10, 95% confidence interval 1.13–3.88). Therefore, of ewes that lost 1 unit of condition post-weaning 68% were diagnosed with multiple fetuses compared with 72% of ewes that had no change in BCS. Ewes with greater BCS prior to breeding have been reported to have greater conception rates (Bastiman 1972) and a greater number of fetuses per ewe (Kleemann & Walker 2005; Scaramuzzi et al. 2006). In their review of BCS, Kenyon et al. (2014a) suggested that heavier ewes were less likely, than lighter ewes, to show

Table 2 Regression coefficients indicating the effect of liveweight change (g/day) and BCS change during lactation (D_{-210} to D_{-110}) and post-weaning (D_{-110} to D_0) on the percentage of ewes bred in the first cycle or identified with multiple fetuses

	n	Lactation (D_{-210} to D_{-110})	Post-weaning (D_{-110} to D_0)
		Liveweight change	
Bred in first cycle (%)	437	0.005 ± 0.002 *	0.006 ± 0.004 #
Diagnosed pregnant (%)	443	0.005 ± 0.004	0.003 ± 0.009
Diagnosed with multiple fetuses	443	0.001 ± 0.002	0.003 ± 0.003
		BCS change	
Bred in first cycle (%)	423	-4.57 ± 1.34	-0.17 ± 0.39
Diagnosed pregnant (%)	443	0.86 ± 0.93	0.27 ± 0.88
Diagnosed with multiple fetuses	428	0.48 ± 0.33	0.74 ± 0.31 *

* Indicates that liveweight or BCS change had a significant effect ($P<0.05$) on the variable of interest (bred in the first cycle, diagnosed pregnant or diagnosed with multiple fetuses). # Indicates that liveweight or BCS change tended to have an effect ($P<0.1$) on the variable of interest (bred in the first cycle, diagnosed pregnant or diagnosed with multiple fetuses).

improvements in reproductive rates with improved levels of nutrition. In the present study the range of BCS across all periods was between 2 and 4.5. Therefore, the absence of a consistent effect of BCS on reproductive performance may be due to ewes having adequate condition. Therefore, to maximise the proportion of ewes bearing multiples farmers should ensure that ewes that are in good condition at weaning then either maintain or gain condition in the period leading up to breeding.

Conclusion

Under the conditions of the present study there was little impact of large increases in hogget live weight during lactation on subsequent reproductive success. These results indicate that offering hoggets alternative forages during lactation while it increases their live weight it provided no further advantage in terms of their two-tooth reproduction.

References

Bastiman B 1972. The effect of ewe condition at tupping on lambing performance. Experimental Husbandry 22: 22-24.

Corner-Thomas RA, Kemp PD, Morris ST, Kenyon PR 2014. Grazing alternative herbages in lactation increases the liveweight of both ewe lambs and their progeny at weaning. Animal Production Science 54: 1741-1746.

Corner RA, Morris ST, Kenyon PR 2013. The effect of live weight and body condition score on the reproductive performance of two-tooth and mature ewes. International Sheep Veterinary Congress, Rotorua, New Zealand. New Zealand Veterinary Association. Pg. 79.

Doney JM, Gunn RG, Horak F 1982. Reproduction in sheep and goat production. In: Coop, I. E. (ed.) World Animal Science. Elsevier Scientific Publishing Company, Amsterdam, Netherlands. 57-79 p.

Golding KP, Kemp PD, Kenyon PR, Morris ST, Agronomy Society of New Z 2008. High weaned lamb live weight gains on herbs. Agronomy New Zealand 2008. 33-39 p.

Hutton PG, Kenyon PR, Bedi MK, Kemp PD, Stafford KJ, West DM, Morris ST 2011. A herb and legume sward mix increased ewe milk production and ewe and lamb live weight gain to weaning compared to a ryegrass dominant sward. Animal Feed Science and Technology 164: 1-7.

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

Kemp PD, Kenyon PR, Morris ST, Johnston T, Appleton H, Best HK 2014. Summer lamb production and grazing management of pure swards of plantain (Plantago lanceolata). Proceedings of the New Zealand Society of Animal Production 74: 94-101.

Kenyon PR, Kemp PD, Stafford KJ, West DM, Morris ST 2010. Can a herb and white clover mix improve the performance of multiple-bearing ewes and their lambs to weaning? Animal Production Science 50: 513-521.

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

Kenyon PR, Morel PCH, Morris ST 2004. The effect of individual liveweight and condition scores of ewes at mating on reproductive and scanning performance. New Zealand Veterinary Journal 52: 230-235.

Kenyon PR, Proctor L, Morel PCH, Morris ST, West DM 2008. The effect of breeding ewe lambs on subsequent two-year-old ewe performance. Livestock Science 115: 206-210.

Kenyon PR, Thompson AN, Morris ST 2014b. Breeding ewe lambs successfully to improve lifetime performance. Small Ruminant Research 118: 2-15.

Kleemann DO, Walker SK 2005. Fertility in South Australian commercial Merino flocks: relationships between reproductive traits and environmental cues. Theriogenology 63: 2416-2433.

Knight TW, Hall DHR, Wilson LD 1983. Effects of teasing and nutrition on the duration of the breeding season in Romney ewes. Proceedings of the New Zealand Society of Animal Production 43: 17-19.

Rattray PV, Jagusch KT, Duganzich DM, MacLean KS, Lynch RJ 1982. Influence of feeding post-lambing on ewe and lamb performance at grazing. Proceedings of the New Zealand Society of Animal Production 42: 179-182.

Scaramuzzi RJ, Campbell BK, Downing JA, Kendall NR, Khalid M, Munoz-Gutierrez M, Somchit A 2006. A review of the effects of supplementary nutrition in the ewe on the concentrations of reproductive and metabolic hormones and the mechanisms that regulate folliculogenesis and ovulation rate. Reproduction Nutrition Development 46: 339-354.

Smeaton DC, Webby RW, Hockey HUP, Wadams TK 1982. Flushing responses of well and poorly reared two-tooth ewes. Proceedings of the New Zealand Society of Animal Production 42: 37-40.