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Liveweight and body condition change through pregnancy as a predictor of ewe litter size.

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ABSTRACT

Prediction of ewe litter size from liveweight and body condition change over pregnancy was examined in two flocks (246 mixed aged Corriedale ewes and 154 mixed aged Romney ewes).

Liveweight and body condition estimates were recorded on five occasions during pregnancy. Litter size (lambs born per ewe present at lambing) was determined at lambing.

Mean liveweight at joining of ewes ultimately producing 0, 1, 2 or 3 lambs was 62.7, 63.1, 65.7 and 66.9 kg respectively in Flock 1. Corresponding values in Flock 2 were 57.0, 59.4, 62.9 and 68.5 kg. Liveweight change over 140 days after ram introduction for ewes carrying 0, 1, 2, or 3 lambs in Flock 1 was -2.7, 5.7, 7.4, and 9.7 kg respectively. Corresponding figures for Flock 2 were -6.4, -0.6, 0.9, and 4.5 kg. Over the same period body condition declined in Flock 1 (mm GR) by 4.3, 3.4, 4.7 and 6.5 mm and in Flock 2 (units condition score, CS) by 0.37, 0.53, 0.82 and 1.00 for ewes lambing 0, 1, 2 or 3 lambs respectively. Lambs born per ewe lambing was 1.44 and 1.50 in Flock 1 and 2 respectively.

Ewes were ranked within a flock on their individual deviation from the flock mean for various liveweight and/or condition criteria and allocated sequentially to nominal 'single' and 'twin' flocks of equal size. Ranking on liveweight at joining, 6 weeks prior to lambing and prior to the start of lambing resulted in a litter size in the 'single':'twin' groups of 1.36:1.52, 1.28:1.60 and 1.24:1.64 respectively in Flock 1. Equivalent figures for Flock 2 were 1.38:1.62, 1.32:1.68 and 1.29:1.71. Ranking ewes on GR (or CS) deviation from GR (or CS) predicted from the regression of GR (or CS) on pre-lambing liveweight gave some further improvement in discrimination between 'single' and 'twin' groups (1.16:1.72 for Flock 1, 1.25:1.75 for Flock 2).

Depending on the accuracy required in determining ewe litter size, the use of individual ewe liveweight and to a lesser extent body condition may be an acceptable alternative to ultrasound pregnancy diagnosis.

Keywords: Litter size, prediction, liveweight, body condition, ewe.

INTRODUCTION

Litter size diagnosis in ewes enables preferential feeding of ewes with higher maternal energy requirements both over the last six weeks of gestation and immediately post-lambing and makes possible differential lambing supervision of ewes with different litter sizes. The economic benefits of pregnancy diagnosis have been examined by Blair (1986).

Currently, ultrasound pregnancy diagnosis is essentially the only means of pre determining litter size. Accuracies of 95-100% (Grace *et al.*, 1989; Gearhart *et al.*, 1988) have been reported using ultrasound equipment, however this technique requires input of specialised technology and incurs some cost. It would be useful to have a simple, cheap alternative with which to determine litter size which relies less on sophisticated equipment and trained operators.

Single and twin bearing ewes differ in liveweight (Russell *et al.*, 1977) and body condition (Lodge and Heaney, 1973). Therefore separation of twin and single bearing ewes may be possible using liveweight and a measure of body condition.

The aim of this study was to evaluate the prediction of individual litter size of ewes from liveweight and body condition.

METHODS

In two mixed-age ewe flocks (Table 1) unfasted liveweight and an estimate of body condition (GR for Flock 1 and condition score for Flock 2.) were recorded at joining, 6 weeks prior to the onset of lambing and pre-lambing (140 days after joining). Flock 1 was maintained on the Lincoln University Sheep Breeding Unit and Flock 2 based at Invermay Agricultural Research Centre (McEwan *et al.*, 1992).

TABLE 1: Size and age structure of Flocks 1 and 2.

	Breed	No. of ewes	Age (years) 2	3	4	5	6+
Flock 1	Corriedale	246	69	64	45	36	32
Flock 2	Romney	154	41	44	39	30	-

In Flock 1, GR (tissue depth over the 12th rib, 13cm from the midline) was estimated, using manual palpation, by a single operator on all ewes. Repeatability estimates of GR taken on a sub-sample of 50 ewes ranged from 0.72 to 0.84. (Table 2). Back-fat depth at position C (3cm ventral to the midline over the twelfth rib) was measured ultrasonically (ALOKA SDD-210DXII, Aloka Co, Japan) in ewes of the sub-sample on each measurement day. The regression of GR on ultrasound C for the sub-sample ewes was used to correct successive GR estimates of the whole flock for operator drift (GR_c). The simple correlations between GR and C ranged from 0.49 to 0.88 (Table 3) which were of the same order as those reported by Kirton *et al.*, (1986). In Flock 2, body condition score was estimated on a five point scale using the method of Jefferies (1961). Individual ewe litter size (lambs born/ewe present at lambing) and lambing date were recorded for all ewes in both flocks.

TABLE 2: Intercept and regression coefficient (± SE) plus 'r' values and residual standard deviations (RSD) of the linear regression relating repeated GR measurements on the same day (n=50).

Day*	Intercept	regression coefficient	r	RSD
0	3.80 ± 1.35	0.822 ± 0.075	0.84	2.38
70	5.18 ± 1.09	0.577 ± 0.081	0.72	2.65
106	2.77 ± 1.04	0.705 ± 0.090	0.76	2.09
128	1.97 ± 0.790	0.717 ± 0.069	0.84	1.52
140	2.78 ± 0.785	0.688 ± 0.080	0.79	1.31

* Day refers to time post-joining

TABLE 3: Intercept and regression coefficients (± SE) plus 'r' values and residual standard deviations (RSD) for the linear regression of C, measured by ultrasound, on GR estimate (n=50) for 5 days of measurement.

Day*	Intercept	regression coefficient	r	RSD
0	0.43 ± 0.857	0.361 ± 0.046	0.75	1.42
70	2.69 ± 0.865	0.263 ± 0.067	0.49	1.76
106	0.48 ± 0.791	0.461 ± 0.068	0.70	1.59
128	1.32 ± 0.839	0.404 ± 0.074	0.64	1.61
140	-1.40± 0.565	0.682 ± 0.057	0.88	1.00

* Day refers to time post-joining

Ewes were ranked, from highest to lowest, within each flock on their individual deviation from the flock mean for various liveweight and/or condition criteria and allocated sequentially to a nominal 'twin' and then 'single' flock, first in a 50:50 proportion and secondly in the same proportion that singles and twins occurred at lambing in each flock. The liveweight and condition criteria used for ranking ewes in both flocks were; joining liveweight, liveweight 6 weeks prior to lambing, pre-lambing liveweight, body condition/liveweight change over pregnancy, body condition/liveweight change during the final trimester of pregnancy, and deviations of actual body condition (GR or CS) from body condition predicted from the condition/liveweight relationship for the whole flock at day 140 post-joining (Table 5). The litter size for the sub-flocks, as defined above, was calculated and compared with the theoretical values of 1.00 and 2.00 lambs per ewe. The accuracy of predicting litter size was taken as the proportion of ewes correctly assigned to 'single' and 'twin' bearing flocks.

RESULTS

Mean liveweight and body condition estimates of non-pregnant, single, twin and triplet bearing ewes recorded on three occasions over pregnancy are presented in Table 4. Increasing litter size was associated with heavier joining liveweight but not body condition. Mean joining weight increased by 2.6kg for each unit increase in litter size.

Ewes in all litter categories, with the exception of non -pregnant ewes in Flock 1, gained liveweight during pregnancy with the increase being proportional to litter size. Ewe liveweight gain during pregnancy increased from 5.7kg for single bearing ewes to 9.7kg for triplet bearing ewes. Ewes in all litter size groups in both flocks lost condition over pregnancy, with the magnitude of the loss directly proportional to litter size. For example, in Flock 1 for each unit increase in litter size the GR decreased over pregnancy by about an additional 1 mm.

The relationships between body condition (GR or CS) and liveweight pre-lambing are presented in Table 5 for the whole flock and single and twin bearing ewes separately for both flocks.

The segregation of ewes by litter size into populations with different body condition/liveweight relationships is illustrated by the higher R^2 in general for single and twin bearing ewes than for the whole flock.

TABLE 4: Mean (± SD) liveweight and body condition measurements for ewes bearing 0,1,2 or 3 lambs in Flocks 1 and 2. Numbers in parenthesis indicate day after ram introduction.

	Litter Size	(n)	Liveweight (kg)	Body condition*	Liveweight (kg)	Body condition*	Liveweight (kg)	Body condition*
Date			1 April (0)		15 July (106)		26 August (140)	
Flock 1								
	0	21	62.7 ± 4.5	18.8 ± 4.6	56.7 ± 6.0	14.1 ± 2.2	60.0 ± 6.6	14.5 ± 4.3
	1	96	63.1 ± 6.3	18.0 ± 4.9	61.6 ± 8.6	14.4 ± 4.0	68.8 ± 9.8	14.6 ± 5.3
	2	127	65.7 ± 6.7	16.5 ± 5.0	66.0 ± 7.8	14.2 ± 4.3	73.1 ± 9.3	11.8 ± 5.5
	3	2	66.9 ± 10.5	16.5 ± 0.7	67.5 ± 10.5	12.9 ± 1.8	76.6 ± 8.9	10.0 ± 0.0
Date			13 May	(40)	21 July	(96)	2 September	(139)
Flock 2	0	8	57.0 ± 3.3	3.4 ± 1.1	55.1 ± 2.9	2.9 ± 1.1	50.6 ± 3.0	3.0 ± 0.8
	1	62	59.4 ± 3.7	3.7 ± 0.7	59.5 ± 3.2	3.2 ± 0.7	58.8 ± 3.1	3.1 ± 0.7
	2	82	62.9 ± 3.7	3.7 ± 0.6	63.8 ± 3.2	3.2 ± 0.7	63.8 ± 2.9	2.9 ± 0.7
	3	2	68.5 ± 4.0	4.0 ± 0.0	73.5 ± 4.0	4.0 ± 0.0	73.0 ± 3.0	3.0 ± 0.0

* GR_c(mm) in Flock 1, Condition score (1-5 scale, 1=thin, 5=fat) in Flock 2.

TABLE 5: Components of the linear regression of GR (Flock 1) or CS (Flock 2) on ewe liveweight pre-lambing (140 days post joining).

Criteria		Intercept	Regression coefficient	R^2	R.S.D
Flock 1:					
GR/liveweight					
pre-lambing	Whole flock	-8.29	0.306	30.0	4.63
	Singles	-11.2	0.378	50.9	3.71
	Twins	-20.0	0.436	50.1	3.97
Flock 2:					
CS/liveweight					
pre-lambing	Whole flock	1.34	0.027	12.5	0.641
	Singles	0.071	0.042	29.4	0.591
	Twins	1.03	0.029	10.3	0.620

Results from the within flock ranking of ewes for various liveweight and/or body condition criteria are shown in Table 6 as the mean litter size of ewes allocated to 'single' and 'twin' bearing flocks

For ranking on joining weight, the difference in average litter size between 'single' and 'twin' sub-flocks was 0.16 lambs per ewe and the difference increased with the use of liveweight later in pregnancy and by using GR or CS deviations at day 140 where the discrimination was 0.5 to 0.6 lambs per ewe giving accuracies of litter size prediction of 78% and 75% for Flocks 1 and 2 respectively.

TABLE 6: Calculated mean litter size of ewes allocated to the nominal 'single' and 'twin' bearing sub-flocks based on various liveweight and condition criteria for Flocks 1 and 2.

	Flock 1				Flock 2	
Litter size of sub-flock	1.50		1.44		1.50	
	'Single'	'Twin'	'Single'	'Twin'	'Single'	'Twin'
Proportion of ewes in sub-flock	50	50	56	44	50	50
Liveweight joining	1.36	1.52	1.33	1.59	1.38	1.62
6 weeks pre-lambing	1.28	1.60	1.30	1.62	1.32	1.68
pre-lambing	1.24	1.64	1.28	1.64	1.29	1.71
Body condition/liveweight deviations 6 weeks prior to lambing*	1.28	1.60	1.28	1.64	1.40	1.60
Body condition/liveweight deviations day 140 post joining*	1.16	1.72	1.20	1.75	1.25	1.75

*Deviation of actual GR or CS from GR or CS predicted from the flock GR/liveweight or CS/liveweight linear relationship.

No further increase in precision of predicting litter size was achieved by using changes in ewe liveweight and body condition over pregnancy, by excluding two tooth ewes from the analysis or considering ewes lambing in only the first cycle (between 147 and 164 days post joining). A small increase in accuracy of predicting litter size was possible when the division into the two groups was made on actual flock litter size rather than an assumption of 1.50 (Table 6.)

DISCUSSION

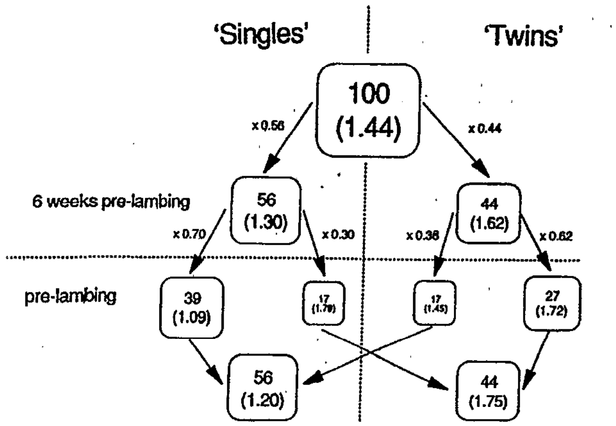
Results of this study show that measurements of ewe liveweight and body condition can be used to separate a high proportion of twin from single bearing ewes within a flock. The success of such a segregation relies on differences in ewe liveweight and body condition associated with differing litter size. Increasing ewe litter size in both flocks here and in earlier work was associated with increases in joining weight (Coop, 1966), greater liveweight gains over pregnancy (Russel *et al.*, 1977) and greater body fat loss (as inferred from GR and CS)(Lodge and Heaney, 1973). The effect of litter size on pre-lambing liveweight recorded here (+4.3 kg for twins vs singles) was similar to that observed by Russel *et al.*, (1977) (+5.0kg for twins vs singles) and is consistent with the data of Rattray *et al.*, (1974) which showed that conceptus weight of twins was 7.5kg heavier than that of singles. Pre-lambing liveweight was recorded on average 13-17 days before the mean lambing date and may not represent the maximum difference in liveweight due to litter size which could be occurring just prior to lambing thus limiting the potential for differences in liveweight alone to predict litter size variation.

Ranking ewes on liveweight alone gave discrimination between 'single' and 'twin' flocks which increased over pregnancy whereas inclusion of body condition only improved the discrimination pre-lambing. There was no advantage in using the change in liveweight and/or body condition over pregnancy presumably because the pre-lambing data are an accumulation of the differences created by litter size on joining liveweight and condition plus liveweight and condition change over pregnancy. In practice this means only a single record of liveweight or liveweight and body condition needs to be made. Discrimination between 'twin' and 'single' flocks at joining may be useful in making decisions on ram allocation for joining.

The most accurate separation (75 to 78%) into 'twin' and 'single' bearing ewe flocks achieved on day 140 after ram introduction is too late to facilitate differential feeding of single and twin bearing ewes. Using an initial separation into 'twin' and 'single' bearing ewes 6 weeks prior to lambing, on liveweight alone, followed by a further separation prior to lambing on GR deviations produced the scenario shown in Figure 1. The initial separation at 6 weeks prior to lambing would permit 'correct' feeding of 70% (39/56) single bearing ewes and 61% of ewes with twins. The additional separation prior to lambing would produce 80% single bearing ewes in the 'singles' flock and 75% twin bearing ewes in the 'twin' flock for lambing supervision and post-lambing feeding. Without hindsight an assumption has to be made as to the accuracy of the initial proportional division into 'single' and 'twin' groups. This decision is not very critical (see comparison between 50:50 and 56:44 in Table 6 for Flock 1) because it is only ewes with small deviations and thus lower probability of accurate prediction of litter size which are moved from one sub-group to the other.

The accuracy of predicting litter size pre-lambing of 75-78% achieved in this study by using liveweight and body condition is significantly lower than values of 96-100% published for ultrasound (Grace *et al.*, 1989). However, if the cost per ewe of ultrasonic litter size determination is, say,

FIGURE 1: A diagrammatic representation of the separation into 'single' and 'twin' bearing ewes 6 weeks prior to lambing on liveweight and a further separation prior to lambing on GR deviations. Figures in parenthesis are litter sizes and those above number of ewes.



twice that involved in recording liveweight and body condition then the marginal cost of ultrasound per **additional** ewe correctly diagnosed (over that achieved by liveweight and body condition score) is increased 100%.

Further development of the concept of using liveweight and body condition to discriminate between ewes on the basis of litter size depends on:

(i) validation of the results obtained in this study in other flocks particularly with higher and lower litter size and with less mobilisation of maternal body weight during pregnancy than the flocks used in this study.

(ii) an appreciation, from a practical viewpoint, of an acceptable accuracy of litter size prediction relative to cost.

(iii) potentially better ways of utilising the effect of litter size on liveweight and body condition to predict litter size.

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