JOINING TIME AND STOCKING RATE ON THE PRODUCTION OF CORRIEDALE AND ROMNEY SHEEP LAMBING ON WINTER IMPROVED PASTURE IN SOUTHERN BRAZIL[1]

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ABSTRACT – Wool weight, fleece components and reproductive performance of Corriedale and Romney sheep joined within three periods (14 january-25 february, 01 march-12 april and 15 april-27 may) and stocked at two rates (10 ewes/ha and 15 ewes/ha) on paddocks of winter improved pasture (*Trifolium repens* and *Lolium multiflorum*) up to weaning, were examined during 5 years (1977-1981) at EMBRAPA, Bagé, RS, Brazil. In the environment employed, the results were consistent in showing that Corriedales were superior to Romneys either in wool quantity and quality or in reproductive performance, and indicated that when 10 or 15 ewes are stocked per hectare, the higher stocking rate did not cause any harmful effect on both wool or reproductive components. Fleeces produced from ewes in later joinings were somewhat lighter, but there was a good improvement in their reproductive performance. Considering the significant joining season x stocking rate interaction, the results also showed that wool production at the higher rate of stocking is dependent on the joining season employed.

Index terms: sheep, breed, wool, lambs.

ÉPOCA DE ACASALAMENTO E LOTAÇÃO NA PRODUÇÃO DE OVINOS CORRIEDALE E ROMNEY COM PARIÇÃO EM PASTAGEM CULTIVADA DE INVERNO NO SUL DO BRASIL

RESUMO – Durante cinco anos (1977-1981), foram avaliadas na EMBRAPA, Bagé, RS, Brasil, a produção de lã (quantidade e qualidade) e a eficácia reprodutiva de ovelhas Corriedale e Romney Marsh, acasaladas em diferentes períodos (14 janeiro-25 fevereiro, 01 de março-12 abril e 15 abril-27 maio) e mantidas em duas lotações (10 ovelhas/ha e 15 ovelhas/ha) em pastagem cultivada de inverno (*Trifolium repens* and *Lolium multiflorum*), até o desmame. Considerando-se o ambiente imposto aos animais, os resultados mostraram que os ovinos Corriedale foram superiores tanto em qualidade e quantidade de lã quanto em eficiência reprodutiva, e indicaram que a mais alta lotação não foi responsável por significativos efeitos nos componentes de lã e eficiência reprodutiva. As ovelhas acasaladas mais tardiamente tiveram velos mais leves, porém, apresentaram melhor desempenho reprodutivo. Considerando a interação entre época de acasalamento e lotação, os resultados mostraram que a produção de lã na alta lotação é dependente da época de acasalamento adotada.

Termos para indexação: ovinos, raça, lã, cordeiros.

INTRODUCTION

Any experiment aiming at a breed comparison should be conducted under conditions which permit a prediction of performance under commercial management for the next decade at least (Dickerson 1974). In addition, Mayala (1974) remarked that, once breeds have been defined, their exploitation becomes topical and

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adds: "The necessity of utilizing these ready differences instead of trying to develop the existing breeds by selection is obvious, since differences in some cases exceed 100% and correspond to a genetic progress to be made in 50-100 years of successful selection". Breed comparisons, however, imply rankings according to an index of value or usefulness, involving definition in terms of components of performance, which may differ, among others, with market differences, management systems and systems of mating (Dickerson 1969).

Studies on breed productivity vs. environmental changes have been made by, for example, Dunlop (1962), who classified both genetic and environmental responses as large or small. The resulting combinations of either effects (genetic x environmental) were summarized in four types, viz:

Type 1 = small x small
Type 2 = large x small
Type 3 = small x large
Type 4 = large x large

The estimation of breed differences where animals are run under similar environment (Type 2 interaction) is seldom an important situation, once the extent of the environment effect cannot be classified. However, when breeds are run under different environmental conditions (e.g., nutritional regime, location, season of the year, year and others) a type 4 interaction operates. This is then considered important because there is a choice upon both breed and environment that may better suit for a specific objective. In the present experiment, three levels of type 4 interaction will be examined: breed x stocking rate, breed x joining season and breed x year.

Breed comparisons evaluating Corriedale and/or Romney and related breeds are somewhat limited and, in some cases, one is unable to determine whether or not they meet the requirements to obtain accurate results. For example, Mayala (1974) mentioned that sampling procedures may be a source of bias in these comparisons, stating that both the representativeness and number of animals in samples should be enough to produce a reliable outcome. In addition, in some circumstances breed comparisons are begun with flocks originally from diverse environment (as in this study), determining another source of bias due to the possible differential responses of breeds when at a similar environment. The estimates of performance, therefore, would be biased if flock origin is not taken into account, as suggested by results of Jackson & Roberts (1970).

The aim of this work is to evaluate the direct effects of breed, stocking rate, time of joining and interactions between them on wool production (quantity and quality), and reproductive performance. An attempt is also made to combine genotypes and/or environmental differences into an estimate of the relative gross wool productivity per hectare.

MATERIALS AND METHODS

Data analysed in this section form a part of a trial on breed comparison conducted during five years (1977-1981) at EMBRAPA - Brazilian Agricultural Research Corporation - located in Bagé, state of Rio Grande do Sul, Brazil.

Experimental Animals

As indicated in Table 1, the sheep initiating this study in 1977 were acquired as hoggets from different properties (three for Corriedales and two for Romneys) in the previous year (hereafter referred as Class I ewes) whereas those initiated in 1979-1981 were born at the EMBRAPA Research Station, from that base population (Class II ewes).

Flock Management

In January 1977, flocks of 180 Corriedale and 120 Romney ewes aged about 18 months, previously shorn in late November of 1976, were randomly divided into 10 groups and assigned to be joined within the following periods, namely:

JS.1 = 14 January - 25 February (Corriedales only)

JS.2 = 1 March - 12 April (Corriedales and Romneys)

JS.3 = 15 April - 27 May (Corriedales and Romneys)

All ewe groups, within their respective joining season, grazed together with beef cattle on native pasture, on which remained until the third or fourth month of gestation. At this time, they were put onto paddocks of improved pastures (*Trifolium repens* and *Lolium multiflorum*) and stocked at two rates: 10 ewes/ha (SR.1) or 15 ewes/ha (SR.2), up to weaning.

There were two replicates for each of the 10 treatments. The number of ewes within each combination of joining season x stocking rate was constant (15 ewes), so that SR.1 and SR.2 were obtained by varying paddocks size (1.5 and 1.0 ha, respectively).

From 1979 onwards, about 20% of ewes in Class I (drop 1975) were culled annually and replaced by two-tooth ewes (drops 1977-1979) born from the respective group (Table 1). Before entering the experiment, these were run as one flock in paddocks of either native or improved pastures.

Measurements

During the annual shearing in late november, the wool records taken were: Greasy fleece weight (GFW), clean fleece weight (CFW), washing yield (WY), fibre diameter (FD) staple length (SL). Fleece free liveweights (LWS) were collected. Sampling methods and traits measurements followed the methods described by Oliveira (1986).

TABLE 1. Number of ewes within breed and age measured at EMBRAPA Research Station, Bagé, Rio Grande do Sul, Brazil.

Year	Breed	Age at shearing (years)					Total
		$2\frac{1}{4}$	$3\frac{1}{4}$	$4\frac{1}{4}$	$5\frac{1}{4}$	$6\frac{1}{4}$	
1977	Cor.	170 (#)					170
	Rom.	107 (#)					107
1978	Cor.		169				169
	Rom.		114				114
1979	Cor.	34 (+)		140			174
	Rom.	22 (+)		89			111
1980	Cor.	36 (+)	32		109		177
	Rom.	24 (+)	22		74		120
1981	Cor.	34 (+)	32	30		75	171
	Rom.	24 (+)	23	21		48	116
Total		451	329	280	183	123	1429

(#) Class I ewes - base population
(+) Class II ewes - progeny

Fleece style and type were assessed by a classer of the Cooperativa Bageense de La Mixta - COBAGELA - according to the official Brazilian classing method. From the sale prices/kg these data were transformed to total fleece value.

Ewes reproductive performance was evaluated by both the number of lambs weaned per ewe joined (LW/EJ) and total weight of lambs weaned per ewe joined (TWW/EJ), adjusted to a common 90-day weaning age (Levine et al. 1978).

Statistical procedures

Four models were fitted by the method of Least Squares (Steel & Torrie 1981) and analysed by the Least-Squares Maximum Likelihood Program (Harvey 1979). All equations described represent the full model analysed; however, when nonsignificant, interactions were dropped, and the reduced model included only the main effects and those significant first order interactions. No higher order interactions were examined.

Model 1

$$Y_{ijkmn} = u + A_i + B(A)_{ij} + C_k + D_m + AC_{ik} + AD_{im} + CD_{km} + B(A)D_{ijm} + E_{ijkmn}$$

where:

Y_{ijkmn} = an observation on GFW, CFW, WY, FD, SL, LWS, LW/EJ and TWW/EJ on the n^{th} ewe of the m^{th} stocking rate in the k^{th} joining season, and in the j^{th} origin of the i^{th} breed.

and:

u = population mean

A_i = the effect of the i^{th} breed (i = 1 (Corriedale); 2 (Romney); $\Sigma i = 0$

$B(A)_{ij}$ = the effect of the j^{th} origin within the i^{th} breed (j = A, B, C for i = 1 and j = D, E for i = 2; $\Sigma j(i) = 0$)

C_k = the effect of the k^{th} joining season (k = 1 (Jan-Fev); 2 (Mar-abr); 3 (Abr-May); $\Sigma k = 0$

D_m = the effect of the m^{th} stocking rate (m = 1 (10 ewe/ha); 2 (15 ewe/ha); $\Sigma m = 0$

$AC_{ik}, \ldots, B(A)D_{ijm}$ = first order interactions

E_{ijkmn} = random error of observations, assumed to be normally distributed (u=0 and σ^2).

This model was used to estimate the effects of breed, joining season, stocking rate and their first order interaction (adjusted for the effects of origin nested within breed), using Class I plot means over all years as the experimental units, so that there were 52 observations in this plot based analysis (see Table 2). This model was not fitted to analyse individual observations and with the inclusion of year of measurement as main effect, due to the residual sum of squares would have contributions from those interactions not in the model, main plot treatment errors, subplot treatment errors (years) and animals within subplot error, which would be all weighed by degrees of freedom on the error sum of squares, where animals variance would get the highest weight.

The $(AC)_{ik}$ interaction fits only one degree of freedom, once A_i=2 effect was not evaluated in the C_k=1 effect. When analysed together with the A_i=1 effect, this missing subclass makes it impossible to fit the origin (breed) x joining season interaction for Romneys, as the $B(A)_{i=2 \text{ and } j=D,E}$ effect was not present in the C_k=1 effect and, therefore, it generates two empty subclasses (in row or column) in their interaction matrix.

Model 2

$$Y_{ikmn} = u + A_i + C_k + D_m + AC_{ik} + AD_{im} + CD_{km} + E_{ikmn}$$

where:

Y_{ikmn} = same observations as in model 1 on the n^{th} ewe of the m^{th} stocking rate in the k^{th} joining season of the i^{th} breed.

and:

u = overall mean

A_i = effect of the i^{th} breed (i=1,2)

C_k = effect of the k^{th} joining season (k = 1-3)

D_m = effect of the m^{th} stocking rate (m = 1,2)

AC_{ik},...,CD_{km} = first order interactions

E_{ikmn} = random error of observations.

Model 2 examined the effects of breed, joining season, stocking rate and their first order interactions on Class II data, within which no origin (breed) confounding exists. Similar analysis procedure to that described in model 1 was applied on the plot means (experimental units), and therefore this analysis contained 20 observations (seen at the foot of Table 2).

TABLE 2. Number of experimental ewes within breed, joining season, stocking rate and replicates (overall years 1977-1981), and number of ewes within replicates regarding different origins of base population (Class I) and its progeny (Class II)

Breed	Corriedale 865												Romney 559							
Join . Season	1 295				2 283				3 287				2 275				3 284			
Stock . Rate	1 147		2 148		1 144		2 139		1 140		2 147		1 132		2 143		1 142		2 142	
Replicates	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
(20 plots)	75	72	74	74	69	75	71	69	70	70	71	76	71	61	75	68	73	69	72	70
Class I origin (52 plots)																				
A	14	23	23	15	12	12	14	16	19	22	11	17								
B	19	19	16	20	20	21	12	15	21	15	16	17								
C	24	13	17	24	23	25	26	21	14	17	28	26								
D													25	23	27	30	28	34	29	24
E													29	20	30	20	31	21	25	28
Class II (20) plots)	18	17	18	15	14	17	18	17	16	16	16	16	18	18	18	18	14	14	18	18

Join . Season 1 = 14 Jan. - 25 Feb.
2 = 01 Mar. - 12 Apr.
3 = 15 Apr. - 27 May

Stock . Rate 1 = 10 ewes/ha
2 = 15 ewes/ha

Model 3

$$Y_{ijkmno} = u + A_i + B(A)_{ij} + C_k + D_m + Y_n + AC_{ik} + AD_{im} + CD_{km} + B(A)D_{ijm} + AY_{in} + B(A)Y_{ijn} + CY_{kn} + DY_{mn} + E_{ijkmno}$$

where:

Y_{ijkmno} = an observation on the same dependent variables described in model 1.

and:

u = overall mean

A_i = the effect of the i^{th} breed (i=1,2)
(i = 1 (Corriedale); 2 (Romney); $\Sigma i = 0$

$B(A)_{ij}$ = the effect of the j^{th} origin within the i^{th} breed (j = A-C for i = 1 and j = D,E for i = 2)

C_k = the effect of the k^{th} joining season (k=1-3)

D_m = the effect of the m^{th} stocking rate (m=1,2)

Y_n = the effect of the n^{th} year of measurement
(n=1 (1977),...,5 (1981); $\Sigma n=0$)

AC_{ik},..., DY_{mn} = interactions between main effects

E_{ijkmno} = random error of observations.

Applied on Class I data, it was used on the plot based analysis (260 plots) and fitted to estimate the effects of interactions of year (subplot treatment) with the main plot treatments of the model, all adjusted for the effect of origin within breed. The effect of year is completely confounded with both the age of ewe at the sampling year and year of birth, as can be seen by the structure of the design presented in Table 1.

It is known that variations in productivity can be expected in different years and the knowledge of their magnitude is important. Although in this particular analysis the extent of the confounding between those effects and year cannot be predicted, any interpretation on the performance of both genotypes within year, is not biased since they are equally represented in terms of age in each year.

Model 4

Similar to model 3, it was employed to investigate the effects of interactions of year of measurement with the other main effects on Class II data (60 plot means).

RESULTS AND DISCUSSION

The "property of origin" had significant effect upon some important data examined (Table 3), so this nested source of variation will be considered as a means of adjusting and improving estimates of productive aspects from both breeds. The results will therefore be based on analyses performed on Class I and Class II data separately.

Breed

Except for CFW in Class I ewes (model 1) and for TWW/EJ in Class II ewes (model 2), the effect of breed was significant upon all traits studied (Table 3). In general, between breed differences accounted for the highest fraction of variance of all effects adjusted in both models.

The least squares means within Classes I and II (Table 4) show that Corriedales were superior to Romneys, producing heavier GFW (+024 kg and +0.28 kg), with finer FD (-4.76 μm and -5.47 μm). Though Corriedales from both Classes were also superior in CFW by 0.08 kg and 0.09 kg, these differences were not significant (P>0.05).

Although the mean greasy fleece weight of Corriedales was greater than that of Romneys by 7.1 % in Class I and 8.2% in Class II, the clean fleece weight was only 3.0% and 3.5% greater. The change in the magnitude of the difference between both traits was due to the higher washing yield of Romneys wools. The contributions of contamination by both vegetable matter and skin contents to this difference, were not estimated, but Daly & Carter (1955) reported that "the output of skin products is unlikely to produce marked differences between breeds".

The relative advantage of the Corriedale breed, in terms of greasy wool production of breeding ewes grazing at a similar environment, has been observed in other studies as ranging between 5.5% and 12.8% (Bigham & Peterson 1974, Cardellino-Stercken 1981, Kalil et al. 1980), which is comparable to that obtained in this work.

Wool production per unit of metabolic liveweight (ML) was calculated to allow for differences in body size between breeds (Sumner 1979). Compared with Romneys, the relative clean wool production/ML of Corriedales was 114.3% and 118.1% for classes I and II, respectively. These figures are in accord with

TABLE 3. Significance levels of effects considered in least squares analyses of variance performed on the classes I and II ewes data.

Class / Model	Effect	GFW	CFW	WY	FD	SL	LWS	LW/EJ	TWW/EJ
Class I									
Model 1	Breed	**	-	**	**	**	**	**	*
	Orig. (breed)	**	**	-	-	-	**	*	-
	J.Season	*	-	-	-	**	-	**	*
	S.Rate	-	-	-	-	-	**	-	*
	J.Season x S. Rate	**	*	-	-	-	-	-	-
Model 3	Year x Breed	-	**	**	-	-	**	-	-
	Year x J.Season	-	-	-	-	-	-	**	**
Class II									
Model 2	Breed	**	-	**	**	**	**	*	-
	J.Season	-	-	-	-	*	*	-	*
	S.Rate	-	-	-	-	-	-	-	-

* (P<0.05)
** (P<0.01)

TABLE 4. Least squares means (±Se) of wool traits, liveweight and reproductive performance for the effects breed and origin (Breed).

Class / Effect	GFW (kg)	CFW (kg)	WY (%)	FD (#)	SL (cm)	LWS (kg)	LW/EJ (%)	TWW/E (kg)
Class I								
Breed								
Corriedale	3.51[a]	2.71	78.36[a]	29.34[a]	12.53[a]	41.45[a]	0.68[a]	19.33[a]
	0.03	0.03	0.59	0.19	0.17	0.33	0.02	0.35
Romney	3.27[b]	2.63[b]	80.67[b]	34.10[b]	15.61[b]	45.96[b]	0.56[b]	20.96[b]
	0.04	0.04	0.83	0.26	0.24	0.47	0.03	0.52
Class II								
Breed								
Corriedale	3.57[a]	2.63	74.46[a]	28.07[a]	11.89	40.28[a]	0.68[a]	17.14
	0.04	0.05	0.37	0.25	0.15	0.78	0.04	0.58
Romney	3.29[b]	2.54	78.30[b]	33.54[b]	16.07[b]	45.92[b]	0.50[b]	17.63
	0.05	0.06	0.51	0.35	0.21	1.07	0.05	0.95

Between breed: means not followed by common superscript are different (P<0.05)
(#) micrometres

Sumner (1979) with respect to the relatively higher efficiency of the Corriedale breed to produce wool.

The relative difference among style characters between breeds, together with the weight of their clean fleece, determined the total fleece value per head. The gross economic return, in terms of wool production/ewe, was higher in the Corriedale breed in both Class I and II (11.1% and 12.4%), respectively.

Overall, the Corriedale breed weaned more lambs per ewe joined (+0.12 and +0.18), but lambs weaning weight were somewhat inferior (-1.63 kg and -0.49 kg). Corriedales LWS was also lower to that of Romneys in Class I (-4.51 kg) and Class II (-5.64 kg). The higher weaning rate found in Corriedales was also a result of small advantages in terms of lambs born/ewe joined (LB/EJ) and lambs surviving to weaning/lamb born (LS/LB). Analyses performed on LB/EJ data within Class I and Class II revealed, respectively, values of 0.93 and 0.89 for the Corriedales and 0.78 and 0.72 for the Romneys, with slightly higher rates of LS/LB.

Higly significant breed x year interaction was detected on CFW, WY, and LWS for Class I ewes. The least squares means are in Table 5 as percentage deviation from the trait overall mean. The genotype x environment interaction mainly occurred as a result of a large between breed difference in the first experimental year (1977), in which only Class I ewes were present. Subsequent contrasting environments, as those encountered from 1979 to 1981, did not change breeds performance after their adaptation to the new environment. These type 4 interactions could be defined as of no practical significance once Jackson & Roberts (1970) postulated that "any interaction which is specific to a particular year is of little importance, since it may never occur again".

Joining Season

The analysis performed on Class I sheep showed the significance of the effect only on few wool traits, as GFW and SL, but it was important on both LW/EJ and TWW/EJ. In Class II sheep, the effect was less intensive and varied significantly only SL, LWS and TWW/EJ (Table 3).

As shown in Table 6, the pooled overall effect did not significantly affect the greasy fleece weight from Class I ewes; however, its partitioning into single degree of freedom regression showed the significance of the quadratic component. This was due to the greasy wool production of ewes joined during March-April (JS.2) being on average 4.6% (0.16 kg) lower than that of ewes joined during January-February (JS.1). Wool traits related to wool quality did not show any consistent variation.

The lower wool weight observed in ewes within later joining seasons can be partly explained by both the higher rate of lambs weaned per ewe joined and by the higher weaning weight of their lambs. Related to January-February joining, there was an advantage in Class I in terms of lambs weaned/ewe joined and total weaning weight/ewe joined in both March-April joining (11.0% and 2.21 kg) and April-May joining (20% and 2.22 kg). The higher reproductive efficiency in the later joinings arose from a higher number of lambs born/ewe joined (17.6% and 31.0%, respectively) and a lower lamb mortality (7.1% and 13.1%, respectively).

It seems, however, that no reasonable interpretation of the joining season effect upon wool production can be made, without considering its interaction with stocking rate (Table 7). The interaction was mainly due to the higher differential response between SR.1 and SR.2 within JS.1, where greasy and clean fleece weight from SR.2 were significantly lighter by 0.26 kg and 0.17 kg. Changes in intake of digestible organic matter reflect changes in liveweight (Doney & Eadie 1967, cited by Bigham et al. 1983) which in turn are related to wool production (Sumner 1979). Thus it is likely that any problem associated with pasture availability between stocking rates in JS.1 influenced wool production. This seems reasonable since ewes in JS.1 entered earlier into the paddocks, which, at that time, might not yet have enough pasture production to support the higher stocking.

TABLE 5. Least squares means (±Se) of wool traits, liveweight and reproductive performance for the effects of joining season and stocking rate.

Class	Traits							
Effect	GFW (kg)	CFW (kg)	WY (%)	FD (#)	SL (cm)	LWS (kg)	LW/EJ (%)	TWW/E (kg)
Class I								
J.Season								
JS.1	3.47[a]	2.75	79.09	31.81	14.64[a]	44.09	0.52[a]	18.67[a]
	0.06	0.05	1.13	0.35	0.33	0.64	0.04	0.70
JS.2	3.31[b]	2.61	70.28	31.38	14.03[ab]	43.09	0.63[b]	20.88[b]
	0.04	0.03	0.73	0.22	0.21	0.41	0.03	0.45
JS.3	3.39[ab]	2.67	78.18	31.97	13.54[b]	43.63	0.72[c]	20.89[b]
	0.04	0.03	0.73	0.21	0.21	0.38	0.03	0.42
S.Rate								
SR.1	3.43	2.70	79.81	31.76	14.01	44.41[a]	0.65	20.71[a]
	0.03	0.03	0.68	0.21	0.20	0.38	0.03	0.41
SR.2	3.35	2.65	79.21	31.68	14.13	43.00[b]	0.59	19.50[b]
	0.03	0.03	0.69	0.21	0.20	0.39	0.03	0.43
Class II								
J.Season								
JS.1	3.35	2.51	76.12	30.83	14.34[a]	40.91[a]	0.60	15.66[a]
	0.11	0.09	0.70	0.48	0.28	1.47	0.08	1.11
JS.2	3.40	2.61	76.83	30.65	14.20[a]	42.48[a]	0.65	17.04[a]
	0.07	0.06	0.44	0.30	0.18	0.92	0.06	0.72
JS.3	3.52	2.63	76.17	30.93	13.41[b]	45.92[b]	0.52	19.46[b]
	0.07	0.08	0.46	0.32	0.19	0.94	0.06	0.88
S.Rate								
SR.1	3.47	2.61	76.13	30.80	14.01	43.36	0.59	17.69
	0.07	0.05	0.43	0.30	0.18	0.89	0.04	0.73
SR.2	3.39	2.56	76.63	30.81	13.95	42.84	0.59	17.08
	0.07	0.05	0.41	0.29	0.17	0.88	0.04	0.73

Means not followed by common superscript are different ($P<0.05$)
(#) micrometres

Stoking Rate

It was only important on Class I ewes (Table 3), on which LWS and TWW/EJ varied significantly. The least squares means (Table 6) show that at the higher stocking rate both ewes and lambs weights were lowered by 1.41 kg and 1.13 kg, respectively.

The nonsignificant depressing effect of stocking rate on greasy and clean wool weight/ewe, differed from finding of Kenney & Davis (1975), FitzGerald (1976), Joyce et al. (1976), Langlands (1977), Reeve & Sharkey (1980), White et al. (1980), Donnelly et al. (1983) and Langlands et al. (1984). However, the magnitude of the effect in these and the present study depended basically on the levels of stocking considered. Conclusions made by those authors were based on a wider range of stocking. Owing to this fact there was no deteriorlation of wool quality components at the higher rate.

According to Langlands & Bennett (1973), when stocking rate is increased the herbage

TABLE 6. Least squares means and standard errors for the interaction between joining season and stocking rate.

Joining season	Trait (kg)	Stocking Rate 10 ewes/ha		Stocking Rate 15 ewes/ha		Significance level between stocking rate
	GFW					
JS.1		3.60	±0.08	3.34	±0.07	**
JS.2		3.36	±0.05	3.26	±0.05	ns
JS.3		3.33	±0.05	3.44	±0.05	ns
	CFW					
JS.1		2.81	±0.07	2.64	±0.06	*
JS.2		2.66	±0.04	2.56	±0.04	ns
JS.3		2.63	±0.04	2.71	±0.04	ns

* (P<0.05)
** (P<0.01)
ns (P>0.05)

TABLE 7. Least squares means (expressed as percentage deviation from the overall mean) for the interactions between breed and year and joining season and year.

Source	Trait	Mean	Year of measurement 1977	1978	1979	1980	1981
Breed							
	CFW (kg)	2.64					
Corried.			-6.2	+6.7	+19.6	+4.8	-18.0
Romney			-17.6	+9.3	+19.2	+1.0	-18.4
	WY (kg)	78.75					
Corried.			+12.4	-1.6	+3.7	-6.7	-2.2
Romney			+10.6	+7.1	+6.0	-4.7	+1.4
	LWS (kg)	44.41					
Corried.			-21.9	-1.7	+1.3	-4.5	-0.8
Romney			-18.1	+7.4	+13.7	+10.3	+14.3
J.Season							
	LW/EJ(%)	0.66					
JS.1			-57.4	-31.6	+10.9	-13.4	+10.9
JS.2			-54.4	-11.9	+26.1	+26.1	+30.7
JS.3			-33.1	+18.5	+4.9	+50.5	+27.7
	TWW/EJ (kg)	19.64					
JS.1			-14.2	+1.6	+3.6	-8.1	-21.1
JS.2			-16.3	+19.7	+17.8	-3.2	-5.4
JS.3			-14.5	+11.9	-2.8	+25.3	+5.6

intake/sheep declines and their liveweight may be adversely affected. The results found are in agreement with these authors; however, it appears that the extent of liveweight reduction in both ewes and lambs at the higher stocking rate was, on average, rather small. The overall results obtained suggest that, when 10 or 15 ewes were stocked per hectare, the levels of feed were relatively similar. Both greasy and clean wool production per ewe were, respectively, 2.0% and 1.8% greater at the lower stocking rate, but these parameters were much less (37.7% and 38.2%, respectively), when expressed on unit area basis. There was also a small advantage of 5.0% in lambs born per ewe joined at the lower stocking rate, in which the relative mean difference in lambs weight to weaning was significantly superior by 4.8%. Considering, however, production per hectare, the higher stocking rate produced more 30.12% kg of lamb weaned (Table 6).

As should be expected, the wool production per unit area was much greater at the higher stocking rate; however, the relatively greatest greasy and clean wool production were achieved with the April-May joining (JS.3) (Table 8). This is also consistent in terms of price received for the wool (Table 9). At the higher rate, the total clean fleece value/ha from ewes in JS.3 was 8.4% and 7.0% greater than those in JS.2 and JS.1, respectively.

In view of the trends obtained, a higher stocking rate than 15 ewes/ha could well be investigated in the environment. In these circumstances, and considering the stocking rate x joining season interaction, such investigation should be conducted particularly within the joining period from April 15 to May 27.

TABLE 8. Greasy and clean wool production (GW / kg/ha; CW / kg/ha) from ewes at different stocking rates and joining seasons

Joining season	GW / kg/ha S. Rate (ewes/ha) 10	GW / kg/ha S. Rate (ewes/ha) 15	CW / kg/ha S. Rate (ewes/ha) 10	CW / kg/ha S. Rate (ewes/ha) 15
JS.1	36.0	50.1	28.1	39.6
	(-14.8)	(+18.6)	(-15.6)	(+19.0)
JS.2	33.6	48.9	26.6	38.4
	(-20.5)	(+15.7)	(-20.1)	(+15.4)
JS.3	33.3	51.6	26.3	40.7
	(-21.2)	(+22.1)	(-21.0)	(+22.3)

Values between brackets are percentage deviation from the overall mean of stocking rate x joining season interaction

TABLE 9 Total clean fleece value per ewe (FV/ewe) and per hectare (FV/ha) at diferent stocking rates and joining seasons.

Joining season	Stocking rate (ewes/ha) 10		15	
	FV/ewe	FV/ha	FV/ewe	FV/ha
JS.1	+8.5	-13.0	-3.4	+16.0
JS.2	+0.2	-19.6	-4.6	+14.6
JS.3	-3.0	-22.3	+2.3	+23.0

Values are expressed as percentage deviation from the mean

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