PATTERN OF CHANGE IN WOOL PRODUCTION FROM CORRIEDALE BREEDING EWES VARYING IN AGE COMPOSITION IN RIO GRANDE DO SUL, BRAZIL[1]

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ABSTRACT - The effects of age and reproductive status on the main wool production components of 1256 Corriedale breeding ewes, ageing 2 1/4 to 8 1/4 years old, were investigated in southern Brazil, and used to predict the mean production of flocks of differing age structure. The results showed that wool production varies considerably with age and reproductive status and that in distinct environments the effects are unlikely to be constant with respect to most productive ages. Results on production from flocks varying in age composition (adjusted for the effects of reproductive status and ewe mortality rates), demonstrated that, in this environment, flocks containing ewes up to 61/4 years old, would have a relatively better wool production than when including older ewes.

Index terms: age, flocks, environment, mortality rates.

MODELO DE VARIAÇÃO DA PRODUÇÃO DE LÃ DE REBANHOS DE CRIA CORRIEDALE DE DIFERENTES IDADES NO RIO GRANDE DO SUL, BRASIL

RESUMO - Os efeitos da idade e condição reprodutiva sobre os principais componentes de produção de lã foram investigados em 1256 ovelhas de cria Corriedale no estado do Rio Grande do Sul. Estes fatores foram empregados para calcular a produção média de rebanhos com estrutura de idade diferenciada. Os resultados mostraram que a produção de lã varia consideravelmente com a idade e condição reprodutiva e que, em ambientes distintos, os efeitos não são constantes com relação à produtividade nas diferentes idades. Os resultados sobre a produção de rebanhos de estrutura de idade diferenciada (ajustados para os efeitos do estado reprodutivo e taxa de mortalidade das ovelhas), demonstraram que, neste ambiente, rebanhos contendo ovelhas até 6 1/4 anos de idade, teriam relativamente melhor produção de lã, daqueles que incluem ovelhas mais velhas.

Termos para indexação: rebanhos, ambiente, ovelhas, taxa de mortalidade.

INTRODUCTION

Wool production and reproductive performance components vary considerably with the age of sheep. Patterns of changes have been examined in different environments and breeds, as reviewed by Brown et al. (1966), Turner & Young (1969) and Mullaney et al. (1969), whose conclusions have highlighted that the effect of age is unlikely to be constant and emphasized the need to know the pattern in distinct areas and breeds. Except the work on Corriedales done by Mullaney et al. (1969) in Australia and by Cardellino (1981) in Uruguay, all others concentrated on strains of Merino breed (Turner 1958, Rose 1974 and 1982, Hawker 1976, Heydenrych 1976, McKinley 1977) or on Romney Marsh and their crosses (Hight et al. 1976, Bigham et al. 1976).

It appears quite important to determine the mean production of breeding ewes at different ages within any sheep production system. This

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provides knowledge of decisions about purchase and management, as the levels of productivity are quite associated with the age flock composition.

In this study, vital statistics of age and reproductive status on wool production of breeding ewes were investigated, and used to predict the mean production in flocks of differing age composition, so that an "optimum flock" could be determined, achieving higher productivity.

MATERIALS AND METHODS

Data presented in this work belong to a long-term experiment on evaluation of performance of the Corriedale breed, carried out during six years (1977-1982) at EMBRAPA (Brazilian Agriculture Research Corporation), in Bagé, Rio Grande do Sul, Brazil. The field station is located at 31°25' South and 54°07' West, with a mean annual rainfall of 1308.7 ± 344.1 mm regularly distributed within the year, and mean temperatures of 24.0°C in Summer and 13.3°C in Winter.

Sheep management

All ewes age groups (Table 1) grazed as one flock on native pasture (mainly composed by *Paspalum notatum flügge* and *Axonopus affinis chase*) at an average stocking rate of six ewes/ha. Shearing was always in late November and early December (late spring) for all animals. The mating, with 3% of rams, averaged 40 days (± 8 days) and started approximately on April 20 (± 7 days). Before weaning ewes were classed as dry, wet-dry or wet (Dun 1963), to establish the lambing status classes applied in the study. As shown in Table 1, the 1978 "drop" was the last one included in the trial in 1980. It had been measured three times, when the trial concluded in November 1982, with mixed-age ewes from 4 1/4 to 8 1/4 years old.

TABLE 1. Numbers of ewes at each year and age group.

Sampling	Age at Shearing								Total
year	1¼	2¼	3¼	4¼	5¼	6¼	7¼	8¼	
1977	40	63	85						188
1978	55	71	48	85					259
1979	61	48	65	43	76				293
1980		59	40	58	43	66			266
1981			50	30	51	30	53		214
1982				47	24	50	25	46	192
Total	156	241	288	263	194	146	78	46	1412

Wool traits and sampling method

The data on wool traits recorded annually were: greasy fleece weight (GFW), clean fleece weight (CFW), washing yield (WY) fibre diameter (FD); staple length (SL) and crimp frequency (CF), following the procedures described below:

Greasy fleece weight: It was obtained in accordance with Short & Chapman (1965), however, fleeces were not skirted. Belly and leg wools were not included.

Staple length: It was measured by inserting a scale into the midside area of the fleece, on the sheep and reading the scale at the blocky part of the tip of the staple (Short & Chapman 1965).

Midside sample: While sheep were being shorn, a wool sample (minimum 70 g) was drawn from the midside area which is generally accepted as a representative site of the fleece to estimate other wool measurements (Turner et al. 1953, Young & Chapman 1958, Sumner & Revfeim 1973).

Crimp frequency: It was determined with the staple straightened but at rest by counting the waves within a 2.5 cm scale (Short & Chapman 1965). Care was taken to measure representative staples from the midside samples.

Washing yield and clean fleece weight: Scouring followed the technique described by Fraser & Short (1960). WY (at 16% regain) and CFW were calculated according to Short & Chapman (1965). This does not take into account the residual wax and vegetable matter content, however, by visual appraisal, the latter did not appear to be excessive in amount.

Fibre diameter: The mean FD of each fleece was obtained on one test specimen (which was taken from the subsample) on a constant pressure W.I.R.A. Air-Flow apparatus. Procedures of sample preparation, conditioning and fibre diameter measurement followed the International Wool Textile Organization (1975) test method, which sets out the measurement for cored wool. Although the original samples were in a staple form, the Shirley Analyser was chosen as the wool carding method and, therefore, all samples had to be cut into approximately 2 cm lengths.

Statistical analysis

Estimates of all fixed effects were obtained by the Least Squares Method (Steel & Torrie 1981), using Harvey's Program (Harvey 1979). The general model fitted examined only first order interactions, which, when non significant, were dropped from the model and a new analysis was run including the main effects and significant two factors interaction terms. The reduced equation is represented by:

$$Y_{jkmn} = u + A_j + L_k + Y_m + (LY)_{km} + E_{jkmn}$$

where:

Y_{jkmn} = an observation of one character
u = overall mean
A_j = effect of the j th age of ewe at shearing ($j=2\ 1/4, \ldots, 8\ 1/4$ years old; $\sum A_j=0$)
L_k = effect of the k th lambing status ($k=1$ (dry), 2 (pregnant), 3 (lactating); $\sum L_k=0$)
Y_m = effect of the m th year of measurement ($m=1977, \ldots, 1982$; $\sum Y_m=0$)
$(LY)_{km}$ = interaction between lambing status and year
E_{jkmn} = random error of observations, assumed to be normally distributed ($u=0$; σ^2).

Data on ewe hoggets shown in Table 1 (1 1/4 year old) were not considered in the model, once its inclusion would increase biases on the estimates of lambing performance effects (Brown et al. 1966). No age x year interaction was able to be fitted because all ages were not present in each year (Table 1). The year of birth, age and year of measurement are somewhat confounded. Year of birth is confounded in year of measurement as the effect of year. According to Harvey's program option, the sums of squares among subclasses of age were partitioned into individual degree of freedom and tested individually against the experimental error.

In the present study, reproductive status was put into six categories (Mullaney et al. 1969), as follows: A) bearing no lambs; B) bearing one lamb and failing to raise it to weaning; C) bearing one lamb and raising it to weaning; D) bearing two lambs and raising neither to weaning; E) bearing two lambs and raising one to weaning; F) bearing two lambs and raising both to weaning. Since the numbers of ewes found in categories D, E and F were not sufficient to constitute a separate group (7, 35 and 13 ewes, respectively), the same procedure of combination adopted by those authors was used, and the effects of reproduction was estimated within the following main ewes categories: 1) Dry (category A); 2) Pregnant (categories B and D) and 3) Lactating (categories C, E and F).

RESULTS AND DISCUSSION

The effects of age (adjusted for the effects of year of measurement and reproductive status), was highly significant for all traits studied (Table 2). Least squares means (expressed as deviation from the overall mean) are presented in Figures 1a, 1b and 1c.

Quadratic and cubic components of age effects accounted for the highest fraction of the variance. GFW reached its highest levels in 3 1/4 and 4 1/4 years old ewes. From 5 1/4 years onwards, the tendency was to decrease within values always lower than those of 2 1/4 years old. Although showing a slight peak at 3 1/4 years, CFW was not significantly different between 2 1/4 and 5 1/4 years old. The decline thereafter was similar to that of GFW. The linear and quadratic terms were significant. Overall, there was a linear tendency of WY to decrease with age. FD increased steadily to 3 1/4 years of age then showed regular changes at each subsequent age group. A linear response

TABLE 2. Least squares analyses of variance for the wool traits.

Source	df	GFW	CFW	WY	FD	SL	CF
		Mean Squares					
Age	6	26.72**	0.47**	233.14**	434.15**	26.16**	81.71**
Linear	1	3.81**	1.81**	974.81**	1480.16**	94.48**	441.34**
Quad.	1	59.54**	0.85**	51.18	656.58**	2.81	1.33
Cubic	1	72.36**	0.01	52.35	357.25**	3.60	118.81**
Quart.	1	37.85**	0	11.96	97.60**	43.59**	7.98
Quint.	1	8.98	0.02	111.39**	12.56	19.58**	2.27
Resid.	1	2.25**	0.11	198.04**	0.71	9.51	0.09
Lamb. Perf.	2	5.83**	2.03**	21.35	8.06	15.91**	0.62
Year	5	37.83**	15.56**	381.69**	559.82**	121.58**	72.18**
Lamb. Perf. x year	10	0.99**	0.41**	-	-	4.14*	-
Remainder		0.23	0.17	25.39	5.28	1.95	2.18
df		1232	1116	1116	952	1137	1092

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

GFW = greasy fleece weight
CFW = clean fleece weight
WY = washing yield
FD = fibre diameter
SL = staple length
CF = crimp frequency

would fit the data, however, the additional improvements due to fitting the second and third order polynomial degrees were also highly significant. SL was highest at 2 1/4 years of age. Though other relations were found, the linear one fitted the age trend on SL. CF decreased with age, showing highly significant linear and cubic relations.

Highly significant effects of reproduction were observed on GFW, CFW, and SL (Table 2). Other characters were not significantly affected. Deviation from the overall mean within the reproductive status categories are given in Figures 2a, 2b and 2c.

The partitioning of the lambing status categories, demonstrated that pregnancy had no effect on CFW, FD or SL ($P > 0.05$), but it depressed GFW by 2.4%. The effect of lactation was greater for all traits. It reduced most markedly GFW (4.0%) and CFW (3.7%). FD and SL showed small changes. The significant reproductive status x year interaction for GFW, CFW and SL were mainly derived from a

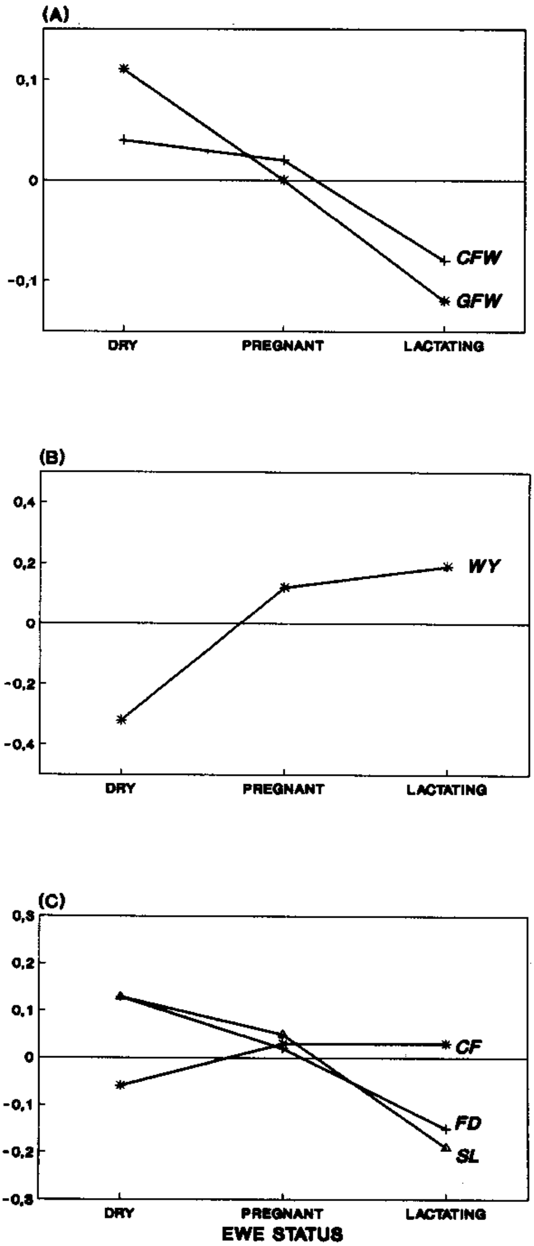

FIG. 1. Association between age and wool production components in Corriedale breeding ewes. (traits are expressed as deviation from the overall trait mean).

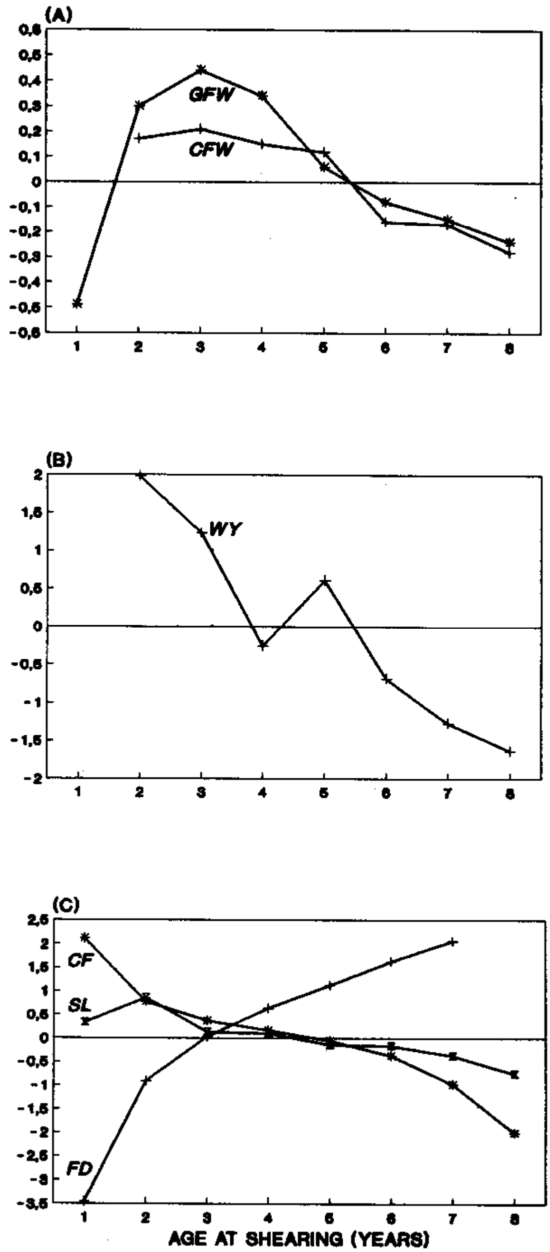

FIG. 2. Association between reproductive performance and wool production components in Corriedale ewes. (traits are expressed as deviation from overall trait mean).

reversal in the rankings of the categories in some experimental years.

Although the trends found for the effect of age on most wool components followed those already described in other works, there did not seem to be agreement regarding the relative magnitude of pregnancy or lactation, or their combined effects, between the results in this study and others done on similar breed. Regarding the effects of reproductive status, it seems that attempts to compare trends might not lead to satisfactory conclusions, once these may partly include biases from sources such as, genetic differences between and within breeds, environmental conditions at the site of the experiment, management procedures or even the extent of their interactions. Additional limitation is given by the significant reproductive status x year interaction for GFW, CFW and SL, indicating that reproduction effects did not affect them similarly in all years. Perhaps grazing management favouring pregnant and/or lactating ewes in bad years, has contributed to this interaction, since ewes experienced favourable and unfavourable years during the experimental period. As stated by Brown et al. (1966), "in the absence of any important age x year interaction, it can be assumed that lambing performance x year interaction is unlikely to be large enough to have a marked influence on the estimation of effects of pregnancy and lactation". Once the interaction between age and year was not able to be fitted, it is rather difficult to obtain accurate estimates on the magnitude of reproductive status effects. However, it is clear that, in the environment investigated, the combined physiological stresses had an appreciable influence on wool productivity.

Patterns of changes in wool production with age and reproductive status have been the subject of much research; however, very little evidence has been found regarding the effects in the Corriedale breed. Such evaluations are, however, important because together with ewe mortality rates, both can be used to determine the actual productivity in flocks of varying age structure.

The estimate of wool production from flocks of different age composition and with varying proportions in each reproductive status category, was in accordance with the method described by Brown et al. (1966). For each age group, the proportion of ewes within each reproductive status (viz., dry, pregnant and lactating) was estimated and adjustments were made upon the means of those traits presented in Figures 1a, 1b and 1c. The death rates were applied and the age effects were adjusted for the different percentages of ewes surviving in each subsequent age group.

The results presented in Table 3 give parallel values for GFW, CFW, WY, FD, SL and CF for flocks aged 2 1/4 to X years, which are deviation from a flock base of 3 1/4 years of age and showing the highest wool weight.

The inspection on the figures in Table 3 reveals that all flocks with an oldest age group greater than 3 1/4 years had lower GFW, CFW, WY, SL and CF. However, FD increased linearly up to a deviation of 1.32 μm in the 8 1/4 years old flock. It appears that the fall in wool production would be the least for flocks terminating at 5 1/4 or 6 1/4 years of age. For example, if the casting age were varied from 5 1/4 to 8 1/4 years, the latter flock would produce, on average per breeding ewe, -0.16 kg in GFW, -0.12 kg in CFW, -0.68% in WY, -0.23 cm in SL and -04.5 crimps/2.5 2.5 cm. FD would be increased by 0.81 μm.

In general, most studies report a negative and linear relationship between age and SL. The results obtained agree with these findings, but the magnitude of decline was found to be smaller. This contrasting results reflect on comparisons of flocks differing in age composition. Related to a 3 1/4 years old flock, ewes at 6 1/4 years old would have fleeces with staples 0.35 cm shorter, which is much lower than that reported by Mullaney et al. (1969). At 8 1/4 years old, however, mean staple length would be decreased by 0.51 cm, suggesting that, at that age, fleeces commercial quality would be somehow being influenced negatively.

Age had a marked effect on FD, which increased from 2 1/4 to 8 1/4 years old, with most

TABLE 3. Wool production for flocks of different age composition: Mean deviation between flocks of ewes aged 2 1/4 to X years and one aged 3 1/4 years.

Age (X) of oldest age group at shearing (years)	Nº of ewes surviving at each age group	Deviation from a 3¼ years-old flock					
		GFW	CFW	WY	SL	FD	CF
2¼	100	-0.03	-0.01	+0.26	+0.40	-0.40	+0.18
3¼	92	0	0	0	0	0	0
4¼	82	-0.02	-0.03	-0.53	-0.15	+0.31	-0.12
5¼	76	-0.10	-0.04	-0.61	-0.28	+0.58	-0.23
6¼	66	-0.17	-0.10	-0.86	-0.35	+0.81	-0.34
7¼	57	-0.21	-0.13	-1.09	-0.42	+1.01	-0.48
8¼	50	-0.26	-0.16	-1.29	-0.51	+1.39	-0.68

GFW = greasy fleece weight (kg)
CFW = clean fleece weight (kg)
WY = washing yield (%)
SL = staple length (cm)
FD = fibre diameter (micrometres)
CF = crimp frequency (number/2.5 cm)

of this increase occurring between 1 1/4 and 3 1/4 years of age. This is in contrast with results of Mullaney et al. (1969) who found FD declining after 4 years of age. For different age flocks and related to the 3 1/4 years old flock, wools from 8 1/4 years old ewes would be 1.39μm greater in diameter and decreased by 0.68 in number of staple crimps. These results indicate that fleeces from older ewes would be classed as finer when appraised visually.

CONCLUSIONS

1. The results from this trial broadly agree with other reports regarding the curvilinear pattern of wool production with age in Corriedales. However, they also demonstrate that, in distinct environments, age effects on fleece components are not constant with respect to most productive ages.

2. The magnitude of the effects of reproductive performance (measured by the effects of pregnancy and/or lactation) on wool quantity and quality, are not comparable to other studies, revealing the need of knowing them in different environments, to improve wool production of ewes.

3. It has been demonstrated that, in terms of wool production, the knowledge of flocks performance (related to both effects of age and reproduction) is an important matter, when one

aims at achieving better productivity from breeding ewes.

4. Considering the mean production from flocks varying in age composition, it has been shown that, within the environment examined, flocks containing ewes up to 6 1/4 years old, would have a relatively better wool productivity than when including older ewes.

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