EFFECT OF SEASONAL CONDITIONS ON FLEECE WEIGHT AND ITS COMPONENTS IN MERINO SHEEP GRAZING MITCHELL GRASS PASTURE IN NORTH WEST QUEENSLAND

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SUMMARY

Seasonal conditions in the pre to post natal period and selected periods before and during wool growth were described using climatic measures and estimates of the quality and quantity of pasture on offer derived from a validated pasture production model (GRASP). The variation in greasy and clean fleece weight, yield, staple length, fibre diameter, neck and side wrinkle score of Merinos grazing Mitchell grass in north west Queensland was explained in terms of these pasture and climatic measures and animal characteristics such as reproductive status, age and skin area. Multiple regression equations predicting clean and greasy fleece weight from the proportion of days in the wool growth period that the green pool in the pasture was less than one kg/ha, the percentage utilisation of the pasture, age, reproductive status and skin area of the ewes explained 87% and 79% of the variation respectively. Equations with similar predictors explained 58-85% of the variation of the other components. The inclusion of pasture conditions in the pre to post natal period did not significantly improve the predictions of the animal's later performance.
Keywords: Merinos, wool, Mitchell grass, seasonal conditions

INTRODUCTION

Rose (1974, 1982) reported the effects of age, year and lambing performance on greasy fleece weight, percentage yield, fibre diameter and staple length of an experimental flock grazing Mitchell grass pasture on Toorak Sheep Field Research Station, Julia Creek, Queensland. The "year" effect, which was the effect of year of measurement compounded with year of drop, was significant in this area of harsh and variable seasonal conditions (Rose 1982). The maturation of secondary follicles can be retarded if the nutrient supply is restricted in the late pregnancy of the ewe and wool growth can be affected if the young lamb is severely undernourished (Corbett 1978).

This paper attempts to unravel the effects of seasonal conditions during the pre to post natal period from the period of actual wool growth. The longer term aim of the study is to predict fleece weight and its components from seasonal conditions and animal characteristics.

MATERIALS AND METHODS

The management of the flocks and the environment have been described previously (Beattie 1961; Rose 1972). Some of the cohorts in this study were born in spring 1959-64 onto normally poor pasture in an area where the summer rainfall dominates. Other cohorts were born in autumn 1966-72 when more favourable conditions usually apply. There were 153 cohorts consisting of one to 120 ewes.

Table 1. Description of wool and animal characteristics

Variable	Description	Range
gfw	greasy fleece weights (kg)	2.0-4.8
cfw	clean fleece weight (kg)	0.8-2.7
yield	yield (%)	38-60
sl	staple length (cm)	2.3-3.8
fd	fibre diameter (μm)	16-22
nws	neck winkle score	1.6-4.5
sws	side wrinkle score	1.0-3.0
sa	area of skin estimated by 0.09 weight $^{2/3}$	0.7-1.2
age	years	1.25-9.75
preg	reproductive status: failed to lamb, lambed and lost (LL), lambed and reared (LR)	

The pre to post natal period in this study was defined as the five months prior to marking.

As the distribution of rainfall rather than the total annual rainfall affects seasonal conditions, various climatic measures which a wool grower would be able to readily calculate were computed.

Table 2. Description of climatic measures finally selected for prediction

Variable	Description	Range
rd_i	the rainfall in the growing season in the year of wool growth (mm) (the beginning of the growing season for Mitchell grass being defined as the date after 1 July when the rain over three days was greater than 10 mm and the average temperature greater than 14^{o}C and the end of the season by the last similar event before 30 June of the next year)	118-503
rd	the total rainfall in the current and previous growing season	419-890
dry	the number of days between the previous growing period to the beginning of the next	187-273
rddays	the number of rain days in the growing period.	10-32

In addition, a pasture production model, GRASP, (McKeon *et al*. 1990) validated for Mitchell grasses on clay at Toorak Research Station and Gilruth Plains (McKeon *et al*. 1990; Hall 1996) was used to predict the quality and quantity of pasture on offer. Numerous possible measures of quality and quantity of pasture on offer were computed using GRASP for both the pre to post natal period and selected periods in the previous two years before a shearing.

Table 3. Description of GRASP measures finally selected for prediction

Variable	Description	Range
gN1	average nitrogen content of pasture on offer over previous pasture growing season	6-15
gN2	average nitrogen content of pasture on offer over the pasture growing season	6-15
avN	the average nitrogen of pasture in wool growth period kg/ha.day	7-15
sgp1	the proportion of days in wool growth period the green pool (leaf & stem) ≤1 kg/ha	.07-.54
sgl5	the proportion of days in wool growth period the green leaf ≤5 kg/ha	.18-.62
util	% utilisation of pasture (total consumed/total growth) over the wool growth period	10-43

Fleece weight and the other characters would be expected to be correlated. These were combined into meaningful groups from the correlation matrix and principal component analyses. Models relating these groups to the animal characteristics and the climatic and GRASP measures, some of which would be expected to have similar prediction value, were determined using the step-forward multiple regression method of successively including the next best predictor. In all analyses, the number of observations in each cohort was used as a weighting factor. The screening analyses, done on the scores from the principal component analyses, reduced the number of predictors and ensuring the same predictors (or a subset of them) for each set of correlated characters. A model for each character was then determined from these reduced number of predictors using step forward multiple regression. In this way, the best overall predictors could be determined for each set of correlated characters.

RESULTS

From the correlation matrix in Table 4 it can be seen that, as expected, cfw, gfw, and sl were highly correlated as were nws and sws. Fibre diameter showed some correlation with fleece weight (cfw and gfw) and with wrinkle score (nws and sws).

Table 4. Correlation matrix of fleece weight and its components

Wool	cfw	gfw	yield	sl	fd	nws
gfw	.925					
yield	.428	.062				
sl	.720	.698	.262			
fd	.418	.472	-.038	.243		
nws	.160	.111	.093	-.161	.448	
sws	.166	.114	.074	-.116	.423	.867

Table 5. Principal component vectors

Variate	All variates			Set 1 variates		Set 2 variates	
	Vector 1	Vector 2	Vector 3	Vector 1	Vector 2	Vector 1	Vector 2
cfw	-.54	-.19	.10	-.60	.34		
gfw	-.51	-.19	-.26	-.59	.42		
yield	-.19	-.10	.88				
sl	-.41	-.38	-.02	-.54	-.84		
fd	-.38	.25	-.36			-.46	.89
nws	-.23	.60	.12			-.63	-.31`
sws	-.24	.59	.11			-.62	-.35
% variation explained	43.1%	29.1%	15.1%	85.6%	11.8%	72.9%	22.7%

Vector two of the principal component analysis of all variates (Table 5) represented a difference between cfw, gfw, sl and fd, nws, sws; vector three, yield. On the basis of these results and the correlations, the characters were grouped into three sets for further principal component analyses (Table 5) and for model fitting: set 1 (cfw, gfw, sl), set 2 (fd, nws, sws) and set 3 (yield). The results of step forward multiple regression analyses of yield and the first vector of the sets one and two on the possible predictors are given in Table 6. None of the GRASP measures for the pre to post natal period significantly improved the predictions.

Table 6. Additional % variation explained with successive best predictors included in multiple regression equations

Predictors	Vector 1 of set 1	Predictors	Vector 1 of set 2	Predictors	Yield (set 3)
sgp1	30.0%	dry	28.3%	rd	46.7%
+ age + age^2	22.7%	+ gN2	28.9%	+ avN	5.6%
+ sa	18.4%	+ preg	6.5%	+ preg	3.3%
+ util	6.7%	+ age + age^2	13.5%	+ age + age^2	2.5%
+ preg	3.8%	+ gN1	3.5%		
		+ sgl5	1.1%		

Prediction equations for fleece weight and its components from multiple regressions analyses using the final predictors from Table 6 were as follows:-

cfw = 0.93±.14 -1.83±.08 • sgp1 +1.76±.16 • sa +.081±.024 • age -.0111±.0021 • age^2 -.014±.0012 • util -.107±.032 • LL -.161±.024 • LR (86.6% variation explained)

gfw = 1.85±.33 -3.09±.19 • sgp1 +2.83±.37 • sa +.215±.055 • age -.0252±.0048 • age^2 -.013±.0027 • util -.185±.074 • LL -.289±.056 • LR (79.3% variation explained)

sl = 3.17±.17 -1.07±.10 • sgp1 +.94±.20 • sa -.058±.030 • age -.0028±.0026 • age^2 -.008±.0015 • util -.082±.039 • LL -.109±.030 • LR (76.1% variation explained)

fd = 20.43±.45 -1.55±.21 • LL -1.99±.15 • LR +.71±.12 • age -.057±.011 • age^2 -2.18±.55 • sgl5 +.118±.029 • gN2 -.0078±.0024 • dry (59.8% variation explained)

nws = 3.29±.19 -.0164±.00079 • dry +.248±.012 • gN2 +.143±.011 • gN1 +0.354±.039 • age -.030±.0036 • age^2 -.200±.070 • LL -.406±.051 • LR -1.40±.19 • sgl5 (84.6% variation explained)

sws = 2.44±.15 -0.013±.0006 • dry +.148±.010 • gN2 +.063±.009 • gN1 +.269±.033 • age -.022±.0031 • age^2 -.179±.058 • LL -.288±.042 • LR (78.0% variation explained)

yield = 41.77±.87 +.0081±.0014 • rd +.368±.088 • avN -0.74±.51 • LL -1.39±.37 • LR +.59±.29 • age -.068±.027 • age^2 (58.1% variation explained)

Restraining the predictors to the same ones for each set lost little in effectiveness of prediction. A similar procedure was undertaken to determine the effectiveness of the climatic measures only.

cfw = -0.14±.21 +3.09±.23 • sa -.056±.007 • age -.00376±.00048 • dry (56.5% variation explained)

gfw = 0.19±.44 +5.21±.48 • sa -.085±.015 • age -.00593±.00102 • dry (44.2% variation explained)

sl = 2.47±.19 +1.66±.24 • sa -.146±.033 • age +.0045±.0029 • age^2 -.00156±.00043 • dry (60.7% variation explained)

fd = 20.82±.48 -.0088±.0019 • dry -1.51±.22 • LL -1.99±.16 • LR +0.72±.13 • age

			$-.059 \pm .012 \bullet \text{age}^2$			(52.4% variation explained)
nws	=	$4.74 \pm .27$	$-.0119 \pm .0011 \bullet \text{dry}$	$+.0015 \pm .0004 \bullet \text{rd}_i$	$+.367 \pm .071 \bullet \text{age}$	$-.031 \pm .007 \bullet \text{age}^2$
			$-.196 \pm .126 \bullet \text{LL}$	$-.409 \pm .090 \bullet \text{LR}$		(48.4% variation explained)
sws	=	$2.88 \pm .18$	$-.0086 \pm .0007 \bullet \text{dry}$	$+.0014 \pm .0002 \bullet \text{rd}_i$	$+.289 \pm .047 \bullet \text{age}$	$-.024 \pm .004 \bullet \text{age}^2$
			$-.228 \pm .082 \bullet \text{LL}$	$-.346 \pm .059 \bullet \text{LR}$		(55.8% variation explained)
yield	=	35.40 ± 2.14	$+.0122 \pm .0010 \bullet \text{rd}$	$-.49 \pm .53 \bullet \text{LL}$	$-.95 \pm .40 \bullet \text{LR}$	$-.27 \pm .40 \bullet \text{age}$
			$+.0005 \pm .0350 \bullet \text{age}^2$	$+9.35 \pm 2.62 \bullet \text{sa}$		(56.8% variation explained)

DISCUSSION

For greasy and clean fleece weight and staple length a combination of animal characteristics (age, reproductive status and skin area) and pasture measures (proportion of days in the wool growing period when the green pool was less than one kg/ha and the % utilisation of the pasture) gave reasonable predictions. Skin area could be estimating intake or alternatively, the larger ewes could just be growing more wool. The amount of variation explained, 76-87%, was reduced to 44-61% if only climatic measures and animal characteristics were considered. For fibre diameter and wrinkle scores the percentage variation explained dropped from 60-85% to 48-56%. It was thus concluded the inclusion of GRASP measures such as the proportion of days in the wool growth period for which the green leaf or green pool is less than a threshold and the utilisation of the pasture, could improve the predictions, similar to cattle (McCown *et al*. 1981). Yield was poorly estimated with and without the GRASP measures (58 and 57%). Common predictors, the rainfall over the last two growing seasons, reproductive status and age, explained 53.4% variation. The average nitrogen in the pasture over the wool growth period was replaced by skin area when only climatic measures and animal characteristics were considered. The explanation of the inclusion of skin area could be that it is correlated with another unmeasured factor which does affect yield.

Kelly *et al.* (1996) found that lambs of ewes on a submaintenance diet produced 0.1 kg less clean wool at lamb shearing, at 0.4 years of age, than those of ewes on a maintenance diet ($P<0.01$) while at hogget shearing, at 1.4 years of age, the difference was not significant ($P=0.10$). Their hogget wool was 0.1 μm broader ($P<0.05$) although there was no significant differences in yield, staple length and strength. The early disadvantage of the progeny of ewes on submaintenance diets was largely overcome by hogget shearing. The ewes in our study ranged in age from 1.25 year to 9.75 years. As the GRASP measures estimating pasture quality and quantity over the pre to post period did not significantly improve prediction, it appears that nutritional status of the pasture during the wool growth period overshadowed any effect the pre to post natal nutrition may have had. Corbett (1978) hypothesised that the rate of wool growth is directly related to feed intake, and undernutrition of young sheep, unless exceptionally severe, has little effect on their ability to grow wool.

Being able to predict fleece weight and its components in different seasons could be a useful management tool for wool growers especially if they could easily obtain the necessary predictors.

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