MATERNAL FOOD CONSUMPTION AND FOETAL GROWTH IN MERINO SHEEP

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Summary

The intake of a pelleted diet offered ***ad libitum*** to pregnant Merino ewes between the 90th and 140th days of pregnancy was influenced by their previous nutritional history and degree of body fatness. Marked compensatory intake occurred in previously ill-fed ewes whereas the intake of well-fed fat ewes carrying single foetuses declined slightly as pregnancy proceeded.

The body weights of single foetuses after 90 and 140 days of gestation were affected to a small extent by the level of maternal feed intake in early and late pregnancy. Male foetuses were significantly heavier than females at 90 days.

I. INTRODUCTION

Severe maternal undernutrition in early pregnancy can affect placental development, retard foetal growth (Everitt 1964) and reduce the number of lambs born, particularly to maiden ewes (Bennett, Axelson and Chapman 1964). On the average, ewes which are heavy at mating show a superior reproductive performance to lighter ewes (Wallace 1961; Coop 1962, 1964). The need, however, to examine the role of ***components*** of body weight, especially fat, in the body weight-fertility relationship has recentiy been advocated by Cockrem (1965).

This present experiment was undertaken to provide information about:-

(i) the effects of body weight, condition (fatness) and skeletal frame size of the ewe at mating, and of maternal undernutrition in early pregnancy, on foetal growth and development; and,

(ii) the response of the pregnant ewe to liberal feeding after a period of undernutrition.

II. METHODS AND MATERIALS

(a) Experimental design and animals

A 2 x 2 factorial design was used to compare the performance of ewes differing markedly in body weight at the time of mating and to compare the effects of a high plane with a low plane of maternal nutrition during the first 90 days of pregnancy.

Fortyeight 3-year-old South Australian Merino ewes were randomised into two groups after weaning their lambs in September. Animals of one group were

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offered a pelleted feed *ad* libitum until mating (He), while the feed intake in the other group (*Li*) was severely restricted causing substantial body weight loss.

After mating to a ram of the same strain, ewes of each group were allocated alternately to the two nutritional regimes so that the gross body weight of each animal either increased (HP) or decreased (*LP*) by 15 % over 90 days of pregnancy. From 91 to 140 days of pregnancy all sheep were offered feed ***ad libitum.***

Six randomly selected He ewes and six *Li* ewes were killed at joining time in October. Six ewes from each of the four groups (He/HP; *He/LP; Li/HP; Li/LP*) were slaughtered after 90 days of pregnancy, and three from each of the four groups after 140 days of pregnancy.

(*b j* ***Management***

(i) General

Sheep were accommodated in a two acre paddock offering no shade and negligible herbage. Differential feeding during pregnancy commenced on the day following the last observed service of the fertile ram (Day 1) .

All ewes were drenched with 1 million I.U. Vitamin A and 250,000 I.U. Vitamin D3 in October 1962, and again in February 1963. Ewes were also drenched with thiabendazole in September 1962 and January 1963.

(ii) Feeding

Ewes were fed twice daily in individual stalls located adjacent to the area. The quantity of feed offered was adjusted after each weekly weighing in order

TABLE 1

Summary of ***the*** *principal* ***dietary constituents***

Constituent	Percentage	*
Pelletted feed†		
Lucerne	45	
Barley	50	
Common salt	2	
Sterilised bone meal	3	
Dry matter	95.2	(78)
Composition (% of dry matter)		
Ash	6.5	
Organic matter	93.5	
Ether extractives	4.6	(83)
Crude fibre	14.2	(78)
Crude protein (N x 6.25)	15.0	(84)
Nitrogen-free extractives	57.4	(77)
Ca	1.80	
P	0.63	
Na	0.62	
Cl	1.31	
Digestible organic matter (%)	72	

Note :

*Apparent digestibility coefficients, derived from feeding trials with three wethers, are shown in parentheses.

†Pellets approximately 1 cm long and 0.4 cm diameter.

to achieve the desired rate of gross body weight change. After 90 days of pregnancy under controlled feeding, all ewes were offered the diet ***ad libitum.***

The composition of the diet used throughout the experiment is recorded in Table 1.

(cj Measurement ***of*** *skeletal* ***frame size and body condition*** **of** ***ewes***

Selected linear body (skeletal j measurements of ewes were recorded at mating as defined by Turner ***et al.*** (1953).

A single subjective condition score was applied to each ewe seven weeks before mating, at mating and subsequently at all weighings. Scores were applied by one experienced observer whose repeatability and discriminatory powers had been studied previously (Everitt 3 962). A scoring system of 10 points was used where score 10 represented "very fat" and score 1 "emaciated".

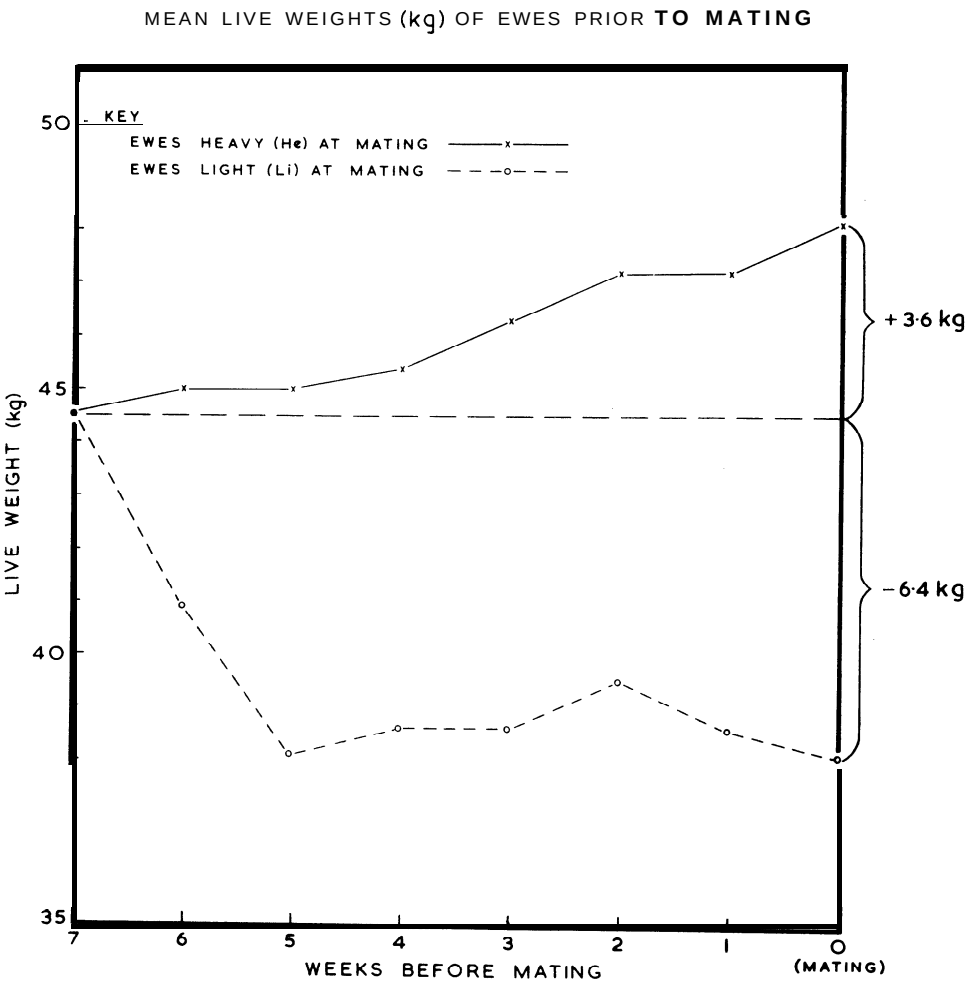

Fig. 1.—Mean gross body weights of all experimental ewes during the seven weeks before mating.

TABLE 2

Mean body condition scores-f

Time of Scoring	Group Means				S.E.	Mean differences	
	He/HP	He/LP	Li/HP	Li/LP		He-Li	HP-LP
Weaning		7.3			0.26	—	—
Mating	8.2			4.5	0.24	3.7***	—
Ewes slaughtered after 90 days	8.0	6.0	6.7	3.5	0.24	1.9***	2.6***
Ewes slaughtered after 140 days							
At 90 days	8.0	5.0	5.7	2.7	0.37	2.3***	3.1***
At 140 days	8.7	7.3	6.7	5.3	0.53	2.0**	1.4*

Note:

†Score 10 = very fat; Score 1 = emaciated.

In this and subsequent tables the following abbreviations are used:—

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

(d) Foetal weights

After removal from the dissected uterus each foetus was dried thoroughly with towels and then weighed to the nearest g.

(e) Biometrical methods

Standard analyses of variance and covariance were used (Snedecor 1956). Variation due to the initial body weight of the ewe at mating time, to maternal nutrition, and to their interaction (each with a single degree of freedom) was isolated.

III. RESULTS

(a) Ewe performance

Seven weeks before mating, the mean weight of all ewes was 44.2 kg ± S.D. 3.2 Ewes ill-fed before mating (*Li*) lost more body weight, on average, than

TABLE 3

Mean body measurements (cm j of ewes at mating time

Measurement	Group Means		S.E.	Mean difference
	He	Li		
Body length	71.1	70.8	0.62	0.3
Withers height	64.6	65.4	0.32	—0.8
Chest depth	31.6	31.8	0.20	—0.2
Pelvis width	18.3	18.6	0.15	—0.3
Pelvis length	22.1	21.9	0.16	0.2
Fore-leg length				
Upper fore-leg	22.2	22.1	0.19	0.1
Lower fore-leg	15.8	16.1	0.13	—0.3
Width at ribs	24.0	22.0	0.38	2.0***

***$P < 0.001$.

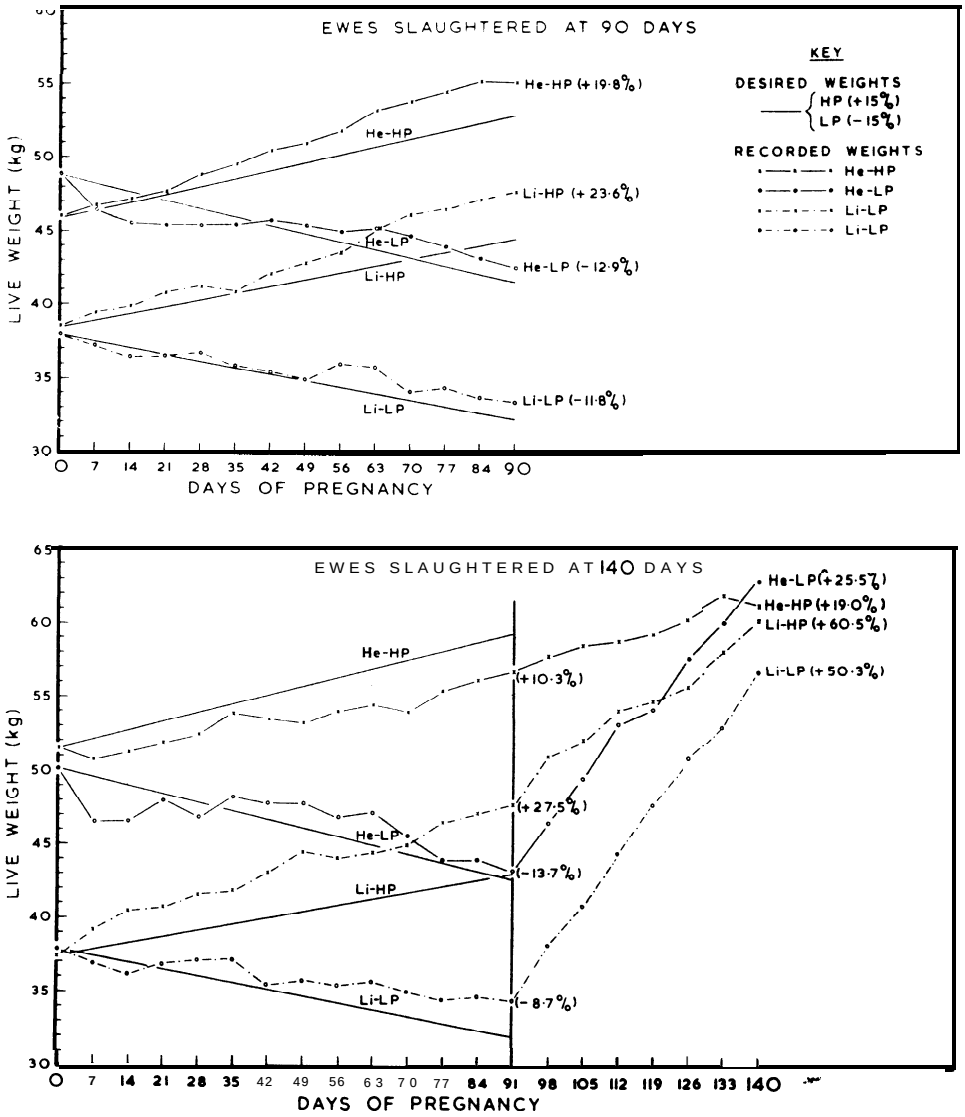

Fig. 2.—Mean gross body weights during pregnancy of ewes slaughtered, each carrying a single foetus.

well-fed ewes (He) gained (Figure 1) . At mating the mean gross body weight of all He ewes was 48.6 kg ± S.D. 3.9 and of all *Li* ewes was 38.1 kg ± S.D. 4.1.

Associated with these changes in gross body weight were alterations in body fatness, as judged by the condition scores (Table 2). He ewes improved in condition immediately before mating, achieving considerable fatness. *Li* ewes were depleted to a lean condition by mating time.

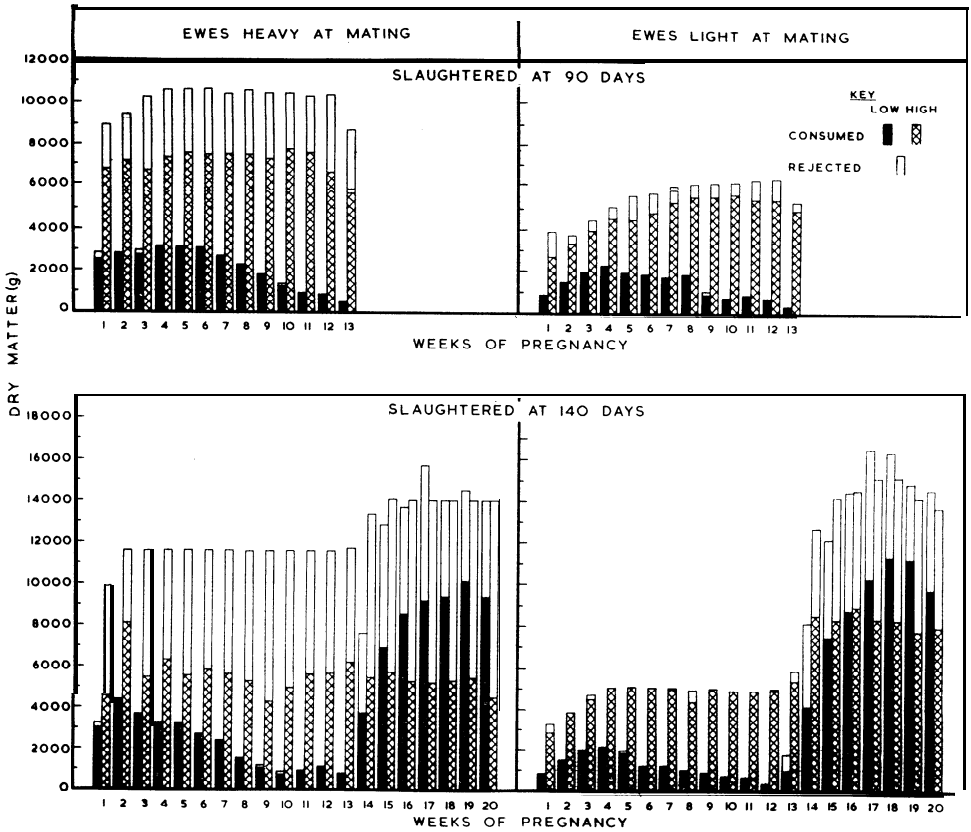

Fig. 3.—Mean weekly amounts of dry matter offered, rejected and consumed by the ewes during pregnancy.

He ewes were significantly wider across the ribs than ***Li*** ewes, suggesting a greater depth of soft tissues overlying the ribs in heavier animals (Table 3). Differences in all other measurements (Table 3) were not significant. Body weight differences at mating, therefore, probably reflected variation in soft body tissues rather than skeletal frame size.

Li/HP ewes tended to gain more weight than desired in early pregnancy (Figure 2), and better accuracy in the control of *LP* animals was achieved. The noticeable body weight reduction of *He/LP* ewes in the first week after mating reflects reduction of gastro-intestinal contents. *Li/HP* animals did not manifest this effect, probably because their meagre rations before mating had already stabilised gut contents at a low level.

Under ***ad libitum*** feeding in late pregnancy, previously underfed ewes gained weight more rapidly than ewes well-fed in early pregnancy.

By 90 days of pregnancy, *Li/LP* ewes had become very lean with *He/LP* and *Li/HP* ewes of comparable fatness (Table 2). At the end of ***ad*** *libitum* feeding (140 days), significant differences still existed in the condition of ewes, *Li/LP* animals recording the lowest mean score.

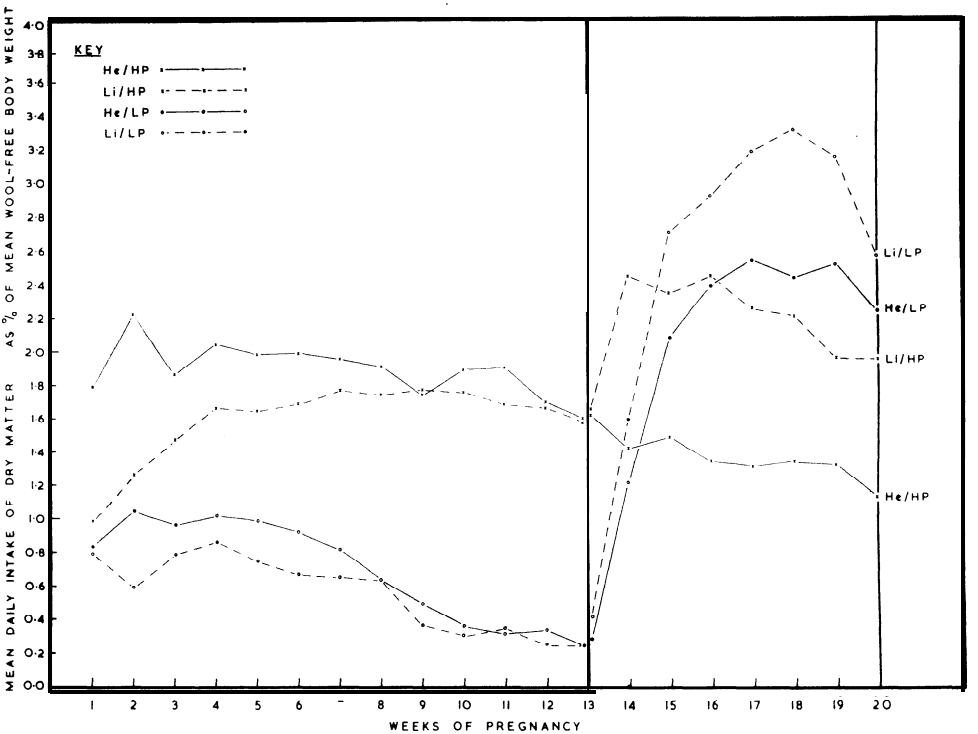

Fig. 4.—Mean daily intake of dry matter during pregnancy as a percentage of mean wool-free body weight. Curves for the first 13 weeks are based on 6 ewes/group but 3 ewes/group for the last 7 weeks.

(b) Food intake

Mean weekly amounts of dry matter (D.M.) offered, rejected and consumed by slaughtered ewes are shown in Figure 3. Trends of feed intake during pregnancy are more clearly seen in Figure 4 where mean daily intakes of D.M. are expressed as percentages of mean wool-free body weights of the ewes.

He/HP ewes were offered feed greatly in excess of appetite throughout pregnancy. The progressive decline of their intake as a proportion of body weight is noteworthy. Intake of *Li/HP* ewes killed after 140 days was slightly restricted in early pregnancy but ewes killed after 90 days were fed in effect ***ad libitum.***

Food offered to, and consumed by, ewes ill-fed in early pregnancy (*He/LP* and *Li/LP*) reached very low levels indeed after 90 days of pregnancy. During the last week (13) of feed restriction, *Li/LP* ewes consumed, on average, 95 g/D.M./day. The pattern of feed consumption in LP ewes during early pregnancy was the result of adjustment to achieve the desired weight changes and was also associated with the stabilisation of gut-fill.

In the last seven weeks of pregnancy, the amount of feed consumed by *Li/LP* ewes, in particular, attained very high levels, much exceeding the intake of ***He/HP*** and *Li/HP* ***ewes.***

TABLE 4

Mean daily intake (g) of digestible organic mutter

Period	Group means				S.E.	Mean differences	
	He/HP	He/LP	Li/HP	Li/LP		He-Li	HP-LP
Ewes killed after 90 days							
0-90 days	744.3	222.0	496.8	139.7	16.2	164.9***	439.7***
Ewes killed after 140 days							
0-90 days	589.3	231.0	483.7	121.7	53.2	107.5	360.2***
91-140 days	533.0	824.0	832.7	904.3	56.9	—190.0*	—181.3*
0-140 days	569.7	442.7	608.7	401.3	46.5	1.2	167.2**

* $P < 0.05$
** $P < 0.01$
*** $P < 0.001$

Mean daily intake of digestible organic matter (D.O.M.) is recorded in Table 4. Intake of D.O.M. in early pregnancy of *He/LP* ewes slaughtered after 90 days was less than one third of the intake of He/HP ewes and less than one-half of the intake of ewes killed after 140 days. Intake of *Li/LP* ***ewes*** was approximately one-quarter of the intake of *Li/HP* ewes. In the last seven weeks of pregnancy, the D.O.M. intake of ewes ill-fed in early pregnancy (*He/LP* and *Li/LP*) was significantly greater than ewes well-fed in early pregnancy (*He/HP* and *Li/HP*). *Li/LP* ewes consumed the most D.O.M./day in late pregnancy and *He/HP* ewes the least. Over the whole of pregnancy, the difference in D.O.M. intake/day between He and ***Li*** ewes was not significant, but ***HP*** ewes consumed significantly more feed than ***LP ewes.***

(c) Foetal Weights

Mean single foetus weights after 90 and 140 days of pregnancy are recorded in Table 5.

After 90 days, ***LP*** foetuses were lighter than ***HP*** foetuses; males were heavier than females; but the difference due to the weight of the ewe at mating was not significant.

After 140 days, ***He/HP*** foetuses were lighter than *He/LP* foetuses, but *Li/HP* foetuses were heavier than those from *Li/LP* ewes; this interaction was significant. The sex difference was not significant.

Foetal weights after 90 and 140 days of gestation were not significantly associated with various measures of skeletal frame size or the condition scores (fatness) of the ewe recorded at mating time.

IV. DISCUSSION

Feed intake of the fat ***ewes*** fed ***ad libitum*** throughout pregnancy (He/HP) declined slightly as pregnancy proceeded. The weight of their single foetuses after 140 days of pregnancy was concomitantly reduced.

TABLE 5

Mean foetal body weights (g)

Age	Group Means						S.E.	Mean differences		
	He/HP	He/LP	Li/HP	Li/LP	Male	Female		He-Li	HP-LP	Male-Female
90-days	620.2 (12)	587.3 (12)	621.6 (12)	561.2 (12)	620.8 (15)	559.0 (9)	18.8	12.3	46.8*	61.8**
140-days	4135.0 (6)	4643.3 (6)	4920.0 (6)	4190.0 (6)	4486.7 (6)	4457.5 (6)	121.8	—165.9	110.9	29.2

* $P < 0.05$

** $P < 0.01$

Number of observations/subgroup given in parentheses.

At 140 days, the interaction between the initial weight of the ewe and plane of nutrition was significant. $P < 0.01$.

These observations may explain the report of Jeffries and Fern (1956) that overfat ewes at pasture gave birth to light single and twin lambs, although they provided little data on bodyweight, condition or the breed of the ewes. A reduction in voluntary feed intake of twin-bearing Border Leicester x Merino ewes over the last 50 days of pregnancy was reported by Reid and Hinks (1962) who discuss possible mechanisms of the reduction in appetite. Birth weight of their lambs was reduced but so also was the period of gestation.

By the time of mating, the He ewes in the present study may have reached an early stage of the inappetence phenomenon reported for very fat sheep fed to appetite (Schinckel 1960). Ambient temperature, too, may have played some part in the curtailment of feed intake during pregnancy by affecting the physiological processes of heat dissipation (Macfarlane 1961) under the field conditions of the experiment.

Foetuses from *He/LP* ewes compared favourably in weight at 140 days with those born to *Li/HP* ewes and the former ewes consumed less feed than the latter (Table 4).

Li/LP ewes consumed the least feed over 140 days of pregnancy, displaying a spectacular compensatory intake in late pregnancy under *ad libitum* feeding. Allden and Scott Young (1964) have recorded compensatory grazing intake of Merino wethers after a period of foor feeding. The foetuses of *Li/LP ewes* at 140 days were not unduly restricted in weight, the deficit being of greater academic than practical importance. This system of management for breeding ewes has little, however, to commend it. Poor ovulation rate and increased barrenness can be expected from ewes of relatively light body weight at mating (Wallace 1961; Coop 1962, 1964; Quinlivan 1964). Secondly, *Li/LP* ewes have little opportunity to accumulate body tissue reserves needed for lactation and concomitant increase of metabolic demand. Thirdly, placental development of these ewes was profoundly affected (Everitt, unpublished data) while foetal growth in early gestation was retarded to the greatest extent.

Differences in skeletal frame size of the ewes played no obvious role in foetal growth, and the effects of ewe body weight must be attributed to other causes; differences in the amount of soft body tissues, largely body fat as a source of catabolisable energy, for example. Under conditions of heavy stocking rates and/or a succession of poor seasons, a cumulative depression of the body weight of the breeding ewe can be anticipated, the ewe being mated in progressively poorer condition with succeeding seasons. The lighter the body weight of the ewe at mating time, the greater appears the risk of damage to the conceptus through undernutrition in early pregnancy. On the other hand, abundant feeding of very fat ewes throughout pregnancy *(He/HP)* also appears critical to foetal growth, as well as wasteful in resources.

V. ACKNOWLEDGMENTS

This work was supported by a grant from the Australian Wool Research Committee.

The following people at the Waite Agricultural Research Institute, University of Adelaide, are thanked for their valuable assistance; Mr. S. Richardson and Miss

Christine Mattsson for bearing the brunt of the routine work; and Mr. D. Messent for help in statistical matters.

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