The nutrition and growth of lambs reared artificially with or without meal

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Science

in

Animal Science

at Massey University, Manawatu, New Zealand.

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2017

Abstract

Jensen, A. (2017). The nutrition and growth of lambs reared artificially with or without meal. A thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Animal Science at Massey University, Manawatu, New Zealand.

Artificial rearing is routinely used in large-scale dairy sheep farms. One approach is to offer milk replacer (MR) and meal *ad libitum* to lambs. The aim was to evaluate the growth of female lambs in the first 12 weeks of rearing with (M) and without (NM) grain-based meal access (n=30/group) during four feeding periods. In period 1 (week 0-3), lambs were offered MR and meal *ad libitum*, and in period 2 (week 4-5) were transitioned outdoors onto pasture with continued access to MR and meal. Lambs were weaned off MR in period 3 (week 6-10), and meal in period 4 (week 10-12). The NM lambs received identical management, but meal was excluded. A treatment-by-time interaction was found whereby NM lambs had lower average daily gain (ADG) ($P<0.05$) in periods 1 (376±6 *vs*. 414±8 g/d) and 3 (146±7 *vs*. 241±7 g/d), no difference in period 2 ($P>0.05$), and higher ADG in period 4 (157±18 *vs*. -55±18 g/d, $P<0.05$) than M lambs. These results indicate that when lambs fed MR *ad libitum* are offered unrestricted access to good-quality pasture before weaning, meal may not be required to achieve a similar live weight at 12 weeks of age.

Data from the aforementioned experiment were further investigated by week to allow investigations of the relationship between nutrient intake and growth, describe variation in ADG in relation to environmental and feeding transitions, and to estimate pasture intakes, which were not measured. The different feeding transitions, nutrient intakes, and feeds were most likely causing the differences in ADG that occurred between treatment groups and weeks. The greatest variation in ADG of lambs occurred in the M lambs after meal

weaning, which was likely due to a poor adaption to a pasture-only diet. Pasture intakes were estimated by calculating lamb requirements for maintenance and growth from actual ADG and live-weight measurements, assuming that pasture intake made up the difference between actual intakes and theoretical intakes. It was found there were significant differences in estimated pasture intakes between M and NM lambs ($P<0.0001$) and intakes changed over weeks. In weeks seven, eight, and nine, M lambs were estimated to not consume any pasture, due to a high intake of meal, to achieve the observed growth rates. However, NM lambs consumed pasture over these weeks as pasture was their only feed source. These results allow speculation that pasture intake was very low in M lambs before meal was removed. It has been previously reported that high meal intakes when combined with low roughage intake can negatively impact rumen health and development, and transitioning from high meal to high roughage diets requires alterations in the ruminal microbe population and fermentation. The estimated low pasture intake before meal weaning, combined with the high meal intake recorded, may have contributed to the growth check that occurred once meal was removed, as lambs required a period to adapt to the pasture diet, as their rumen underwent the changes associated with transitioning between these diets. Further investigation into differences in pasture intake between lambs reared with and without meal, and more evidence as to what caused the growth check after meal weaning may allow further optimisation of different lamb-rearing systems.

Acknowledgements

I would like to sincerely thank my supervisors Sam Peterson and Patrick Morel (Massey University), and Sue McCoard (AgResearch) for their tireless help and guidance. I would like to thank the AgResearch-led Ministry of Business, Innovation, and Employment "Boosting exports of the emerging NZ dairy sheep industry" program for funding this research, in partnership with Kingsmeade Artisan Cheese, Maui Milk, and Spring Sheep Milk Co. I would also like to thank the Animal Nutrition & Physiology Team and Ulyatt-Reid Large Animal Facility staff from AgResearch Limited Grasslands for their assistance with animal care and data collection.

A great many thanks to Ajmal Khan, Frederik Knol, Catherine McKenzie, and David Stevens for their feedback and assistance in the writing of this thesis and analysis of results. I would also like to acknowledge the Lois Turnbull Postgraduate scholarship for personal funding.

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List of abbreviations

a	Metabolisable energy requirement for maintenance
ADF	Acid detergent fibre
ADG	Average daily gain
ANOVA	Analysis of variance
ATP	Adenosine triphosphate
b	Metabolisable energy required for growth
c	Crude protein
CMR	Milk replacer designed to be fed to calves
CP	Crude protein requirement for maintenance
CPI	Crude protein intake
CPgrowth	Crude protein that was required for growth (calculated for this trial)
CPmaintenance	Crude protein required for maintenance (calculated for this trial)
CPtheoretical	Calculated crude protein required to meet calculated maintenance and growth requirements
d	Crude protein required for growth
DM	Dry matter
DMI	Dry matter intake
g/d	grams per day
GE	Gross energy
K_g	Efficiency of utilisation of metabolisable energy for growth
Kg	kilograms
LMR	Milk replacer designed to be fed to lambs
LWT	Live weight
LWTend	Live weight at the end of the week
LWTstart	Live weight at the start of the week
ME	Metabolisable energy
MEI	Metabolisable energy intake

MEgrowth	Metabolisable energy that was required for growth (calculated for this trial)
MEmaintenance	Metabolisable energy required for maintenance (calculated for this trial)
METheoretical	Calculated metabolisable energy required to meet calculated maintenance and growth requirements
MJ	Megajoules
MR	Milk replacer
M	Lambs allowed meal
NDF	Neutral detergent fibre
NM	Lambs not fed any meal
OMD	Organic matter digestibility
P	Period
REML	Repeated-measure mixed-effects model
TCA cycle	Tricarboxylic acid cycle
VFAs	Volatile fatty acids