Chapter 6

FEEDING OF LACTATING EWES

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6.1. Introduction

Milk production with dairy ewes requires more intensive systems and more nutrients per animal than it is usually necessary for meat or wool production systems. During lactation, nutrient requirements may be very high. Inadequate feeding may reduce both the daily milk production and the length of the lactation. Adequate feeding requires proper ration balancing. This, in turn, requires estimation of animal nutrient requirements and feed intake and of the nutritive value of feed. Proper feeding strategies for the lactating ewe cannot be based simply on what is known about dairy cows. Even though much of the information available for dairy cattle is valid for dairy sheep, it is necessary to be aware of the differences between the two species to avoid using improper feeding strategies for the lactating ewe.

6.2. Dairy sheep are not just dairy cows ten times smaller

Recommendations for feeding dairy sheep are often derived from research on dairy cows, whose nutrition and feeding management have been studied more extensively. Even though both sheep and cattle are ruminants and have many similarities, they tend to have different feeding strategies and are also different in some physiological functions (e.g. wool growth).
Some of the most important differences between the two species are related to their body size. Dairy sheep are, in general, 10-12 times smaller than dairy cows. Many studies have shown that in both species the total volume of the gastrointestinal (GI) tract (as weight of liquid contents) makes up 13-18% of the body volume [52]. As adult ruminants increase in size, the wet fermentation contents of the GI tract increases in direct proportion to body weight[24]. This means that the volume (as above defined) of the GI tract of a 60 kg ewe is, on aver-

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age, 10 times smaller than that of a 600 kg cow. However, as the body weight increases, there is a lower proportional increase in energy requirement for maintenance. Maintenance energy requirements are proportional to the 0.75 power of body weight ($BW^{0.75}$, often called metabolic weight, MW). The INRA system[34] reports that maintenance requirements are equal to 56.1 and 70.0 kcal of NE_L/kg of MW for sheep and cattle, respectively. This means that maintenance requirements of a 600 kg (MW = 121.2 kg) cow are only 7 times higher than those of a 60 kg (MW= 21.6 kg) ewe. An index of the fermentative capacity may be estimated by dividing the liquid contents of the GI tract by the maintenance energy requirements. The resulting fermentative capacity curve (Figure 6.1) shows that cattle tend to have more GI tract contents per unit of energy required for maintenance than sheep.

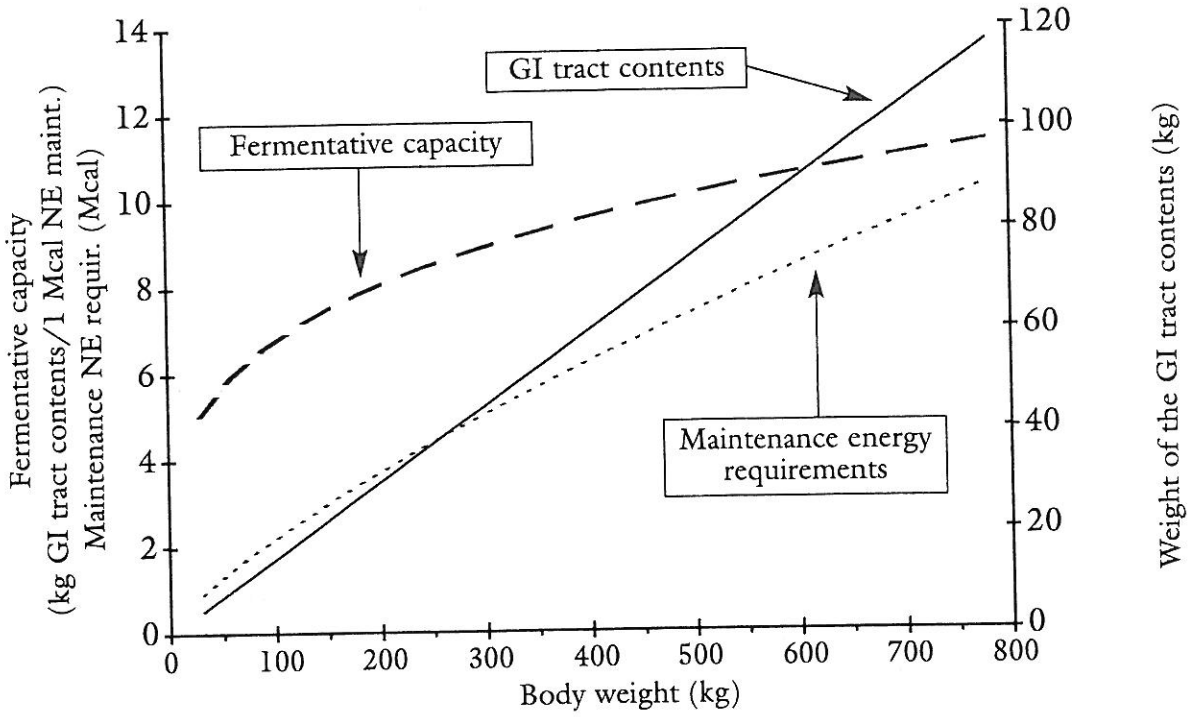

Figure 6.1. - Effect of body weight on gastrointestinal tract (GI) contents, maintenance energy requirements (net energy, NE) and fermentative capacity. With the purpose of making the plot clearer, energy requirements for maintenance are considered equal to 65 kcal/NE per kg of metabolic weight for the whole BW range considered, even though these requirements differ depending on the species (see the text).

This implies that cattle can "store" more feedstuff in the GI tract for each unit (e.g. Mcal) of energy required for maintenance than sheep.

Many feed components (mainly cellulose and hemicellulose, but also insoluble protein and starch) have low degradation rates. Their extent of fermentation is highly dependent on the time they spend in the rumen (retention time). The longer they are fermented in the rumen, the more they are digested (up to a certain limit). In practice, if sheep and cattle are fed the same fibrous feedstuff, cattle tend to digest it more because they have more room and they can retain the feed in the rumen for a longer period (Table 6.1). This difference in digestibility is maintained even at high feeding levels[9].

These facts have important practical implications. Sheep have to speed up the passage of feedstuff in the rumen (i.e. decrease the retention time) to compensate for their low fermentative capacity. Thus, sheep need to eat more feed per day (as % of BW) than cattle to satisfy their requirements but digest it less. Despite this, the total amount of nutrients digested per day usually increases due to the higher intake of dry matter. This explains why high producing dairy sheep may have a level of intake of between 4% and 6% of their body weight, while in high producing cows this figure does not usually exceed 4%.

Table 6.1. - Apparent digestibility and retention times for ruminants fed the same medium quality timothy hay ad libitum[73, 74]. The intake per kg of BW was higher in goats and sheep than in cattle. As a result, rumen retention time and dietary total tract digestibility were highest in cattle.

Item	Goats	Sheep	Heifer
Body weight	29	30	555
Intake of dry matter			
g/d	700	650	7830
g/kg BW	24.3	21.7	14
g/kg $BW^{0.75}$	56	51	68
Digestibility (%)			
Dry matter	47	47	54
NDF	44	44	52
Retention time of forage particles			
Rumen (hr)	28	35	47
Whole GI tract (hr)	52	70	79
Ratio: rumen/whole GI tract	54	50	59

BW = body weight; NDF = neutral detergent fibre; GI = gastro-intestinal.

Another way sheep deal with this problem is by exercising greater feed selection[75]. They tend to choose feeds or parts of feeds (young stems, leaves, buds) which are of good quality and whose digestibility is less affected by rumen retention time. In this, they are helped by their narrow muzzle and by the high mobility of their tongue and lips. However, feed selection cannot be explained only in terms of body size. For example, even though sheep and goats have similar body size, when fed on the same mixed (grassland and shrubs) pasture, they showed quite different behaviour, with goats preferring shrubs and sheep herbs[35].

Sheep differ from cattle in chewing activity as well. Sheep spend between 9 and 16 longer time than cows to eat and ruminate 1 kg of dry matter[22]. Sheep have to chew more than cattle because they are smaller animals and their chewing activity is less powerful. Sheep also have to grind the particles more finely than cattle to allow them to pass through the rumen and other compartments of the foregut[75]. This behaviour was clearly demonstrated when lactating dairy cows (Holstein) and dairy sheep (Sarda breed) were fed a pelleted total mixed ration as their only feed (Table 6.2).

Table 6.2. - Intake and chewing activity of cows and sheep fed the same pelleted total mixed ration as the only feed (Rossi, 1994, cited by [77]).

Variable		Dairy cows	Dairy ewes
Intake	(kg of DM/day)	8.4	1.2
Eating time	(min/day)	110.7	56.0
Rumination time	(min/day)	19.4	78.5
Total chewing time	(min/day)	130.1	134.5
Eating efficiency	(min/kg of DM)	13.1	46.3
Rumination efficiency	(min/kg of DM)	2.3	64.9
Total chewing efficiency	(min/kg of DM)	15.4	111.2

While sheep needed more than one hour to ruminate 1 kg of dry matter, cows ruminated very little. Indeed, while sheep were doing well on this diet and were producing a good quantity of milk, the milk yield of the cows dropped, there was less milk fat, and clear signs of acidosis occurred.

Since there is a limit to the amount of time a ruminant can spend ruminating (10-11 hours per day[79]), intake tends to be more limited in sheep than cattle

by the particle size of diets containing long hay. This fact, and the lower fermentative capacity of sheep, explains why grinding often increases intake of forage and why the response is stronger in sheep than in cattle. A comparison[32] between sheep and cattle fed 3 different diets (high quality (A) and medium quality (B) dehydrated ryegrass; and a mix of medium quality ryegrass with barley grains (C)), presented in either long or ground and pelleted form, showed that grinding and pelleting (Table 6.3): a) increased intake more in sheep than in cattle; b) increased intake more in young animals than in adult animals; c) increased intake in inverse proportion to dietary quality (B > A > C). However even in ground diets the total daily intake of digested dry matter was higher in high quality than in low quality diets.

Intense rumination in sheep can also be important when the diet includes grains. Rumination reduces the particle size and increases the rumen digestibility of grains and therefore of starch. Sheep tend to chew grains more finely than cattle. This may explain why highly digestible diets (> 66%) tend to be digested better by sheep than by cattle, while with low digestible diets cattle are more efficient[42].

Table 6.3. - Effects of grinding and pelleting various diets on intake in sheep and cattle [32].

			Sheep			Steers		
		Age (months)	6	18	36	6	18	36
		Body weight (kg)	49	72	83	272	464	614
Diet	**form**	**Intake**						
A	Long*	g/kg of BW	21.9	18.1	23.8	20.5	19.9	15.7
	Ground & pelleted**	difference in %	+59	+46	+29	+18	-17.1	+5
B	Long*	g/kg of BW	17.8	15.2	18.0	19.6	15.9	13.7
	Ground & pelleted**	difference in %	+76	+74	+61	+31	+21	+30
C	Long*	g/kg of BW	22.0	17.5	24.6	20.5	19.7	17.3
	Ground & pelleted**	difference in %	+49	+25	+11	+20	0	0

A = perennial ryegrass, 2nd cut, harvested 7 weeks after the 1st cut (NDF 59%, CP 19%, ADL 3.3%)

B = perennial ryegrass, 2nd cut, harvested 12 weeks after the 1st cut (NDF 64%, CP 16.6%, ADL 4.1%)

C = 60% hay B and 40% milled and pelleted barley

* = long (baled) for cows, coarsely chopped (5 cm screen) for sheep

** = chopped (1.44 cm screen) and pelleted through a 16 mm die

In conclusion, compared to cows, sheep:

a) have to eat more to satisfy their maintenance requirements. This results in a higher passage rate of feed and lower fibre (forage) digestibility
b) tend to have more selective feeding behaviour
c) are more affected in their intake by the particle size and the fibre content of the forage
d) have to spend more time eating and ruminating each kg of feed
e) tend to have higher digestibility of grains and high energy diets.

6.3. Feed evaluation for dairy sheep

Most feeding systems for sheep[1, 21, 47] were developed for and on meat or wool breeds. Only the French INRA system[33, 34] specifically considered dairy sheep requirements. This is why it is the most widely used system in the Mediterranean countries, where dairy sheep are particularly common.

The INRA system[34] has been criticised because diets formulated with this system tend to underestimate feed allowances, especially when medium-low quality forages are used[7, 23, 54, 55]. One of the main problems of the system is that the energy value of feed is estimated assuming that the animals are fed at near maintenance feeding levels. It is, however, well known that when the level of intake is high, as always occurs in lactating ewes, the passage rate of feed increases. Thus the digestibility of slowly fermenting feed fractions (mostly fibre) is less than that of animals fed at near maintenance. In the case of lactating cows the INRA system[34] compensates for this effect by increasing the requirements of the cows in proportion to their feeding levels and their intake of concentrates. No corrections are used for sheep, despite the facts that sheep are often fed at feeding levels similar or higher to those typical of dairy cows and that sheep have a faster feed passage rate than cows when fed at the same feeding level[75].

The accuracy of the INRA system was tested calculating the energy balances by using published experiments in which 32 different dietary treatments were applied to lactating dairy sheep[14, 68]. The energy balances were calculated as the difference between net energy intake (UFL/d, as reported in each publications) and net energy requirements of the ewes (UFL/d, estimated on the basis of BW, BW variations, and milk yield and quality reported in the publications). These energy balances were then regressed, after discarding 3 large outliers, against the feeding level (total energy intake divided by energy requirements for maintenance) observed for each feeding treatment (Figure