Pre-lambing preparation in sheep: feeding, metabolic profiles and minerals

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ABSTRACT

The pre-lambing period is a critical time in the sheep production cycle, and one where careful balance is required from a nutritional standpoint.

Just at a time when the nutritional requirements of a heavily pregnant ewe will be increasing, her dry matter intake will decrease, putting her and her lambs at risk. The effects of underfeeding during this time are not restricted to the imminent lambing period, but can extend much further. Careful planning, management and monitoring during this time is, therefore, critical to ensuring a successful lambing.

The final six weeks before lambing are the most important to manage, as the ewe is at greatest risk of energy deficit at this stage.

Figure 1. Ewes should be grouped according to the number of lambs they are carrying to ensure targeted feeding.

Lamb growth – 75% of which occurs in the final six weeks – foetal wool deposition, udder development and colostrum production all mean a ewe's energy and protein requirements increase significantly in this period. The increase in requirements is not the same for each ewe, and will differ according to her weight, the number of lambs she is carrying and the stage of pregnancy (**Table 1**; **Figure 1**).

Although her requirements increase, and can even double, a ewe's intakes decrease due to the growing foetus or foetuses taking up an increasing volume of the abdominal cavity, which causes a resultant decrease in the ruminoreticular volume. She adapts to this by increasing her food passage rate and increasing her rate of protein absorption by approximately 15%. A high energy content diet is important in enabling her to do this, as the efficiency of protein absorption will fall with a decrease in energy supply.

The ewe's total dry matter intake in late pregnancy is approximately 2% to 2.5%, so an 80kg ewe would be expected to eat between 1.6kg and 2kg of total dry matter each day. However, the actual dry matter intake will vary according to the number of lambs they are carrying, with ewes scanned for multiple pregnancies expected to have lower intakes than those expecting single lambs.

Table 1. Metabolisable energy (ME) and metabolisable protein (MP) requirements of housed, pregnant ewes according to ewe bodyweight, number of lambs and stage of pregnancy

		Weeks Pre-Lambing						
		7		5		3		1
Ewe weight	Number of lambs	ME (MJ)	MP (g)	ME (MJ)	MP (g)	ME (MJ)		MP (g)
50	1	7.9	72	8.7	76	9.8	81	11.2
	2	8.8	77	10.1	83	11.9	92	14.2
60	1	9.1	80	10.0	84	11.2	90	12.8
	2	10.1	85	11.6	92	13.7	102	16.3
70	1	10.2	87	11.2	92	12.6	98	14.4
	2	11.4	93	13.1	101	15.3	112	18.3
	3	12.0	96	14.0	106	16.7	119	20.3
80	1	11.3	94	12.4	99	13.9	107	15.9
	2	12.6	100	14.4	109	17.0	122	20.2
	3	13.3	104	15.5	115	18.5	129	22.5

Note: Based on static bodyweight. For 50g/day gain, in addition to foetus, add 2.5MJ ME and 7g of MP. Subtract 1MJ or ME and 65g/day of MP for a live weight loss of 50g/day in late pregnancy for ewes in BCS 3 or greater.

Source: EBLEX Sheep BBP Manual 12 *Improving Ewe Nutrition For Better Returns*

Table 1. Metabolisable energy (ME) and metabolisable protein (MP) requirements of housed, pregnant ewes according to ewe bodyweight, number of lambs and stage of pregnancy

A number of additional factors affect dry matter intake in late pregnancy (**Table 2**), and all must be considered when assessing ewe nutrition in late pregnancy (**Figure 2**).

Consequences of underfeeding

Underfeeding in late pregnancy can have detrimental effects on ewes and their lambs. Ewes are unable to alter the energy requirements of their growing foetuses, so if they don’t receive sufficient energy in their diet, they must draw on their own body reserves to make up the shortfall.

Lipid mobilisation, in the absence of a sufficient supply of propionate from dietary carbohydrate, leads to production of ketones, including beta-hydroxybutyrate (BOHB). In the final six weeks of pregnancy, plasma concentrations of BOHB should be below 0.8mmol/L if the diet is adequate.

Levels between 0.8mmol/L to 1.6mmol/L are indicative of moderate undernourishment and levels above 1.6mmol/L point to severe malnourishment (Russel et al, 1977). Ewes with excessively high BOHB levels (above 3.0mmol/L) are likely to suffer from pregnancy toxaemia, also known as twin-lamb disease. Unless this is diagnosed very early, the treatment response in affected ewes is usually very poor, and ewes and their lambs are invariably lost. Therefore, emphasis must be given to prevention and monitoring of metabolic status during late pregnancy to determine whether ewes are at risk.

Figure 2. A number of factors affect intakes in late pregnancy, including feed barrier design and space.

It is well documented lamb mortality is higher when ewes carrying multiple foetuses have been underfed, with the impact greater for triplets than twins. This is due to a number of factors. Lambs from undernourished ewes will have less brown fat than those from ewes with adequate nutrition, leaving them more susceptible to hypothermia and hypoglycaemia following birth. Colostrum production is also suboptimal, both in terms of quantity and quality, so lambs do not receive immunity through passive transfer and are more susceptible to neonatal diseases such as watery mouth.

Since udder development takes place during late pregnancy, there is a knock-on effect on milk yield following lambing,
with detrimental effects on lamb growth rates. Studies also suggest, additional to milk yield, reduced growth rates may be due to reduced circulating insulin-like growth factor 1 (IGF-1) and decreased expression of insulin-like growth factor-binding protein 3 (IGFBP-3) in the liver of lambs born to undernourished ewes (Hoffman et al, 2014).

Table 2. Factors affecting dry matter intake
Forage quality
Forage availability/feeding regime
Feed barrier design and space
Water availability and quality
Stage of pregnancy
Number of lambs carried
Dentition
Concurrent conditions (eg, lameness)

Table 2. Factors affecting
dry matter intake

Any deficit in nutrition during a lamb's rearing period can only be partially compensated for by a high plane of nutrition during its adult life. As a result, ewe lambs from ewes undernourished during pregnancy produce more single lambs in their first three pregnancies in comparison to ewe lambs born from adequately nourished ewes (Borwick et al, 1995). Therefore, the effects feeding during late pregnancy have on subsequent lamb productivity do not stop at birth, but continue well beyond (**Figure 3**).

Ewe nutritional management

Nutritional management should ideally be based on the results of pregnancy scanning and body condition scoring (BCS) eight weeks before lambing. BCSs are fundamental for aiding flock management during the production cycle, and target BCSs (**Table 3**) should be established for the flock and regular monitoring performed.

Even if all ewes are in good condition at tupping (BCS 3.5 for lowland), it is likely a proportion will be too lean at the beginning of late pregnancy. Checking BCSs eight weeks before lambing allows these ewes to be identified and separated for supplementary feeding (BCS lower than 2.5, dependent on system and breed). At this stage, ewes in BCS 3 can still afford to lose a further 0.5 BCS unit without any adverse effects on lambing performance. However, this must be managed so poorer ewes do not fall below BCS 2 at lambing, since some reserves must be maintained for use in the early post-lambing period.

Figure 3. Pre-lambing nutrition impacts the ewe and her lambs in not only the short, but also the much longer term.

As already discussed, a ewe's requirements in late pregnancy depend on the number of lambs she is carrying, proximity to lambing and her bodyweight.

Where energy requirements cannot be met through forage alone – which will almost certainly be the case with multiple pregnancies – supplementation is required, with choices including compound feeds or the addition of straights to the forage. If compound feeds are used, they must have a minimum metabolisable energy (ME) of 12.0MJ/Kg DM through the use of good-quality ingredients such as cereals, maize, gluten and sugar beet pulp. Lower-quality ingredients, such as oat feed, shea nut and cocoa shells, should be avoided. Compounds with lower MEs will need to be fed at a higher rate, potentially compromising forage intake.

While cereals and cereal by-products are an excellent source of additional energy, care must be taken when feeding them, since high levels, particularly of wheat, can induce ruminal acidosis. When cereals are fed as straights, they can be fed whole with hay, but should be lightly processed if fed with silage.

Table 3. Target body condition scores for different systems

	Hill ewes	Upland ewes	Lowland ewes
Weaning	2.0	2.0	2.5
Tupping	2.5	3.0	3.0
Mid-pregnancy	2.0	2.5	3.0
Late-pregnancy	2.0	2.5	3.0

Source: Stubbings, 2007

Table 3. Target body condition scores for different systems.

Molasses are another source of readily available energy, as well as aiding palatability – thus assisting with achieving optimal intakes. In addition they can improve the quality of the ration by reducing dust and can be a carrier for minerals where supplementation is required.

As well as extra requirements for energy, the ewe in late pregnancy has increased protein requirements due to lamb growth and the production of colostrum. Any protein supplement must provide adequate effective rumen degradable protein (ERDP), as well as digestible, undegradable protein (DUP). If using a compound feed, one with an overall crude protein (CP) level of 18% should be selected and the formulation assessed to determine sufficient levels of ERDP and DUP.

Table 4 outlines a suggested protocol for assessing whether a ration is meeting the energy demands of ewes in late pregnancy, and whether on-farm factors may influence its effectiveness. It can be corrected in a number of ways.

Table 4. Recommended steps for assessing the ration

1. Does the formulated ration meet the demands of the ewe?	
■ Determine the energy requirements of the ewe based on her live weight, stage of pregnancy and number of lambs (from **Table 1**). *For example: an 80kg ewe carrying twins and five weeks prior to lambing being fed ad lib good quality hay and 0.4kg concentrate. Requires 14.4 ME.*	
■ Determine the energy received from forage using forage analysis (where available) and expected daily dry matter intake of forage by percentage bodyweight using the information to the right (Source: EBLEX Sheep BBP Manual 12). *For example: a 80kg ewe being fed ad lib good hay five weeks before lambing can be expected to eat 1.44 kg DM of hay a day (1.8 per cent of 80kg) providing her with 13.68 ME (1.44kg x 9.5MJ/kg DM).*	(see table below)
■ Determine the energy received from concentrate based on feeding rate and available compound analysis. (Note: remember to convert fresh weight of concentrate to dry matter for calculations of ME). *For example: 0.4kg concentrate (86 per cent DM, 12.8 MJ/kg DM) will provide 4.4 ME (0.4kg fresh weight equals 0.344kg DM. 0.344kg DM at 12.8 MJ/kg DM equals 4.4 ME).*	
■ Does the total energy provided meet the demands of the ewes? *For example: in this case the ewe is receiving a total of 18.08 ME, which is sufficient for this stage, but it would not meet her energy demands as she gets closer to lambing (one week prior to lambing her requirement would be 20.2 ME).*	
2. Is the formulated ration the same as that being fed?	
■ Check ingredients being fed at the correct weight by weighing where possible.	
■ If feeding ad lib forage, check it is truly available 24 hours a day.	
3. Is the ration being offered being eaten?	
■ Check for wastage, particularly when fed in troughs.	
4. Is there adequate trough space?	
■ For concentrates: 45cm/ewe so that all ewes can feed at the same time.	
■ For forage: 15cm/ewe so that a third of the group can feed at the same time.	
■ Even with sufficient feed barrier space, check the design does not restrict intakes.	

	ME (MJ/kg DM)	Pre-lambing (% ewe liveweight)	
		12-3 weeks	3-0 weeks
Straw	6.5	1.0	0.8
Average hay	8.5	1.5	1.1
Good hay	9.5	1.8	1.4
Poor silage	9.5	1.4	1.2
Good silage	10.5	1.6	1.4

Adapted from EBLEX *Improving Ewe Nutrition for Better Returns* and SAC *Year Round Feeding the Ewe for Lifetime Production*

Table 4. Recommended steps for assessing the ration.

The rate of concentrate fed can be increased, but this can only be done if it will not have a detrimental impact on forage intake or put ewes at risk of acidosis. If the forage is poor quality, this can be replaced with a better quality forage with a higher energy density to reduce the amount of concentrate required. An additional option is the use of high energy licks or buckets, for example, Extra High Energy Crystalyx, which provide a readily available supply of energy and are simple to incorporate into the diet. In certain instances, these buckets can also be used to supplement minerals where required.

Metabolic profiling

In addition to the ration assessment and BCSs, metabolic profiling, principally to measure BOHB levels, can also be undertaken during late pregnancy. A representative selection of between 10 and 20 ewes should be blood sampled and, when known, should be selected equally from each group (singles, twins and triplets).

Sampling should be carried out three to four weeks prior to lambing to allow precise determination of any metabolisable energy deficit, while still allowing time for adjustment of the ration accordingly. When changes are required, further sampling two weeks later is prudent to ensure these have been addressed.

A range of BOHB concentrations are often found, which will be largely correlated with fetal numbers. Where ewes have not been scanned and the fetal numbers are unknown, a threshold of 0.8mmol/L is used. When fetal numbers are known, however, this is raised to 1.0mmol/L for ewes bearing twins and triplets.

A number of ways of analysing the blood samples are available. These include sheep side using a ketone meter, through a diagnostic laboratory or as part of a specific metabolic profiling package. An example of the latter is the pre-lambing profile offered by the University of Edinburgh's Dairy Herd Health and Productivity (DHHPS) scheme (**Table 5**), which provides a comprehensive analysis and feedback of the pre-lambing diet.

Macro and micro-minerals

Table 5. Breakdown of the pre-lambing profile by DHHPS (University of Edinburgh)

Ewes to sample	20 ewes with at least five from each group (singles, twins, triplets)
Information required	Ration details, ewe bodyweights, BCS, fetal numbers
Analysis undertaken	BOHB: to assess energy status. Urea: to measure protein intakes. Albumin: to assess liver function or the presence of prolonged disease or long-term protein undernutrition. Magnesium: indicator of dietary levels and also calcium availability due to its role as a co-factor in regulating calcium levels. Copper: assessment of levels to determine risk of low levels (swayback) or potential toxicity.

Table 5. Breakdown of the pre-lambing profile by DHHPS (University of Edinburgh).

Of the major macro-minerals, calcium and magnesium are most commonly problematic in sheep. Since no magnesium reserves are maintained in the body, it must be constantly supplied in the diet so ewes are not put at risk of hypomagnesaemia (grass staggers). Although it is generally seen post-lambing, ensuring adequate dietary supplies in late pregnancy is essential for maintaining protein synthesis, immunity and calcium regulation.

As in the dairy cow, calcium balance during late pregnancy in the ewe is critical to prevent the development of hypocalcaemia (milk fever). Restricting calcium intake in the run up to lambing (recommended level 0.9% in compound feed) is important to prime ewes' calcium pathways so they are able to draw on their own reserves quickly and effectively at the point of lambing.

Additional to the macro-minerals, micro-minerals are also essential for optimal performance of both ewes and their offspring. However, in some instances (especially in the case of copper), over-supplementation can lead to toxicity, so level monitoring through blood sampling or liver analysis is always recommended.

Certain geographical locations or soil types are more prone to trace element deficiency. In these areas, farms feeding only home-grown forage and straights must always be monitored closely, since no external feed sources can make up for any deficiencies.

Cobalt is a constituent of vitamin B12 synthesised in the rumen. Deficiency in the pregnant ewe has been linked to poor viability in her offspring and poor mothering. Cobalt can be measured easily through blood sampling and supplementation provided through concentrates or oral boluses when levels are low.

Copper deficiency in late pregnancy is linked to swayback in lambs, with some breeds, such as the Welsh mountain, more susceptible than others due to a variation in the efficiency of absorption. Rarely is true copper deficiency an issue; instead, it is invariably due to copper lock-up by molybdenum and sulphur, which reduce the availability of copper.

Figure 4. Iodine deficiencies are more common on coastal ground.

Sheep must only be supplemented when a deficiency is proven to be present, since over-supplementation can lead to copper toxicity. Due to the way copper is stored in the liver, circulating blood concentrations may not be a true reflection of copper status, since normal levels can be maintained even when levels in the liver are high. Therefore, when deficiencies are corrected, on-going monitoring is essential, with the measurement of copper levels in the livers of cull ewes providing a more accurate indication of true copper supply.

In comparison to cattle, sheep are more susceptible to iodine deficiency, with the most common clinical sign being late abortion or the birth of weak lambs with visibly enlarged thyroid glands, that is goitre. Deficiencies may occur due to low levels in the soil (particularly common on coastal ground; **Figure 4**) or through the feeding of brassicas, which impair iodine uptake. Where possible, brassicas should be avoided in late pregnancy, or supplementation should be provided.

Although independent in their roles, vitamin E and selenium are commonly considered together due to their complementary action, with deficiencies resulting in the birth of weak lambs with white muscle disease. The most common reason for deficiency is a lack of dietary supply.

Since it is difficult to assess a ewe’s selenium body reserves, it is recommended 0.1mg/kg DM of selenium and 30mg/kg to 50mg/kg DM of vitamin E is provided during late pregnancy.

When mineral deficiencies are diagnosed, supplementation can be provided, dependent on the mineral involved. In-feed supplementation is perhaps the most simple, but is of no value when ewes are on grazing only. In these circumstances, oral boluses, injectable formulations (where available) and mineral licks are options. The route of supplementation must be decided on a flock-by-flock basis, based on compliance, system and cost.

Summary

The pre-lambing period is one of the most critical points in the sheep calendar and can determine the success of the subsequent lambing period. Careful balancing of nutrition is essential to prevent the consequences of underfeeding on both ewe and lamb health, and avoid overfeeding, which can be costly.

Careful planning is essential to prevent problems from arising, and strategic monitoring can help identify when intervention is required, so productivity of the flock in both the short and longer term is maximised.

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