Learning objectives

On completion of this topic you should:

- Understand the concepts of precision nutrition
- Be able to identify situations where precision nutrition of sheep is cost-effective
- Have a basic knowledge of trigger points and how to set these for supplementary feeding
- Understand the principles and practical aspects of feeding for precision management systems
- Understand nutritional constraints in the context of other limiting factors

Key terms and concepts

Targeted feeding, individual animal monitoring, feeding to change risk and/or production category.

Introduction to the topic

Precision nutrition of grazing animals is a very new field of animal nutrition that is made possible by the convergence of a number of new technologies. Automatic walk-over weighing allows monitoring of individual animals, electronic (Radio Frequency) identification allows individual animals to be monitored and managed and wireless data transfer allows sophisticated use of information, even in remote locations.

The concept of feeding an animal to meet its requirements and production potential is not new. Individual animal feeding is very common in the dairy industry where the level of milk production and the cows’ stage of lactation determine the amount of concentrate fed to each cow. Until the availability of new management technologies developed by the Sheep CRC, this level of sophistication has not been available for the management of grazing animals.

There are very significant differences between animals in their nutritional requirements. Phenotypic variation and differences in nutritional requirements is based not only on different physiological status between animals but also on genetic differences that determine production potential, feed intake and nutrient utilization. Implementation of precision nutrition and monitoring allows better management of individual animals and also provides a valuable basis for identifying those animals that will be most valuable and productive for flock improvement and genetic progress. Table 29-1 summarises the amount of variation commonly found in sheep flocks and emphasises the need to manage and use this variation more effectively than is currently the case.
Table 29.1 Variation in key parameters with an ‘average’ flock.
Source: Rowe and Atkins (2004)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Mean</th>
<th>Range 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleece wt (kg)</td>
<td>6</td>
<td>4 - 8</td>
</tr>
<tr>
<td>Diameter (um)</td>
<td>20</td>
<td>16 - 24</td>
</tr>
<tr>
<td>Staple Strength</td>
<td>35</td>
<td>15 - 55</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>50</td>
<td>40 - 60</td>
</tr>
<tr>
<td>Eye muscle area</td>
<td>25</td>
<td>20 - 30</td>
</tr>
<tr>
<td>Average lambs/ewe</td>
<td>0.7</td>
<td>0 - 2</td>
</tr>
</tbody>
</table>

29.1 Situations where feeding will be most effective

Supplementary feeding of sheep is most cost-effective under conditions where the additional nutrition is expected to change the status or category of the animal in terms of its survival, production or better meeting target specifications. This sounds simplistic but it is an important concept. The main categories for consideration are as follows.

a) Feeding to reduce risk of mortality (and address animal welfare).

b) Feeding ewes that, without additional nutrition, would not have a high probability of conceiving or raising a lamb.

c) Additional nutrition to increase resilience and resistance to parasites and reduce drench requirements.

d) Targeted nutrition to overcome rapid weight loss and consequences in terms of low tensile wool.

e) Additional weight gain from supplementary feeding for increased meat value alone is normally of marginal value.

a. Mortality

Animals at greatest risk are lambs during the peri-natal stage and weaners during the first twelve months of age. Lamb survival is largely a function of the condition of the ewe during late pregnancy and at lambing. As Figure 29-1 shows, ewes in poor condition score are less likely to successfully raise a lamb through to weaning compared to ewes in better condition. Supplementary feeding of ewes in low condition score, particularly those carrying twin lambs can significantly improve lamb survival. The condition score of an animal is closely related to its weight and the correlation between these two parameters is discussed in a later section. The importance of better nutrition for ewes in late pregnancy, particularly twin-bearing ewes, is well established. However even with twin-bearing ewes only part of the group will require and respond to additional nutrition. As a general rule it is often less than 1.3rd of animals in a flock that require supplementary feeding. Table 29-2 illustrates the range of weights and condition score commonly found in commercial ewe flocks.

Risk of weaner mortality has been defined by a number of researchers (eg. Lloyd Davies, 1987; Campbell, 2004.) Data from Campbell is summarized in Figure 29-2 and shows the increasing probability of survival with increasing body-weight of animals at weaning. Across a number of years, the same conclusion can be drawn: increasing the body weight at weaning by about 4 kg effectively doubles the chances of survival. It is therefore relatively easy to identify those animals at risk of dying and their chances of survival are significantly improved by supplementary feeding. Obviously higher weaning weights is desirable but more important is monitoring weight and weight change post weaning so that timely and targeted intervention can be implemented.
Figure 29.1 Peri-natal lamb mortality associated with a range of condition scores of ewes at lambing. Crosses represent data for all sheep, filled triangles and squares represent twins and open triangles and squares single lambs. The boxed area signifies a set of condition scores and mortalities that respond to nutritional and climatic conditions at time of lambing. Source: Rowe (2003).

Table 29.2  Average weight and condition score at joining for ewes with different numbers of fetuses when scanned between days 77 and 95 of pregnancy. 

<table>
<thead>
<tr>
<th>Property</th>
<th>Number of ewes</th>
<th>Average weight</th>
<th>Condition score</th>
<th>Weight range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin</td>
<td>154</td>
<td>48</td>
<td>2.8</td>
<td>38 - 62</td>
</tr>
<tr>
<td>(482 ewes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>299</td>
<td>46</td>
<td>2.8</td>
<td>34 - 64</td>
</tr>
<tr>
<td>Empty</td>
<td>29</td>
<td>46</td>
<td>2.8</td>
<td>39 - 52</td>
</tr>
<tr>
<td>Twin</td>
<td>90</td>
<td>44</td>
<td>2.7</td>
<td>34 - 58</td>
</tr>
<tr>
<td>(390 ewes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>167</td>
<td>43</td>
<td>2.6</td>
<td>31 - 56</td>
</tr>
<tr>
<td>Empty</td>
<td>133</td>
<td>41</td>
<td>2.5</td>
<td>26 - 55</td>
</tr>
</tbody>
</table>

b. Reproduction
Whether or not ewes ovulate, and the number of eggs shed at ovulation, is determined by the condition (weight) of the ewe as well as the plane of nutrition immediately prior to ovulation. Figure 29-3 shows the relationship between live-weight and ovulation rate as well as the effect of additional short-term nutrition. The main goal should be to have the ewe in good condition at joining. Short-term nutrition, while effective, is difficult to justify on the basis on the high cost of feeding the entire flock.

Figure 29.2 Probability that lambs with different weaning weights will survive to 12 months of age. Source: Campbell (2004).
It is important to understand the significant nutritional drain on the ewe imposed by pregnancy and lactation. Figure 29-4 shows the decrease in maternal body-weight under pasture conditions that are adequate to maintain weight in a non-pregnant ewe. While it is important to account for the additional nutritional requirements of the current reproductive cycle, it is essential to also consider the extent of the nutritional ‘drain’ of the previous pregnancy and lactation. These carry over effects are not normally accounted for in traditional sheep management but with good records possible through RFID this additional information can be very valuable when managing individuals in a ewe flock.

It is not only survival and additional lambs born that are important in nutritional management of the ewe. There are long-term production losses that result from under-nutrition of ewes during pregnancy. Lambs from under-fed ewes produce wool of an increased diameter and lower value throughout their life. Solid evidence of the long-term benefits of good ewe nutrition have been accumulated as part of the ‘lifetime wool’ project coordinated by AWI.

Testicular volume and sperm production in rams can be increased through short and long term nutrition. Due to the relatively small numbers of rams, the cost of setting up targeted nutrition may not be justified.

**Fig. 29.4 Nutritional ‘drain’ on ewes bearing and raising 0, 1 or 2 lambs.** The data was generated using Grazfeed by setting pasture conditions at a quality at which a 50 kg ewe with no lamb was able to maintain liveweight constant. **Source:** Rowe and Masters (2005).
c. Parasites
Sheep most sensitive to parasite infections are young animals and ewes during the per-parturient phase. At these stages, additional nutrition has a significant effect on immune system function as well as improving the animals resilience. As seen in Figure 29-5, faecal egg counts can be significantly reduced by supplementary feeding. As with other opportunities for targeted feeding, the best responses are most likely from feeding those animals in greatest need, ie those losing weight most rapidly or in the lowest condition score.

d. Wool
The tensile strength of fine and super-fine wool is a major determinant of price. Significant discounts are applied to fine wools of low tensile strength. Apart from the genetic control, nutrition appears to be the major factor leading to reduced staple strength. Figure 29-6 shows the effect of pregnancy on staple strength as well as relationship between weight-loss during short or long periods of time and the consequent effect on staple strength. Under-nutrition is likely to be the primary reason for low staple strength in both situations. Monitoring of weight change and targeted feeding is likely to be an effective way of reducing the impact of fluctuating nutrition on staple strength and wool value. Bear in mind that in pregnant ewes it is the maternal body weight and not total liveweight (weight of ewe plus conceptus) that should be monitored. The easiest way to estimate maternal body weight in dealing with pregnant ewes is to use the Grazfeed program (see the practical session for ruminant nutrition and the UNE Edserve web site.) Precision nutritional management of pregnant ewes is an area that is currently under investigation in a series of experiments within the Sheep CRC.
29.2 Trigger points

It is important to be able to set targets for feeding individual animals based on the probability of a positive response and the economic value of that response. Information presented in section 29.1 above can be used to estimate the magnitude of the effect of various parameters for different production objectives. These should be considered in conjunction with the check-list below.

- Check that current weight and condition score are adequate for desired production and survival.
- Correlate condition score with weight. This only needs to be done once for each animal as the condition score and weight are closely related. One condition score unit equates to approximately 4 kg of liveweight. Linking weight and condition score for individual animals is important as frame size can vary significantly.
- Weight change should be considered together with current weight and condition score as animals gaining weight will have completely different requirements to those losing weight at the same absolute body weight and condition score.
- Reproductive status including stage of pregnancy and number of lambs in-utero, is an important consideration. Ultrasound scanning to determine the number of fetuses present is critical for nutritional management of the pregnant ewe. It is also important to consider the reproductive history of the ewe; how many lambs did it carry and raise last season?
- Wool quality of each animal will effect the decision as to whether or not feeding is cost effective. Ewes with finer wool will suffer higher discounts for low staple strength and it will be of greater value to feed these animals than those with courser wool. Length of the wool at time of feeding is an important consideration. Weight-loss occurring in the middle of the staple will produce a position of break half way along the length will result in a higher discount than a period of under-nutrition immediately pre or post shearing.
- Pasture conditions have a major impact on the requirements for additional nutrition and should be considered together with the nutritional requirements of the animal. There should also be some assessment of the influence of past feed availability and the likelihood of conditions changing in the short term future.
• Anticipated climatic conditions should also be considered, particularly where cold, wet conditions may apply and have a significant impact on mortality, particularly of those animals in low condition score.

### 29.3 Principles of feeding

The most common method of implementing precision nutrition is to fence off a watering point and create a single access lane that contains an RFID reader and computer directed drafting gate. Animals requiring feed are drafted into a fenced-off area with a self feeder. In this area animals have free access to feed but no water. When they leave the feeding area via a one-directional spear-gate leading to water, they are not able to re-enter the feeding area until next time that they are drafted into the feeding area by the computer system as they approach water. At this stage, Sheep CRC research is concentrating on a two-way drafter that involves just one type of feed. The drafting decision is ‘feed’ or no feed’. Therefore, the feed and the feeding system need to present a low risk with respect to acidosis (grain poisoning). It is possible that three-way drafting systems will be available in the future and this will allow access to an introductory feed for a period before animals are given access to a lower cost feed that may have a higher risk of causing acidosis.

**What to feed?**

Currently CRC research is based on the use of lupins, known to be a very safe and highly effective supplementary feed that meets practically all animal requirements. Questions that remain to be answered include: the role of salt mixed with lupins to reduce the amount eaten during any one feeding session; managing the transition from lupins to other grains; the role of protein, non-protein and mineral supplements in mixed feeds.

**Practical considerations**

Selection of feed must be suitable for the self-feeders being used. “Flowability” of the diet is important to ensure that animals have uninterrupted access to the feed. The use of self feeders often limits the amount of roughage that can be included in diet formulation since high roughage feeds do not flow well through the hopper into the trough. However, it is possible to feed hay separately to complement the grain component of the diet in the self feeder. Again, this is a new area of nutritional management and further research will be needed to determine effectiveness of including both hay and grain in the feeding area. “Mixability” is important. Mineral such as calcium and urea are very important for cereal grain-based diets but can be difficult to mix evenly with the grain. Dietary components should be considered for mixing ability as well as for the nutritional value. There is often considerable merit in having a simple, single component, diet as costs of mixing and of storing multiple ingredients can become costly.

**Management of feeding patterns**

The computer-based feeding system provides flexibility when individual animals have access to the self-feeder. A weekly cycle is easy to manage and the following categories are currently recommended.

<table>
<thead>
<tr>
<th>Feeding category</th>
<th>Corresponding conditions and action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>No supplementary feed required; never has access to self-feeder.</td>
</tr>
<tr>
<td>2.</td>
<td>Animal requires supplement to maintain weight or for slow growth; access to self-feeder once per week.</td>
</tr>
<tr>
<td>3.</td>
<td>Animal requires moderate level of supplementary feeding; access to feeder twice per week.</td>
</tr>
<tr>
<td>4.</td>
<td>Animal requires significant levels of supplementary; has access to feeder once every day.</td>
</tr>
</tbody>
</table>
In determining the size of self-feeder required, consider that only 25% may require supplementary feeding and that a significant proportion may only need to be fed once per week. Of those sheep being fed once per week, it can be arranged so that 1/7th of the group are fed each day of the week. The size of the self-feeder can therefore be quite modest even when feeding a large flock of ewes using precision nutrition technology.

29.4 Nutrition doesn’t fix everything

It is important to have access to benchmark performance information in order to determine whether the average response of animals to the nutritional supplement is within the expected range. Under-performance can be related to problems in feed quality or to the functioning of the self-feeder. For example, the gap controlling flow of feed into the trough may be too narrow and restricting intake. There may also be problems of insufficient trough space and some animals not getting adequate access.

In addition, it is important to identify individual animals that are performing below expectation. Reasons for poor performance can include: high parasite load; disease (including acidosis); whether the animal was born as a single or twin; and for ewes, whether they are carrying or have carried single or twin lambs. There will inevitably be a group of “poor doers”. Animals that do not respond to nutrition or parasite treatment and with no signs of disease, should be culled if they continue on a path of under performance before costing more money than they are worth.

Readings

The following readings are available on CD:

Activities

Multi-Choice Questions
Available on WebCT
Submit answers via WebCT
Self Assessment Questions
Refer to self assessment questions on WebCT.
Useful Web Links
Available on WebCT
Assignment Questions
Choose ONE question from ONE of the topics as your assignment. Short answer questions appear on WebCT. Submit your answer via WebCT
Summary

Sheep nutrition is a new area of nutritional management that allows individual animals to be fed according to their genetic potential and nutritional requirements. The lecture describes situations in which individual animals are likely to respond to supplementary feeding and consideration of the trigger points that can be used to initiate supplementary feeding. The lecture covers the principles and practical aspects of feeding systems as well as identifying areas where knowledge is currently lacking. An additional benefit of precision nutrition is that close monitoring helps to identify non-nutritional problems that may limit animal performance and provides a basis for addressing these issues.

References


Lloyd-Davies, H., 1987, ‘Studies on times of lambing in ewes grazing subterranean- based pastures in relation to stocking rates in South-Western Australia’. (Ed.) D A W Johnston Technical Bulletin No. 72, Department of Agriculture, South Perth, Western Australia. (ISSN 0083-8675)


Rowe, J.B. and Atkins, K.D. ‘Increasing Productivity in the Australian Sheep Flock’. ABARE conference, Canberra 2004
