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Proper feeding is the key to more and better quality lambs per ewe. Proper nutrition, from as early in life as an embryo or even an egg can have a substantial effect on a sheep's lifetime performance.

This guide pulls together the latest information on sheep nutrition and identifies when supplemental strategies and products are most likely to give you a return.

Breeders use EBVs to sell lifetime genetic productivity but to get that lifetime performance sheep must be properly fed. Getting it right benefits those breeding replacements and their clients.

This booklet provides essential information to help you achieve that and presents the theory and latest research findings alongside practical guidelines to use to enable you to put the theory into practice in your flock.

Whilst feed can bring out an animal to look its best for the sale, feeding for performance has beneficial effects for a lifetime.

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Replacement stock targets

Replacements
Lambing percentage and stocking rate account for most of the variation in gross margin between farms and hence potential profitability. Increasing production from one to two lambs per year reduces the energy requirement/kg of carcase produced by around 40% and this clearly contributes to a reduction in costs.

A useful target is: 1kg of lamb sold or retained / kg ewe mated

For example, a Mule ewe weighing 75 kg can produce on average 1.7 lambs weighing 45kg each. With the UK average lambing percentage sitting at only 110% there is plenty of room for improvement, so:

- Ewes must be prolific
- Lambs must survive to sale or retention
- Ewe liveweight must not be excessive
- Nutrition is the driver

Targets for rearing replacements
Ewe replacements should be reared well and to targets if they are to be good breeding sheep. Liveweight targets based on reaching 60% of mature body weight (MBWT) at mating as a ewe lamb (7 months) or 80% as a two-tooth (18 months) have proved useful.

Nutrition and genetics
Sheep adapt to periods of little food or plentiful food by switching on and off the genes for growth so the final animal you produce is the result of the interaction between nutrition and genetics.

Correct nutrition + good genetics = optimum performance

MBWT – Mature body weight. The mature weight of the ewe is important for accurately predicting the requirements for her growing lambs.

2 Feeding the ewe for lifetime production
...into practice

Replacement stock targets on your farm

Growing your own replacements

• Target for mating as a ewe lamb = 60% of MBWT
• Target weight for mating as two–tooths = 80% of MBWT

Lambs need to grow without check to weaning; a 10% reduction in growth will permanently reduce adult prolificacy. Poor growth due to an upland/hill environment means that puberty may not be achieved in the first autumn or reached below target weight.

• Good lowland farms selling finished lambs off grass can produce ewe lambs that are capable of breeding in their first year. Quantity and quality of grazing from August is the key. Lambs on the best quality grass should gain around 120–150g per day (g/d); with high sugar grasses this might increase to 200g/d and with white clover-rich swards 225g/d.

• Lambs holding to first oestrus is a good indicator of further high lifetime performance. If breeding your own replacements, mate 15–20% more ewe lambs than you need and select only those holding in the first 17–21 days.

• Producing early lambs using supplementary concentrates increases fatty deposition in the udder of ewe lambs which compromises their potential future milk yield. In this situation it is better to buy in replacements from a respected source rather than risk buying ewe lambs that have been fed unnecessarily high levels of concentrates.

• Later lambing and upland farms that produce finished and store lambs off grass are a good source of breeding replacements. These are generally best left unmated in their first year and need careful management to ensure a target 80% of mature body weight is reached by mating as two–tooths.

Feeding lambs to be mated at 18 months

• Crossbred lambs under 30kg by September are too small for breeding; finish these quickly on concentrates or other finishing rations.

• In their first winter, lambs chosen as replacements need to gain about 50g/day - around 5kg over the winter. If they gain no weight over the winter they are less able to respond to flushing in later life.

• Housed hill breed ewe lambs will usually need around 135kg of hay and 25kg of concentrates for the winter or 300kg of baled silage at 30% dry matter and 22kg of mineralised barley or oats.

• In the spring, shear as early as weather allows and give them access to the best grass available on the farm after shearing when appetite is high – it really is important to do these replacements well - if left too late the body weight target can easily be missed.
Prolific breeds

The science of fertility in new breeds

Fertility in sheep is thought to be influenced by hundreds of genes all with a small effect. However there are some major genes that affect prolificacy. Some of these have graded effects on a trait – eg, a ewe having inherited the ‘Booroola’ allele for prolificacy from both parents is more prolific than a ewe inheriting it from only one parent, and it in turn outperforms an animal that did not inherit the allele from either parent (i.e., 2 > 1 > 0).

A notable exception to this – termed ‘Heterozygote advantage’ – is seen in other genes that have major influences on prolificacy in sheep, including the ‘Inverdale’. In this case, ewes that have inherited an allele for prolificacy from one parent only (heterozygous carriers) are more prolific than homozygous non-carriers but homozygous carriers are infertile. Here, instead of graded effects on a trait, one copy is enough but two is too many – nature’s way of regulating prolificacy. In these cases careful management of ewe and ram pairings is important. Among the breeds of sheep noted for Heterozygote advantage-style prolificacy are the Belclare, the Cambridge, and the Inverdale Texel and its cross with the Welsh – the Aberdale. The Aberdale and its crosses have been closely controlled and blood typed so that one copy of the gene for high prolificacy will be in all ewes and none have two copies, but in the other breeds the incidence of these genes is unknown, theoretically it will be in around 10-20% of ewes.

The Lleyn breed is noted for its prolificacy, giving rise to the Belclare and Cambridge sheep, both of which are known to carry more than one major gene affecting prolificacy. Two of the 3 mutations implicated in the prolificacy of these composite breeds have also been identified within the Lleyn breed itself and at least one study showed a 15% incidence of Lleyn ewe lamb infertility consistent with the ‘one is enough but two is too many’ allele scenario. It is also possible that many Lleyn flocks contain no major genes for fertility.

New rules for prolific breeds

A “one size fits all” approach to ewe nutrition at mating is not applicable to prolific breeds and these breeds should be managed appropriately to produce the optimal number of lambs to meet your particular breeding goals.

Correct management is essential to ensure your chosen breed achieves its potential.

Homozygous – Carrying two identical alleles for a single trait
Heterozygous – Carrying two different alleles for a single trait – one of the alleles will be dominant
Graded effects – Two copies are better than 1, 1 copy is better than none
Heterozygous advantage – One copy of the dominant gene is better than none or two copies
Mating management for prolific and traditional breeds

A “one size fits all” approach to ewe nutrition at mating is not applicable to prolific breeds and these breeds should be managed appropriately to produce the optimal number of lambs to meet your particular breeding goals.

<table>
<thead>
<tr>
<th>Prolific breeds</th>
<th>Traditional breeds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lleyn</strong> – mate Lleyn ewes on short swards</td>
<td><strong>Welsh mules</strong> – target condition score 3.5 for mules</td>
</tr>
<tr>
<td><strong>Cambridge</strong> – High litter size puts pressure on management</td>
<td><strong>NZ Romneys</strong> – respond well to flushing</td>
</tr>
<tr>
<td><strong>Aberdale</strong> – should be put onto low quality pastures pre-mating releasing better grass for lamb finishing</td>
<td><strong>Welsh mountain</strong> – wean in August to allow ewes time to regain condition</td>
</tr>
</tbody>
</table>
Taking theory...

Nutrition around mating

Research shows that if the target of 60% of mature body weight at the time of mating has not been met, then feeding ewe lambs for catch-up growth after mating risks producing lambs of low birthweight with problems of lack of vigour, limited brown fat reserves and poorer survival.

Good body condition before mating encourages the egg producing structures on the ovary (follicles) to develop and sets the potential lamb crop. However, overfeeding ewe lambs during pregnancy compromises the birth weights and viability of their offspring (see below). At the opposite extreme, a small ewe lamb invests any extra feeding in her own weight gain which undermines establishment of the placenta. So it is important to get ewes into the right body condition before mating.

![A comparison of overfed ewe lambs (gaining 240 g/d) vs those fed to target weight (gain 80 g/d).](image)

For lowland crossbred ewes increasing condition score from 2.5 to 3.0 can increase scanning percentage by 20-40%. Realising this potential depends on successful implantation of the released egg and development of the placenta.

Nutrition affects each stage of development independently. If nutrition is inadequate at one stage the damage cannot be undone by heavy feeding later.

**Progesterone levels govern placental development**

Progesterone is the key hormone influencing the generation, establishment and performance of the placenta and its ability to support foetal development. Adequate amounts of progesterone are needed in the fortnight immediately after conception otherwise the viability and liveweight of the lambs will be compromised.

High feed intake increases blood flow through the liver and increases the rate at which progesterone is lost; this compromises the development of the lamb.

Ewes with major prolificacy genes ovulate more eggs but they have less effective progesterone-producing capacity and this is why flushing these ewes should be avoided.

**Progesterone is secreted by the corpus luteum in the ovaries after ovulation and prepares the uterus for pregnancy and the mammary glands for milk production. Progesterone levels are determined by the ewe’s ability to produce it following ovulation and by the rate at which it is lost by breakdown in the liver.**
Feeding the ewe for lifetime production

Managing nutrition around mating

Mature sheep should be at the optimum condition score for mating. Set the ewe’s targets for growth and body condition in the months before mating so that there is no need for dramatic ‘catch-up’ feeding during the time that ewes are with the rams or in the months that follow.

**Achieving condition score targets:**
Putting on one unit of condition score adds 13% of liveweight so to go from CS 2 at weaning to CS 3.5 at mating, a 65kg ewe has to put down about 13kg, mainly as fat.

- The energy content of the weight gain is 24 MJ/kg
- On reasonable diets the efficiency of gain is about 45%, so the ewe needs to eat about 55MJ per kilo gain – about an extra 700 MJ in total
- Over 10 weeks this is 10MJ/day – equivalent to 1kg of concentrates/day or an extra kilo of DM of best quality grass.
- For thin ewes or if swards are too short (<4 cm) or brown due to drought (rather than green) or where heavy rainfall interferes with grazing, then feed around 0.5 kg/day of cereal/beet pulp mix using a snacker to minimise grazing disturbance.

**Do you need to flush?**
- Flushing traditional breeds that are already fit in terms of body condition won’t stimulate the ovaries to release even more eggs for fertilization but there is a place for traditional ‘flushing’ where adult sheep have missed the condition score target due to bad weather or feed shortage.
- Avoid flushing and heavy feeding around mating for breeds that carry major genes eg. the Lleyn, Cambridge, Belclare and Aberdale.

**Missed the target weights?**
Lambs mated at under 60% of mature body size can safely gain up to 80g/day in pregnancy (4 kg in total), but beware – if they are overfed they direct too much nutrient to their own growth and produce very small lambs at birth.

- Condition score ewe lambs 5 weeks pre-lambing
- Give twin bearing and thin ewes (CS less than 2) an extra 150 g/day of soya or access to buckets (200g/day) that are designed to increase the supply of microbial and digestible undegraded protein (DUP).
- Don’t allow them to rear twins; cross-foster if possible
Managing lambing percentage

**Synchronised and/or superovulated sheep**
Nutritional flushing is not applicable to ewes being stimulated artificially to produce higher numbers of embryos because the ovaries of the ewe will be influenced more by the injections than by ‘nutritional flushing’. In particular, if synchronisation depends on an intravaginal progesterone-releasing device such as a sponge then the timing of ovulation depends on a fall in progesterone following device removal. Over-generous feeding while the device is in place increases the blood flow through the liver and this lowers progesterone concentrations. This can limit the number and quality of embryos generated.

**Prolific ewes need different treatment**
Farmers will be familiar with the classic liveweight and ‘body condition change’ pattern (solid line) shown below. Mature prolific ewes carrying more than two lambs (broken line) do not follow the classic pattern.

Prolific ewes should be held at CS 3 during early pregnancy and the traditional “flush and fall” scenario should be avoided. Ewes bearing multiples will tend to be heavier pre-lambing and lighter post-lambing. If lamb survival is good (and especially if rearing all her lambs) the ewe is likely to lose more weight during lactation. Consequently, she will be tupped at a lower body weight and CS and faces an uphill struggle to hit conventional targets at tupping. She needs to be managed so that she reaches CS 3 again 1 month before tupping. Prolific breeds that produce more than enough eggs can be in optimum condition for mating below CS 3. Hence the recovery period can extend into the subsequent pregnancy and by having thinner ewes this will reduce triplets and quads.

**Condition score targets**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Weaning</th>
<th>Mating</th>
<th>Mid-pregnancy</th>
<th>Lambing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill / Upland</td>
<td>2</td>
<td>2.5 - 3</td>
<td>2.5</td>
<td>2 – 2.5</td>
</tr>
<tr>
<td>Lowland</td>
<td>2</td>
<td>3.5</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Prolific</td>
<td>2</td>
<td>2.5-3.0</td>
<td>2.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Increasing the number of lambs born is only worthwhile if the ewe can rear the additional lambs. Triplet and quadruplet births are generally unprofitable where lambs have to be reared off the dam. Surveys suggest that on average farms mortality levels to weaning amongst singles are around 5% versus 10% amongst twins and up to 30% in triplets.

Controlling the incidence of triplets and quads by nutrition at mating is a good start.

Hence, Lleyn and Aberdale ewes can achieve over 200 lambs born per 100 ewes easily without flushing. Recent studies on Aberdale (Inverdale Texel X Welsh Mountain) ewes showed that grazing on low quality swards of native grasses at a pre-tupping sward height of 8cm rather than perennial ryegrass/clover kept 19 of 26 flocks in the desired lambing percentage range (160-200%).

Both Lleyn and Aberdale ewes are also well-suited for later-season lamb production when they scan around 10-20% lower.

What to aim for:
- The target condition score at 3-4 weeks pre mating is 2.5 for prolific ewes
- Hold them at this level to one month post tupping
- Typically sward heights of 4 cm are fine or use mature pasture
- Supplement mature pasture with trace elements
- Avoid stress from extremes in weather by providing adequate shelter and reduce any unnecessary handling
- For mating on forage brassicas allow 50g/day intake of a feed block containing 40mg/kg Iodine
Taking theory...

Trace elements and reproduction

Specific effects of cobalt - early stages
Cobalt (Co) is a key nutrient during oocyte (egg) development and for the early foetus. However, its effects on lamb vigour at birth are not seen until much later and long after any remedial action can be taken. In trials involving Scottish Blackface ewes from farms with cobalt-deficient pasture, the cobalt status during egg production and embryogenesis was found to have a major long-term influence on lamb behaviour.

Studies of lambs from ewes which were deprived of cobalt and sulphur during the very early stages of egg production and embryonic development (ie from 8 weeks before conception to 6 days after conception) showed that while there were no effects on pregnancy establishment or birth weights, there were long-term effects on the offspring including:

- More fat and lower muscle: bone ratio
- Less effective immune responses
- Insulin resistance
- Elevated blood pressure

Cobalt given before mating affects lamb behaviour

![Graph showing the effect of cobalt on lamb behaviour](image)

Cobalt status of embryo donor ewe increased active behaviour of lambs at birth (Mitchell et al, 2007)

Selenium supplementation pre mating
There is positive benefit from supplementing with selenium (Se) but the extent of the problem needs to be established well before the start of the breeding season (ie if required, rams need treatment 12 weeks pre-mating, ewes 6 weeks).

Where Se levels are low, supplementation will help to reduce the number of barren ewes and increase the number of lambs born. Lambs will be livelier and can be as much as 0.6 kg heavier at weaning. The effects of poor Se levels on the lambs are often long-lasting and can last for weeks or even years.

Vitamin E levels in late pregnancy
Vitamin E supplementation during late pregnancy generally improves lamb vigour. Ewes will mobilise their own reserves of vitamin E from their fat if needed, but since these body reserves are not known it is wise to provide 80-100mg Vitamin E/day during late pregnancy – particularly for ewes lambing outdoors at lower condition scores.

Early stage development
The very early stages of egg production and embryonic development occur from around 8 weeks before conception to 6 days after conception. Ewe nutrition during this period not only has a marked effect on the resulting lambs but the effects also tend to be long-term.

Monitor

Vitamin and mineral status by blood sampling in conjunction with your vet
Provideing your ewes with adequate trace elements for reproduction

Identify the problem - do you have a trace element deficiency?

If scanning rates are low and lambing spread out despite having good liveweight gain and condition scores, have forage, soils and blood or tissue tests done to identify trace element deficiency. Many companies will test forages for free for major and trace elements which provides a useful starting point. There are many trace element products available for treating Co and Se deficiencies so use all sources of information possible in your supplementation decision and discuss results with your vet.

Use the table below to plan tissue sampling.

<table>
<thead>
<tr>
<th>Trace Element</th>
<th>Clinical signs</th>
<th>When to sample</th>
<th>Number to sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>Swayback</td>
<td>Ewes pre-topping (useful if results are within or below marginal band)</td>
<td>Blood: 7-10 (heparin samples best, clotted OK)</td>
</tr>
<tr>
<td></td>
<td>Ill-thrift</td>
<td>Lambs at weaning</td>
<td>Liver: 3</td>
</tr>
<tr>
<td></td>
<td>(uncommon)</td>
<td>Cases of ill-thrift</td>
<td></td>
</tr>
<tr>
<td>Cobalt</td>
<td>Ill-thrift</td>
<td>Ewes pre-topping and pre-lambing</td>
<td>Blood: 10 (clotted samples)</td>
</tr>
<tr>
<td></td>
<td>Poor fertility</td>
<td>Lambs at weaning</td>
<td>Liver: 3</td>
</tr>
<tr>
<td></td>
<td>Neonatal losses</td>
<td>Cases of ill-thrift</td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>Ill-thrift, poor fertility</td>
<td>Tups and ewes</td>
<td>Blood: 3-5 (clotted samples)</td>
</tr>
<tr>
<td></td>
<td>High barren rate</td>
<td>pre-topping</td>
<td>Liver: 3</td>
</tr>
<tr>
<td></td>
<td>Stillbirths</td>
<td>Lambs at weaning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>White muscle disease</td>
<td>Cases of ill-thrift</td>
<td></td>
</tr>
</tbody>
</table>

If you have:
- A history of scanning percentages which are below target
- Thin sheep
- Feed supplies which are sparse at tupping (e.g. late lambing)
- Feed supplies which are of low quality

Do use high energy, high intake (200-300 g/day) type feed blocks. These can give a 10-20% increase in lambing percentage but the minimum Co and Se content of these needs to be 1.2 mg/kg and 0.8 mg/kg, respectively.

Don’t use anthelmintic products containing trace elements to address production problems, trace element levels may not be sufficient to redress the balance and you increase the risk of encouraging drench resistance.

For prolific sheep and well grown ewe lambs where no extra energy and protein is needed:

Do – consider minerals/mineral blocks or low intake hard licks to supply Co and Se (minimum levels in licks with an intake of 30-70 g/day are 6 mg/kg and 3.6 mg/kg respectively).

Don’t – buy supplements on the basis of high phosphorous and digestible undegraded protein (DUP) levels, they are not necessary.

If you do need to supplement:
- Select the most appropriate supplement
- Train young sheep to take minerals in the format used
- Set up one site per 30 ewes to avoid stress around tupping
- Keep supplies topped up
- Start two weeks before ram turnout and feed for a further month
Taking theory...

Pregnancy to 90 days

Under-nutrition effects on lifetime performance

In the first half of pregnancy, while various organs and processes are being established in the growing foetus, under-nutrition can have a permanent effect. Work on hill ewes has shown that under-nutrition of foetal ovaries limited litter size in later life when the foetus itself became a breeding ewe. Permanent effects from under-nutrition on muscle growth, cardiovascular development, endocrine glands (implicated in reaction to stress), the immune system and brain development have also been found. By comparison, prolific genotypes carrying the Inverdale gene do not appear to be compromised in this way.

Effects of underfeeding energy and protein on foetal development and mother-offspring interactions

Studies on underfed ewes using ultrasound and video surveillance of ewes and lambs at lambing and testing the ability of lambs to recognise their mothers at 24 hours old showed:

- Reduced foetal growth and birth weight
- Poorer quality of maternal care to their offspring
- Lambs less vigorous at birth with higher mortality
- Reduced birth weight in some breeds
- Effects on lamb behaviour and survival
- Underfed ewes groom and bleat to their lambs less immediately after birth and scored lower in tests of maternal attachment

Longer term effects of under-nutrition (e.g. on reproduction and health, as well as trans-generational effects) are currently being investigated.

Effects of underfeeding energy and protein on the placenta

In general, a moderate mid-pregnancy ‘check’ in terms of feed intake can favour the mature ewe’s inclination to invest resources in the placenta with a subsequent pay-off in terms of good lamb birthweights. This capability – which is absent in the ‘need-to-grow’ adolescent ewe - may reflect evolutionary adaptations to cope with winter snowfall scenarios in mid-pregnancy.

Remember – nutrition affects each stage of development independently.

The impact of inadequate nutrition at each stage of development often has permanent or long-lasting effects in the lamb.

If nutrition is inadequate at one stage the damage cannot be undone by heavy feeding later.
Aim to maintain body condition and avoid stress for the first month after mating and whilst rams are running with the flock. In stressful conditions ewes will reabsorb embryos and end up barren despite having been mated.

**Avoiding stress:**
- Stress can be caused by sheep fighting for feed from a trough so avoid daily supplementation if possible
- Heat stress kills embryos so avoid sheep being run to exhaustion
- Avoid weather stress by using sheltered fields
- Do not gather sheep to the ram, if he is any good he will find them

**Avoiding under-nutrition**
Severe under-nutrition causes problems but most lowland ewes should have sufficient body reserves to avoid this. Thin hill ewes can be supplemented with a hard type feed block/lick and 0.6 kg of hay (30 ewes/bale) in snowy conditions.

In the second and third months from mating ewes can be allowed to lose half a body condition score and may benefit from mild under-nutrition. Ewes can be scanned at 80 days onwards for litter size.

**Don’t overfeed lowland ewes, prolific breeds and ewe lambs**
Graze either short leafy swards at around 4 cm or old pasture but check that cobalt levels are adequate. If cobalt is a known problem treat the ewes with cobalt bullets or if there are multiple deficiencies use a bolus. Blocks or licks may suffice but do not rely on oral drenching or the cobalt in a wormer.

### Pregnancy timetable for timing of management tasks

<table>
<thead>
<tr>
<th>Day</th>
<th>Events</th>
<th>Key Stages</th>
<th>Management tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Mating</td>
<td>Pre-implantation</td>
<td>Avoid stress and handling ewes</td>
</tr>
<tr>
<td>3</td>
<td>Fertilisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Migration</td>
<td>Implantation</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Implantation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Foetus weighs 5g</td>
<td>Placental Growth</td>
<td>Embryos now ‘safe’</td>
</tr>
<tr>
<td>90</td>
<td>Foetus weighs 700g</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Some feeds can impair breeding through the effects of plant secondary metabolites. These are plant components that have chemical structures that are similar to the hormones that control reproduction in the animal.

**Red Clover**

Plant breeders are trying to reduce the concentration of formononetin, the major oestrogenic factor in red clover varieties. Formononetin in red clover is converted to phyto-oestrogen in the rumen and has been shown to cause infertility in sheep. Making silage from red clover concentrates the oestrogens and makes the problem worse. White clover however, as a grazed crop or silage, is safe.

**Forage brassicas**

Forage brassicas contain goitrogens that prevent iodine uptake by the thyroid so where they are fed for long periods supplementation with iodine is beneficial. Another metabolite, S-methyl cysteine sulphonate, may cause the breakdown of the red blood cells which carry oxygen around the body (haemolytic anaemia). Plant breeders have reduced the concentration of harmful metabolites so by controlled use of forage brassicas around mating and providing access to other feeds such as grass the problem is usually avoided.

**Beneficial effects on reproduction**

However, some plants may have beneficial effects on reproduction if fed around mating time. For example, chicory is high in trace elements and evidence suggests that the condensed tannins that chicory contains may inhibit or reduce worms. Early indications are that it is useful for ewes and rams pre-mating.

**Oestrogenic factors** – compounds which are structurally similar to oestrogen and can either compete with or mimic oestrogen thus reducing the effect of the oestrogen and causing infertility.

**Goitrogens** – compounds which inhibit the synthesis of the thyroid hormones thereby reducing the output of these hormones. Some goitrogens reduce or inhibit the uptake of iodine.

**Tannins** – plant compounds that either bind to or shrink proteins and various other organic compounds. Tannins are widely distributed in many species of plants, where they play a role in protection from predation and may also be involved in growth regulation.
Forage brassicas
Forage brassicas contain goitrogens that prevent iodine uptake by the thyroid. Symptoms of goitre are swollen thyroid glands in the neck.
Other metabolites may cause haemolytic anaemia and thyroid damage. Anaemic sheep are lethargic and have pale mucous membranes.
• Look out for these symptoms as problems are rare.
• Use kale at least part-time for flushing and tupping leaner ewes and gimmers in later lambing flocks.
  Avoid this for fit ewes and very prolific breeds. Kale made into silage loses its toxicity.
• Ration the crop and introduce it gradually on and off for 3 – 4 days then full time or one day on and one day off, but avoid putting sheep onto frosty kale.
• Have a run back with grass or provide straw.
• Supplement brassica crops fed during tupping or in pregnancy with blocks/ buckets containing iodine or give iodine injections.

Red Clover
• Don’t feed swards with over 30% red clover to ewes or rams 45 days either side of tupping.
• Don’t feed red clover silage after tupping – it will result in barren ewes and undersized lambs.
• Silage made from red clover can be fed safely in the last third of pregnancy.
• Remember that white clover, as a grazed crop or silage, is safe.

Do you know what your replacements have been fed?
Many farmers are moving to rearing their own replacements for a variety of reasons including biosecurity and the need to bring in high performance and easy care traits. These traits are often ignored by many traditional breeders who base sales on looks.
Farmers buying in replacements as ewe lambs or gimmers tend to pay more for the biggest ones; this is not a sensible strategy if the nutritional basis of this has been heavy supplementary feeding just prior to sale. All this does is mask inefficient grazing and/or worm resistance.

If you buy in replacements, ensure that they come from a respected source. By rearing sheep correctly longevity is increased; all farmers agree that sheep with longer productive lives are needed.
Having looked at feed requirements at mating (pages 6-11), during very early pregnancy and up to 90 days (pages 12-13), any changes to feeding management during late pregnancy (4-5 months) should be based on pregnancy scanning at 80 days and body condition scoring 8 weeks before lambing.

In months 4 and 5, providing the ewe was in good condition at mating (3.5) and is now around 3, another 0.5 of a condition score can be lost without affecting foetal growth to achieve a score of 2.5 at lambing. This provides reserves for lactation and insulation while helping to reduce the incidence of lambing difficulty.

Ewes that are underfed in late pregnancy produce lambs with low reserves of brown fat used specifically for protection against hypothermia. In late pregnancy the ewe adapts to rumen restriction by increasing the food passage rate and increasing protein absorption by 15%. A high energy content (at least 12 ME) in the diet is critical as the ewe eats less.

Cereals and cereal by-products are a good source of energy but high levels of cereals, particularly wheat, can cause acidosis so the inclusion of a digestible fibre source, such as molassed sugar beet pulp at around 20% is desirable. Cereals can be fed whole with hay but should be lightly processed with silage. The inclusion of molasses will provide readily available energy, aid palatability and will reduce dust and carry minerals.

Protein is required for lamb growth and colostrum yield and quality. Rumen microbes also need a sufficient supply of effective rumen degradable protein (ERDP). In late pregnancy the concentrate should also provide digestible undegradable protein (DUP), which is resistant to breakdown by the rumen microbes and is digested in the small intestine. Hipro Soya is the best protein source supplying 130 g/kg followed by cottonseed meal 110 g/kg and rapeseed meal 57 g/kg. Home grown peas and beans providing around 40 g/kg can be used to provide protein but are less efficient as sources of DUP. Compounds containing supplementary mannan-oligosaccharides increase colostrum quality and protection for lambs against disease.

### Rumen degradable protein
- protein which can be broken down and utilised by rumen microbes. Microbial protein can then be absorbed by the animal when it passes into the small intestine.

### Digestible undegradable protein
- proteins that have a slow rate of degradability and escape digestion in the rumen. The undegradable protein is then broken down in the gastrointestinal tract as it would be in non-ruminants.

### Mannan oligosaccharides
- are normally obtained from the yeast cells and are widely used in animal feed to encourage gastrointestinal health and performance.

#### Energy requirements of pregnant 75 kg twin bearing ewes

<table>
<thead>
<tr>
<th>WEEKS BEFORE LAMBING</th>
<th>Energy MJ ME/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Good silage</td>
<td>16</td>
</tr>
<tr>
<td>Good hay/bailed silage</td>
<td>17</td>
</tr>
<tr>
<td>Average Hay</td>
<td>18</td>
</tr>
</tbody>
</table>

For 65 kg ewes reduce daily ME requirement by 1 MJ

Cereals and cereal by-products are a good source of energy but high levels of cereals, particularly wheat, can cause acidosis so the inclusion of a digestible fibre source, such as molassed sugar beet pulp at around 20% is desirable. Cereals can be fed whole with hay but should be lightly processed with silage. The inclusion of molasses will provide readily available energy, aid palatability and will reduce dust and carry minerals.
In late pregnancy rations may be based on straw, average or good quality hay or silage. Hay and silage can be very variable in their nutrient content and so it is essential to have forages analysed well before this period so that rations can be formulated and the amount and type of supplement required can be determined. Daily forage dry matter intake (percentage of liveweight) is shown in the table below.

<table>
<thead>
<tr>
<th>Feed</th>
<th>do not use compounds with lower energy content because they will need to be fed at higher levels</th>
</tr>
</thead>
</table>

For example, the graph opposite shows that a 75 kg ewe just before lambing needs 19 MJ ME/day.

The table above shows that if you are feeding average quality hay she is able to eat 1.5% of her liveweight. 1.5% of her bodyweight = 1.13 kg.

To calculate how many MJ of energy this will supply multiply by the ME of the feed e.g. 1.13 x 8.5 = 9.6 MJ

If she needs 19 MJ ME/day then to calculate how much concentrates to feed; 19 – 9.6 = 9.4

A good quality concentrate has an energy content of approx 12.5 MJ/kg of dry matter and the dry matter is 86%.

Therefore each ewe needs:

\[
\frac{9.4 \times 100}{12.5 \times 86} = 0.9 \text{kg/day}
\]

**Choosing a compound feed**

- Do work out what the nutrient content of your forage is first so that you know what type of compound feed you need.
- The minimum metabolisable energy (ME) in a compound should be 12.0 MJ/kg DM and good quality ingredients should be used to achieve this with no reliance on low energy by-products.
- Do not use compounds with lower energy content because they will need to be fed at higher levels – this will reduce forage intake.
- Get your supplier to provide a full formulation and specification of the compound. The protein level should be 18%CP, but this gives no indication about the protein quality (ERDP & DUP). The formulation will provide this information and will show the source of energy being used – cereals, maize gluten, sugar beet pulp, soya hulls.
- Avoid formulations with low quality ingredients such as oatfeed, olive pulp, shea nut, cocoa shells or coffee residues.
Monitoring nutritional status

Interpreting forage analyses
The key components of analysis are dry matter (DM), metabolisable energy (ME) and crude protein (CP). Current analytical techniques supply information regarding the degradability of the protein.

For silages the intake potential will also be provided with an estimate of the fermentation quality. Ideally samples should be taken from several bales and for pits, cores should be taken at several points across the diagonals of the pit to ensure that the material analysed is representative of the whole. The voluntary intake of precision chopped silage is higher than that of big bale material and ration formulation programmes should take this factor into account.

Assessment of the ration
• Is the ration on paper the same as the ration being fed? Check weights
• Is the ration being offered actually being eaten? Check wastage, clean out troughs.
• Is there adequate trough space for all the ewes to consume their concentrate allowance at the same time?
• A useful check for diet adequacy is a blood sample for the concentration of a compound in the blood called ß-hydroxy butyrate (BOHB). Discuss results with your vet to get an accurate interpretation and to work out the best course of action.

Forage samples are essential for planning rations.
Monitoring nutritional status

Typical rations for 75 kg housed ewes

<table>
<thead>
<tr>
<th>Hay to appetite (around 0.86 kgDM/d) with the following concentrate allowances (kg)</th>
<th>Silage to appetite (around 1.0 kgDM/d) plus concentrates (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weeks from lambing</strong></td>
<td><strong>Weeks from lambing</strong></td>
</tr>
<tr>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td><strong>Singles</strong></td>
<td><strong>Singles</strong></td>
</tr>
<tr>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>0.2</td>
<td>0.35</td>
</tr>
<tr>
<td>0.25</td>
<td>0.5</td>
</tr>
</tbody>
</table>

For ewes below CS 2 and with triplets feed extra concentrates or buckets.

Supplements for hill ewes

The value of supplements given to pregnant hill ewes on indigenous grazing is difficult to estimate as deficits are hard to quantify and will include minerals and trace elements.

On heather-dominant hills, extra protein supply in mid pregnancy from feeding blocks increases lamb birth weight. The cost of feeding out in time and labour has also to be accounted and supplements may affect grazing behaviour and hence overall feed intake.

Hence simple comparisons of cost per unit of ME and CP are less relevant for hill ewes than with other classes of stock.

<table>
<thead>
<tr>
<th>Supplement &amp; typical intake/day</th>
<th>Cost per tonne (£)</th>
<th>Cost per day (£)</th>
<th>Labour cost of feeding</th>
<th>Packaging cost of feeding</th>
<th>Approx % of energy required</th>
<th>% of min vit required met</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.45 kg compound (12.5 ME, 18% CP)</td>
<td>180</td>
<td>8.1</td>
<td>Very high</td>
<td>Bags (£25) Tote (£5)</td>
<td>45</td>
<td>70</td>
</tr>
<tr>
<td>0.8 kg good quality hay (9.2 MSME)</td>
<td>100</td>
<td>8.0</td>
<td>Moderate</td>
<td>Nil</td>
<td>55</td>
<td>Variable</td>
</tr>
<tr>
<td>0.45 kg beet pulp</td>
<td>210</td>
<td>9.4</td>
<td>Very high</td>
<td>Bags (£25) Tote (£5)</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>80g Hard pour type high energy bucket</td>
<td>618</td>
<td>4.9</td>
<td>Very low</td>
<td>Plastic (£80)</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>0.15 kg cold pressed standard feed block</td>
<td>400</td>
<td>6.0</td>
<td>Very low</td>
<td>Bags (£8)</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>0.25 kg cold pressed super energy feed block</td>
<td>430</td>
<td>10.7</td>
<td>Low</td>
<td>Bags (£8)</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>0.2l Urea containing liquid feed</td>
<td>285</td>
<td>7.4</td>
<td>Moderate</td>
<td>N/A</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

Check protein supplies for hill ewes carrying twins
Taking theory... Outdoor lambing

Research at Greenmount in Northern Ireland over two years showed that outdoor born lambs were heavier at birth, grew faster to six weeks and had similar mortality to housed lambs except in exceptional weather.

**Parasites have a significant effect on performance**

Wormy ewes produce less milk and are a major source of infection for their lambs. One ewe at 300 eggs per gram can produce enough infective larvae to reduce weight gain in 10 lambs or more.

High DUP in late pregnancy and lactation can reduce worm numbers and eggs deposited onto pasture, reducing dependancy on wormers and the development of anthelmintic resistance. SAC trials show that to achieve this, protein levels must be approximately 20% higher than AFRC currently recommends – but the increased colostrum and milk production are a bonus and reduce labour costs.

For twin-rearing Mules, this means approximately 170 g metabolizable protein (MP) per head per day during late pregnancy, increasing to approximately 370 g MP per day during early lactation. The study showed around 10% heavier lambs at birth, 30% increased milk production and a more than 60% reduction in worm burden (Figure 3) with almost 90% reduction in worm egg output (Figure 4). As a result, lambs had a temporary lower worm egg output, higher growth rate and higher weaning weight. These all contribute to getting lambs away from the farm early in the season. This usually results in higher prices and better carcase quality. Savings can also be made on drenching, reducing the development of anthelmintic resistance.

**Extra protein**
can improve milk supply and reduce worm burdens

**Targeting protein**

Not all ewes however are equally infective to the pasture. The protein available to ewes is prioritised to body maintenance, reproduction and finally mounting the immune response. Multiple bearing ewes in late pregnancy have to break down body protein reserves to supply glucose to keep their lambs alive. Hence, ewes rearing twins excrete 70-80% more worm eggs than ewes rearing singles, especially if they are in a poor condition. It may be worth grazing single rearing ewes separately and targeting twin-rearing ewes with extra protein during late pregnancy.

**Other approaches**

Grazing ewes and lambs on forages such as chicory can also improve lamb growth and reduce worm burdens by 40%. In early growing areas turning ewes and lambs onto second year chicory reduces dependance on concentrates for finishing and helps control the effects of worms.
...into practice

Outdoor lambing

Low labour availability is driving farmers to lambing outdoors, but low losses are a priority and 150-160% lambs sold /ewe mated is a realistic target. One person to 600-1000 ewes at lambing can reduce fixed costs.

Using temporary housing

Ewes can be housed from 12 to 2 weeks pre-lambing to rest lambing fields. The stocking rate when housed can be 50% higher by winter shearing ewes and cutting out lambing pens. Turn out 2 weeks prior to lambing.

Grazing

Newly grazed grass not only meets protein and energy needs but sets up ewes to lamb unaided.
• Clear fields 2-3 months pre-lambing to achieve target 6cm sward height at turnout.
• Ewes should be lean at turnout – CS 2.0-2.5 otherwise later born singles can be too heavy for an unassisted birth.
• Turnout 10-14 days pre-lambing to give ewes time to settle and choose a lambing site.
• Stop daily supplementary feeds – these disturb grazing and lambing behaviour.
• Stock lowland twins at 17/ha (range 7- 27), singles at up to 40/ha, halve this on upland units.
• Mob size maximum of 120 ewes, unsorted on lambing date.
• Lamb over 28 days - take rams out to ensure this.
• Consider grazing single rearing ewes separately, and targeting twin-rearing ewes with extra protein to help reduce worm burdens. Protein can be fed as 200 g soya per head per day during late pregnancy, increasing to 400 g soya per day during early lactation. Similar effects can be expected from 125 and 250 g/d of protected soya.

Lambing Management

Avoiding having to handle outdoor ewes is key although an emergency overnight shelter is valuable.
• Start with lean ewes and a lambing date matched to pasture growth
• Ewes with plenty of colostrum and used to human contact help
• Use high maternal EBV ewes and rams
• Select rams for easy births and the ability to suck unaided.
• Supplement with trace elements/vitamins to maximise lamb vigour.
• Cull problem ewes early – big teats, persistent footrot etc.
• Have a comprehensive health plan that is a working document
• Expect some cross fostering – only some are able to rear triplets
• Consider supplemental feeds such as buckets or blocks designed for outdoor lambing to help improve colostrum supply and lamb survival. These can be targeted at triplets, underweight twin bearing ewes and gimmers.
• Avoid having to tube lambs with supplemental colostrum – it is expensive and time consuming.

Feeding the ewe for lifetime production   21
Feeding your ewes for lifetime performance

Year round attention to detail is needed
Trace elements from very early in life can have big effects, so relying on pre-lambing supplementation alone is not the answer. Avoid the impact of over or under-nutrition by feeding according to the needs of the ewe at the different stages of pregnancy.

Not all sheep are the same
Prolific breeds and first time lambers need different management.

New rules – new practices
If holding condition do not under supply cobalt as this can affect lamb viability through effects on the developing embryo.

An 18% CP ewe concentrate is an inadequate description
Dig deeper than looking just at the crude protein content of concentrates for pregnant sheep to avoid getting basic feeding wrong by underfeeding rumen undegradable protein in late pregnancy.

Getting it right saves lives
Extra rumen undegradable protein not only improves milk supply and lamb birth weight but also has long term effects on immunity and bonding between the ewe and lamb. Feeding extra to multiple bearing ewes also reduces the worm challenge to their lambs.

Use this information to update your feeding management