Organic Beef and Sheep Nutrition

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Introduction

Research has demonstrated that, providing high quality grazing or conserved forages are available, organic beef and sheep production systems can be managed without the need to supplement with concentrate feeds. The objective of feeding organic beef cattle and sheep should therefore be the provision of predominantly forage based diets supplied by the unit itself. This will normally be based on grass/clover grazing and quality conserved forages. This Technical Leaflet reviews relevant research on beef and sheep nutrition, takes account of the experience of producers and provides practical recommendations.

Nutritional Principles

The Rumen

As grazing and conserved forages are the basis of organic production, a basic understanding of rumen function and fibre digestion is important for good nutrition. In essence, the principle of feeding cattle and sheep is feeding the rumen for maximum microbial production. A good description of rumen function is provided by Bax (2008).

The rumen is basically a large fermentation vat and the microbial population that it contains thrives on a steady supply of feed containing a source of readily degradable protein and fermentable energy. This is not normally an issue under grazing systems, but has been recognised as a problem in organic beef production based on grass silage (Forages for Beef Production, Defra Project LS0803). Wet, poorly fermented and low protein silages lack the key nutrients for efficient rumen fermentation and such a diet will not sustain young cattle or in-lamb ewes. Silage making under difficult weather conditions or from crops low in sugars such as red clover can benefit greatly from the use of an approved silage inoculant.

Minerals, buffers and fibre are also important components of the diet in that they help control rumen pH. The bacteria and protozoa responsible for fibre digestion are very sensitive to pH change and have very specific pH requirements. Those which degrade plant cell walls require a pH in the 6.0 to 7.0 range. If the pH falls below 6.0, fibre digestion is increasingly affected and this condition is commonly known as sub acute rumen acidosis.

This Technical Leaflet is one of a series commissioned and prepared by the Institute of Organic Training & Advice (IOTA) as part of its Defra-funded PACARes (Providing Access, Collation and Analysis of Defra Research in the organic sector) project. The PACARes project aims to improve awareness and uptake of organic research by farmers. For more information go to www.organicadvice.org.uk/pacares.htm

The Leaflets aim to provide a summary of the key practical recommendations for organic farming, drawing on the findings of research including IOTA's own Research Reviews commissioned for the PACARes project. Other Leaflets in the series include: Composting, Dairy Cow Nutrition, Financial Management for Organic Farms, Nutrient Budgeting and Soil Analysis.

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The latter should not be a problem under organic systems as high concentrate or high starch diets will not be fed. However, the problem can still arise if feed allocation and diet change is not managed well.

Nutrient Requirements

It was over 25 years ago (AFRC, 1993) that the last set of UK feeding standards for beef cattle and sheep were formally published. Over this time there have been considerable developments in the genetics of beef and sheep breeds, feedstuffs available and knowledge of the way in which ruminants digest and utilise feed. As a result in the UK, there is no universally adopted system used by livestock farmers, feed manufacturers and consultants to formulate diets for beef cattle and sheep.

Nutrient requirements of conventionally fed livestock do not usually make any allowance for breed effect or production system. Undoubtedly, there are significant differences between breeds which relate to factors such as body size, growth rate, fat and body hair insulation, foraging ability, mothering instinct, etc. There is some evidence for cattle and sheep of different breeds having varying abilities to cope with high forage systems. For example, Givens and Moss (1994) showed Cheviot ewes had a higher ability to digest forages compared with Suffolks. However, there is no evidence to suggest any fundamental difference in nutritional physiology. Breed differences are probably more related to factors such as foraging ability, intake, rumen volume and passage rates. Breeds or strains suitable for organic farming are usually selected on the basis of production system, their ability to adapt to local conditions and their disease resistance. Preference is often given to indigenous breeds. There is no evidence to show differences in the nutrient requirements of cattle and sheep produced organically compared with conventional livestock.

Energy Requirements: There are differences between published rationing systems in their estimates of the energy requirements of cattle and sheep which are predominantly due to differences in estimates of requirements for maintenance. Energy requirements for both beef cattle and sheep in the UK were last revised in 1993, but are broadly in line with those published subsequently in the USA. However, research undertaken since then suggests that current standards underestimate requirements for maintenance of suckler cows and beef cattle by up to 30% and for sheep by up to 28%. The effect of these differences is to overestimate productivity from a given energy intake. There is a need to revise maintenance requirements for cattle and sheep especially for extensive systems which are typical of organic production.

Grazing ruminants expend more energy in consuming the same amount of feed when compared with housed animals eating from a trough. It has been estimated that the heat production in growing cattle eating 1kg of forage DM was nearly double that when feed was cut and presented in a trough. Extra energy is obviously required in the physical effort of grazing. NRC (1988) recommends a 10% increase in maintenance allowance for cattle grazing good pasture and up to 20% on sparse pasture. SCA (1990) suggest a proportional increase of up to 50% extra for animals grazing extensive hilly pastures. These extra allowances should be taken into account when formulating diets for extensively managed organic livestock.

Protein Requirements: The UK metabolisable protein system first proposed by ARC (1980) revised in 1992 and modified by the UK ‘Feed into Milk’ project (FIM, 2004) has been widely adopted in the UK for calculating the protein requirements of dairy cows. It has merit for organic based systems since it addresses separately the N needs of rumen micro-organisms and the animal. A deficiency in the evaluation of the system is that it has not been adequately tested in grazing systems and this could limit its accuracy for high forage systems. Nevertheless it is recommended as the system of choice at present for estimating the protein requirements of organically fed ruminants. Whilst a number of modifications have been suggested and incorporated in rationing systems for dairy cows, there remain a number of uncertainties in the values adopted for beef and sheep (e.g. a number of reviews have concluded that the original UK standards underestimated requirements for MP).

AFRC (1993) proposed an increase in the estimates of maintenance requirements for growing cattle from 2.3 to 3.8g/kg $W^{0.75}$ and this is recommended for organic systems. It is also noted that the current UK estimates of the MP requirements for growing lambs are some 20% higher than in other published systems. Whilst there may be scope for reducing MP intake by these animals without compromising growth rates, further studies are needed before this can be recommended.

As forages are the main components of the diet in organic livestock systems, the level of protein in the forage has a major influence on productivity. With ruminants, the major need is to provide sufficient nitrogen for microbial protein synthesis. The requirement for supplementation with high quality protein sources of low rumen degradability to provide rumen by-pass protein should not be needed in organic systems.

Where N supply in the rumen is low through a low intake of rumen degradable protein, microbial growth is limited, intake is depressed and production is affected. It is now well established that recycled N in the form of urea N is important in low N intake situations (NRC, 1985). The net effect of this is that the efficiency of dietary N utilisation is improved at lower N intakes. Protein synthesis within the rumen requires an adequate supply of utilisable energy for microbial growth and this is taken account of in the revised MP system.

Providing protein in excess of the current recommendations has been shown to be effective in the development of immunity to gastro-intestinal nematodes (Donaldson *et al*., 2001). They estimated that the current metabolisable protein recommendations for twin-bearing ewes in late pregnancy would have to be increased by 20% for maximum immunity. In view of the variable response there is insufficient evidence to justify a 'blanket' recommendation for organic systems on increasing protein levels in the diet above normal requirements.

Trace elements: Normally ruminants adapted to local conditions do not need extra minerals or vitamins in their diet and this is often the case in a grazing situation. Jakobsen and Hermansen (2001) have concluded that minerals and vitamins in the soil and forage and synthesis from sunlight can be utilised to a higher degree than is assumed in conventional feeding systems.

The potential for deficiencies of both vitamins and minerals may nevertheless be more of a problem on organic farms where farmers rely on their own home grown feeds for their livestock. Such deficiencies have been reported (Andrews, 1999 and Roderick *et al*., 1999).

With wide variations in soil type on organic farms in the UK and differences in their inherent mineral content, deficiencies are more likely to be related to a particular area or region. It is well known for example that molybdenum induced copper deficiency is a particular and potentially serious problem in some parts of the country (e.g. the 'teart' areas of Somerset). Soil analyses can give an indication of deficiencies as can forage analyses. The latter is obviously more directly related to what the animal is eating, particularly if it is sampled from conserved forage. In a grazing situation, trying to obtain a herbage sample representative of what the animal is eating can be very difficult or even misleading. By its nature, organic grassland will have a diverse range of species and animals will preferentially graze certain species. Sampling the animal directly (blood or tissue samples) should provide the best information on a potential deficiency.

Even here, because of the inherent need through homeostatic mechanisms to maintain steady levels of blood nutrients, blood sampling may only pick up a problem when body reserves are very low and production has already been affected. Sometimes justification for including a particular type of mineral supplement has been made on the basis of an increase in the measured tissue element concentration following its use but this does not necessarily signify that such supplementation may confer any nutritional or productive benefit. For example, work at Redesdale (Defra project OF0147) showed that the use of a trace element bolus raised circulatory levels of indicators of cobalt, copper and selenium status, but there were no significant effects on ewe liveweight, litter size or barren rate compared to unsupplemented animals.

Intake

Feed intake: The ability to accurately predict the amount of forage an animal consumes when offered *ad libitum* is necessary for effective ration formulation. In recent years, near infra-red spectroscopy has become an effective tool for predicting intake of grass silages but there is still considerable uncertainty when it comes to estimating intakes of grazed grass (Agnew *et al.,* 2004). Intake predictions based on NIRS should be used where possible but those predictions developed for the Feed into Milk project and commonly quoted on silage analyses should strictly be used for dairy cows. They are used for suckler cows rationing but are not relevant to younger animals or sheep.

In the absence of NIRS, grass silage intake for growing and finishing beef cattle can be predicted using published models. The model of Steen *et al.,* (1998) is used routinely as part of the Hillsborough Feeding Information System and is recommended for wider use.

Intake predictions for sheep have been attempted by research institutes in several countries (Robinson, 2002) but a review of these is beyond the scope of this Leaflet. In the UK, there is no recommended approach and most rationing systems still use estimated intakes as a percentage of live body weight (e.g. ADAS, 1988).

Forages

Whilst ryegrass/white clover swards are the cornerstone of organic grazing systems, there are many alternative forage crops that are widely grown in rotations and well suited to organic beef and sheep production. (Defra project OF0328). A thorough review of these has recently been given by McCalman (2008) and there are several advisory publications detailing forage crops and winter management options available from IBERS (formally IGER) at Aberystwyth. Making best use of home-grown cereals and protein crops is also covered in depth in a publication of that name produced by DairyCo (formerly MDC).

On many organic farms, one cut of silage is made and this is often late in the growing season to maximise quantity. Inevitably, this usually results in conserved forage of low D value which needs supplementation with concentrates for young cattle and in-lamb ewes. If at all possible, farmers should avoid depending on a single large cut of forage and adopt one or more of the following (SA Factsheet, 2005):

- Graze the sward before shutting up for silage. This will give a later cut but of higher quality. This may be a risky strategy in areas with low rainfall or light soils.
- Make an earlier but smaller first cut of high quality forage and a larger, higher protein second cut.
- Introduce a second forage for silage, such as whole crop cereals with vetches, peas, lucerne or lupins, to reduce reliance on bought-in concentrates. (Defra project OF0347).
- Either layer different forages into a single silage clamp or put different forages into different clamps. A second forage in the system introduces a crop rotation to break pest and disease cycles, which will also result in an increase in forage dry matter intake.

It is important to analyse conserved forages so that a balanced winter ration can be made up to optimise production.

Feed Composition

The composition of commonly used organic feeds is available from a number of sources. A basic table of common feeds is given in the Organic Farm Management Handbook. The most comprehensive set of data was generated for the ‘Feed into Milk’ project and is published in a book of that name which includes data on a CD (Thomas, 2004).

Crop variety, soil type, climate and crop management can all significantly affect the composition of feeds. A chemical analysis of a feed to be used in a diet is much more accurate than tabulated composition data and an actual analysis should be obtained and used whenever possible.

Practical Recommendations

In view of the uncertainties and lack of data discussed above on the nutrient requirements, intake and feed composition of organic beef and sheep systems, monitoring of body condition is the most important practical ‘tool’ for effective rationing. This is the basis of the following recommendations. Consultants and farmers should be fully aware of the use of this technique.

The Beef Suckler Herd

Producer experience shows clearly that suckled calf production can take place without the need for concentrates (Hoskins, 2008). The organically managed spring calving suckler herd at ADAS Redesdale receives <5% (on a dry matter basis) of its annual feed inputs as concentrates, but still produces a commercially acceptable level performance with calf growth rates to weaning in excess of 1.0kg/day, and calving percentages of 95% (Defra project: OF0319). Spring calving at the start of the main growing season is the ideal system as the peak nutrient requirement is matched by the grass growth curve.

Grazed grass is a relatively cheap feed when compared with silage and concentrates. Cows will gain body condition both quickly and cheaply during the summer grazing season. The stored nutrients can be used during the winter to save silage. Each unit of body condition score above 2.0 can save approximately one tonne of medium quality silage. However, it is important to continuously monitor condition score throughout the winter to ensure that body condition remains on target.

Aim to have spring calving cows at condition score 3.0 at housing, 2.5 at calving and 2.0 at turnout. Cows should be managed to maintain body condition or only lose a small amount of condition during the last two months of pregnancy. If condition score is increased rapidly during late pregnancy, extra fat is deposited round the birth canal which can lead to calving difficulties. On the other hand, very thin cows (less than condition score 2.0) at calving, can be difficult to get back in calf.

An easy way to control body condition in the autumn is to alter weaning date. Delayed weaning can reduce body condition score, while early weaning allows the cow to start gaining condition. It takes as much feed to produce 6kg of milk as it does to produce 1kg of liveweight gain.

Weaned Calves

The stress of weaning can result in a significant check in growth which many producers overcome by good creep management before weaning and by offering a high quality concentrate in the post weaning period. For example in the Redesdale organic herd (Defra project OF0319) a concentrate based on organic barley and beans introduced to the calves at housing and increased to 2.5 kg/day fresh weight produced good growth rates. Other producers by offering the very best forage on the farm to weaned calves avoid the need to feed concentrates.

Growing and Finishing Cattle

The contribution of forage to these systems varies widely but the limitations of forage and forage quality can be demonstrated in the following calculations.

Tables 1 & 2: *Calculated liveweight gains at various levels of forage: concentrate in the diet of beef cattle at varying levels of forage energy level and a concentrate of 13 MJ ME/kg DM. (Energy allowances and estimated intake figures are taken from ADAS [1988]).*

Table 1 : 350kg growing animal.

Forage ME (MJ ME/kg DM	12	10	8
Forage: conc ratio			
100.00	1	0.7	0.4
60:40	1.2	0.9	0.7

Table 2: 500kg finishing animal.

Forage ME (MJ ME/kg DM	12	10	8
Forage: conc ratio			
100.00	1.2	0.9	0.6
60:40	1.4	1.1	0.9

Traditionally with slower maturing breeds, growing cattle are managed over the winter on a conserved forage diet for a ‘store’ rate of gain which is usually at least 0.5kg/d.

This allows a period of compensatory growth when turned out to grazing. The above calculations show that poor quality forages will not allow even a 'store' rate of gain without supplementation. Medium quality forage without supplementation is adequate for a winter 'store' period. High or medium quality forage with concentrate is needed for high rates of gain. Poor quality forage even with supplementation does not supply enough energy for finishing cattle whereas it should be possible to finish cattle on high quality forage alone.

The Ewe Flock

The feeding of ewes before mating and during pregnancy is critical to the profitability of sheep production because it influences the lambing percentage, ewe mortality rates, lamb survival, lamb growth rates and the flock replacement rates.

Nutritional management between weaning and mating is critical to ensure optimal condition score at mating. Cross-bred ewes with body condition scores at mating of 3.0 to 3.5 generally have higher ovulation rates than leaner animals. The ovulation rate is also influenced by the plane of nutrition before and during the mating period. Ewes with moderate body condition scores of 2.5 to 3.0 generally respond best to a rising plane of nutrition for at least three weeks before and continuing for about three weeks after mating. The response is less defined in fatter ewes, but weight loss should always be avoided during the mating period.

During early pregnancy, the foetus is reasonably resilient to the effects of nutritional stress. The body condition of ewes which were at or below target scores for mating of 3.0 to 3.5 should be maintained, but ewes with body condition scores greater than 4.0 can afford to lose body weight. Protein and energy requirements for foetal growth remain relatively small throughout the middle third of pregnancy when most placental development occurs. During this period, ewes which were mated in target body condition can afford to lose up to 5% of their body weight or 0.5 unit of body condition score without affecting lamb birth weights. Nutritional stress during mid pregnancy only affects the lambing percentage when it is severe and prolonged, resulting in retarded placental development and the subsequent birth of twin lambs with disproportionate weights. Underfeeding also results in ewes entering the final six weeks of pregnancy, and ultimately lambing, in poor body condition. Overfeeding during this period may have an adverse effect on placental development as well as contributing to excessive body condition at parturition with subsequent dystocia or possibly vaginal prolapse problems. The adequacy of nutrition during early and mid pregnancy can be adequately monitored using changes in body condition score.

Most mammary development occurs during the final third of pregnancy and, whilst energy is the key nutrient for the pregnant ewe, there is evidence to indicate that low protein intakes, for example due to feeding poor forage, can result in poor colostrum accumulation and milk production with subsequent poor lamb survival, poor lamb growth rates and ewe losses from acute mastitis.

About 75% of foetal growth occurs during the final six weeks of gestation. It is normal for the dietary metabolisable energy intake of late pregnant ewes to fall short of the requirements of twin and triplet litters and provided that their body condition score is adequate, it is not necessary to meet in full their nutritional requirements. Nevertheless, undernutrition can result in poor lamb survival associated with low birth weights and poor colostrum accumulation, while overnutrition is wasteful and can result in birth stress problems. Skilful nutritional management throughout the second half of pregnancy is therefore crucial to ensure high lambing percentages.

Sheep are very sensitive to the fermentation quality of silage. They will not eat sufficient quantities of badly fermented silage to meet their needs in late pregnancy. Chop length will also have a major effect on the quantity of silage eaten. Ewes, unlike beef cattle, will eat approximately 30% more precision chopped silage compared with unchopped baled silage. With precision chop silage the performance of ewes will be substantially improved and concentrate supplementation reduced accordingly.

A calculation can be made for in-lamb ewes to assess the effect of quality of available forage in supplying the energy needs.

Table 3: *Calculated energy intake (MJ/d) at various levels of forage: concentrate in the diet of ewes in late pregnancy at varying levels of forage energy level and a concentrate of 13 MJ ME/kgDM.*

Forage ME (MJ ME/kg DM	12	10	8
Forage: conc ratio			
100:00	18.0	15.0	12.0
80:20	18.3	15.9	13.5
60:40	18.6	16.8	15.0

The energy allowance in late pregnancy for a twin bearing ewe with a maternal body weight of 70kg is estimated at 16.5 MJ/d and the dry matter intake is given as 1.5kg/d (ADAS, 1988).

It can be seen from the above that very high quality forage (e.g. grazed grass) without supplementation is needed to support the energy needs of an in-lamb ewe. Medium quality forage (average silage, good hay) needs to be supplemented with concentrates. With poor quality forage even with maximum supplementation, the energy intake is borderline for a ewe carrying twin lambs in late pregnancy.

Early spring grass typically has an energy content of at least 11.0 MJ/kg and a protein content of 18-22%, depending on the clover proportion. Studies carried out at AFBI Hillsborough, have clearly demonstrated that grazed grass has the potential to meet the nutritional requirements of twin-bearing ewes in late pregnancy without the need for additional concentrates. Achieving target grass covers at turnout is key to a successful grass-based lambing system.

Excessive grass covers inevitably leads to problems with oversized lambs and increased lambing difficulties.

Table 4: *Total concentrate requirements during the last two months of pregnancy: twin bearing cross bred ewes.*

	Total Concentrate kg/ewe	
Silage quality	**Precision chop**	**Baled silage**
High (Intake potential above 90)	5	10
Average (Intake potential 75-90)	10	18
Low (Intake potential below 75)	15	28

Average silage analysis: ME (MJ/kg DM) 10.5

A sward height of 4-5cm (1,200-1,300kg DM/ha) should be sufficient to meet the nutritional requirements of twin-bearing ewes at a maximum stocking rate of 12 ewes/ha (5 ewes/acre), provided weather and conditions are suitable.

Separation of ewes into different feeding groups on the basis of ultrasound scanning results, ram harness marks and body condition score can serve to ensure adequate nutrition during late pregnancy and avoid wasteful overfeeding of late-lambing or single-bearing animals. Sick ewes, thin ewes and those not representative of the flock need to be investigated separately.

In summary, monitoring condition scores can be used to determine the adequacy of nutrition during early pregnancy.

Finishing Lambs

Trial work at Redesdale has clearly shown the importance of making high quality, high dry matter silage with good intake characteristics if lambs are to be finished on a conserved forage diet achieving a minimum 60% of the diet as forage (Defra project OF0302). There was little difference in growth rates in lambs on high quality ryegrass/white clover or red clover silages.

The trial work also confirmed that in a cereal based diet, field beans could be used as the sole protein source within the concentrate portion of the diet rather than soya bean meal widely used in conventional lamb finisher diets.

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- International open-access archive for research papers on organic agriculture: www.orgprints.org

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[March 2009]