THE ROLE AND PLACE OF SUPPLEMENTARY FEEDING AND PROTECTED PROTEIN FOR SHEEP AND CATTLE

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As a concept, supplementary feeding seems simple, but the frequency of complete failures with or erratic responses to supplements suggests that in the field, the response to supplements is quite complex. Only one thing is certain; the best supplement is more pasture. When supplements are fed, there are in fact three possible outcomes, which depend on whether energy supplements (e.g. grain) or protein supplements (e.g. cottonseed meal) are being fed and how the mixture of herbage and supplement behaves during rumen digestion.

1. **Supplementation**: the supplement is eaten and pasture intake is not reduced. This is a rare event.
2. **Substitution**: the consumption of supplement reduces pasture intake. This is the norm with green pasture and may be enough to counteract the effects of the supplement.
3. **Complementation**: the consumption of supplement increases herbage consumption. This can occur with dry pastures or crop residues.

RUMINANT DIGESTION AND SUPPLEMENTARY FEEDING

The ruminant relies on its rumen population of bacteria, protozoa and fungi to digest plant fibre. These microbes have their own nutrient requirements, sometimes in conflict with those of the host animal. In a very real sense, one can be supplementing either the host animal or its rumen microorganisms. To carry out fibre digestion, rumen microbes require nitrogen in the form of either protein or non-protein nitrogen (e.g. urea), which they can only get from the animal's diet. Dietary protein entering the rumen may pass through unaffected, and is then referred to as 'bypass protein' or 'undegraded dietary protein'. This can occur naturally (e.g. cottonseed meal, fishmeal) or as a result of chemical or physical treatment of the dietary protein, in which case it is referred to as 'protected protein'. Protection of protein, like all food processing, costs money.

More usually, 75-90% of plant protein is broken down to ammonia by rumen microbes and then coupled with the products of fibre digestion to produce microbial protein, which becomes the main protein source for the animal. Unfortunately, this can be a relatively inefficient process because the energy from fibre digestion is produced more slowly than the ammonia. To prevent the buildup of toxic ammonia, it is excreted as urea in the urine. This represents a major loss of protein to the animal and means that the effective protein content of high protein diets may be much lower than expected. Such diets may therefore not give the expected nutritional advantage; protein and money have been wasted. Conversely, if the protein is rendered too resistant to microbial degradation, e.g., by extreme chemical protection, then it is possible to starve the rumen microbes of ammonia. Fibre digestion and intake will then fall.

SUPPLEMENTATION OF ANIMALS ON GREEN PASTURE

Leaving economic questions aside, it is unlikely that responses to supplements will occur if stocking rates are such that green pasture supply exceeds about 0.8-1.2 tonne dry matter/ha (for sheep) or about 1.7-2.4 tonne dry matter/ha (for cattle). Above these levels, the animals' intake approaches a maximum and substitution between supplement and pasture becomes so great that there is no net response to the supplement. If pasture digestibility falls, substitution will decrease somewhat and there is a better chance of a response to supplementation, even if plenty of pasture is available. It follows from these comments that the ability to assess how much pasture is on offer is a great help in making decisions about when to supplement.

SUPPLEMENTING EWES AT MATING

When ewes are joined in late summer-autumn, pasture is often sparse. If, at this time,the overall flock condition score can be improved by one unit, then one can expect 16-20 extra lambs per 100 ewes joined, as a result of the greater incidence of twins (Morley *et al.* 1978; Donnelly *et al.* 1982). Whether such a result is desirable in terms of lamb survival and economics is another matter. The response is probably not economic if supplements are required to achieve it (Donnelly, 1984; White and Bowman, 1987), but may still be worthwhile if it also improves the ewes' capacity to cope with pregnancy and lactation.

SUPPLEMENTATION DURING MID-PREGNANCY

There is a widespread belief that animals can be subjected to nutritional restrictions during mid-pregnancy (e.g. days 30-100 in sheep), since the rate of foetal growth is slow. However, mid-pregnancy is the main period of growth of the placenta, which then ensures the nutrient supply to the foetus in late-pregnancy. Inadequate placental growth can lead to reduced lamb birth weights (and thus survival) and to depressed milk production. Our work near Canberra (Dove *et al.* 1988) found that, compared with ewes which gained weight in mid-pregnancy, those which lost weight produced 20% less milk over 86 days of lactation, and their lambs were 3 kg lighter. Normally, the needs of mid-pregnancy can be met by appropriate pasture management, but energy supplements should be fed if ewes lose more than 0.5 units of condition score. There is no need for a protein supplement.

SUPPLEMENTATION DURING LATE-PREGNANCY

This period involves two major processes. It is the period during which the foetus makes most (70%) of its growth, but it is also the period during which good nutrition is essential for the development of mammary tissue and the subsequent onset of lactation. Moreover, severe undernutrition and/or stress can lead to pregnancy toxaemia, especially in twin-bearing ewes. When some ewes present with pregnancy toxaemia, it is highly likely that others in the flock are avoiding the condition at the expense of the growth of the foetus and mammary tissue. Though less obvious, on a flock basis this may result in the greater loss of production and ultimately be more expensive.

Under Australian grazing conditions, sheep and cattle often do not meet all the nutritional requirements of late-pregnancy, but this does not necessarily mean that supplements should be fed. A moderate degree of weight loss can be tolerated, but only if the animals were in good condition to start with. If supplements are needed, then in animals with one foetus, energy supplements such as oat grain are probably sufficient. However, in twin-bearing ewes, there is increasing evidence of a need for a protein supplement. First, this supports the high protein requirements of mammary development and second, if pasture is scarce and energy intakes low, then protein can increase the efficiency with which body energy reserves are used. Bypass protein seems especially helpful for this second response. Protein supplements are probably not necessary for beef cows, and may even increase the likelihood of grass tetany (Caple, 1989).

SUPPLEMENTATION DURING LACTATION

In the period up to peak lactation, it is unlikely that ewes or cows will meet their nutritional rquirements from pasture. Indeed, twin-suckling ewes probably could not eat enough pasture. Hence, both ewes and cows lose condition in early lactation provided, of course, that they have it to lose. Three other points are important.

(a) The protein demands of milk production are high, but when body reserves are mobilised, they provide little protein.
(b) Lactating animals supplemented with more protein may produce more milk, but are also likely to lose more weight, as the protein stimulates the mobilisation of body reserves.
(c) Relative to their body weight, beef cows produce less milk and certainly less milk protein than do ewes. Responses to protein are therefore more likely in ewes. Again, high protein

intakes in beef cows may even be a problem, since they can increase the incidence of grass tetany.

When pasture is in short supply, lactating ewes can certainly show large responses to bypass or protected protein supplements, as in Table 1 (Dove *et al.* 1985). Moreover, there is increasing evidence that, for the same combination of supplement and pasture, substitution is much lower in early to peak lactation, than at other times (Dove *et al.* 1985).

Table 1. Responses of lactating ewes to energy or protected protein supplements while grazing perennial ryegrass (0.6 tonne DM/ha)

	Nil	Supplement EnergyA	ProteinB
Protein from rumen (g/d)	276	344	430
Milk yield (g/d)	2048	2133	2846
Lamb growth (g/d)	254	308	332

A 600 g/d sugarbeet pulp B 600 g/d 1:1 sugarbeet pulp:formaldehyde-treated soyabean meal

However, many other studies have found little difference in the response to energy and protein supplements. This has never been resolved fully, but in many cases, disappointing responses to supplements in lactating ewes can be traced to substitution effects, or the effect of previous nutrition. For example, if body reserves are low due to poor nutrition in pregnancy, responses to protein supplements in lactation are unlikely.

SUPPLEMENTATION OF ANIMALS ON DRY HERBAGE

Weight loss in older stock grazing dry pastures or cereal residues, particularly wethers or steers, can often be tolerated since these animals can show compensatory weight gains when greener pasture becomes available. Maintenance of wool quality is still a concern. In young stock, relying on compensatory gains can be risky. Put bluntly, dead weaners rarely exhibit compensatory growth ! In terms of survival, elimination of wool strength faults, wool growth, weight gain and future reproductive performance, supplementation of weaned animals is usually a good investment. In passing, it is worth mentioning that money spent on supplements may be wasted if worm control is inadequate. Helminths have a devastating effect on nutrient absorption, especially in young animals, and must be controlled if responses to supplements are to be realised.

Table 2. Effects of a protein supplement on intake and performance of crossbred weaners grazing dry pasture

Supplement intake (g/d)	Dry pasture intake (g/d)	Total intake	Fasted gain (g/d)	Wool growth (g/d greasy)
0	544	544	-62	4.2
161	808	969	-9	5.5
324	859	1183	41	7.4
669	514	1183	103	10.9

Dead summer pasture or crop stubble may contain as little as 4-6% crude protein, and the animals' herbage intake can easily be limited because the rumen microorganisms are starved for protein. Protein supplements can make good this deficiency, stimulate fibre digestion and increase herbage intake. This is 'complementation', mentioned above, and represents a double benefit for the weaner as shown in Table 2 above. Note that the improved weaner growth was due not only to the supplement, but also to the increased herbage intake. We have found similar effects in Merino hoggets (Coombe *et al.* 1987) and in Victoria. Smith and Warren (1986) found that supplements of 1 kg/d of cottonseed meal,

a partial bypass protein, increased dry herbage intake by 67% and the weight gains of Hereford weaner steers by about 0.5 kg/d.

In young sheep, supplementation not only affects wool growth but also fibre diameter and staple length and strength. These effects need to be kept in balance in terms of their effects on the eventual wool price, but it is probably fair to say that the effects on fibre diameter have been over-emphasized and the effects on strength under-emphasized.

In Merino hoggets grazing cereal stubbles near Canberra, a supplement of 300 g/d sunflower meal increased wool growth by 70% while formaldehyde-protected meal led to a 106% increase. In both cases, the fibre diameter of the wool grown during supplementation was increased from 19.6 to 22.0 microns. However, once 'diluted' by the remainder of the fleece grown during the ensuing 8 months, the effect on the average fibre diameter of the whole fleece at shearing would be expected to be much less. In work conducted in W.A. (Rowe *et al.* 1989), 150 g/d of lupins fed between 7 February and the end of April increased the average fibre diameter of the fleece by only 5% (18.6 up to 19.5 microns). More importantly, staple length was increased by 10% and staple strength by 42%. With 450 g/d lupins, effects on fibre diameter, length and strength were 5%, 18% and 52% respectively. Such large effects on staple length and strength cannot be ignored. Moreover, unlike supplement effects on fibre diameter, the effect of a supplement on wool strength is not 'diluted' by the wool grown after supplementation finishes.

SOME PRACTICAL CONSIDERATIONS

1. The decision to supplement should not be left to the last minute, especially with young stock. If they need supplement now, they will actually get worse before things improve, because they have to become accustomed to the supplements. Training of young stock to take supplements is very worthwhile. It can be achieved by offering supplements while the lambs or calves are on the dam, or by including 'experienced' animals in the weaner flock when supplements are introduced. If there is a chance that supplements will be fed in the January-April period, then weaners should be trained to supplements before the end of the previous year.

2. The pioneering work of Franklin over 30 years ago showed that supplements do not have to be fed daily. Feeding less frequently, e.g. every third day, uses less labour and can result in fewer deaths and less variation in intake and performance between animals. Studies in W.A., Victoria and southern N.S.W. have subsequently shown that infrequent feeding may actually enhance wool growth, but the situation with weight gains is less clear. If pasture supplies are scarce by late summer, then enough grain supplement for several weeks can be broadcast in the paddock.

3. The question of how much to feed depends on the supplement, but is still basically an economic question. There will rarely be economic responses above about 500 g/d in sheep or 2.5 kg/d in cattle.

THE ECONOMICS OF SUPPLEMENTARY FEEDING

Two major problems exist in the economic analysis of supplementary feeding. First, what is the cost of labour and, more importantly, is it constant? For example, is it fair to charge the same for labour in mid-summer, when there may be less happening on-farm? Second, what actually is the response to the supplement? Far too frequently, economic analyses of supplementary feeding have ignored animal welfare aspects and also the sometimes substantial long-term effects of even moderate periods of supplementation. For example, studies near Canberra found that, after the growth of autumn pasture, it took 11-14 weeks for the wool growth of unsupplemented Merino hoggets to catch up to their supplemented counterparts (Coombe *et al.* 1987). Moreover, several studies have found that supplement effects on wool growth continue after feeding has finished, with the result that the extra fleece weight in supplemented animals is considerably greater (>40%) than the extra wool grown during the period of supplementation. Ewe hoggets, if unsupplemented over the summer period, can also show delayed conception in a portion of the flock, with a resultant

spread of lambing (Coombe *et al.* 1987). It is very difficult to put an economic value on some of these effects. For example, what is the economic effect of a greater spread of lambing? Future analyses need to pay more attention to such issues.

Notwithstanding these problems, there is little doubt that supplementary feeding can be profitable once one understands what 'drives' the response to supplements. This is especially true for weaners over summer. For example, in 230 kg weaner Herefords grazing dry pasture and fed 2 kg/d of 1:1 oat grain:sunflower meal, we increased live weights by 58 kg and valuation by 16 cents/kg live, compared with unsupplemented animals. As a result, the surplus of sale price over feed costs was over $66 per beast.

CONCLUSION

Supplementary feeding has a role within our production systems, but requires careful evaluation in relation to the amount and quality of pasture, the desired level of production and the price or price penalty involved in the product. The main animals likely to show responses to protein supplements, bypass or otherwise, are twin-suckling ewes and weaner stock over summer. Regardless of the supplement fed, the training of young stock to consume supplements is very important, and should be done before the supplements are needed. Finally, we need to pay more attention to longer-term benefits of supplementation, and the ramifications of these through the whole production cycle, before drawing conclusions about the economics of supplementary feeding.

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