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THE ROLE OF FISH MEAL IN RATIONS FOR SHEEP

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SUMMARY AND CONCLUSIONS

Principles of digestion in the ruminant, including dietary protein degradation and microbial protein production in the rumen are outlined. Factors affecting the contribution of microbial protein, and the dietary protein escaping degradation in the rumen, to the host animal's protein requirements are discussed.

Practical results from trials with both intensively and extensively fed lambs, pregnant and lactating ewes are reviewed. The use of fish meal to manipulate the body composition of lambs, increasing carcase lean and reducing carcase fat is included. It is concluded from the evidence that there are five major areas in which fish meal has a role in improving productivity, product quality and reducing production costs:

1. As the protein supplement in high energy diets for fattening of early weaned lambs.
2. As a supplement to high roughage diets in the later stages of fattening of older lambs (6-15 months of age).
3. As a method of manipulating body fat stores in systems when excess body fat can be used to fuel protein deposition.
4. During the last 2-3 weeks of pregnancy for ewes given mainly roughage diets.
5. During the first 5-6 weeks of lactation when body fat in the ewes can help to sustain a large milk production.

Finally, it should be pointed out that fish meal poorly processed or allowed to autolyse before processing is no better or sometimes worse than vegetable protein sources (Mehrez et al.,1980). However, given optimal processing conditions and incorporation of a minimal amount of stickwater the degradability of the fish meal and its amino acid composition makes it the most desirable protein supplement for ruminants.

CONTENTS

INTRODUCTION

The special feature of the ruminant digestive system which makes them such efficient herbivores, is the reticulo-rumen. This is the collective name given to the first two stomachs of the ruminant, the reticulum and the rumen, which together form one large container. The reticulo-rumen empties into the third stomach, the omasum, which is very much smaller and is folded into a number of leaves. The fourth stomach, the abomasum is the same as the stomach of mono-gastric animals such as man and the pig, and from this point onwards the digestive system of the ruminant is very similar to that of monogastric animals.

MICROBIAL FERMENTATION

In order to understand principles of feeding in ruminants it is important to discuss briefly some aspects of how the rumen functions. The reticulo-rumen of the host animal contains a multitude of micro-organisms (bacteria and protozoa) and provides an environment in which the temperature is kept constant, the food supply (or substrate) is constantly replenished, and the waste products are constantly removed. Under these ideal conditions, the food eaten by the animal is subjected to the initial stages of digestion - known as fermentation in which the starch, cellulose and proteins of the food are broken down into simpler compounds by the action of the micro-organisms. Quantitatively the most important waste products of this fermentation are the volatile fatty acids (VFA); acetic, propionic and butyric acids. The VFA's are absorbed from the reticulo-rumen into the blood and are used by the host animal as its main source of energy. In order for fermentation to proceed optimally the rumen microbes must be supplied with a source of protein which they can degrade to ammonia. This is generally known as RDP and can also consist of urea or other products which can yield ammonia in the rumen.

MICROBIAL PROTEIN

The microbial fermentation also allow the micro-organisms to multiply and to build up their own body protein. Part of this microbial biomass is washed out of the reticulo-rumen with normal digesta flow and is digested in the abomasum and small intestine. It thus provides the host animal with a source of protein. The amount of microbial protein which is produced in the reticulo-rumen is proportional to the amount of food (substrate) that is fermented and thus the more food a ruminant eats and digests by microbial fermentation in the reticulo-rumen, the greater will be its protein supply.

The amount of microbial protein produced is, on average, about 130g crude protein per kg of apparently digested organic matter. However, estimates of this in the scientific literature range from about 50 to 250g (ARC 1984). It is likely that part of this range is due to the methods used to make the measurements but there are probably also real differences due to the type of diet given to the animal. At the moment this is not well understood and no recommendations can be made as to feeding regimes which will maximise microbial protein production.

DIETARY PROTEIN

Dietary proteins are degraded by the rumen micro-organisms to form volatile fatty acids and ammonia. The amount of degradation differs between different protein sources but in general animal proteins (such as fish meal, blood meal*, meat meal*) are degraded to a lesser extent than vegetable proteins (such as barley, soya, rape seed, sunflower, groundnut). Clearly the host animal derives less benefit from protein supplements which are degraded within the reticulo-rumen since these merely serve as a source of ammonia for the formation of microbial protein and this may be inferior in quality to the original protein given in the diet.

However, a certain quantity of ammonia is necessary in the rumen to allow efficient growth and function of the rumen microbes.

DEGRADATION OF PROTEINS IN THE RUMEN

The old terms 'Crude Protein' (CP) and 'Digestible Crude Protein' (DCP) are no longer of the two components rumen degradable protein (RDP) and undegraded dietary protein (UDP). A third term, rumen degradable nitrogen (RDN)

*Blood and meat meals of ruminant origin are not allowed to be used in ruminant feeds in the UK.

is also frequently used: this relates to the nitrogen present in RDP, or to the nitrogen available from non-protein nitrogen sources such as urea or ammonia. RDN provides the primary nitrogen supply of the rumen microbes.
The first two questions to ask of the protein content of a feed are thus:

(a) How will it degrade in the rumen, and

(b) Will the degradation product (ammonia) be sufficient to satisfy the nitrogen requirements of the rumen micro-organisms?
If not we must consider supplementation with RDP, or with a non-protein nitrogen source providing RDN.

We then need to ask a third question:

(c) Is the protein produced as microbial protein during fermentation sufficient for the host animal's needs? If not, we then need to consider supplementation with a protein source which has a high content of UDP.

RUMEN DEGRADABLE NITROGEN (RDN)

As noted above, the rumen micro-organisms can synthesise their own amino-acids, and hence their protein, using only ammonia as a source of nitrogen. This ammonia can be provided either from the microbial degradation of dietary proteins, or by non-protein nitrogen (NPN) such as urea or the ammonia of ammonia treated roughages. NPN is usually the cheapest source of RDN. A small amount of dietary protein is however required but there is generally sufficient in the basal diets to meet that demand.

If the diet is deficient in RDN, then the intake and digestibility of the diet will be below optimum as is demonstrated by Table 1. This shows the intake and digestibility of a barley straw either treated with sodium hydroxide or untreated. It can be seen that although both straws were of low initial digestibility they showed progressive improvements in both intake and digestibility when supplemented with RDN in the form of urea. If practically possible attempts should be made to ensure that NPN such as urea is not given intermittently. In forage or straw diets it is most usefully given by spraying it on in solution.

SULPHUR

With diets in which most of the nitrogen is provided by NPN, there is also the need to add a small amount of sulphur to provide for the synthesis of the sulphur containing amino-acids of the bacteria.

The ARC (1984) recommendations for RDN and Sulphur are:

RDN:- The amount of RDN necessary for the optimum microbial growth is 1.34g N/MJ ME; this is equivalent to about 21g N/kg digestible organic matter (DOM). As indicated above this can be provided either from degradable protein sources (RDP) or from supplements of NPN.

Sulphur:- 0.07g Sulphur per g RDN, equivalent to 0.13g anhydrous sodium sulphate/g urea (urea has 47% N).

Other supplements:- With low quality roughages the intake and digestion is often stimulated by small amounts of easily digestible fibre such as sugar beet pulp, (Silva & Ørskov, 1988), even some vegetable protein supplements can act both as protein sources and as sources of easily digestible fibre, e.g. cotton seed, etc. Fish meal, probably by giving a steady supply of RDP, also has been shown to stimulate digestion (Silva & Ørskov, 1988).

VALUE OF PROTEINS TO THE HOST ANIMAL

The two sources of protein available to the host animal are the microbial protein produced in the rumen and the digestible UDP from the diet,. Although it has been known for many years that different protein sources were broken down to different degrees in the rumen, it is only in relatively recent times that this knowledge has been put to practical use. The break through came with the introduction of the nylon bag technique, which allows the time-related degradation of protein sources to be measured within the rumen of the animal. Typical degradation curves for 3 protein sources measured in this way are shown in Fig. 1.

TABLE 1

The necessity for RDN.
The effect of urea supplementation on the voluntary intake and digestibility by sheep of barley straw treated or untreated with sodium hydroxide (NaOH)

Urea (g/kg straw)	Untreated straw Intake (g/d)	Untreated straw Digestibility (%)	NaOH treated straw Intake (g/d)	NaOH treated straw Digestibility (%)
0	423	45.8	355	42.3
6	451	46.7	402	48.0
12	441	49.0	531	58.9
18	463	48.3	567	62.8

(Ørskov and Grubb, 1978)

Figure 1

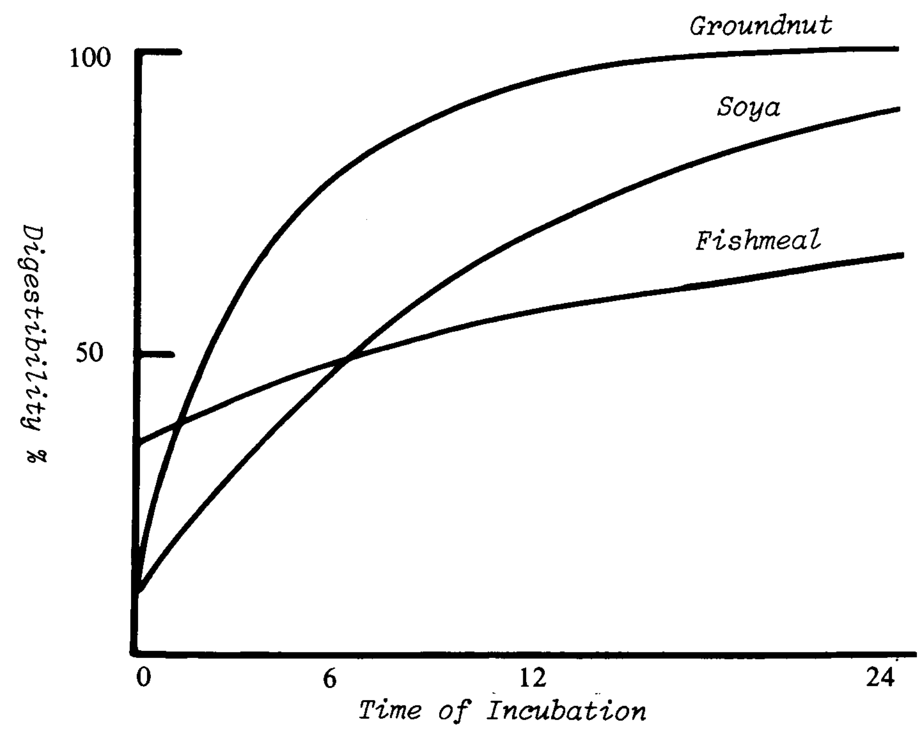


TABLE 2

The effective % degradability (P) of a range of different protein supplements at three rumen outflow rates

	Outflow rate (proportion per hour)		
	0.02	0.05	0.08
White fishmeal A	64.3	49.6	41.5
White fishmeal B	72.6	58.5	52.4
Soybean meal	80.8	62.5	50.4
Groundnut meal	87.4	74.1	64.3
Rapeseed meal	88.7	78.6	71.5

TABLE 3

Digestion (%) of UDP from various sources[1]

Protein Source	Digestibility	SE_{Mean}
Soyabean meal	96	0.3
Fish meal	90	1.0
Sunflower	86	1.8
Cotton seed meal	85	1.4
Rapeseed meal	76	0.4
0.5% formalin treated soya	74	1.7
Fish meal (heat damaged)	11	2.6

(Hvelplund, 1985)

[1]Undegraded residue after 24 hours exposure to rumen subjected to digestibility determination between duodenum and ileum.

What is immediately apparent from these curves (Fig. 1) is if we relate them to the actual degradation which will occur in a normal feeding situation when the supplement is free to leave the rumen (rather than being contained in a nylon bag), then soya and groundnut will be very sensitive to the time that it stays in the rumen, and the fish meal much less so.

The effective degradabilities, i.e. the degradability when outflow rate is taken into account, of a range of protein supplements at different outflow rates are shown in Table 2. There are two points to note. First, that the vegetable supplements are generally more degradable than the animal protein supplements, and that this difference is greatest at the slower outflow rates. Second that fish meals can differ considerably; this is due to the different proportions of water soluble material incorporated in different fish meals. Feed companies are now beginning to state the degradabilities of their feeds and, in general, the lower the degradability of the protein, the greater will be the value to the animal.

Typical rumen outflow rates in sheep are between 0.02 and 0.06 per hour. In general the more a sheep eats, the greater will be the outflow rate. Protein supplements fed with a roughage will have a greater outflow rate than if given with a concentrate diet at the same DM intake, since roughages tend to promote higher outflow rates.

The amino acid composition of the UDP is also important and a great deal of work is presently carried out to determine the optimum amino acids for growth. For instance (Orskov et al. 1970) observed that fish meal given post-ruminally was utilized better than soyabean meal and casein indicating that some of the superiority of fish meal over other sources can be attributed to the amino acid composition which appears to ideally complement the amino acid composition of microbial protein.

DIGESTION OF UDP

Clearly the value of UDP to the animal will depend on its digestibility in the small intestine. At the moment there is no simple test for the digestibility of UDP which is widely accepted. However, Hvelplund (1983) has developed a simple technique which appears to give good results. In his technique, the digestion of a sample contained in a nylon bag is measured during its passage through the small intestine. Some of his data is shown in Table 3.

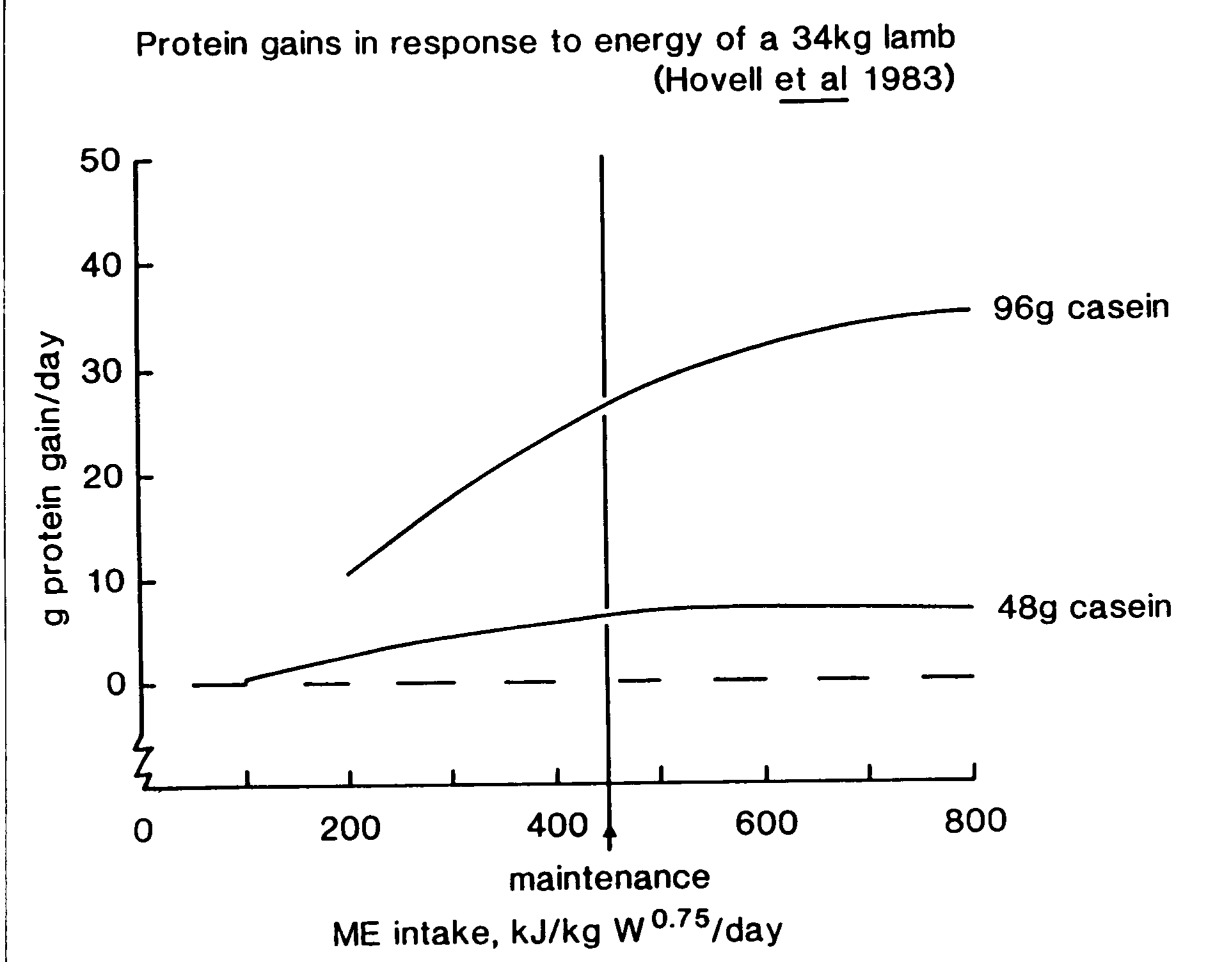
Hvelplund's values are true digestibilities. They demonstrate the importance of not using heat damaged meals and also a possible disadvantage in the use of formalin (formaldehyde) to reduce the rumen degradability of a protein since the UDP so produced may also have a reduced digestibility in the small intestine of the host animal. Hvelplund (personal communication) also found a sample of a commercial rapeseed meal which was badly heat-damaged. Clearly there is an urgent need for a rapid and reliable method for measuring the digestibility of UDP. ARC (1984) adopted a value of 0.85 for the true digestibility of all sources of UDP and Hvelplund's data suggest that this is probably a reasonable value for undamaged proteins.

EFFECT OF ENERGY SUPPLY ON HOST ANIMAL PROTEIN UTILIZATION

In all species, a greater energy supply results in faster growth until protein becomes limiting. This is because the tissues within the animal respond to a greater supply of nutrient, and greater supplies of nutrients also trigger hormonal responses within the animal, which accelerate growth. However, it is difficult to study the effect of changing energy supply at a constant protein intake in weaned ruminants because of the relationship between energy intake and microbial protein production. The effect is that in ruminants, if the animal is given more energy, then more microbial protein will be produced.

The method of intra-gastric nutrition developed at the Rowett in which pure nutrients are infused into the rumen and abomasum eliminates any rumen fermentation and avoids that problem. Fig. 2 shows the effect of giving a constant amount of protein (48 or 96g casein) to 34kg lambs over a range of energy intakes (Hovell, Ørskov, MacLeod and McDonald, 1983). There was a clear response to energy supply, particularly at the high protein intake, and protein gain increased from about 10g/day when the lambs were at half maintenance to 35g/day when they were at nearly twice maintenance (800kJ/kgW$^{0.75}$ per day). Had these animals been normally fed with no protein supplement, their supply of truly digestible protein from microbial protein would have been about 64g/day when getting 800kJ ME/kgW$^{0.75}$ per day, and proportionally less at other energy intakes (i.e. about 16g/day when getting 200 kJ/kgW$^{0.75}$ per day). Therefore this experiment also demonstrated that microbial protein supply would have been limiting, as the lambs clearly responded to greater amounts of protein supplied as casein.

Figure 2



Black and Griffiths (1975) overcame the problem of interdependence of energy supply and microbial protein production by infusing liquid milk based diets directly into the abomasum. They also found a clear response of protein deposition to increased energy supply for lambs of up to 35kg given excess protein and their results are summarised by Fig. 3 which is from their paper. The potential protein deposition shown by this experiment is considerably greater than that achieved by normally fed lambs.

Fig. 4 has been calculated from ARC 1980 and 1984 and shows protein requirement in relation to microbial supply. The data is based on the determined body protein accretion of normally fed lambs. This suggests that the only true scope for the 35kg lambs to respond to additional protein as UDP is when energy supply is less than that needed to sustain a daily gain of 100g/day. However, as we have shown above, this does not conform to the potential of the animal which is to be able to make substantial protein gains even when in negative energy balance. Fig. 5, which is Fig. 4 redrawn, indicates the potential of the 35kg lamb to deposit protein and consequently a greater deficit between potential need and microbial protein supply which can only be corrected by increased UDP supply.

Fig. 5 shows that in most situations the growing lamb will be deficient in protein if it is dependent only on the microbial supply, and only at the highest energy intakes on concentrates will the microbial supply approach the potential of the animals. However, in this situation, the high energy intakes will also lead to substantial fat deposition. Evolution has responded to the constraint imposed by microbial protein supply by ensuring that the young lamb 'tops up' its microbial protein supply with milk. Thus, in practical situations, our expectation is that lambs will respond to UDP with the exception of lambs getting a good supply of milk, and possibly at later stages of growth on high concentrate diets (when they may be laying down too much fat).

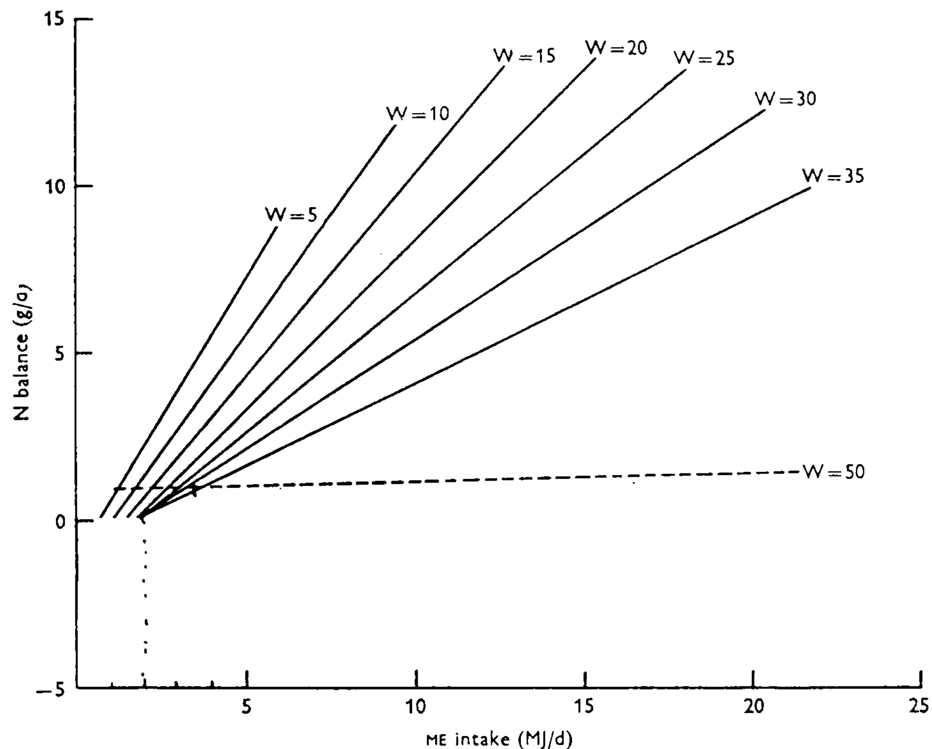


Figure 3

Fitted relationship between nitrogen balance (g/d) and metabolizable energy (ME) intake (MJ/d) of lambs, when N intake was in excess of requirement, at different live weights (W, kg). – – – –, Extrapolation beyond the range of experimental results.

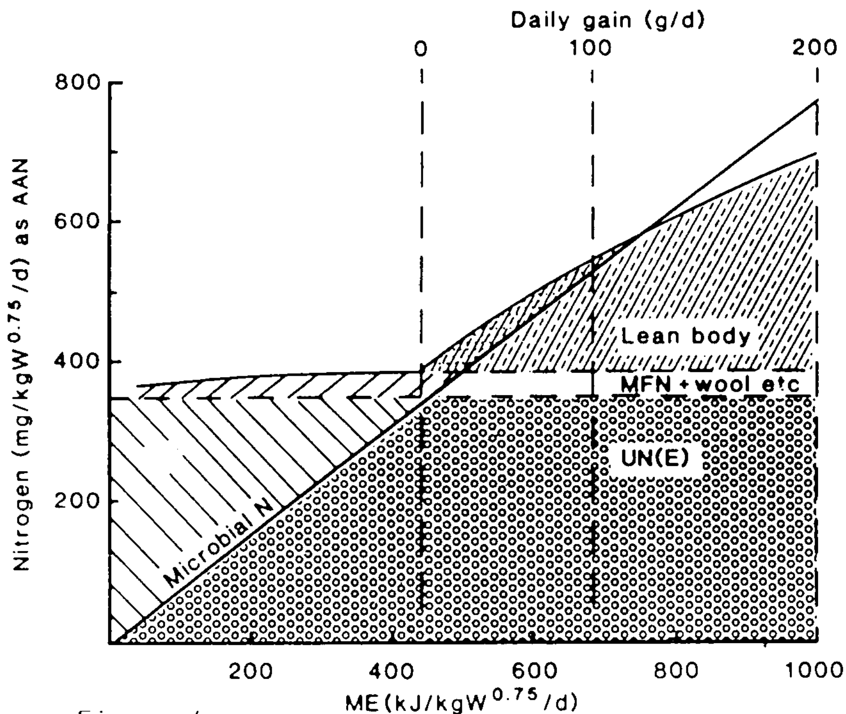


Figure 4

Nitrogen requirement of a 35 kg lamb in relation to microbial protein supply

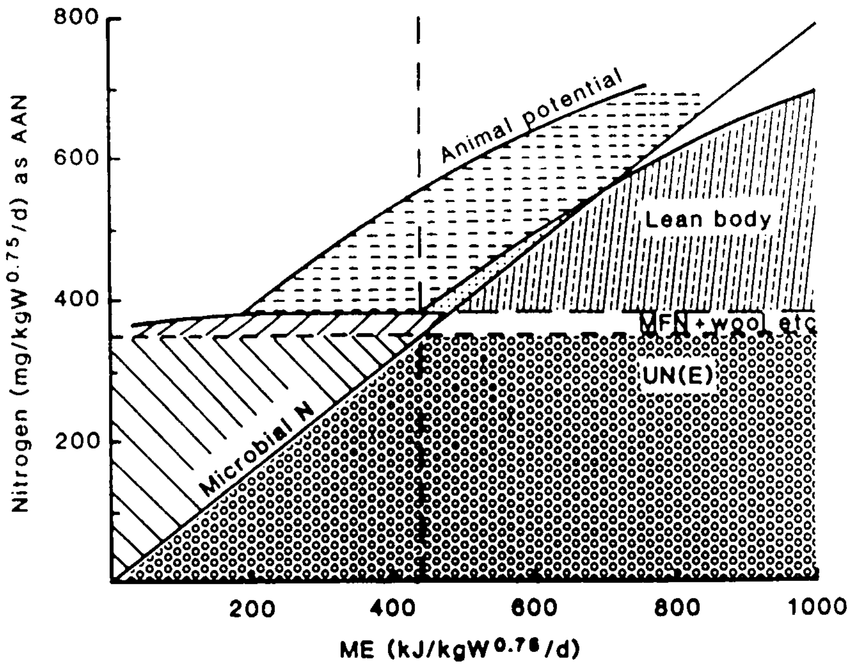


Figure 5: **Nitrogen requirement of a 35 kg lamb in relation to microbial protein supply and animal potential.**

PRACTICAL RESULTS FROM THE USE OF FISH MEAL IN DIETS FOR RUMINANTS

Since fish meal has the characteristic of being degraded to a lesser extent than most other protein supplements (see Table 2) and also having an amino acid composition which complements that of the microbial protein, excellent results have been obtained with the use of fish meal in diets for intensive fattening of early weaned lambs and for roughage-fed store lambs and lactating ewes.

INTENSIVE FEEDING OF LAMBS

The outstanding value of fish meal for growing lambs was clearly demonstrated by the results of an experiment in which different concentrations of fish meal were included in diets for lambs between 15 and 40kg live weight (Ørskov et al. 1974). The results of these trials are given in Table 4: the inclusion of fish meal in barley based diets had a pronounced effect both on the growth rate of the lambs and on their feed conversion ratios.

We had earlier conducted a similar type of experiment to investigate aspects of body composition (Ørskov et al, 1971). Here the effect of including fish meal in a barley diet was measured during the growing period from 15 to 50kg live weight in both entire male and in female lambs (Table 5). The lambs responded to fish meal inclusions both by increasing daily live weight gain and by improving the feed conversion ratio. The improvement in the feed conversion ratio was also reflected in a high N content in the carcasses of the lambs receiving fish meal. American workers have also investigated the effects of fish meal inclusions and Hogue and Adam (1982) reported (Table 6) that when part of the cottonseed meal in concentrate diets for early weaned lambs was replaced by fish meal there were improvements in live weight gain and in feed conversion ratio similar to the earlier observations made at the Rowett Research Institute.

Recently workers at Cornell (Beerman et al., 1986) found that when fish meal was given with soyabean meal there was an increase in growth rate (see Table 7), particularly in diets which did not contain the β-agonist cimaterol. It is extremely interesting to note that the response to cimaterol was similar to the response to fish meal increasing live weight gain and lean content of the carcasses. For young, intensively-fed, early weaned lambs fish meal seems to be superior to most other sources of proteins.

FISH MEAL AS SUPPLEMENT TO ROUGHAGE BASED DIETS

In some observations summarised by Ørskov (1982) it was observed that the tissue maintenance requirement of sheep was about 300 mg N/kg$W^{0.75}$. It was also observed that approximately this amount was produced from a maintenance energy diet from rumen microbial protein. It follows that if the sheep are experiencing a period of undernutrition they would lose tissue protein and show compensatory gains when protein was again supplied. It has now been demonstrated (see Hovell et al., 1983) that lambs do respond to protein at low levels of nutrition. This is shown in Table 8. The lambs were given diets based on caustic soda treated straw. It can be seen that a positive gain was possible on the unsupplemented diet but this was dramatically increased as a result of supplementation with only 66g/day of fish meal. There were no further consistent increases in live weight gain as a result of increasing the supplement to 132g/day. In this work no information was obtained on changes in body composition, i.e. whether the animals were gaining or losing body fat (see later).

Marchment and Miller (1983, 1984), using diets based on caustic soda treated straw and sugar beet pulp pellets, similarly found that inclusion of 6% special product fish meal in the diet increased the growth and feed conversion ratio of store lambs of 25-40kg live weight, compared with 10.5% rapeseed meal. Similarly, Hassan and Bryant (1986a) obtained linear increases in feed intake and growth rate of 35kg store lambs when 3, 6 or 9% fish meal was included in caustic soda treated straw diets with a 60:40 forage-to-concentrate ratio. The response to fish meal was greater than with formaldehyde treated rapeseed meal. In a further trial Hassan and Bryant (1986b) showed 10% fish meal gave similar increases in live weight with both 60:40 and 40:60 forage-to-concentrate ratio diets.

TABLE 4

Effect of fish meal inclusion in barley based diet
on growth rate and feed conversion in early weaned lambs
from 15-40kg live weight

Fish meal concentration (%)	Growth rate (g/d)	Feed conversion (kg DM/kg gain)
0	102	5.9
3	176	4.2
6	210	3.7
9	269	2.9

(Ørskov et al., 1974)

TABLE 5

Effect of fish meal content in barley based diet
on growth rate and feed conversion in male and female lambs
from 15-50kg live weight

Fish Meal (%)	MALES		FEMALES	
	Gain/d (g)	Food conversion	Gain/d (g)	Food conversion
1	191	4.5	177	4.5
6	270	3.5	225	4.2
12	330	3.1	301	3.5

(Ørskov et al., 1971)

TABLE 6

Effect of giving isonitrogenous concentrate diet
based on maize but substituting some cottonseed meal with fish meal

Fish meal (%)	Cottonseed (%)	Live weight gain (g/d)	Feed conversion ratio
0	15	230	3.8
3.7	10	270	3.2
0	17.9	205	4.1
3.9	11.5	345	3.0

(Hogue & Adam, 1982)

TABLE 7

Effect of fish meal and cimaterol on live weight gain
and feed conversion in intensively fed lambs during 69 days

Protein supplement	Cimaterol	Live weight gain	Feed conversion
Soyabean meal	-	350	3.9
Soyabean meal + fish meal	-	441	3.5
Soyabean meal	+	370	3.7
Soyabean meal + fish meal	+	395	3.6

(Beerman et al., 1986)

Using good quality, high protein silage, Marchment and Miller (1985) also showed better growth rates in finishing lambs were obtained with fish meal than with rapeseed meal supplements in combination with 150g barley dry matter but not with 300g barley DM. Similarly Yilala and Bryant (1985) obtained increased intake of silage and increased growth rate with fish meal supplement compared with barley or rapeseed meal supplements. Hunter and Tempest (1987) showed molassed sugar beet pulp plus fish meal was a better supplement than whole barley plus fish meal for finishing lambs on silage and that beet pulp plus fish meal gave increased growth rates compared with beet pulp alone.

Penning, Orr and Treacher (1988) demonstrated that feeding supplements containing fish meal as the protein source to lactating ewes increased milk yield by 24% and lamb growth rate over first 12 weeks of lactation by 15% for ewes either receiving cut herbage indoors or grazing respectively.

USING FISH MEAL TO MANIPULATE BODY FAT STORES

In work carried out using the technique of intragastric nutrition it was shown that lambs given protein but no energy could attain positive protein balance. Since energy is required to achieve protein storage, the energy required by these lambs could only have come from the breakdown of body fat stores. In fact the utilization of amino acids was very efficient as long as body fat was available. This observation led to the more practical experiment reported by Fattet et al., (1984). Lambs were given diets of straw at two levels of feeding (LS and HS) and each was supplemented with 75g per day of fish meal. The gain in body tissues during 92 day is given in Table 9. As expected the lambs lost fat and protein on the LS diet but they were in positive protein balance when given 75g per day of fish meal as indicated by the gain in lean or non-fat tissue. With the HS diet it can be seen that the lambs in fact gained 4.2kg empty body weight while losing fat. This phenomenon has enormous implications, particularly in areas of fluctuating supplies of nutrients. Fish meal can be used to manipulate body fat stores to fuel protein deposition. Recently it became of interest to cause loss of fat in overfat lambs due to delay in slaughter resulting from high radiation counts from the Chernobyl disaster. Lambs were taken back to the farms and given straw and a supplement of fish meal. The results of Vipond et al (1988) (see Table 10) illustrate the differences in carcass weight, live weight loss and lean tissue accretion when overfat lambs were, so to speak, defatted to suit the market.

FISH MEAL SUPPLEMENTATION DURING PREGNANCY

During the last 2-3 weeks before parturition in twin bearing ewes the intake of roughage is often reduced. As a result, the microbial protein production is also reduced during a time when foetuses grow rapidly and udder tissue is formed to prepare for lactation. There is little scientific work reported on fish meal supplementation during the last few weeks of pregnancy although farmers report higher vitality of lambs and higher initial milk yields in the ewes given such supplements. Robinson (1987) reported data from an earlier unpublished experiment at the Rowett Research Institute (McPherson, V.O.M., Robinson J.J. and Fraser C, 1981) in which fish meal supplementation in late pregnancy increased colostrum production in the first 24h after lambing. Penning et al have shown the amount of colostrum ingested by lambs is not only important for survival and growth rate to weaning but also influences age to market slaughter weight.

FISH MEAL FOR LACTATING EWES

Large quantities of fish meal are presently being used for dairy cows in early lactation to manipulate fat stores and avoid loss in protein tissue. Work has been done with lactating ewes, and fish meal supplements are now marketed for ewes in early lactation. Gonzales et al (1982) compared the milk yield response in underfed ewes when different supplements were given. While the yield was 2 l/d with no supplement it increased to 2.2 l/d with a supplement of groundnut meal, 2.5 l/d with soyabean meal and 2.8 l/d with fish meal at equal levels of protein intake. These results are similar to many results obtained in feeding of dairy cows in early lactation.

In a further experiment with lactating ewes Gonzales et al 1984 fed ewes complete diets

TABLE 8

Effect of feeding small amounts of fish meal
to store lambs given a basal diet of caustic soda treated straw

Fish meal (g/d)	Live weight gain (g/d)		Straw intake (g/d)	
	0-69d	70-119d	0-69d	70-117d
0	30	31	824	858
66	100	89	911	1081
132	68	136	855	986

(Hovell et al., 1983)

TABLE 9

Effect of fish meal supplements to straw diets
on body gain and composition of lambs

Treatment	Live weight gain (kg)	Empty body gain (kg)	Body fat (kg)	Non fat gain
Low straw	-4.32	-5.05	-3.53	-1.52
Low straw + fish meal	0.29	0.64	-1.53	2.27
High straw	0.08	-0.80	-1.40	-0.60
High straw + fish meal	6.22	4.18	-0.90	5.08

(From Fattet et al., 1984)

TABLE 10

Effect of supplementation of fish meal to over fat lambs
given straw diets in an attempt to reduce body fat and retain body weight

	Live weight gain 0-42d	Carcass weight (kg)	Lean meat (kg)
Straw only	-129	20.2	11.1
Straw + 100g/d fish meal	-2	22.0	12.5

(Vipond et al., 1988)

based on chopped hay and barley with three protein concentrations achieved with increasing amounts of white fish meal, 60, 100 and 140 g per kg. The three diets were fed at three levels of feeding corresponding to daily energy intakes of 19, 23 and 27 MJ ME. At each energy intake the milk yield of the ewes responded to increasing amounts of fish meal fed, the response being greater with increasing energy intake:

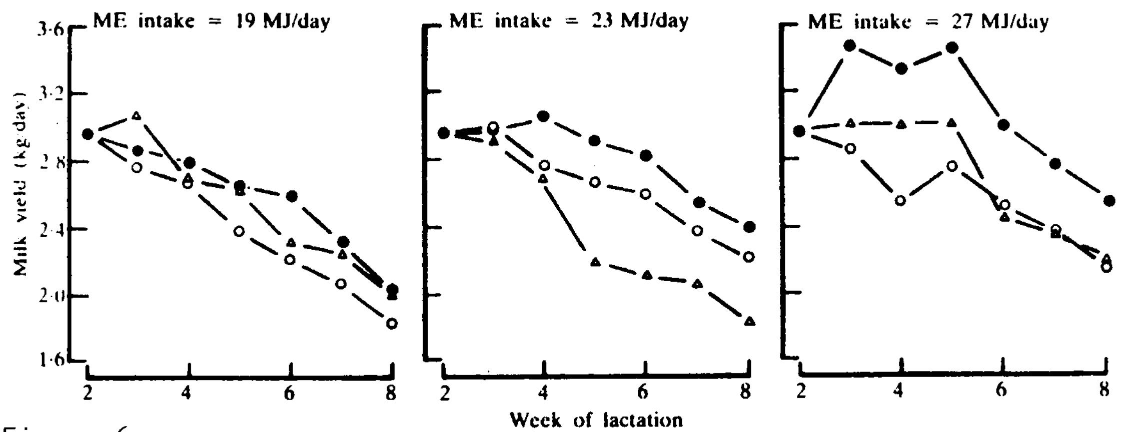


Figure 6

The milk yield of ewes receiving daily 19, 23 or 27 MJ metabolizable energy (ME) from diets containing 128 (○), 155 (Δ) or 186 (●) g crude protein per kg dry matter.

Over all energy intakes, the concentration of crude protein in the milk increased significantly with increasing protein concentration in the diet (49.6, 53.6 and 54.1 g per kg respectively). There was no consistent trend in milk fat concentration attributed to the treatments imposed.

The effect of increasing milk yield in ewes was no doubt also the reason why lambs reared by fish meal supplemented ewes had higher live weight gain (290g/day) than those by ewes supplemented with an equal amount of soyabean meal (232g/day). (Robinson et al, 1987). These results confirm an earlier trial where fish meal supplement supported higher milk yields and lamb growth rates in weeks 2 and 3 of lactation (257g/day) than either soyabean meal (215g/day) or groundnut meal (224g/day) (Robinson et al 1979).

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