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24 Possibilities for change in the output from grassland: an overall view

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INTRODUCTION

In reviewing the possibilities for change in the output from grassland, we commissioned papers to deal with grass and legume production and conservation, the use of grassland products by different animal species and factors affecting efficiency in the use of support energy, labour and capital in production from grassland. Our remit was limited to developments we considered feasible with existing technology. Thus, possibilities for further advance through, for instance, plant breeding were not considered. The papers also concentrated on developments in animal production from grassland that were related to the input of grassland feeds. Advances through, for instance, improvements in disease control were considered only if an important interaction with the use of grassland feeds was envisaged.

With these restrictions, it is, perhaps, not surprising that our conclusions are rather conservative. We anticipate that, over the next 20 years, the species of plants and animals that we use are likely to continue to be those that are at present important, and that herbage plants will still be grazed during the summer and conserved, without fractionation, for winter feeding. We do, however, see opportunities for large increases in output from grassland and for changes in the pattern of production that will vary according to the availability and cost of the different resource inputs.

In this paper we discuss firstly the possibilities of grass contributing to the diet of animals other than cattle and sheep, either after fractionation or as a 'whole' crop. Potential herbage output and the output from cattle and sheep are then discussed with reference to land use, concentrate feed inputs and support energy. Finally, consideration is given to the extent to which change might be limited by the availability of capital and human resources.

Grass for animals other than cattle and sheep

The possibilities for using unfractionated grass in the feeding of animals other than cattle and sheep were reviewed by Walsingham (1981). Clearly, unfractionated grass has only a low potential for use with non-herbivorous animals, but there are possibilities for increased use by horses, rabbits, deer and goats. At present, about 200 000 ha of grassland is used by horses and this figure may well increase with increased use of horses for recreational purposes.

Increased demand for goat meat and milk may be stimulated by population increase in the UK of ethnic groups from countries where goat products are commonly consumed. The low content of fat in the meat of deer and goats and the anti-allergic properties of goats milk may also be important factors. Increasing concern for health factors in food choice may increase the demand for the products from these animals.

Goats and deer appear to have the potential to produce at an equivalent level to the conventional species, or even outyield them. Critical experiments on the efficiency of these species are, however, needed and although there is long-term potential, it is most unlikely that there will be an explosion in the use of grass by animals other than cattle or sheep during the next ten years.

Grass fractionation

Jones (1981) noted that the fractionation of young grass crops, with the use of the fibrous residue in cattle feeding and the juice in pig feeding, can lead to increases in the production of carcase meat per ha of land. This arises from the more efficient use of the protein fraction and the higher efficiency of feed conversion by pigs than by cattle. An alternative approach is to prepare a dried leaf-protein concentrate from the juice. It was calculated, however, that fractionation of young grass may not be justified if the grass is to be fed to very young growing ruminants or high-yielding dairy cows. Also, with other stock, a better approach may be to cut the grass at a more mature stage of growth, with lower crude protein content but higher yield per ha. Thus the scope for grass fractionation may be rather limited and it is notable that, despite a substantial R & D effort in the UK during the last decade, there is now no practical development of the process and research in the context of animal feeding has stopped.

We feel that major advances in the machinery required for fractionation or major changes in the economic situation are required before this process warrants further consideration for practical adoption in the UK.

The production and utilisation of grassland by the traditional ruminant species is now considered in more detail.

GRASS AND LEGUME PRODUCTION

It is clear that the key to achieving high grass production at any particular site is the supply of nitrogen to the crop, and that differences in potential yield between sites arise largely from differences in water supply and from differences in the length of the growing season as affected by altitude. Wilkins *et al.* (1981) calculated that the average yield of the existing enclosed grassland in the UK could be increased, by the use of higher levels of N fertiliser, from the current estimated level of 5–6 t DM/ha (Green & Baker, 1981) to 11–12 t DM/ha with cutting at four-weekly intervals and to 15–17 t DM/ha with less frequent cutting (Table 1). The removal of water stress by irrigation would increase these figures, on average, by only 6%, although the responses are much greater in the dry south and east of England. Further increases of 10–15% could result from the control of pest damage, but the cost of control with the currently available insecticides is high and their use is likely to be restricted to the grass establishment phase. The production of some swards may be below these levels, because of the

Table 1
Current UK grassland production and mean potential production from grass and grass/white clover swards

	Production/ha			N fertiliser (kg/ha)
	DM (t)	ME (GJ)	UME (GJ)	
Current grassland[1]	5–6	—	37	106
Potential[2]				
Grass[3]				
Four-weekly cutting	10.9	128	—	371
Less frequent cutting	15.7	162	—	272
Grass/white clover				
Four-weekly cutting	8.2	98	—	0

1 From Green & Baker (1981).

2 From Wilkins *et al.* (1981) for swards growth without irrigation.

3 With N fertiliser applied to a level at which the incremental response is 10 kg DM/kg N fertiliser.

grass species present, but we accept that, in most circumstances, improvements in nitrogen supply will increase the content of the more productive species.

Potential production from hill land was not considered in detail, but it is clear that there are also opportunities for large increases in the production of hill grassland.

The possibility of basing herbage production on forage legumes was considered. In the south and east of England, levels of yield from lucerne approach those from grass cut at similar intervals and experimental data suggest that the yield of a mixed grass/white clover sward without fertiliser N can be about 75% that achieved from pure grass swards with high levels of N fertiliser and cut at four-weekly intervals. Legume-based swards can thus give yields considerably higher than those achieved, on average, from grassland at present (Table 1). There is, however, as yet, little farm experience in the exploitation of legume-based swards and the variability in production between years and between sites may well be greater than with grass. We see, however, no insurmountable problems in the development of legume-based ruminant production systems.

Support energy use was discussed by Wilkins & Bather (1981). The support energy required for feed production is the largest energy input in the production of meat and milk from cattle. The largest energy inputs in grassland are for N fertiliser and for harvesting and conservation but, despite this, the support energy used per unit of ME output is rather lower for grassland feeds than for concentrate feeds.

In grazed swards, the input of support energy per unit output of UME was calculated for grass-white clover to be only one-tenth of that for grass with high N fertiliser. There are also opportunities for improving energy efficiency through the use of animal excreta, both as a source of plant nutrients and to produce 'biogas'. The excreta from housed rather than from grazing animals can be more readily exploited in this way and this could offset the higher energy inputs in systems involving conserved rather than grazed grass.

From the viewpoint solely of support energy use, the forage legumes have much to offer but, as noted earlier, the level of yield per ha will be lower than that from grass with high levels of N fertiliser.

CONSERVATION AND GRAZING

Wilkinson (1981) concluded that there are large opportunities for reduction in nutrient loss during conservation. Losses are lowest with high-temperature dehydration but, at present, there are massive inputs of support energy with this method. The efficiency of support energy use can be improved by field wilting prior to high-temperature dehydration and there is also the possibility on some farms of using straw as fuel. These developments would allow high-temperature dehydration to compete with ensilage and haymaking in efficiency of support energy use. We support, however, Wilkinson's view that high capital requirements will continue to limit the adoption of high-temperature dehydration.

With ensilage and haymaking, the application of existing technology could reduce loss to less than 10% and 20% of initial DM yield respectively (compared with present figures that are probably around 30% and 40% respectively). With silage making, the use of short wilting periods, well-sealed silos and chemical additives are required to attain this figure and with haymaking the use of barn drying or a chemical preservative would be essential. There is the possibility of adding ammonia to hay at harvest, to act both as a preservative and to increase crude protein content and digestibility of the hay.

It is difficult to estimate the efficiency with which grass is harvested by grazing animals. The papers dealing with dairy cows, beef cattle and sheep (Gordon, 1981; Prescott, 1981; Newton, 1981) all stress the importance of matching stock numbers to the quantity of herbage available in order to achieve high utilisation by grazing. Prescott considered 85% utilisation an appropriate target, whereas Newton based his calculations on 70% utilisation. The matching of the availability of herbage and animal requirements may be facilitated by:

(i) integration of grazing with conservation;

(ii) manipulation of the animal system to fit the grass production pattern through, say, late lambing;

(iii) manipulation of herbage supply to fit animal requirements through, say, altering the pattern of N fertiliser inputs;

(iv) the use of supplementary feeds (concentrates or conserved grass) at times when herbage growth rate is low or the nutrient demand of the animal is particularly high.

This area was considered to be of critical importance not only in achieving high grazing efficiency, but also to the whole question of animal production from grassland. All the approaches listed above, in different circumstances, have an important role to play, with clear analysis and planning at the farm level being of vital importance.

CATTLE AND SHEEP PRODUCTION FROM GRASSLAND

The Working Group papers indicated that, although supplementary feeds have a part to play in achieving efficient grass utilisation, it is possible to achieve high rates of individual animal output without the need for high levels of concentrate feeding. Thus, intensification of grassland use need not lead to increased total requirements for concentrate feed.

Table 2 is derived from Working Group papers and details animal output that could be achieved per grassland ha from systems involving low concentrate feed inputs. The quantity of concentrate feed required is also listed, as is the area required to produce that concentrate. A simplified assumption was made, that the concentrates were barley grain, obtained with a yield of 4.0 t/ha – about the national average. Different grass yields were assumed in the different papers and in Table 3 the outputs and requirements have been adjusted to standardised yields which reflect the national average yield obtainable from grass cut at four-weekly intervals with optimal application of N fertiliser and from legume-based swards without fertiliser N (Wilkins *et al.* 1981).

Table 2
Animal output from grassland in systems involving low concentrate feed inputs

	Assumed grass yield (t DM/ha)	Stocking rate (animals/ grass ha)	Con-centrates (kg/head)	Area for concentrate production (ha/ha grass)	Animal output per annum (kg/grass ha)	(kg/total ha)
					Milk	
Cows[1]	12.6	2.9	500	0.36	16 000	11 800
					Carcase weight	
Dairy-bred beef[2]	10.7	4.2	500	0.52	1 070	700
Production of weaned suckler cattle[3]	8.0	2.2	250	0.14	370	320
Finishing sucklers or store cattle[4]	10.7	5.9	220	0.32	660	500
Sheep[5]	11.6	12.7	36	0.12	370	330

1 From Gordon (1981) with annual yield 5 500 kg milk/cow.

2 From Prescott (1981) with the production of 255 kg carcase weight in system involving growth at 0.8 kg LWG/day.

3 From Prescott (1981) with the production of a weaned calf of 300 kg LW (170 kg carcase weight). A stocking rate of 2.2 beef cows and calves per ha.

4 For cattle growing from 300 to 500 kg LW at 0.8 kg/day with 1.1 kg concentrates/kg LWG. Nutrient requirements from MAFF (1975). Grass utilisation, 85%.

5 From Newton (1981) with 1.8 lambs sold/ewe at a carcase weight of 16 kg.

Table 3

Animal outputs from grassland adjusted to standardised yields of 10.9 t DM/ha for grass with N fertiliser and 8.6 t DM/ha for grass/white clover[1]

	Stocking rate (animals/grass ha)	Area for concentrate production (ha/ha grass)	Animal output (kg/grass ha)	Animal output (kg/total ha)
Output from grass with N fertiliser				
			Milk	
Cows	2.5	0.31	13 800	10 500
			Carcase weight	
Dairy-bred beef	4.3	0.54	1 100	710
Integrated suckler production[2]	2.0	0.24	560	450
Sheep	11.9	0.11	350	320
Output from grass/white clover				
			Milk	
Cows	2.0	0.25	11 040	8 830
			Carcase weight	
Dairy-bred beef	3.4	0.42	870	610
Integrated suckler production[2]	1.6	0.19	450	380
Sheep	9.4	0.08	270	250

1 Animal systems from Table 2 and herbage yields from Wilkins *et al.* (1981).

2 Production through to a LW of 500 kg. A stocking rate of 2.0 animals/ha indicates two beef cows and their progeny up to 500 kg LW.

The quantity of concentrate feed required per grassland ha varied between the animal systems, being highest for dairy-bred beef and least for sheep production. These differences reflect, in part, the different assumptions made in the different papers for target rates of animal output.

In Table 4 the analysis is extended to calculate the areas of grassland that would be required to give ruminant products to the level of either the current UK output or consumption. It was assumed that the ratio between the outputs of milk and dairy-bred beef would remain as at present and that any additional beef production would be suckler beef. Notionally, the total ruminant output has been derived from enclosed grassland and concentrate feeds; any contribution from rough grazings has been ignored.

Table 4

Area of grassland and cereals required to sustain the current UK output and consumption of ruminant products[1]

	Milk	Dairy-bred beef[2]	Suckler beef[2]	Sheep	Total
To produce current UK output					
Output required	14.4 Ml	599 kt	433 kt	229 kt	
Area required (Mha):					
Grass with N fertiliser					
Grassland	1.04	0.54	0.78	0.65	3.01
Cereals	0.32	0.29	0.19	0.07	0.87
Grass/white clover					
Grassland	1.30	0.68	1.04	0.85	3.87
Cereals	0.32	0.29	0.19	0.07	0.87
To produce current UK consumption					
Output required	22.6 Ml	940 kt	265 kt	397 kt	
Area required (Mha):					
Grass with N fertiliser					
Grassland	1.64	0.85	0.47	1.13	4.09
Cereals	0.51	0.46	0.11	0.12	1.20
Grass/white clover					
Grassland	2.05	1.08	0.59	1.47	5.19
Cereals	0.51	0.46	0.11	0.12	1.20

1 Systems from Table 2. Output and consumption data for 1977 from Amies & Wragg (1981) for milk and Swinbank (1981) for meat. Yields of grass and grass/white clover from Wilkins *et al.* (1981).

2 Distinction between dairy-bred beef and suckler beef according to Dench & Kilkenny (1981) with cull dairy cows considered as dairy-bred beef and cull beef cows and imported Irish stores considered as suckler beef.

With the use of grass and optimum levels of N fertiliser, it appears that the current ruminant output could be sustained from 3 Mha of grassland and

0.9 Mha of cereals. The current area of grassland (excluding rough grazings) is 7.1 Mha and the current input of concentrate feed is 9 Mt, which would require 2.2 Mha of land. There is then the potential for obtaining our current ruminant output with the release for other purposes of 4.1 Mha of grassland and 1.3 Mha of land from cereal production. At the other extreme, the output of ruminant products from the existing land area could be increased two and a half times. The current consumption of ruminant products in the UK could be supplied from little more than half of the area that is now used for producing feed for ruminants.

The table also indicates that legume-based forage production could sustain the current ruminant output or consumption, and still release land for other purposes.

It is most likely that, should output from grassland be increased towards this practical potential, some combination of increased ruminant output and release of land for other purposes would occur. In this context, it is relevant that Green (1974) found that 56% of all grassland had no physical restriction to cultivation, so that a large proportion of grassland could be used for other cropping purposes. For grassland with limitations to cultivation, there is potential for use in forestry and recreation.

Constraints to increasing output from grassland

There will, of course, be no dramatic and immediate increase in output from grassland and brief consideration is given here to some factors which may limit change.

Grassland is, of course, farmed in individual farm units and the biological, economic and management constraints of these units must be borne in mind. We do not see a major change within the next few years to the present state of farm structure. Hence physical farm circumstances and constraints are expected to remain broadly as at present.

Support energy has already been mentioned and the total input of fertiliser N, the most important single energy input in grassland production, would need to increase by some 47% to obtain the existing ruminant output from a reduced area of grass. We believe that output is equally likely to be constrained by the requirements for capital and the human resources available than by considerations of support energy.

Clearly, increased output per ha requires higher rates of capital investment. James (1981) noted that a 10% increase in stocking rate would add up to £100 per ha to the capital employed in the business. As there is, on average, the potential for more than a 100% increase in stocking rate, additional investment of around £1 000 per ha is required. James concludes that the 'current high cost of capital . . . leads to acute problems in introducing developments which will pay their way'. This situation is likely to limit the rate of intensification of production from grassland or, at least, lead to developments which may release land from grassland, rather than increase ruminant output from the total farm unit. Different ruminant enterprises have different capital requirements, with tenants capital/ha on sheep farms being only about a quarter that on specialist dairy farms. This variation in the availability and cost of capital is likely to influence the pattern of grassland enterprises as well as their level of intensity.

Although there has been a progressive reduction in the agricultural labour force over the last century, we consider that, in the next years, there will be less pressure for further reduction in labour input in grassland enterprises. Factors contributing to this view are the increasing unemployment in the country at large, high costs of mechanisation and the need to have at least some labour on farms. We are much more concerned with qualitative rather than quantitative aspects of the farming population. The ability and inclination of farmers to adopt new technology has been discussed within Working Group 2 by Johnson & Bastiman (1981) and by Tayler (1981). We believe that the rate of change in output from grassland will be much affected by such human factors.

CONCLUSION

There is great scope for increasing the output of ruminant products from grassland. Increases should be achieved without recourse to either high rates of feeding cereal-based concentrate feeds or high support energy inputs in fertiliser N. Although increase in total output of ruminant products is possible, it is more likely that increase in output per ha will result in the release of land from grassland for other purposes. The availability of capital and the aptitude and inclination of farmers will limit the rate at which output from grassland is increased.

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