LOW PRODUCTIVITY OF LAMBS ON IMPROVED PASTURE

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I. INTRODUCTION

Pasture improvement has increased animal production. by enhancing 'both the quantity and quality of herbage available, especially in particular seasons of' the year. Despite these improvements , there are 'instances where levels of animal production have remained far below potential. The extreme manifestation of this syndrome is commonly referred to as "ill thrift" and in New Zealand, Scott, Rattray and Smeaton (1976) have described the problem as being "characterised by negligible weight gains... despite' ample pasture, anthelmintic drenching and the correction of known mineral deficiencies". Apart from such obvious examples, animal production often varies considerably on apparently good pastures and this indicates some basic problem with pasture quality which limits the intake or the availability to the animal of nutrients derived from pasture.

The objective of this paper is to define some aspects of pasture quality which adversely affect animal production. It is not proposed to extensively review the literature but to draw attention to the major areas using selected published references and unpublished data from current studies at Glen Innes.

II. GROWTH POTENTIAL OF LAMBS

It is' difficult to determine what constitutes a satisfactory rate of liveweight gain of lambs on pasture especially when the large number of breeds and their crosses are considered. In pen feeding experiments in the United Kingdom, liveweight gains of Suffolk x (Finnish Landrace x 'Dorset Horn) lambs have exceeded 400 g/h/d (Orskov et al. (1976). Rates of gain in excess of 300 g/h/d are common in crossbred lambs on grain based diets in Australia.

Langlands (1972, 1973) measured liveweight gains of Merino, Border Leicester, Merino x Border Leicester and Merino x Dorset Horn cross lambs on phalaris, white clover pastures at Armidale, N.S.W. Pre-weaning liveweight gains were approximately 185, 276, 237 and 231 g/h/d while post-weaning gains were approximately 80, 130, 130 and 133 g/h/d. Although lambs grazing pasture may not be expected to reach the high rates of gain achieved under pen feeding conditions, it is quite apparent that liveweight gains on pasture are generally far below the genetic potential of the animal.

Also, there are often inconsistencies in animal performance on pastures of apparently similar quality as measured by normally accepted indicies such as digestibility and crude protein contents. The best documented examples of this phenomenon occur on grass pasture compared with legume pasture and on autumn pasture compared with spring pasture.

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III. EFFECTS OF PASTURE SPECIES AND SEASON ON LIVEWEIGHT GAIN

In a review., Reed (1972) concluded that animal production was directly related to the 'proportion of legumes in the diet of grazing . ahimals. Data in Table 1 indicate the range of differences which have been reported in the literature. Average liveweight gains on pure legume pastures were more than twice those obtained on pure grass.

TABLE 1 Examples of differences in the growth of lambs on grass and clover

	Liveweight gain (g/h/d)		
	Pure Grass	Mixed Pasture	Pure Legume
Heinemann & Van Keuren (1958) U.S.	127	172	213
Sinclair et al. (1956) N.Z.	52	-	172
McLean et al. (1962) N.Z.	122		254
Hight & Sinclair (1965) N.Z.	37	128	191
Wilson (1966) Australia	82		159
Corbett et al. (1976) Australia	83	-	148
Means	83		190

Differences in animal growth rates between seasons have also been well documented, especially in New Zealand and Great Britain where 'animals grazing autumn grass pastures often fail to produce satisfactory liveweight gains. In New Zealand, Sinclair, Clarke and Filmer (1956) report that lambsbecome unthrifty on perennial ryegrass in autumn 'despite vigorous pasture growth. In Australia, this problem has not been well documented but a comparison of seasonal growth rates of animals would suggest that it could be a significant factor. Hamilton, "Hutchinson and Swain (1970) compared growth of lambs on four temperate grasses at two stocking rates. Liveweight gains of lambs at the lower stocking rate for spring, summer, autumn and winter were approximately 160, 60, 30 and 20 g/h/d, respectively. Data on pasture availability and quality were notprovided, but apart from winter, differences in animal production would be expected to occur largely as a result of differences in pasture quality.

Data of Langlands, Bowles and Donald (1979) indicate that the organic matter digestibility (OMD) of diets selected by sheep grazing fertilized improved pastures on the northern tablelands of N.S.W. is lowest in winter and may fall to 60% while from spring to late autumn, OMD usually remains between 70 and 85%. Dietary nitrogen contents remain in excess of 2% and for much of the year are above 2.5%. The quantity of available green forage is a major determinant of both OMD and N contents and this is generally at its lowest level during winter. Such data . indicate that under normal climatic conditions and sufficient availability of green material, pasture quality should be adequate to sustain at least moderate levels of liveweight gain during much of the year.

Why then do pastures with similar digestibilities differ so greatly in feeding value?

(a) Grasses versus legumes

Sinclair, Clarke and Filmer (1956) found in New Zealand during autumn that the dry matter digestibility of perennial ryegrass was 63% compared with 73% for white clover. However, intakes of digestible dry matter by lambs were 400 and 800 g/h/d respectively and liveweight gains were 52 and'172 g/h/d. Corbett et al. (1976) compared growth of lambs on lucerne and phalaris pasture on the northern tablelands of N.S.W. (Table 1). Their results indicate that lucerne may be fermented more efficiently and have shorter residency periods in the rumen than phalaris as differences in intake per se did not always adequately explain 'differences in liveweight gain.

Rattray and Joyce (1974) found that although ryegrass and white clover had similar metabolizable energy (ME) contents, the net availability of ME for fattening from ryegrass was only 33% compared with 51% for white clover. In pen feeding experiments with subterranean clover, Graham (1969) concluded that the net energy (NE) value of clover was equal to that of any other feed with similar chemical composition and digestibility. Its exceptional value was simply due to the very high levels of voluntary intake. The superior value of clover has also been associated with its faster rate of digestion compared with grasses rather than digestibility per se (Marsh and Chestnutt,1976).

These data suggest that the higher feeding value of legumes is due to a combination of factors which include higher voluntary intake, greater efficiency of utilization of ME and more efficient fermentation in the rumen.

(b) Spring versus autumn growth

The superiority of spring compared With autumn growth may also be related to voluntary intake. In New Zealand, Clarke (1959) fed dried spring and autumn grass with digestibilities of 74.9 and 71.5% respectively. Digestible dry matter intakes were approximately 620 and 450 g/h/d. Sheep fed autumn and spring grass at the same level of intake had similar liveweight gains.

In Tasmania, Michell (1973a) showed that dry matter intakes of both legumes and grasses reached a peak in early spring and then gradually fell to a minimum level in winter. Intake of legume was generally higher than that of grass. Although intake was positively correlated with digestibility, the intake of spring-summer pasture at any digestibility level was 15 to 20% higher than intake of winter pasture. Autumn pasture was intermediate.

In the United 'Kingdom, Corbett et al. (1966) and Blaxter et 'al. (1971) both showed that early cut grass was utilized much more efficiently for liveweight gain than late cut grass of similar digestibility. The net availability of metabolizable energy for early cut forage was 43.5% and for late cut forage 32.5% (Corbett et a1.1966). Blaxter et al.' (1971) found no effect on season of pasture growth on voluntary intake.

In a review, Reed (1978) concluded that at similar digestibilities the nutritive value of early pasture growth in the United Kingdom was 20-35% higher than late cut pasture. This was associated with differences in voluntary intake, rumen retention times and efficiency of utilization of metabolizable energy. It was also interesting that the effects of season on the feeding value of clovers appeared to be less than for grasses.

IV. EFFECTS OF PLANT CHEMICAL COMPOSITION ON NUTRITIVE VALUE

(a) Soluble carbohydrates

The chemical composition of grasses and legumes grown in spring and autumn may vary considerably as shown in Table 2. The main differences are that spring grass has higher soluble carbohydrate 'levels

TABLE 2 Chemical composition (% of dry matter) of pastures grown in spring and autumn

	Grass		Clover		Grass	
Component	Autumn*	Spring*	Autumn†	Spring††	Autumn†	Spring††
Soluble carbohydrates	12.4	19.3	5.3	7.9	4.0	12.6
Hemicellulose	19.2	19.9	7.0	9.7	14.1	12.6
Cellulose	25.5	29.4	17.5	20.9	27.6	25.4
Lignin	5.1	1.6	6.5	8.2	5.9	6.8
Total nitrogen	2.2	1.6	4.7	4.1	4.1	3.3

* Beever et al. (1978) - U.K.
† Joyce and Newth (1967) - N.Z.
†† Rattray and Joyce (1969) - N.Z.

and lower crude protein contents than autumn grass. Composition of clover is not as greatly affected by season as the grasses. Corbett et al. (1966), Blaxter et al. (1971) and Beever et al. (1978) suggested that the higher feeding-e of early cut grass was due to the higher content of soluble carbohydrates which produce a higher proportion of propionic acid:acetic acid in the rumen. Propionic acid is the main precursor of glucose in ruminants. Grimes, Watkin and Gallagher (19.67) also found that clovers were superior to grasses due to the production of higher levels of propionic acid in the rumen. Conversely, a higher ratio of acetic acid:propionic acid in the rumen will depress intakes (Egan, 1977).

Hight et al. (1968) grew ryegrass under artificial shading to reduce the levels of soluble carbohydrates.. This treatment produced lower intakes and liveweight gains in penned'sheep compared with comparable unshaded ryegrass. Intakes and liveweight gains on clover were higher than for both grass treatments. Intake accounted for most of the observed differences in liveweight gain. These authors pointed out that there was no clear relationship between intake and digestibility above 70%. .

The apparent relationship between level of soluble carbohydrates in herbage and animal performance through the alteration in VFA proportions in favour of propionic acid is the most consistent factor emerging from these studies to explain the superiority of clovers over grasses and spring over autumn grown grass. However Hight and Sinclair (19.65) obtained no response when molasses was used as a supplement. In Tasmania, Michell (1973b) found that intake could generally be predicted from multiple regressions involving digestibility and water soluble carbohydrate contents, but no chemical composition measurement adequately explained the reason for low intakes on winter pastures. The winter pastures did have low water soluble carbohydrate levels but so did late summer pasture which had normal intakes. Although the level of water soluble carbohydrates was positively correlated with the proportion of propionate in the rumen this was not closely related to intake of digestible energy (Michell, 1974).

(b) Protein

McRae and Ulyatt (1974) suggested that differences in animal performance between grasses and clovers may be associated with differences in protein absorption from the small intestine: They found that the energy absorbed as VFA's from the stomach and small intestines was similar for clovers and grasses (about 2100 to 2400 K cal/day) while the ratio of absorbed protein:absorbed energy was higher from clovers and was highly correlated with liveweight gain. Egan (1977) proposed that voluntary intake is dependent upon the ratio of digestible protein: digestible energy. For diets which yielded less than 12-13% of digestible energy as digestible protein, voluntary intake could be increased by infusing protein into the duodenum. Kempton and Nolan (1978) have suggested that in growing animals, the requirement for amino acids often exceeds the supply from rumen microbial sources. They argue that it may sometimes be necessary to supply dietary protein in a form which is non-degradable in the rumen but which is digestible in the small intestine. This would stimulate voluntary intake by increasingthe ratio of digestible protein:digestible energy (Egan, 1977).

Although Beever et al.(1978) found that a lower proportion of the protein in autumn pasture did by-pass rumen fermentation compared with spring pasture, the digestion products from autumn pasture ultimately contained a higher proportion of protein (26% compared with 20%). Beever et al. (1978) proposed that protein degradation in the rumen may be associated with low recovery of energy as VFA and excessive losses as heat, causing a depression in the utilization of ME. However, as already reviewed, some studies have also shown reduced intakes on autumn pasture and it may be possible therefore, that in some environments, the higher protein degradability on autumn pasture may reduce protein:energy ratios to critical levels.

V. RESEARCH AT GLEN INNES

(a) Supplementation with by-pass protein

An experiment was undertaken from 27th April to 22nd June, 1976, to determine whether weaned lambs grazing high quality green pasture during autumn and early winter may be deficient in protein due to excessive fermentationof dietary protein in the rumen. Merino lambs were supplemented with either 40, 60, 80 or 100 g/h/d of fishmeal by mixing the meal with water and administering it directly into the reticulo-rumen using a drenching procedure. Similar experiments were undertaken in 1977 and 1978. Responses to the by-pass protein supplement were variable. In 1976, a significant response occurred to the supplement and for the total period average liveweight gains were ill and 75 g/h/d for the supplemented and unsupplemented groups respectively. 'The OMD and N contents of the pastures were 80.3 and 2.9% in early May and 71.5 and 2.7% in mid June. In 1977 and 1978 there were no significant effects of protein supplementation although there were trends for increased liveweight gains in supplemented animals during 1977.

(b) Effects of anthelmintics and legumes on autumn/winter production

The 1978 experiment also investigated the effects of anthelmintic drenching and mineral (Se, Co and Cu) supplementation on the growth of weaner sheep. For this reason, treatments were given to groups of sheep run in different plots and two replicates of each treatment were used- - The results indicated *(Figure 1) that infrequentdrenching in autumn (4-6 week frequency) predisposed the Merino lambs to heavy worm infestation and contributed to severe liveweight loss and even mortality compared with frequent drenching (every 2 weeks). There were no other significant treatment effects, including the supplementation of by-pass proteins.

However, it was noticeable after 6-8 weeks that differences were occurring in liveweight gain between replicates within certain treatments. The basic pasture on which the experiment was located comprised fescue, subterranean clover and lucerne, but most plots. in one 'of the . replicates developed marked legume dominance and animals on these plots grew- faster than those on the more grass dominant replicate, as shown in Figure 1. Although this contributed to problems in statistical analysis, it strongly illustrated the potential significance of legumes in the nutrition of growing animals on pastures during autumn and early winter on the northern tablelands.

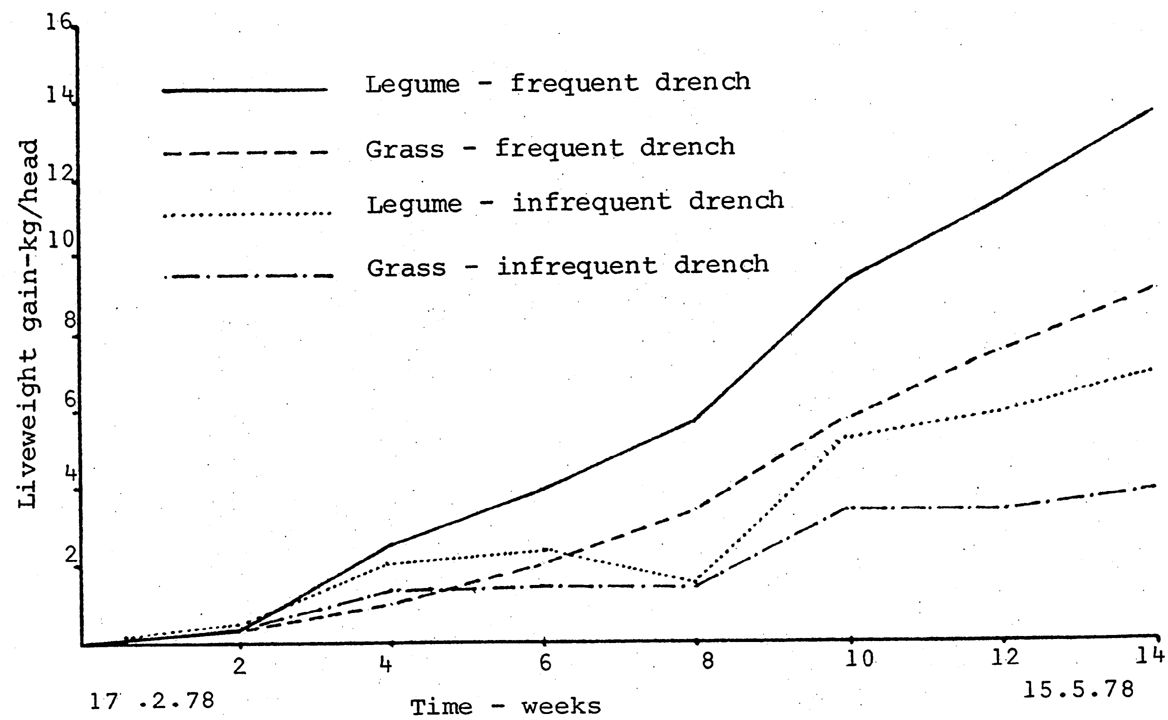

FIGURE 1. Effects of anthelmintics and botanical composition of pasture on liveweight gain of Merino lambs

A further experiment was undertaken in 1979 to explore this theme further. Weaned Merino lambs were placed on either grass dominant, legume dominant (subterranean clover) or mixed grass/legume pastures from mid April until November. The main effect of legumes on animal growth 'occurred during winter when liveweight gains were 67, 96 and 119 g/h/d for the respective treatments. The lower rate of gain on the legume plots compared with the mixed plots was due to low herbage availability.

Studies are continuing with legumes and grasses to obtain further data on their relative potentials for animal production in this environment and to measure the 'nutritional factors involved based on recently developed techniques and hypotheses. We see these studies as an extension of basic research to the field situation in an attempt to solve practical problems.

(c) Agronomic evaluation of pasture legumes

Research on pasture legumes has largely been neglected on the northern tablelands in favour of evaluation studies on exotic grasses such as fescue, phalaris, ryegrass, cocksfoot etc. White clover is the standard legume used and although this species may be efficient for soil nitrification, it is really a spring/summer growing species and because of its susceptibility to dry periods may even grow as an annual. If legumes are proven to have a majorinfluence on the nutritional status of grazing animals, especially during autumn and winter, then currently used cultivars of white clover are unlikely to be of significant benefit. 'At Glen Innes, we are also vitally interested in the nutritional evaluation of native grass species and the use of legumes to improve the quality and productivity of natural pastures.

Legumes such as subterranean clovers and lucernes offer enormous potential advantages for the improvement of both sown and natural pastures on the northern tablelands but substantial research inputs are required to develop these species and their management requirements. Such programmes are currently being implemented at the Agricultural Research Station, Glen Innes.

VI. CONCLUSIONS

Beever et al. (1978) stressed that the true causal reasons for different animal performance on pastures with similar digestibility coefficients, such as autumn vs spring herbage, have not been elucidated. They highlighted in their research the misleading nature of apparent digestibility as a measure of nutritive value, and the danger of using a fixed value to convert DE to ME. Minson (1978) also stressed this point indicating that the net availability of ME for fattening may differ by up to 65% for pastures with similar ME concentration.

Such differences in efficiency of utilization of ME have been shown to be a major reason for differences between herbage species and season of growth. Differences in intake are also strongly implicated. Possible factors associated with these differences include variations in readily available carbohydrates, the proportion of propionate in rumen VFA's and the proportion of protein energy to total energy. However, no explanation has yet produced satisfactory reasons for low growth rates on highly digestible pastures., Research in this area still therefore poses a major challenge to ruminant nutritionists, while a resolution of the factors associated with the overall inefficiency of conversion of pasture to animal product could have enormous implications in the pastoral industries.

In the meantime, one necessary agronomic objective should be to promote the proportion of legumes in pastures, especially during autumn and winter.

VII. REFERENCES

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