ASPECTS OF THE FEEDING VALUE OF PASTURES

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ABSTRACT

Current knowledge of the factors affecting the feeding value of pastures in New Zealand is reviewed. The main nutritive problem is the decline in digestibility that occurs in mid summer. As herbage matures the proportion of stem increases and the proportion of slowly digested structural carbohydrates in the stem also increases. The result is a decline in digestibility. Furthermore, both efficiency of utilization of digested nutrients and voluntary intake also decline as digestibility declines. All these factors compounded reduce the feeding value of pasture in summer. The best solution is to increase the proportion of legumes either as pure swards or by management procedures. Legumes grow in the summer and have high feeding value. In late winter digestibility is high and low pasture growth rate is the main problem. Any extra pasture grown or supplement fed should be of high feeding value or nutritional problems will occur.

INTRODUCTION

This paper will review our knowledge of the various factors that determine the feeding value[1] of pasture. It will show the contribution feeding value makes to seasonal deficits in feed supply. The discussion will be limited to a consideration of pastures, as other papers in this symposium will deal with supplementary feeds. Furthermore, metabolic diseases associated with pasture feeding will not be considered in detail, although the constraints these place on the farmer are fully appreciated. Most of these diseases are the subject of considerable research effort in their own right. Instead, the emphasis will be placed on positive things that can be done to improve the feeding value of pasture.

COMPARATIVE FEEDING VALUE OF PASTURE SPECIES

The comparative feeding values of several New Zealand pasture species for sheep growth have been assessed under grazing conditions and are given in Table 1. This work has established several major differences: the legumes are in general of higher feeding value than the grasses, although there are considerable differences among legumes; there are major differences among the grasses, e.g., the annual-type ryegrasses are of higher feeding value than the perennial types. It is also significant that the two most widely used pasture grass species used in New Zealand, perennial ryegrass and browntop, have the lowest feeding values. There appears to be a negative correlation between persistence and feeding value. The small amoung of work that has been done comparing the feeding values of pasture species for cattle growth and milk production suggests the ranking is similar to that for sheep growth.

1 Throughout this paper herbage *feeding value* is defined as an animal production response to a herbage and *nutritive value* as a response per unit of feed intake. Feeding value is thus a function of both intake and nutritive value (Ulyatt, 1973).

TABLE 1: The comparative feeding values of some pasture species grown in New Zealand for sheep liveweight gain.

	Relative liveweight gain
Perennial ryegrass, "Grasslands Ruanui"	100
Perennial ryegrass, "Grasslands Ariki"	111
Short rotation ryegrass, "Grasslands Manawa"	148
Italian ryegrass, "Grasslands Paroa"	160
Timothy, common	129
Browntop, common: Spring	100
Early Summer	83
Lucerne "Wairau"	170
Lotus pedunculatus "Grasslands Maku"	143
White clover, "Grasslands Huia"	186

CHANGES IN PASTURE DIGESTIBILITY

The major components of the nutritive value of a feed are the proportion of nutrients digested (apparent digestibility) and the efficiency with which the end products of this digestion are utilized within the animal. Digestibility is a major component of nutritive value and thus has received a great deal of research attention, so that the factors that determine it are reasonably well understood. New Zealand pastures show a general pattern in digestibility: values are high (75 to 85%) in winter and spring, decline to between 60 and 70% in mid summer and then rise again with the onset of rain in the autumn. Actual values will vary between districts and the type of farming employed.

Seasonal changes in digestibility are related to changes in herbage maturity. In both grasses and legumes the proportion of stem increases with the onset of flowering in early summer. At the same time the digestibility of stem tissue decreases while the digestibility of leaves stays reasonably constant (Terry and Tilley, 1964). The two-fold effect of an increasing proportion of stem of decreasing digestibility thus reduces the digestibility of the whole plant as it matures. The rate of decline in digestibility varies between species. For example, white clover declines less than the forage legumes, red clover and lucerne (Davies *et al.*, 1966), while at the same cutting date the later flowering varieties of ryegrass are of higher digestibility than the early flowering varieties (Minson *et al.*, 1964). An extreme example of declining digestibility is seen with browntop which declines from approximately 80% in early spring to approximately 50% in mid summer (Lancashire and Ulyatt, 1974). Legumes like white clover maintain a high digestibility because the harvestable material is not stem, but leaves and petioles, which are continually renewed as aged material is replaced in the canopy by new growth. It is for this reason that plants with a growth form like white clover are ideal for maintaining a high digestibility throughout the year.

The decline in digestibility with maturity is caused by changes in the chemical composition of the plant. For example, as lucerne matures, several significant changes in chemical composition occur (Bailey *et al.*, 1970): cell wall or structural carbohydrates (cellulose and hemicellulose), which are slowly digested, increase rapidly in stems and slowly in leaves; lignin, which is itself indigestible and through its close association with cell wall carbohydrates reduces their digestibility, also increases rapidly in stems and slowly in leaves; the readily fermentable carbohydrates (soluble sugars, starch and pectin) decrease slowly in stems and remain constant in leaves; crude protein declines more rapidly in stems than leaves. A very similar effect is seen in grasses (Waite *et al.*, 1964). Thus as a plant matures the proportion of stem increases, the proportion of slowly digested chemical components in the stem also increase, and these two effects are responsible for the decline in digestibility.

In the grazing situation, we are concerned with the digestibility of either regrowths (rotational management), or with the herbage continually available to the set stocked animal. In these cases the herbage available will be a changing mixture of leaves, stems and dead material. When plant material dies its digestibility will decline as the soluble components, such as soluble carbohydrate and protein, are either leached by the effects of weather, or are removed by either saprophytic micro organisms or the autolytic activity of the plants. Therefore, the higher the proportion of dead material in a pasture, the lower will be its digestibility. The decline in digestibility of grazed pastures that occurs during summer is thus due to an increase in the proportion of stem as the plants try to flower, followed by an accumulation of an increasing proportion of dead material as growth slows with high temperatures and low moisture.

EFFICIENCY OF HERBAGE UTILIZATION

The efficiency of utilization of digested herbage is the other major component of nutritive value. However, the factors that cause differences in efficiency are more difficult to measure than those affecting digestibility, thus they are not as clearly understood. Efficiency, expressed as the efficiency of utilization of metabolizable energy (ME), can be subdivided into the partial efficiencies of utilization for various functions of the animal, such as maintenance (k_m), growth (k_g) and lactation (kl). The partial efficiencies change with the digestibility of the diet (A.R.C., 1965). As a generalisation when digestibility increases from 40 to 80%; k_m increases from 65 to 75% and k_g increases from 30 to 60%. At a digestibility of 40% kl is 60%, increases to 70% at a digestibility of 70% and thereafter declines slowly as digestibility increases. Thus the partial efficiency showing the greatest response to changes in digestibility is that for growth (k_g). There are important exceptions to this generalisation that are pertinent to the New Zealand pastoral scene. It has been demonstrated (Ulyatt, 1971; Rattray and Joyce, 1974) that at the same digestibility the efficiency of utilization of perennial ryegrass is significantly lower than that of white clover. This is not because white clover is especially high, but because perennial ryegrass is low. The reason for this is not clear. Another exception is autumn pasture, which has been shown to have a lower k_g than would be expected from its digestibility (Corbett *et al.*, 1966; Blaxter *et al.*, 1971). Various reasons have been suggested for this phenomenon (e.g. Scott *et al.*, 1976) but no convincing explanation has been made.

VOLUNTARY INTAKE

The amount of herbage an animal voluntarily consumes is one of the main determinants of feeding value. Calculations that have been made (see Ulyatt, 1973) indicate that variation in intake could account for up to 70% of variation in feeding value. Indoor feeding trials, largely with wether sheep, have demonstrated that there is a good general reationship between intake and herbage maturity (often expressed as digestibility). Similar affects have been noted with cows grazing pasture in New Zealand (Hutton, 1962). Several authors (e.g., Minson *et al.*, 1964) have shown that the intake of grasses is highest at the first cut in early spring and declines in subsequent cuts as the herbage matures. Both the maximum intake and the rate of decline vary among herbage species and differences can occur among species at all stages of maturity. This positive relationship between intake and digestibility is not precise and there are many instances of significant differences in intake between plants of the same digestibility. For example, cocksfoot has a lower intake than perennial ryegrass (Greenhalgh and Reid, 1969) and the annual ryegrasses produce higher intakes than perennial ryegrass (Ulyatt, 1971). Limited evidence suggests that the intake of legumes is higher than grasses: white clover is higher than perennial ryegrass (Thomson, 1971; Ulyatt *et al.*, 1977); red clover has a higher intake than S24 ryegrass (Hodgson, 1975). There is also evidence of differences in voluntary intake between legume species (Ulyatt *et al.*, 1977). Fresh herbage also has a characteristically high bulk density because of the large amount of intracellular water it contains. This bulk may restrict the amount of fresh pasture that can be consumed in certain cases, e.g., rapidly growing spring pasture.

Voluntary intake is thus a major determinant of feeding value and large differences in intake occur among pasture species, yet we have almost no information on the comparative voluntary intakes of pasture species sown in New Zealand.

If pasture is conserved as hay or silage, the conserved product will usually be of lower feeding value than the starting material. Therefore if conserved material of high quality is required it is critical to conserve before the pasture is too mature.

OVERCOMING PASTURE DEFICITS

What can be done, in nutritive terms, to overcome the deficits in pasture production in summer and late winter?

The problem in summer is that most pasture available is dry, mature, contains a high proportion of dead material, and thus has low soluble carbohydrate and protein content. This pasture characteristically is of low digestibility, which means that both efficiency of utilization and voluntary intake will be reduced. If stocking rate is high and maintenance feeding is the aim, then supplementary feeding with meadow hay would probably be satisfactory. If supplementation is to be used to achieve high production, then the supplement needs to remedy the deficiencies in the summer pasture. A concentrate supplement high in protein and soluble carbohydrate is the answer, but the cost is high. There are other ways of solving the problem: use pasture plants that grow well and have a high feeding value in the summer; or, adopt management procedures that prevent the summer decline in digestibility. The answer is increased use of legumes, either by sowing special purpose pastures or managing pasture to increase its content of legume in the summer.

In late winter the digestibility of pasture is usually high, unless large amounts of dead or frosted material are present. The main problem is low pasture growth rate. The solutions are either to grow pasture species that grow better in late winter, to accumulate pasture for feeding in late gestation, or to use feed supplements. In late gestation the ruminant has, for physiological reasons, a reduced voluntary feed intake (Forbes *et al.*, 1967). It is essential therefore that any pasture or supplement offered at this time is of high feeding value. To complement the pasture available any supplement should have a high soluble carbohydrate content. Reliance on poor quality hay will almost certainly reduce intake and lead to nutritional problems.

CONCLUSIONS

In conclusion, the first thing that can be done to increase production in the summer and late winter is to increase pasture growth during these periods. Further gains in production can be achieved by exploiting our knowledge of the nutritive characterisitcs of pasture plants. This usually means increasing the content of legumes in our pastures. There is a definite lack in New Zealand of research aimed at incorporating pasture species of high nutritional merit into new management systems. To fully exploit the nutritional potential of our herbage, higher risks must be accepted, therefore skilled management is required. The farmer must decide whether any increased production is worth the cost.

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