QUALITY OF PASTURE SPECIES

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Pastures provide at least 85 percent of the nutrients used for animal production in Australia and hence contribute significantly to our national wellbeing. The production of grazing animals is dependent upon the quantity and quality of the available pasture and the efficiency of pasture use.

Quantity is readily perceived, but not so accurately estimated and generally is the yardstick on which grazing management decisions are made. Quality is much harder to perceive or measure and is often not even considered when assessing pastures for animal production. Quality is a description of a pasture's "goodness" and refers to its capacity to meet animal requirements for energy, protein, and other essential nutrients. It depends not only on yield, but also on chemical constituents, freedom from toxic compounds and its digestion and utilization by livestock.

This paper will emphasize the importance of pasture quality and quantity for animal performance and provide some evidence of differences in quality between pasture species.

Significance of nutritive value

One measure which is used to denote pasture quality is nutritive value. This is the concentration of nutrients per unit of forage dry matter and includes digestibility (a measure of available energy), nitrogen, cell-wall constituents (cellulose, hemi-cellulose, lignin - together these comprise plant fibre), soluble carbohydrates (sugars, starches, fructosans), fats, minerals and vitamins.

High levels of animal performance require high daily intakes of digestible forage. The intake of food is mainly influenced by the composition of the plant components notably the structural and inter-cellular components, including the minerals and vitamins. This is because of their effect on the rate of passage of digesta through the gut and on the forage's digestibility. Sometimes the components of nutritive value are correlated with intake; for example, digestibility and fibre components can be used for comparing the potential animal production of various forages. However, the situation is complicated by differences in animal performance that can sometimes be obtained by feeding forages of the same digestibility eg grasses and legumes. Other factors such as the rate and products of digestion need also to be considered. Not even crude protein is a satisfactory measure of the value of plant protein for animal production in all situations. The level of protein which is not fermented in the rumen (by-pass protein) is also important especially for young, fast growing and highly productive animals. Whilst some measures of nutritive value are useful in predicting animal performance, ultimately pasture species need to be compared in terms of their feeding value, which is a measure of the animal production response as either meat, milk or fibre, relative to the total herbage consumed. It is the net effect of the level of nutrients, intake, digestion and the utilisation of nutrients.

Factors affecting nutrient content

The nutrient content of a forage is affected mainly through its stage of development. As plants advance in age increasing amounts of the structural carbohydrates, cellulose, hemi-cellulose and lignin are produced to supply rigidity and support for the plant structure. These are relatively indigestible and since they can comprise more than 70% of the plant mass, they have a large effect on quality. Cellular components such as starches and sugars are very digestible and highly desirable in pasture species. In most species nutritive value appears to be maximal about early flowering.

At equivalent stages of development legumes have more nitrogen and generally less sugar and other soluble carbohydrates than grasses. Cell walls of legumes have less hemi-cellulose than grasses and more lignin. Leguminous leaves have a high proportion of cell contents and a low proportion of fibre and the composition remains almost constant provided the leaves are green and active. Leguminous plants normally contain more calcium, magnesium, cobalt, copper, iron and zinc but less manganese and molybdenum than grasses, but at low supply the differences are often negligible. Plant nutrients are diluted during phases of rapid pasture growth and grazing livestock are most at risk from deficiencies of trace elements during this time. It may be noted that for sodium, iron, cobalt, selenium, iodine, barium, strontium and chromium, more mineral intake is obtained from the soil than from the pasture.

The effects of nitrogen fertilizer on the digestibility of grass herbage are small and variable in direction. Phosphorus fertilizer has little effect on digestibility but may improve palatability and herbage intake. The effect of added calcium, sulphur and potassium on pasture digestibility is equivocal, but all would affect intake.

Climate can also affect nutrient content. High light intensities and low temperatures will produce plants that have more soluble carbohydrates than those grown in the shade at high temperatures. Unpalatable grass around trees is probably a consequence of this. There is a negative relation between temperature and the rate of decline of digestibility of individual leaves with age for both temperature and tropical species. Severe frosting can bring about a rapid decline in digestibility, while water-stress, providing the herbage is green, can result in increased quality.

Deleterious factors in forages

Many plants contain deleterious or toxin substances. Some substances seriously affect the health of animals while others exert a sub-clinical effect resulting in reduced production. The following plant constituents have been implicated in animal disorders - protein (bloat), amino acids (mimosine toxicity), alkaloids (alkaloid toxicity), nitrate (nitrate toxicity), organic acids (oxalic acid and fluoro-acids), cyanoglycosides (cyanide poisoning and goitre), toxic sulphur compounds (goitre and anemia), heterocyclic compounds (infertility caused by phytooestrogens), mycotoxins (facial exzema, lupinosis, and several staggers syndromes) (Hegarty, 1981).

Feeding Value

The variability in quality is reflected in the feeding value of species and cultivars. Many feeding experiments have demonstrated the superiority of legumes over grasses in promoting liveweight gain and milk production. This is clearly illustrated in the results of Freer and Jones (1984). They found that there was no difference in the intake of either lucerne or subterranean clover or between phalaris or Wimmera ryegrass, but at the same level of digestibility the intake of a legume diet was 187 g/d higher than that of a grass diet and that the intake of both increased at about 20 g/d for each percentage unit increase in digestibility.

The relative feeding value of the spring growth of a number of temperate species for liveweight gain in young sheep is given in Table 1. Two points to note are (i) the large differences between species and that short-lived cultivars of ryegrass had superior nutritive value to perennial ryegrass and (ii) while the legumes are superior to the grasses, there are also substantial differences between the legumes. Limited comparisons with beef and dairy cattle would suggest a similar ranking. About half of the better performance of legumes is due to their higher intake and the remainder to the more efficient utilization of the products of digestion, in particular the amount of nitrogen available for tissue growth.

Table 1. Relative Feeding Value of several temperate pasture species for sheep liveweight gain in New Zealand or in Southern Australia.

PASTURE SPECIES	RELATIVE LIVEWEIGHT GAIN	REFERENCE
Perennial Ryegrass	100	Ulyatt (1981) Short-rotation Italian Ryegrass
Ryegrass	148	
	160	
Timothy	129	
White Clover	186	
Lucerne	~~140~~ 170	
Wimmera Ryegrass	100	Freer & Jones (1984)
Phalaris (Australia)	109	
Subclover (Bacchus Marsh)	124	
Lucerne (Hunter River)	134	

At Canberra, Axelsen and Morley (1968) studying mixed pastures found that animal production on phalaris was slightly better than for perennial ryegrass and these were superior to cocksfoot, tall fescue and the annual soft brome, in that order.

Biddiscombe *et al* (1976) have provided evidence of the relative value of subterranean clover cv. Woogenellup, annual ryegrass cv. Merridin, the volunteer grasses great (ripgut) brome (*Bromus rigidis*), vulpia, barley grass, soft brome (*B. mollis*) and the herbs long stork's bill and capeweed (Figure 1).

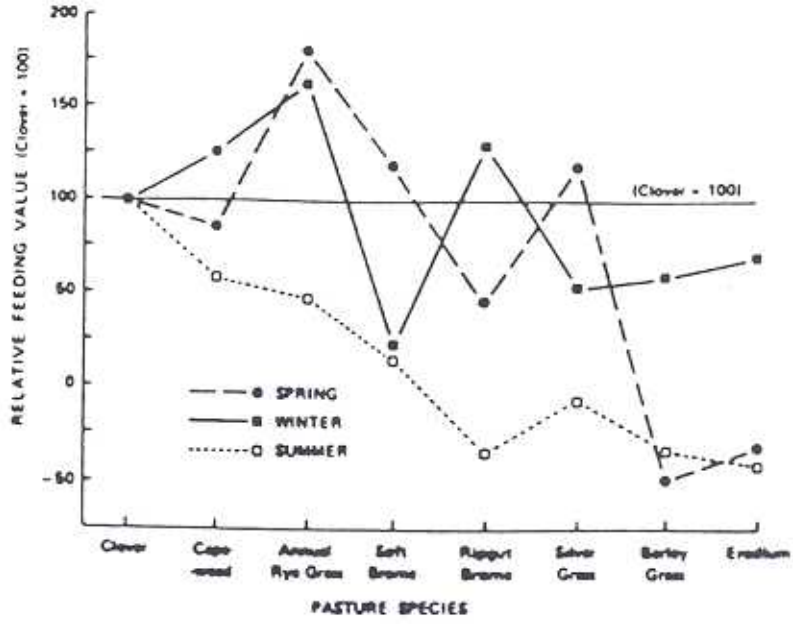

Figure 1. Feeding values of various pasture plants relative to the feeding value of clover; for winter, spring and summer. Adapted by Purser (1981) from the data of Biddiscombe et al (1976).

Both barley grass and stork's bill had low feeding value throughout the year. Silver grass and soft brome had good relative feeding values only during the spring, while ripgut brome and capeweed performed well only in the winter. However feeding values expressed during winter should be treated with some caution because of a possible feed limitation in some species. On an annual basis all species were inferior to subterranean clover.

Current research at the Agricultural Research Institute, Wagga is aimed at measuring the feeding value of a number of varieties of subterranean clover and other annual legumes. Preliminary results from grazing experiments conducted in the spring of 1988 and 1989 are given in Table 2. The relative liveweight gains closely reflected the best performed varieties in each year. The results indicate substantial differences between species and between cultivars of annual legumes and a potential within plant selection programmes to improve the quality of future commercial varieties.

Table 2 Feeding value of annual legume species at Wagga.

Species	Variety	Relative Liveweight Gain	Species	Variety	Relative Liveweight Gain
Trifolium subterraneum	Dalkeith	81	T. balansae	Paradana	92
	Esperance	88			
	Woogenellup	100	Medicago scutellata	Sava	58
	Karridale	115+			
T.brachicalycinum	Clare	84	M.polymorpha	Circle Valley	92
T.yanninicum	Trikkala	106	M.truncatula	Sephi	103
	Larisa	75	M.murex	Zodiac	80
T.vesiculosum (Arrowleaf clover)	Zulu	88	Ornithopis compressus (Serradella)	Avila	75
T.alexandrinum (Berseem clover)	Bigbee	103	O.sativus	Koha	82

+ RESULT FOR 1988 ONLY

Quality of Native Species

Native grass species are receiving more prominence because of their wide ranging adaptability and their ability to respond to summer rainfall and hence play a role in mitigating soil acidity, salinity and complimenting winter-growing introduced species. Recent studies of nutritive value have produced some encouraging results (Table 3). The list contains some of the more desirable native species surveyed on the southern and central tablelands of NSW (Dowling *et al* 1989) eg. *Danthonia*, *Microlaena* and *Bothriochloa*. The results reflect the growing seasons of the various species, but apart from white clover

there are only marginal differences between some of the native species and the introduced species. Table 3. Organic matter digestibility (%) of improved and native pasture species on the Northern Tableland of N.S.W.

	Early spring	Late spring	Summer
Trifolium repens cv. Haifa	82	72	-
Festuca arundinacea cv Demeter	70	62	64
Phalaris aquatica cv Sirosa	76	-	66
Danthonia linkii	73	62	63
Poa seiberana	69	62	64
Microlaena stipoides	-	66	67
Sporobulus elongatus	-	61	57
Bothriochloa macra	-	58	60
Themeda australis	62	58	65

Source: Archer and Robinson (1988).

However their ability to sustain high levels of animal production is questionable. In grazing experiments both wool production and liveweight gain have been lower for pastures of native species. Langlands and Bowles (1974) found that at similar stocking rates wool production per sheep on phalaris/white clover was 28% higher than on Poa/Themeda/ Bothriochloa pasture. At stocking rates supporting the same level of wool production per sheep, wool production per ha was 4 to 10 times greater on improved than on native pastures. Liveweight gains of cattle grazing native pasture (Poa/Themeda), native pasture topdressed with superphosphate and oversown with white clover, and two phalaris pastures were 223, 498, 726 and 763 g/day respectively when forage was available ad libitum (Langlands and Donald, 1978). These results will probably be improved through current efforts to select superior lines of our native grass species.

Pasture Quantity and Allowance

The availability of pasture affects both the quality and quantity eaten. In unrestricted situations all grazing animals are selective in their choice of diet. Selection of one species or plant part in preference to another depends on the relative palatability, accessibility, and availability of the pasture and its components. As availability declines so will selectivity, and lower quality forage must be eaten. The selected herbage is frequently higher in protein, phosphorus, soluble carbohydrates, digestibility and gross energy and lower in lignin and structural carbohydrates than the pasture as a whole.

Changes in availability are reflected in grazing behaviour. Grazing time and the number of bites increases as the size of the bite decreases. In the extreme, intake will be reduced significantly by a low availability or acceptability of herbage.

Studies in the United Kingdom have shown that the rate of net pasture production is insensitive to a wide range of pasture conditions and grazing managements (Figure 2). Both the maximum rate of net pasture production and the maximum intake by livestock occur at approximately the same pasture mass. For sheep this ocurs at an availability of about 1500 kg dry matter/ha and for cattle at about 2500 to 3500 kg/ha. The aim of

good grazing management is to maintain a feed supply of approximately 800 - 2500 kg/ha, which is the range for the maintenance of maximum pasture growth rates and animal intakes without suffering undue loss of pasture quality or loss of herbage through decay. Thus grazing management can be an important means of influencing both pasture quality and animal production.

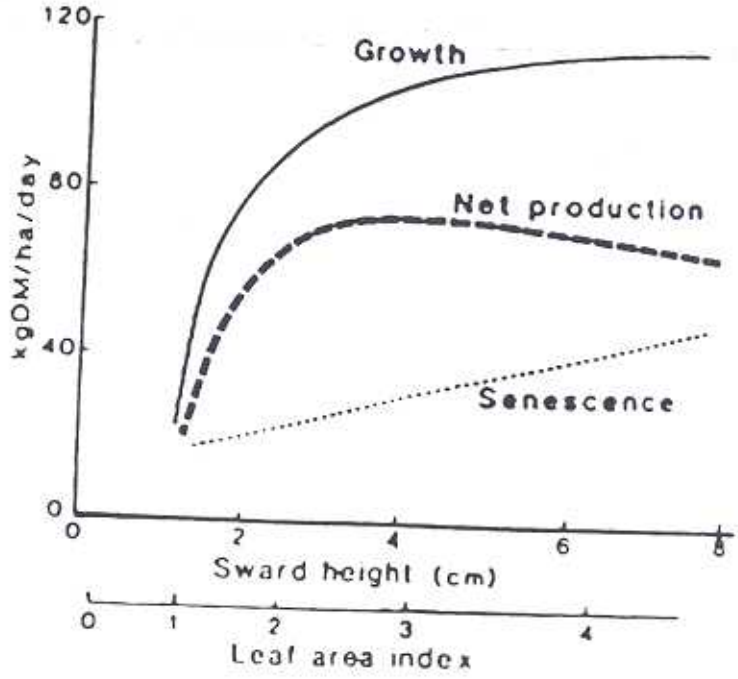

Figure 2. The relationship between pasture condition and rates of herbage production and loss under continuous stocking management (from Bircham and Hodgson, 1983).

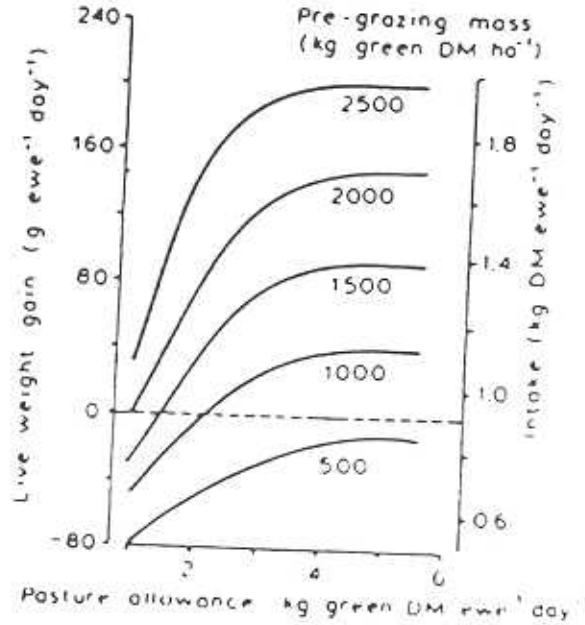

Figure 3. The effect of liveweight gain and feed intake of ewes of feed allowance and the amount of green feed per hectare initially offered (Rattray *et al* 1983).

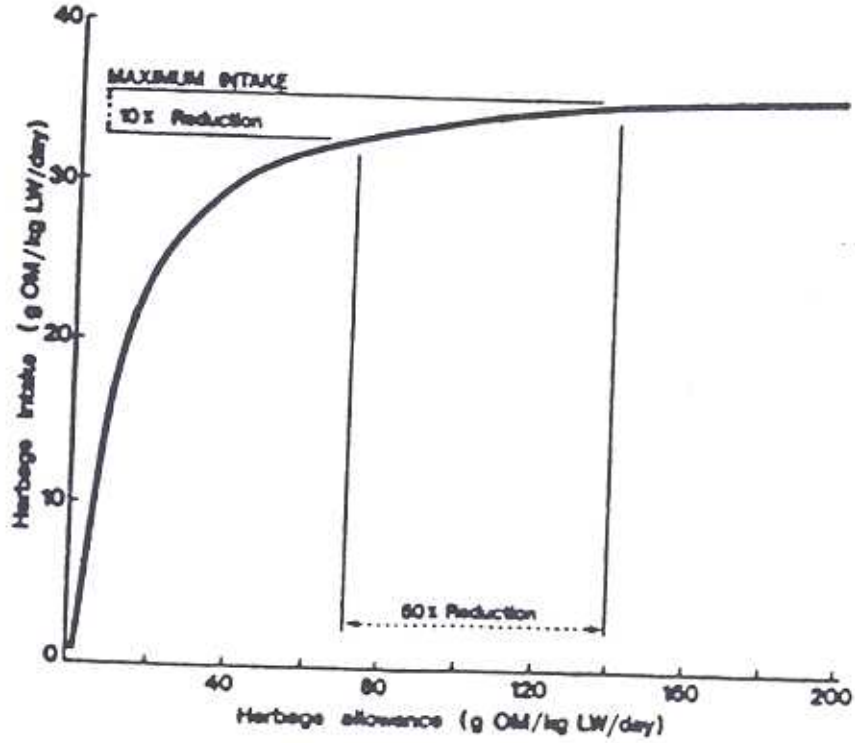

Figure 4. The relationship between daily herbage allowance and herbage intake in lambs (Gibbs and Treacher, 1976).

Some examples of target sward heights for continuous stocking systems are given in Table 4.

Table 4. Target sward heights for grazing systems

Ewes and lambs (medium growth rate)	4 - 5 cm
Ewes and lambs (high growth rate)	5 - 6 cm
Lactating dairy cows	7 - 10 cm
Finishing cattle	7 - 9 cm
Store cattle	6 - 8 cm

(Source: Hodgson *et al*, 1986)

The effect of herbage allowance and the amount of green feed initially offered is shown in Figure 3. The increasing intake and liveweight gain due to the greater availability of pasture at a set daily allowance occurs because of the greater ease of grazing when large

amounts of herbage are present. However, substantial changes in the allowance at the upper end of the curve have little effect on intake. A reduction in the allowance of 50% of the value providing maximum consumption only depresses intake by 10% (Figure 4). Thus there is considerable scope for modifying grazing management to achieve a sensible compromise between the demands for high animal performance, efficient sward utilization and maximum animal production per ha.

It has been estimated that maximal animal production is achieved when the efficiency of pasture utilization is only 30-40%. Hence the paramount importance of stocking rate in effecting pasture utilisation and determining animal production/ha is easily recognised.

Conclusion

The determination of nutritive value is a useful tool for predicting the potential feeding value of feeds but its limitations must be recognised. Differences in feeding value are most marked between legumes and grasses but differences also occur within species. Annual grasses tend to be of higher feeding value than perennials, while some native species generally are of lower feeding value.

Pasture quality is an important factor in optimizing animal production per unit of land and should be considered along with agronomic factors such as yield and persistence under grazing.

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