MANAGEMENT OF THE PASTURE COMMUNITY:

THE ROLE OF GRAZING MANAGEMENT IN SUSTAINING THE PASTURE COMMUNITY

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SUMMARY: Grazing management systems should only be applied to produce a desirable species composition, or maintain a non-resilient pasture at stocking rates at which it would otherwise deteriorate, or ration feed from one time period to another. They are not required if a pasture is stable and resilient and should also not be used *solely* to increase short-term animal production. Any increases in animal production must occur as an indirect result of species composition being improved or maintained. Hence, grazing management for animal production is justified only when stocking rate exceeds the inherent carrying capacity of the land. Clearly, there is overwhelming evidence of pasture degradation, declining quality and reduced carrying capacity. Grazing management has been proposed as providing a solution to these problems. This paper reviews the literature on grazing management in an attempt to provide graziers with clear guidelines to use when considering whether or not to adopt a grazing management strategy. For this purpose a set of rules are provided as a check list to use in the planning stages. These rules may also assist land managers in deciding what sort of strategies need to be implemented, and their likely success.

Considerable skill is necessary in judging the optimal proportion of pasture to exclude for rest and lengths of rest and grazing periods. The greater the stock density index, the greater the precision of judgement that is necessary. In this regard in deciding on the method of management the knowledge and skill of the operator must be considered. (Gammon 1972, cited by Roberts 1993).

The grazing dilemma

Grazing management has been defined by Morley (1966) as "the control of pastures and livestock and their movements in a pasture ecosystem". This broad definition embraces control of the pattern of stock movements or grazing strategy, pasture management or control of species, fertility, agronomic practices, animal management, stock type and enterprise mixes. McMeekan (1956) argued that the impact of grazing management depended on three components controllable by man; the grazing method, the stocking rate and the type of stock used. Traditionally the main objectives of pasture management have been maximum animal production, consistent with long-term sustainability.

The options that are available for farmers to implement grazing management systems are stocking rate, and the time and duration of grazing and rest. Stocking rate is commonly applied to a paddock, part of a property, whole-farms and districts as a measure of the number of stock per unit area. As such it is a confusing term, with different interpretations and its is an imprecise measure of grazing pressure. This confusion could be largely overcome by adding a time element to stocking rate (*i.e* number per area for the grazing period).

The above definition of grazing management encompasses continuous grazing, rotational grazing, strip grazing and other feed deferment (e.g. autumn deferment or saving of pasture) methods. The use of grazing methods that attempt to match forage production with the requirements of a livestock enterprise by carrying forward forage to fill expected feed periods of feed deficit (*e.g.* controlled or block grazing, Beattie and Thompson 1989; Clark 1993), are outside the scope of this paper since they do not have as their primary aim the manipulation of botanical composition to sustain the pasture. An innovative approach to overcoming periods of feed deficit, however, was adopted by Fleming (1986) who altered livestock enterprise to better suit forage availability. In examining the role of grazing management this paper focuses on grazing systems that are designed to bring about changes in botanical composition or plant density (Wilson 1986), which consequently lead to increased animal production.

From several other studies, stocking rate (McMeekan 1956; Bryant *et al.* 1989; O'Reagain and Turner 1992) or stock intensity (*i.e.* the number of animals grazed on and area of land for a full season, Wilson 1986) was identified as the factor most likely to be important in any grazing system. However, this may depend on the aim of the grazing system (production *versus* species change) and its flexibility. Additionally, since grazing systems are only required when the stocking rate required for optimum animal productivity is higher than the carrying capacity of the pasture (Wilson 1986), there is some support for the view expressed by Savory (1988) that the timing or duration of grazing rather than the animal numbers determines the impact of grazing. In particular it has been argued (Savory 1988; McCosker 1993) that individual plants should not be grazed until recovery from defoliation has occurred.

However, in any grazing system, irrespective of the grazing interval animals graze selectively and Gammon and Roberts (1978) found little difference in the frequency of defoliation of individual tillers in continuous or rotationally grazed swards at the same stocking rate. Hence, the benefits of rest may have more to do with favouring the regenerative capacity of grazed plants by allowing increases in the seed or bud bank than with any benefits directly associated with avoiding defoliation. However, results from short duration grazing with graze and rest periods determined on a calendar basis have shown little or no benefit for both animal and pasture performance (Hacker 1993; Jones 1993; McCosker 1993) when compared with continuous grazing.

Timing of grazing and rest on a calendar basis ignores basic facts about the biology of pasture growth and changing animal needs, and are not related to species phenology such as flowering and seedling recruitment. This idea is not new. Sampson (1913, 1914) recommended a deferred rotational grazing system to improve range condition by correlating grazing use with vegetational phenology. Resting from grazing allows established plants to gain vigour, produce seed and encourages seedling establishment.

The grazing dilemma then is the different requirements of animals and plants. Animals require sufficient plant material to sustain their daily intake of forage. Plants have requirements of growth, flowering, seedling recruitment and development of new basal buds or stolons. Sufficient ground cover and litter are also prerequisites for soil stability and future carrying capacity.

Current practices

Development of a continuous grazing philosophy

Analysis of the grazing management literature in the 1960s and 1970s (Heady 1961; Wheeler 1962; Myers 1972) supported the view that continuous grazing would provide more consistently than rotational systems, a bulk of feed in excess of the critical levels required for animal production (about 1200 kg/ha for cattle and 400 kg/ha for sheep). Continuous grazing was also assumed to provide a reasonably uniform daily intake of herbage and theoretically a continuously grazed pasture could be more efficient in its utilisation of light then one that fluctuated in height. A management system was likely to be beneficial to animal production only if stocking rate was high enough to limit pasture growth for a substantial proportion of the year.

Willoughby (1970) considered that grazing management involved the adjusting of grazing periods on different parts of a property to reduce the disadvantages of not always being able to make adjustments between pasture production and animal demands. Feed supply is the balance between plant growth and its depletion by breakdown or intake. Increasing stocking rate or restricting grazing to only one part of the grassland to decrease intake, lowered current animal production, but was a prerequisite for increasing feed supply by management (Willoughby 1970). Any system of pasture management that requires stock to be restricted to only a proportion of the total of the available food supply, introduces the risk of lower animal production in the short-term, particularly if intake falls below the critical levels for production or maintenance.

Continuous grazing has been considered by many (*e.g.* Pieper 1980) to be a practical system of grassland utilisation, capable of high animal production. Comparisons of animal production under continuous and rotational grazing generally show little or no advantage of rotational grazing for current or short-term animal production per head (Wheeler 1962; Pratt and Gwynne 1977; Gammon 1978; Bryant *et al.* 1989; Pieper and Heitschmidt 1988; Taylor 1989). However, if additional factors such as variable costs, risk minimisation and a likely decline in production optima with time (Gardener *et al.* 1990) were also included then it is likely that more conservative stocking policies may have been adopted in Australia. Hutchinson (1992) summarised our current situation, suggesting that a continuous grazing policy to maximise short-term animal production has led to a system that excels at low cost efficient management of ruminants, but neglects the regenerative needs of grazed plants, which are often grazed year-long, even under climatic stress.

The concentration of grazing issues on production rather than sustainability and the fact that the free market undervalues land and water resources, tends to encourage their over-use. Scott *et al.* (1992) proposed that farm management decisions are based on firstly, financial criteria, then technical issues related to cropping and livestock enterprises, then pasture resources, and finally soil resources. This sequencing of priorities means that decisions are often made in favour of short-term financial profit without adequate regard for the degradative processes related to farm physical/chemical/biological resources. A recent survey of producers (Lees and Reeves 1995) in the temperate pasture zones of NSW, Victoria, Tasmania and South Australia reflected this view, with farmers indicating that stock water supplies, animal health and stocking rate were the most important factors in achieving a successful grazing enterprise. Grazing management ranked fourteenth out of a list of sixteen factors, only slightly ahead of stock and paddock records.

What is unclear is the extent to which continuous grazing or set stocking has been used in Australia and its exact role in land degradation. High drought frequency should lead to conservative stocking levels, but anecdotal evidence indicates that continuous grazing was the preferred form of grazing management into the 1970s in many areas and is still widely practised in annual zones (Doyle *et al.* 1993). In Queensland, continuous grazing of native pastures with occasional strategic rests, using not more than 30% of the herbage available is widely recommended (Roberts 1993). Producers indicated that the most common systems of year-round grazing management (Lees and Reeve 1995) in temperate pasture areas were strategic grazing (40%), set stocking (21%) and rotational grazing (21%). Strategic grazing involved no fixed plan in the way stock were spread over a property or moved from one paddock to another. Stock were moved when feed shortages occurred in a particular paddock. These results vary from those of Garden *et al.* (1993) who reported that most producers continuously grazed native pastures on the Central and Southern Tablelands of NSW.

Carrying capacity and stocking rate

Carrying capacity is the inherent productivity of land and is influenced by climate, soil type, topography, aspect, tree cover, pasture composition (or its successional level) and the management imposed, including choice of enterprises. Stocking rate is the number of animals on a unit of land and is a management decision. When stocking rate exceeds carrying capacity a property is overstocked and over time this may lead to pasture deterioration if species are not resilient (Wilson 1986).

When deciding whether or not to implement a grazing management strategy to increase long-term animal production, it is essential to know where current stocking rate is in relation to the carrying capacity of a pasture. If stocking rate is below carrying capacity, animal production is sub-optimal, and there is likely to be little advantage in implementing a grazing management system, solely to increase short-term animal production. However, at stocking rates below carrying capacity, rotational systems may have an advantage for livestock production, if subdivision to reduce paddock size results in an improvement in water supply and utilisation. Before implementation, the economics of such systems should be carefully considered and there would need to be management goals other than short-term animal production. When stocking rate exceeds carrying capacity it is essential to know if a pasture will be stable in production and persistence, since a grazing management system will only be required if pasture deterioration is likely to occur at unsustainably higher stocking rates (Wilson 1986).

Land degradation

It has been widely recognised (*e.g.* Hutchinson 1992; Kemp 1994) that in extensive sheep and cattle enterprises farmers have developed good skills for animal management, but generally have poor pasture and soil management skills. Unfortunately, animals are the least sensitive and last indicator in the soil-plant-animal continuum to signal that a system is not resilient and is becoming unsustainable. This animocentric approach (Kemp 1994) has meant that since we do not understand the plant and soil processes, land degradation occurs well before animal production declines.

Over 70% of NSW has been adversely affected by soil erosion, salinisation and woody weed invasion (Reed 1990). A consequence of land degradation is pasture decline and Wheeler (1986) reported a 47% reduction in carrying capacity of grazing lands from 1970 to 1984. A producer survey (Lees and Reeve 1995) found that 35% of graziers thought declining pasture quality was a problem in their region and 55% indicated pasture quality had declined on their property. When resowing to overcome this decline most producers expected their stands to last 10 years, but 44% expected to have to resow within five years. Clearly, since it takes 5-8 years to repay the cost of pasture establishment (Vere *et al.* 1993) many sown pastures are not providing their expected economic return.

In a survey of land degradation (Hall and Hyberg 1991), 37% of farmers reported a problem or potential problems with land degradation. From this survey, farmers estimated that land degradation in temperate grazing lands resulted in an average gross revenue loss of $10,000 /farm/year. In some areas this may be an underestimate. In northern NSW, for example, Lang (1979) found that if ground cover in overgrazed pastures on sloping grazing country was below 40%, up to 100 tonnes per hectare of topsoil could be lost in a year (1 mm of topsoil over a hectare equals 10 tonnes).

To overcome problems of land degradation as a result of grazing practices in South Africa and the United States, Savory (1988) proposed a philosophy of Holistic Resource Management (HRM). This is a decision making process based on the concept that the world is a diverse series of "wholes". By defining a whole in terms of the people, resource base and sources of money a goal can be set for the whole. Such a goal is a single goal expressed in three parts; quality of life values; forms of production that are necessary to attain the quality of life values, and a description of how the resource base should look in 100 years or more. Decisions affecting the whole are then tested against the goal using seven testing questions to ensure that the final result is economically, socially and ecologically sound. Importantly, it is assumed that any decision is wrong and a feed back loop is implemented to assess the effects of the decision. HRM also recognises four "Ecosystem Foundation Blocks" that can be used to manipulate ecosystems; succession, the water cycle, the mineral cycle and energy flow. While some may argue about the terminology and a view of succession based on outdated Clemensian theory (*e.g.* Michalk and Kemp 1993), few would disagree that these are important considerations for any grazing management method that has as its goal long-term sustainability. However, dynamic botanical change, soil structural decline and the cycling of nutrients are general ecological principles, important to sustaining all productive grazing systems and as such they have no particular affinity to any one method (Hutchinson 1993).

Planning: The key to successful grazing management

Pasture management was defined by Whalley (1980) as the manipulation of the species composition of a pasture to obtain and maintain a desirable species composition consistent with the overall management objectives for a particular pasture.

This statement encompasses many of the elements that are required for a successful grazing system in that:

- it implies that there is a willingness on the part of the land manager to undertake grazing management
- there is an overall management goal and a species composition goal
- there is potential to change or maintain species composition by management
- the knowledge exists on how to manipulate the species to move composition in a desired direction, and
- the land manager has the necessary skills to implement the management program, monitor its performance, and if required to make adjustments.

Willingness to undertake grazing management

The high proportion of graziers practising some form of strategic grazing (Lees and Reeve 1995), and a willingness by more than 70% of producers to vary grazing pressure on selected paddocks, in all seasons except winter (Lees and Reeve 1995), is encouraging. Over 80% of producers were receptive to the idea that grazing management could be used to obtain a desirable species composition. However, grazing management as a pasture management problem that needed research, rated lowly and well behind high-priority problems of poor species persistence and weed control, which farmers apparently did not associate with grazing method.

How to get farmers to adopt a grazing management system remains a problem, even in well researched areas. Rotational grazing of lucerne has long been recommended (*e.g.* Moore *et al.* 1946), for example, but it is widely known that this technology has a low rate of adoption. Reasons for this lack of adoption are the additional costs associated with fencing and water supply; the conflict between small paddocks for grazing and large paddocks for cropping; the significant contribution lucerne can have under continuous grazing at low stocking rate; the unwillingness of producers to undertake additional management, and their lack of conviction of the benefits of intensively managed lucerne (Lodge 1991). While approaches such as the pasture management envelope (Kemp and Dowling 1991) may have some merit in decision making when *implementing* a system, it would appear that economic returns that result from either improving the composition of a degraded pasture or maintaining a desirable composition are likely to lead to a system that is readily *adopted*. Information on these benefits should be available before producers undertake any system, so that they can make informed decisions. Clearly, demonstrable and achievable financial benefits of increased stocking rates and substantially higher returns from wool and meat products that occurred as a result of reducing wiregrass were major factors in the widespread adoption of a grazing management system for its control (McCormick *et al.* 1988). After five years the adoption rate was surveyed at 53% of producers in the target area (Lodge *et al.* 1991).

Is species change or maintenance likely?

In general, grazing management systems with periods of rest and grazing favour perennials, while continuous grazing favours annuals (Wilson 1986). Hence, grazing management of perennial pastures that have a range of species in terms of desirability and palatability are the most likely to succeed. Manipulation of the composition to favour particular species must offer measurable advantages in terms of improved palatability, growth of green forage, pasture quality or persistence. Again any improvement in these factors should be able to be quantified before implementing a strategy.

The likelihood of grazing management producing either species change or maintaining desirable species, depends on their responses to either increased stocking rate or resting from grazing. Advantage will occur if grazing and rest periods are timed to coincide with critical times in plant growth cycles such as active growth, flowering and seed production and seedling establishment, rather than being random or calendar based events.

Species composition is only stable when conditions that suit that particular species assemblage can be created or maintained. To maintain a desirable species composition these conditions need to be maintained within the bounds of the current equilibrium. To change species composition, however, the pasture ecosystem needs to be disrupted, upsetting the equilibrium and moving it out of its bounds so that it temporarily becomes unstable in the transition stage, and altering conditions to favour or discourage particular species.

If current stocking rates are less than carrying capacity then it is likely that any grazing management system that includes subdivision will allow stocking rate to be increased to the level of carrying capacity, by increasing utilisation without changing species composition. This occurs because the boundaries of the equilibrium conditions for the present species composition have not been exceeded. This situation commonly occurs in many native pastures where producers often have a deliberate policy of understocking.

Is there sufficient species specific knowledge?

Unfortunately, the answer to this question is no. For most of the major pasture species in Australia, there is insufficient information on the interaction of seasons of grazing or rest and plant growth stage and environment specific flowering and seedling emergence times to be able to predictably manipulate species composition. Examples of grazing management systems based on the collection of detailed autecological and phenological information are rare, but when implemented they have successfully changed species composition in a desired direction (*e.g.* Suijendorp 1969; Lodge 1983; Lodge and Whalley 1985).

In temperate pasture areas, the Meat Research Corporation Temperate Pasture Sustainability Key Program is collecting information that will allow grazing management systems to be designed to maintain or improve pasture species composition. In the first phase of this project, seasonal plant growth, flowering and seedling emergence and bud bank data are being collected under a range of grazing and resting strategies at twenty two sites in NSW, Victoria, South Australia and Tasmania. The main species being studied are phalaris, fescue, perennial ryegrass and cocksfoot as well as native pastures at sites in Tasmania and near Canberra, Orange and Manilla. While the study is concentrating on the perennial grass component of the pasture, information is also being collected on subterranean and white clover. The information arising from these and other studies (e.g. Culvenor 1994) may allow the development of strategic grazing management systems for a wider range of pastures in the near future.

Skill levels

Implied in the statement of Whalley (1980) is that producer's also need to have skills to make objective assessments about:

- pasture quantity,
- pasture quality,
- ground cover and litter,
- species identification and abundance,

The producer must also have the ability to put into place monitoring procedures to indicate if the system is moving in the right direction or is in a stable condition, and if not how to correct it. On the basis of this information a manager has to decide how many animals to graze, the type of stock, how long to graze for, when animals should be removed from a paddock, how long to rest, and which paddock animals should be moved to. An important component of any grazing strategy will be its ability to cope with rainfall variation, particularly in more arid environments (Wilson and Simpson 1993) where large year-to-year differences can mask smaller, but important changes in composition induced by management.

Pasture assessment skills imparted to graziers by courses such as PROGRAZE, and guides such as GRASS Check (QDPI) and private consultants will do much toward improving the ability of graziers to better understand pasture-animal relationships and so successfully undertake grazing management.

Grazing management in practice

General guidelines for seasonal (*e.g.* Kemp 1993; Hutchinson 1993) and species specific grazing management (*e.g.* Beattie 1993; Kemp 1994) have been proposed, but these often lack sufficient details on stocking rates and the length of graze and rest periods for their immediate implementation.

To date few grazing management systems have been widely adopted and implemented by producers in Australia. Examples of such systems include strategies to decrease the undesirable native perennial grass *Aristida ramosa* (wiregrass) and increase the desirable wallaby grasses (Lodge and Whalley 1985) in NSW and the Waite-Nicolson method of grazing to maintain chenopods in the rangelands of South Australia (Lange *et al.* 1984).

Time control grazing has been adopted by a few producers (McCosker 1994), but has generated considerable debate about its advantages and disadvantages (*e.g.* McCosker 1993, 1994; Hacker 1993; Jones 1993; Roberts 1993; Hutchinson 1993) and its application to Australian conditions. Central watering points and electric fencing are relatively cheap and effective methods of paddock subdivision. Large numbers of small paddocks and planned livestock movements provide opportunities for farmers to better assess feed availability and quality and adjust stocking rate. Additionally, except at low stocking rates any grazing method that includes a rest period will be of more beneficial than continuous grazing.

Direct comparisons between time control grazing and other grazing systems are often invalid for two reasons. Firstly, by most definitions time control grazing is not a grazing system. It is a grazing method developed to attempt to cater for the needs of plants, animals and soils, so that all develop simultaneously to achieve maximum productivity. Time control grazing does not have a species composition goal and has broader objectives than most grazing management systems. Secondly, time control grazing is a totally integrated management package, of which the use of cells for grazing is one component, and improved practices for livestock management, farm planning, decision making and finances are implemented at the same time as the grazing method. Often it is difficult to separate any benefits of the grazing method from those arising from improvements in other critical areas of management. However, some of the principles of time control grazing are contentious, specifically; the use of plant growth rate to determine the time of grazing and length of rest periods; doubts over claims to be able to double carrying capacity; a lack of emphasis on legume management, which in many pastures is essential for productive and persistent grasses; the role of the herd effect; and a lack of hard data to indicate that time control grazing has any effect on species succession, water or mineral cycling. Many of these issues have been dealt with by others, but further comment is warranted on the use of plant growth stage and reported increases in carrying capacity.

A pasture may contain over 100 different species, but is usually dominated by up to 12 species often with different growth habits, plant physiology, growth rates, palatability and responses to grazing The interaction of these factors with a variable climate, makes logistic growth, as a practical tool for maintaining a pasture in the productive phase 2 stage, an imprecise measure of pasture status that would be difficult to apply without favouring some species to the detriment of others. Application of any discriminatory management strategy that has no relationship to achieving a desirable species composition is likely to lead, at best to little improvement in botanical composition, or at worst, undirected change. This appears to have been acknowledged by McCosker (Grazing For Profit Field Day, Somerton 1994) who indicated that if time control grazing was applied in the wrong way, the results could be worse than continuous grazing.

Studies of short duration grazing (Gammon 1984) or rotation resting systems (Bryant *et al.* 1989) indicated that stocking rate increases of 10-30% could be expected compared with less intensive systems. McCosker (1994) indicated two examples where stocking rate was doubled on properties using time control grazing over a 13 year period in Namibia and 8 years in New Mexico. This suggests that any of the direct and indirect benefits of these techniques to animal production are long-term. Data (McCosker 1994; Randall *et al.* 1995) indicated that stocking rate increases do not occur in the short term with time control grazing. Increased stocking rate may result from the benefits of subdivision, water supply, strategic supplementary feeding, increased utilisation, favourable seasons or the grazing method. However, because of the holistic nature of time control grazing it is difficult to separate these effects from improved livestock, pasture and financial management skills. What is not clear is if other grazing management systems would have had a similar result if equal resources had been applied. Unfortunately, there are also few examples of time control grazing in which detailed botanical composition records have been reported, and the carrying capacity of the land is known. This information would assist greatly in interpreting any increases in stocking rate. In the case of Randall *et al.* (1995), for example, there was no change in botanical composition and so little increase in stocking rate may have been expected. With some supplementation, stocking rate, however, was approximately equal to the carrying capacity of this type of country (about 5 dry sheep equivalents per hectare for natural pastures in the region, Lodge and Roberts 1979; Lodge 1983) which is the first principle of time control grazing. If, however, stocking rate was higher than carrying capacity would it be maintainable in the long term?

Rules for grazing managers

Given the conflicting views on the likelihood of success of implementing different grazing management methods, it is probably time to re-examine the relevance of the grazing management principles proposed by Wilson (1986). These principles together with some elements of other grazing management methods form the basis for a set of rules that should be applied to every grazing situation to assess the validity of using grazing management to manipulate species composition and improve long-term animal production.

These rules are:

(1) establish a goal of a desirable pasture composition in terms of species.

(2) sustainable long-term gains in animal production will only occur if there is a change in pasture composition or quality. Grazing management should not have as its *sole* aim an increase in short-term animal production.

(3) for manipulating species composition grazing management systems on perennial based pastures, with a diversity of desirable and undesirable species, responses to grazing and palatability, have the best chance of success.

(4) in favouring a species, the critical part of a management system is the length and timing of the rest period. The more the rest period can be timed to coincide with active plant growth, flowering and seedling establishment and bud bank replenishment the better.

(5) for animal performance the length of the graze period is important. For species manipulation the timing of the graze period is critical.

(6) know where current stocking rate is in relation to carrying capacity. Only implement a grazing management system in non-resilient pastures where stocking rate is such that the pasture would otherwise deteriorate.

(7) find out what knowledge exists to manipulate a pasture species in a desired direction. If there is no species specific information, can general principles or observational information be applied?

(8) acquire the pasture assessment skills needed for the day-to-day decision making process as well as the monitoring process.

(9) establish an objective monitoring system to see if the species goal is being achieved, by measuring trends over time. If the required result is not being achieved, be prepared to make further decisions.

(10) remember that you are dealing with a complex ecosystem and that plants and soil are major factors in sustaining the pasture community as a productive grazing system.

In the final analysis however, the success of any grazing management program depends largely on the extent to which the temporal pattern of grazing matches the physiological and ecological requirements for pasture regeneration and maintenance (Hacker 1993).

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