GRAZING MANAGEMENT: SOME KEY ISSUES

A BRIEF EVALUATION OF TIME CONTROL GRAZING

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Abstract: This paper sets out briefly the theoretical basis of time control grazing and evaluates its fundamental principles in terms of available research evidence and current models of rangeland vegetation dynamics. The supposed importance of animal impact is questionable in Australia based on both theoretical considerations and (mostly overseas) research evidence. The need for rapid movement of animals to prevent repeated defoliation is also questionable. Claims that substantial short-term increases in stocking rate can be achieved are considered exaggerated although modest increases (10-30%) over moderate continuous stocking rates may be sustainable. A reduction in per head productivity could generally be expected unless offset by benefits resulting from altered paddock design. Stock densities considered necessary for time control grazing indicate that the method would be impractical in the Western Division. Any benefit of high stock density should most readily accrue to cattle operations on native pastures on the slopes and plains. Despite reservations, pastoralists practising time control grazing may improve pasture production and composition compared with set stocking. However the results are unpredictable. Management which is based on the ecology of the major pasture species is more likely to achieve management objectives but the research base for development of such approaches is limited.

INTRODUCTION

The introduction of the "time control" or "cell grazing" concept to Australia has stimulated widespread interest among graziers and agency staff alike. This interest has resulted from an increased awareness on the part of many producers of the need for more sustainable pasture management, the limited ability of government agencies to provide well-researched recommendations in this area, and the claimed benefits of an approach which appears to be both scientifically based and supported by considerable practical experience. As a result the Australian pasture scene in the early 1990's is experiencing the same stimulus, and the same controversy, which irrupted following the introduction of the concept to the United States in the late 1970's.

The new management philosophy currently being promoted, however, is not merely time control grazing but "Holistic Resource Management" (HRM) (Savory, 1988). This philosophy stresses the management of all aspects of the production system, including human, biological and financial resources, in order to achieve a producer-defined goal. The goal itself comprises a "quality of life" statement, a desired "form of production", and a "landscape description" which is consistent with what might be termed sustainability. Given the current emphasis on Ecologically Sustainable Development in Australia there is no doubt that such an integrated approach would be universally endorsed regardless of the grazing management involved. What remains distinctive about the HRM model, however, is the particular form of grazing management advocated, and it is thus reasonable to consider this in isolation despite the objection of some proponents that to do so is to unfairly consider only part of the system.

PRINCIPLES AND PRACTICE

The Basic Components

As described by Savory (1988), HRM seeks to achieve its biological or landscape goals by manipulating four basic "Ecosystem Foundation Blocks" viz. succession ("the process of change and development in communities of living organisms"), the water cycle, the mineral cycle and energy flow (the carbon cycle). Grazing management aims to achieve the desired successional state, in terms of the abundance and composition of forage, and maintain that state, through promotion and/or maintenance of an "effective" water cycle and a "good" mineral cycle, while simultaneously maximising the flow of energy through the system which can be harvested as animal products.

An "effective" water cycle results in the maximum amount of incident rainfall available for plant growth and ground water recharge while "a good mineral cycle implies a biologically active, *living* soil" which is well aerated and able to sustain an abundance of organisms. Energy flow, or the efficiency with which sunlight can be "captured and put to use", is considered to depend primarily on the "time (duration) of growth", the "volume" of plants present (actually density, or plants per unit area, as defined by Savory) and the "area of leaf" available for photosynthesis. These factors can be manipulated directly to some extent eg by adjusting the degree of defoliation during any grazing period, but energy flow is largely maximised as a consequence of management which achieves the correct successional state, and healthy water and mineral cycles.

Fundamental principles

In addition to this basic understanding the HRM model, and the grazing management which it implies, depends on three basic principles which relate to ecosystem function.

The first is that all ecosystems can be ranked along a "brittleness" gradient according to the way in which certain ecological processes are assumed to operate. "Brittleness" is related to the distribution of rainfall and humidity throughout the year. Brittle environments experience frequent periods of severe water stress eg breaks in the growing season or long dry seasons, even though the annual rainfall total may be high. Under such conditions the decay of old plant material is considered to occur slowly, through chemical and physical processes rather than the rapid biological processes which characterise "non-brittle" environments. Succession, and response to animal impact, are considered to differ fundamentally between these two extreme conditions, with important implications for grazing management. Where any landscape lies on the brittleness gradient may be assessed most readily by considering the dominant processes involved in plant decay.

The second concerns the role of herding animals and their predators in brittle environments. The trampling of large herds of wild herbivores, particularly when disturbed by predators, is considered essential to ecosystem function in environments in which nutrient cycling and succession are slowed by limited water availability. Laying of old growth, incorporation of litter, dunging and urination, and the breaking of capped soil surfaces to provide opportunities for seedling establishment are major benefits which are considered to result from animal impact.

Finally, the model emphasizes the importance of timing, or duration of grazing, rather than animal numbers, in determining impact on individual plants and communities. Of fundamental importance is the view that individual plants should not be regrazed until recovery has occurred so that grazing and rest periods must be adjusted to ensure that grazing of regrowth is avoided.

Practical implications

The HRM model uses this understanding of grazing systems to achieve its goals by judicious application of certain "tools". Those which relate specifically to grazing management include rest, fire, grazing, and animal impact. These are applied with the aid of certain "management guidelines" of which the ones most directly related to grazing management are time, stock density, herd effect, burning, flexibility, and biological planning and monitoring.

In practice, the grazing management "method" which results from this model is characterised by multiple paddocks (15 per cell is considered to be the minimum desirable), usually a single herd or flock in each cell, and grazing and rest periods which are related to the growth rate of the pasture and are intended to ensure that animals leave a paddock before any grazing of regrowth is possible, and do not return before recovery is complete. The time required to achieve recovery, and the number of paddocks, are the fundamental factors influencing grazing periods which may be as short as 1 day, though more commonly 3-5 days, or as long as 10-14 days. Recovery periods vary from around 30-100 days, the shorter periods occurring at times of rapid pasture growth. Multiple paddocks ensure high stock densities during grazing periods which are argued to result in more uniform distribution of grazing, dung and urine and also facilitate application of the "herd effect" where this is required to induce successional change in brittle environments. Application of herd effect actually requires that animals be stimulated by some form of training or by provision of an attractant (*eg.* hay or supplement) that will induce excited behaviour for a short period. It is also enhanced by the presence of large numbers of animals, quite apart from high density, and this is ensured by the amalgamation of herds or flocks which the establishment of cells usually entails. The short grazing periods, which multiple paddocks allow, are also claimed to improve animal performance

Finally, time control grazing involves regular assessment of forage availability and planning of animal movements, the flexibility to entirely replan the operation should conditions change dramatically, and ongoing monitoring aimed at determining progress towards the goal.

The ecological benefits are considered so great that substantial short term stocking rate increases are frequently claimed to be possible.

AN ASSESSMENT

Some aspects of the practical scheme outlined above are worthy of consideration in any grazing management program, or are supported by research findings. However, not all aspects of the method are so supported, or sit easily with our current understanding of Australian ecosystems. It must be emphasized, however, that no Australian studies of time control grazing have yet been published, and that overseas research relates mainly to rangelands grazed by cattle. A rangelands bias is thus inevitable in the following assessment.

Establishment of a resource management (or landscape) goal and monitoring of progress towards it

This is certainly a beneficial component of the time control grazing concept and one that should be part of any management program. Without goals management of any form is really impossible. Much of the skill required of managers in future will be in determining appropriate (long-term) pasture management goals, and in balancing these with both short and long term economic goals. A major challenge for agencies will be to provide effective support in both these areas.

Fodder budgeting and flexible stocking rates.

This aspect of time control grazing, especially if combined with an enterprise mix which allows ready adjustment of forage demand to forage supply (*eg.* inclusion of wethers) is a potentially powerful management tool. A concern, however, is that the subjective procedure used for assessing forage availability, in terms of animal unit days per hectare, seems to take no account of the short term impact of grazing on important pasture species (eg the level of utilisation which has been achieved). Unless short term forage availability estimates are modified by such considerations no adjustment to stock numbers may occur until monitoring reveals that the resource management goal is not being achieved. Important opportunities to promote favourable pasture changes may by this time have been missed.

Non-continuous grazing

Although some sustainable management systems based on continuous grazing have been demonstrated (*eg.* Lange *et al.*. 1984) this form of management is usually regarded as detrimental to long run pasture production and/or composition unless stocking rate is low. While no significant difference in pasture response between continuous and rotational grazing systems has been found in a substantial minority of trials (*eg.* Currie 1976) those which have revealed differences have mostly favoured rotation. Only rarely has pasture response under continuous grazing been found superior (*eg.* Fisher and Marion, 1951). The provision for pasture resting in time control grazing should thus be advantageous but, as will be discussed further below, its benefits may be limited by the lack of attention to individual species or to the particular changes required by the landscape goal. Furthermore the need for rapid movement to avoid repeated defoliation may be overstated as Gammon and Roberts (1978) found little difference in frequency of defoliation of individual tillers between continuously and rotationally grazed swards.

Intensive subdivision

The intensive subdivision advocated by proponents of time control grazing is argued to serve two purposes *viz.* a reduction in grazing period for any given rest period, and an increase in stock density leading to better animal impact. Intensive subdivision theoretically makes no difference to the post-grazing recovery period since in time control grazing this is determined by the seasonal growth rate. Nevertheless the proportion of time spent resting in any cycle will change little once paddock numbers exceed about 6-8.

Short grazing periods. Short grazing periods allow rapid movement of animals, supposedly ensuring that regrowth is not grazed before animals leave the paddock. As indicated above, however, the need for this is questionable.

Short grazing periods also allow animals greater selectivity and may improve diet quality. Improved animal production per head with shorter grazing periods in single herd, rotational grazing systems has been demonstrated by Denny and Barnes (1977). Conversely, poor animal performance under "high intensity, low frequency" grazing systems in the US may be attributed to low diet quality associated with long grazing periods (Taylor *et al.*, 1980; Bryant *et al.*, 1989). However, while short grazing periods may be beneficial in rotational systems, animal production per head is generally highest under continuous grazing. The majority of experiments which have demonstrated differences in animal production between rotational and continuous grazing systems have favoured the latter (Pieper, 1980). Reduced production per head under time control grazing could be expected (Bryant *et al.*, 1989) unless compensated by benefits resulting from changes in paddock design (see below).

Stock density and animal impact. The benefits of high stock density in terms of soil physical properties, seedling estalishment and nutrient cycling remain amongst the most contentious claims of time control grazing.

Generally, US research in semi-arid rangelands indicates adverse rather than beneficial effects of heavy trampling under short duration grazing on infiltration rate, sediment yield and soil compaction (Weltz *et al.*, 1989; Wood and Blackburn, 1984; Thurlow *et al.*, 1986; Phular *et al.*, 1987). Although heavy trampling can improve seed burial, high percentages of seeds may be buried too deep for seedling emergence (Winkel *et al.*, 1991). Reported impact of trampling on seedling establishment has ranged from severely adverse (Salihi and Norton, 1987), to neglegible (Bryant *et al.*, 1989), to beneficial in moderate rainfall years but with little benefit in wet or dry years depending on species and soil (Winkel and Roundy, 1991). Eckert *et al.* (1986) demonstrated that heavy trampling of big sagebrush communities in Nevada could favour undesirable botanical change, although their study did not relate specifically to time control grazing. Of the *Atriplex* seedling cohorts studied by Eldridge *et al.* (1991) near Broken Hill, only 5 per cent occurred in the "depression" microsite, commonly formed by hooves of sheep or cattle.

Direct research on the "herd effect" does not appear to have been reported. Savory (1988) emphasises that the benefits of this component of animal impact are not achieved simply through high stock density since unexcited animals do not disturb the soil surface in a manner comparable to an excited herd. Some anecdotal evidence does indicate the benefit of hoof action in reclaiming degraded areas (*eg.* scalds). However such effects can be produced under any management system, albeit perhaps with more difficulty than when animals are run at the high densities required by time control grazing.

The alleged role of animals in nutrient cycling in "brittle" environments warrants particular comment. Unlike African and American rangelands, Australian ecosystems were not grazed by large hooved animals prior to the introduction of domestic stock. Most plant production would have been consumed by detritivores rather than herbivores, although little is known of this consumption pathway apart from the importance of termites in arid rangelands (Stafford-Smith and Morton, 1990). Since nutrient cycling was not dependent on large grazing herds this justification for animal impact, and high stock densities, is not present in the Australian scene. It is notable that at the same time as promoters of time control grazing are emphasising the supposed benefits of animal impact others are arguing the benefits of removing stock from our rangelands in favour of soft-footed native species which are claimed to be less damaging to soil surfaces (Grigg, 1987; 1988).

Reduced paddock size/distance to water. Where subdivision results in reduced paddock size and reduced distance to water, both uniformity of grazing and live weight gain may be increased (Hart *et al.*, 1993). Improved animal performance, in this case of cows and calves, was associated with reduced distance travelled. However, similar benefits were achieved under continuous grazing and resulted from paddock size and design rather than grazing system. More uniform distribution of dung and urine associated with itensive subdivision could also be expected, but no research data are apparently available.

An increase in spatial uniformity, however, is not necessarily associated with improved uniformity of grazing among species. Unpalatable species may remain ungrazed despite high stock density, particularly during the growing season when grazing periods are short.

Succession

The concept of succession inherent in the HRM model is today subject to substantial challenge. Rangeland pasture composition is generally no longer regarded as representing an equilibrium between the natural tendency of a site to reach some climax or stable vegetation type and the counteracting grazing pressure applied. Under this classical or so-called Clementsian view, pastures can progressively change in composition, as grazing pressure is varied, from "early seral" communities of annuals to climax or stable communities of perennials or even trees. While this model often does seem to work reasonably well in humid areas it is frequently inadequate in semi-arid and arid zones. Here the composition of vegetation is frequently determined by the outcome of occasional major events eg drought, high rainfall or fire (Griffin and Friedel, 1985).

Pastures can thus exist in a number of alternative states which may be stable for relatively long periods. Transition between these states requires specific conditions and is not necessarily mediated by grazing alone (Westoby, 1980; Westoby *et al.*, 1989). Under these circumstances pasture management requires a detailed understanding of community ecology and exploitation of "windows of opportunity" to promote desirable changes in pasture abundance and composition, or inhibit undesirable ones. In the absence of such directed management the results of any grazing regime are unpredictable.

Even in higher rainfall environments where seasonal growth cycles are more predictable desired pasture changes must be considered more likely when management is directly related to the ecology of the species involved (Lodge and Whalley, 1985) than when "succession" is simply allowed to take its course as a consequence of improved water relations or soil conditions. The resulting lack of predictability has long been recognised in relation to the rotational grazing systems practiced in South Africa (Booysen, 1969), from which time control grazing is an evolutionary development.

Stocking rate

Claims are frequently made that stocking rates can be substantially increased under time control grazing. Such claims can be extremely misleading and need careful scrutiny. Increases in stocking rate may be feasible if the intensive subdivision involved results in more uniform utilisation of pasture (cf. Hart *et al.*, 1993). Such increases, however, result from paddock design rather than grazing system. In the US claims were commonly made that HRM would allow doubling of the stocking rate recommended by the Soil Conservation Service. However, as in Australia, many producers probably were already stocked at levels well in excess of those recommended by extension agencies.

Other things being equal, some increase in stocking rate is probably feasible under the more intensive management involved in time control grazing. However for Zimbabwe, Gammon (1984) suggested that increases should not exceed 30 %, under average rainfall conditions, compared with less intensive systems. For semi-arid parts of the US Bryant *et al.* (1989) and White *et al.* (1991) indicate that stocking rates compatible with maintenance of range condition could be 10-20 % higher under short duration grazing compared with continuous grazing.

No comparable research has been reported in Australia. However preliminary observations on short duration grazing in the East Kimberley region of Western Australia (Hacker, unpublished data) suggest that compared with continuous grazing the system could reduce the impact of patch grazing on sensitive parts of the landscape but that no marked increase in stocking rate could be sustained.

The fundamental principle of HRM, that time rather than animal numbers determines the impact of grazing on plants, is at variance with the vast weight

Table 1: Estimated minimum stock densities (animals/ha) required for time control grazing (Source: Cell Grazing Seminar. Hassall & Associates Pty Ltd and T.McCosker, Dubbo, February, 1992)

	Sand				Clay			
	Cattle		Sheep		Cattle		Sheep	
	LGP	SGP	LGP	SGP	LGP	SGP	LGP	SGP
Animal impact + even utilisation	5	10	30	60	5	10	30	60
Animal impact only	2	5	5	10	5	10	10	20

Notes: LGP = long graze period = 10-14 days; SGP = short graze period = 3-5 days.

of research evidence which identifies stocking rate as the overwhelmingly important factor in any grazing system (Bryant *et al.*, 1989; O'Reagain and Turner, 1992). While discontinuous grazing is accepted as beneficial, any grazing system will eventually break down if stock numbers are excessive.

APPLICATION

Regardless of any theoretical deficiencies of the HRM model practical advantages may result from the application of time control grazing, and establishment of the associated infrastructure. Ease of mustering may be improved, and labour requirements reduced, due to the formation of large mobs which quickly learn to move in response to signals. Animal husbandry may also be improved by the frequent inspections which regular movement permits. Animal health could be improved if rest periods are long enough to break the life cycle of internal parasites.

On the other hand fewer mobs run at higher densities could increase mismothering in lambing ewes, exceed the capacity of available yard or watering facilities, reduce the opportunity for special treatment of some classes of animals, and increase the risk of contagious diseases or transmission of internal and external parasites. Wild dog attacks may also be more devastating if stock are concentrated in large mobs.

Apart from these somewhat peripheral issues the major difficulty in determining the likely success of the method lies in assessing the importance of animal impact for pasture regeneration and maintenance, and the extent to which management which is not related to specific species is likely to achieve desirable changes in pasture production and composition.

Table 2: Number of paddocks per cell required to achieve minimum recommended stock densities for animal impact and even utilisation (Figure apply to both sand and clay).

Stocking rate DSE/ha	Cattle		Sheep	
	LGP	SGP	LGP	SGP
0.2	200	400	150	300
0.4	100	200	75	150
0.7	58	115	43	86
1	40	80	30	60
3	14	27	10	20
5	8	16	6	12
10	4	8	3	6
15	3	6	2	4

Notes: 1 animal = 1 DSE or 1 LSU; 1 LSU = 8 DSE; LGP = long graze period ; SGP = short graze period.

Table 3: Number of paddocks per cell required to achieve minimum recommended stock densities for animal impact only.

	Sand				Clay			
Stocking rate	Cattle		Sheep		Cattle		Sheep	
(DSE/ha)	LGP	SGP	LGP	SGP	LGP	SGP	LGP	SGP
0.2	80	200	25	50	200	400	50	100
0.4	40	100	13	25	100	200	25	50
0.7	23	58	8	15	58	115	15	29
1	16	40	5	10	40	80	10	20
3	6	14	2	4	14	27	4	7
5	4	8	1	2	8	16	2	4
10	2	4	1	2	4	8	1	2
15	2	3	1	1	3	6	1	2

Notes: 1 animal = 1 DSE or 1 LSU; 1 LSU = 8 DSE; LGP = long graze period ; SGP = short graze period.

As already noted, herbivores were probably not dominant in nutrient cycling in Australian ecosystems prior to European settlement. Nevertheless assuming animal impact does confer other benefits, despite the generally contrary research evidence, it is instructive to look at the implications of the minimum stock densities considered necessary to achieve it in order to assess the conditions under which time control grazing may be beneficial. Minimum stock densities recommended for animal impact alone, and for animal impact combined with uniform pasture utilisation, are given in Table 1. Tables 2 and 3 indicate the number of paddocks required to produce these stock densities over a range of stocking rates.

At stocking rates below 1 DSE/ha the minimum number of paddocks required, even for animal impact only, is generally large, particularly for cattle. The amount of development required would thus seem to limit application of the approach throughout virtually all of the Western Division. Above 1 DSE/ha the minimum stock densities, for animal impact only, can be achieved with relatively low paddock numbers except for cattle on clay soils at the lower stocking rates. Further subdivision would probably be required, in many instances, to allow grazing times to be reduced. At high stocking rates, particularly with sheep, little if any benefit could be expected from intensive subdivision and amalgamation of mobs, at least in terms of animal impact, although paddock size may still influence uniformity of grazing. If animal impact is indeed an important component of pasture management the benefits of time control grazing are most likely to accrue to cattle operations on unimproved native pasture under lower rainfall conditions.

It could be argued that the pasture resting inherent in time control grazing may produce beneficial results in a wide range of environments regardless of the importance of animal impact. 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 or maintenance. Any approach which satisfies these requirements only by chance cannot hope to be universally successful. Both rigid rotational systems and time control grazing will sometimes fail in this respect, particularly under low and variable rainfall conditions, since management is not aimed at satisfying the requirements of particular species.

Opportunistic or tactical approaches, which alter stock numbers and distribution among paddocks based on an understanding of species requirements, should be better able to achieve pasture management objectives. Unfortunately the knowledge available to formulate such methods is far from adequate, and their application on a whole property basis may require more skill than formal rotational systems or even time control grazing. It is indeed ironic that such concepts are now being advocated by some scientists in South Africa (O'Reagain and Turner, 1992) at the very time when the most elaborate development of an earlier African grazing philosophy is being advocated in Australia.

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