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# PRINCIPLES OF SUSTAINABLE GRAZING MANAGEMENT FOR THE NORTHERN SAVANNAS

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## ABSTRACT

An urgent need exists for the development of principles for the sustainable management of the savannas of northern Australia. Based on current and recent research we propose five principles for the sustainable grazing management of these systems. These are (i) *conservative use* of the grass layer with utilisation levels of 15-25 % of annual pasture growth (ii) *even utilisation* of pasture at the paddock scale to prevent localised overgrazing (iii) regular *wet season spelling* to maintain pasture vigour and condition (iv) *prescribed fire* to manage savanna structure and improve rangeland condition and (v) *managing for biodiversity* by protecting areas of high conservation value. We suggest that these principles can be applied using relatively simple systems of grazing management.

## INTRODUCTION

The pastoral industry is the dominant land user in the northern savannas with relatively small, but increasingly important, areas used for tourism, military training or Aboriginal use. The grazing management applied on these pastoral areas thus has the capacity to impact upon the integrity and functioning of vast expanses of savanna as well as major downstream systems such as the Great Barrier Reef Lagoon. Although large areas of the savannas are in apparently good condition, evidence exists that pastoralism has caused significant degradation at both local and regional scales. This includes the decline or loss of perennial grasses and their replacement by annuals and\or exotic species, a decline in ground cover and increased erosion, increased woody weeds and losses of faunal and floral biodiversity e.g. De Corte *et al.* (1991).

The establishment of principles for sustainable management in these northern savannas is therefore critical to prevent further degradation and maintain a sustainable and viable grazing industry. This is of particular relevance given the potential conflict between the opposing pressures to increase productivity through intensification and increasing societal demands for the responsible and sustainable management of grazing lands.

Unfortunately, compared to countries like the USA and South Africa, a relative paucity of research on sustainable management exists in northern Australia with most earlier work focussing on 'improved' pasture development. What work was done was fragmentary and seen as a sideline to the basic aim of increasing animal production through the sowing of exotic legumes and grasses. Nevertheless, recent work conducted in Queensland and the Northern Territory has allowed the development of preliminary principles for sustainable management but much research remains to be done on this issue.

This paper draws on empirical evidence from recent and current research to synthesise principles for the sustainable management of the northern savannas. Where necessary, we utilise theoretical and/or anecdotal evidence for support. The principles are given within the context of a grazing industry that must aim to first, maintain or improve profitability while managing grazing so as to improve sustainability. Second, minimise off site impacts on water quality by reducing nutrient and soil loss from grazing lands. And third, conserve and promote biodiversity within the constraints of commercial cattle production.

Based on the above, the following principles can be identified for sustainable management in the northern savannas.

## CONSERVATIVE UTILISATION

Possibly the most important principle of sustainable management is that of conservative utilisation of the grass layer. This is commonly defined as about 15 – 25 % of annual growth, depending upon the vegetation community involved (Johnson *et al* 1996; Ash *et al* 2001). Evidence however suggests that with early wet season spelling, utilisation levels can be increased to 50 % of annual growth without detriment to the pasture. Thus, work on the ECOGRAZE project near Charters Towers showed that despite severe drought, pastures in good condition maintained their coverage of desirable, perennial grasses under both 25% utilisation or 50 % utilisation coupled with spelling (Ash *et al* 2001). At the same time, pastures in poor condition recovered almost completely in five years under the latter grazing regimes. In contrast, heavy utilisation (75%) or moderate (50%) utilisation without spelling, resulted in local extinction of perennial grasses and a rapid increase in bare ground and the proportion of annuals and undesirable forbs in the pasture. Importantly, net primary production under heavy utilisation declined to less than 50 % of that in the lighter utilised paddocks, resulting in a significant decline in carrying capacity (Ash *et al* 2001).

In practice, major difficulties exist in achieving recommended utilisation levels at the paddock scale. Most commercial paddocks are large and heterogeneous and estimating the potential productivity of different land types is problematic even in the presence of detailed data on rainfall, nutrient availability and pasture yields. Further, unless discounted for species composition, applying a gross average 'safe' utilisation level may still result in overgrazing of more preferred grasses, ultimately resulting in a decline in pasture condition.

More importantly, the extreme variability in annual rainfall that characterises much of northern Australia results in major fluctuations in inter-annual pasture availability. Properties that are stocked to achieve some recommended 'average' utilisation level can still be overgrazed in below average rainfall years. If a sequence of dry years occurs, resource degradation and financial loss can consequently result unless stock numbers are reduced.

A number of strategies have been proposed to address the key issue of matching utilisation to available feed:

- *Light stocking* could be applied so as to ensure that utilisation levels are consistently low eg < 15 %, and over grazing does not occur except in the most extreme years. Unfortunately this strategy is unlikely to be economic and could theoretically still cause degradation in the worst seasons;
- *Variable stocking* – by adjusting animal numbers to match feed demand with supply, utilisation levels could be kept within acceptable levels. This involves assessing pasture availability at a certain time, for example at the end of the wet season, and adjusting stock numbers accordingly. Major practical problems however exist with assessing feed availability at the paddock scale, calculating the resultant carrying capacity and determining the optimum de- or re- stocking strategy to be applied without compromising long term herd productivity;
- *Rotational spelling* could be used to accumulate forage for use in dry years as well as maintaining pasture health (Danckwerts *et al.* 1993). Although insufficient to cope with catastrophic drought, rotational spelling could nevertheless buffer most inter-seasonal fluctuations in fodder supply and markedly improve the ability of most properties to cope with rainfall variability;
- *Seasonal climate forecasting* may allow producers to adjust stock numbers pro-actively to avoid overgrazing in poor years or capitalise on the increased carrying capacities of good years (Ash *et al.* 2000). Despite its attractiveness, major limitations exist in terms of forecast skill as well as the practical application of such forecasts at a property level. For example, graziers need to integrate forecasts with other indices like forage availability and quality, before any appropriate adjustments to stock numbers can be made. An example of a simple stocking rate selector based on the SOI and standing forage is given in Table 1.

Optimisation studies have also shown that for a breeding enterprise the economic optimum upward or downward adjustment in stock numbers in response to a forecast is only 10-20%, providing only modest potential benefits in cash returns through the use of forecasts (Ash *et al.* 2000).

| *End of dry season Standing Herbage* | *SOI Value* | | |
|---|---|---|---|
| | *SOI < -5* | *SOI -5 to + 5* | *SOI > +5* |
| | **Stocking Rate Selected** | | |
| **Very high (> 3000 kg/ha)** | High | High | Very high |
| **High (>2500 kg/ha)** | Moderate | Moderate | High |
| **Moderate (>2000 kg/ha)** | Low | Moderate | Moderate |
| **Low (>1000 kg/ha)** | Very low | Low | Moderate |
| **Very Low( <1000 kg/ha)** | Very low | Very low | Low |

***Table 1: Example of an integrated stocking rate selector based on SOI value and standing herbage at the end of the dry season. Ideally, rules should also be set based upon the stocking rate currently being run.***

While some of the above strategies have been tested through simulation modelling e.g. McKeon *et al.*1998, no test has been conducted at a scale relevant to property management and adoption rates of these strategies remain accordingly. This issue is currently being addressed in the Wambiana project where a range of strategies are being objectively compared in a long term, large scale grazing trial (O'Reagain and Bushell 1999).

## EVEN UTILISATION

A second basic principle of sustainable management is that of the evenness of use at the paddock scale. However, most commercial paddocks in northern Australia are large (> 4000 ha), poorly watered and contain a mixture of soil types often differing markedly in the amount, quality and timing of forage availability and hence in their attractiveness to the grazing animal. Spatial utilisation is thus usually highly variable leading to consistent over-use of some areas in a paddock and under-use of others. Accordingly, overuse and degradation of certain areas is almost inevitable irrespective of the application of some overall 'safe utilisation rate'.

*Fencing* of different land types is a basic strategy to ensure even utilisation and prevent over use of preferred areas. However, whilst some basic land type separations are easy to make e.g. separation of riparian areas, the efficacy of this method is usually restricted by the complex, fine grained mosaic of soil types that occur in many paddocks.

Increasing the number of *water points*, opening or closing water points on a rotational basis and/or siting *supplementary feeding* on less favoured land types has also been suggested as a means to encourage animals to utilise less preferred areas. Although there is some anecdotal evidence to suggest that these practices have some degree of success, research has yet to be done on their effectivity in the northern savannas.

*Patch burning* may also be used to change spatial selection patterns at the paddock scale. In monsoon grasslands burning different halves of a paddock in alternate years has been shown to be effective in shifting cattle from preferred to less preferred areas (Andrew 1986). Alternatively, small-scale patch or mosaic burning of moribund grass may be effective in attracting cattle to under utilised areas and reducing the extent of patch grazing. However, such changes in spatial selection may be temporary with animals returning to previously favoured areas within two to three months of burning (Hobbs *et al.* 1991).

While some or all of these strategies may encourage more even use of mixed country, their effect on animal selection patterns and hence other factors like rangeland condition, biodiversity and soil loss have not been studied in any detail and should be a high priority for future research. Further, current understanding of the underlying basis for patch and landscape selection in large paddocks is superficial and requires urgent investigation.

## WET SEASON SPELLING

Regular wet season spelling is an essential prerequisite for the sustainable management of savannas e.g. Partridge (1999). Spelling maintains plant vigour and productivity in healthy pastures and, provided the vegetation has not crossed any degradation thresholds, allows poorer condition rangeland to recover following drought and overgrazing (McIvor 2001). Spelling may also buffer the effects of increased grazing pressure and allow utilisation rates to be increased without pasture degradation. For example, in a trial conducted on three contrasting land types near Charters Towers, regular early wet season spelling allowed utilisation rates to be increased to 50 % of annual pasture growth without loss of the desirable perennial grasses (Ash *et al.* 2001).

As described earlier, spelling is also important to buffer inter-seasonal fluctuations in forage supply and may be necessary to accumulate fuel for burning. Spelling is probably also essential to counteract area selective grazing and allow previously overgrazed patches to recover. Unfortunately, aside from the work of McIvor (2001) and Ash *et al.* (2001), surprisingly little research has been conducted in northern Australia on this key management principle. Consequently, little or no data are available on the required frequency, timing or duration of spelling for sustainable management. Guidelines also need to be developed to integrate spelling with other management issues such as burning, breeder management and supplementary feeding.

## FIRE

Prescribed fire is a critical ingredient of sustainable management in the northern savannas. Fire may be used to remove moribund grass and increase the vigour, productivity and quality of the available pasture e.g. Dyer (2002). Animals are attracted onto this high quality regrowth and fire is thus often used to even out grazing pressure at the paddock scale. Fire may also be used to improve pasture condition by favouring fire adapted perennial grasses such as *Heteropogon contortus* at the expense of undesirable, less fire tolerant species such as *Aristida* (Orr *et al.* 1997). Burning is also an important tool in managing the structure, composition and, in some cases, density of savanna vegetation (Dyer 2002). Although most savanna trees are fire tolerant, significant top kill can result from intense fires late in the dry season (Cook and Williams 1995), markedly reducing tree height and canopy size and hence the magnitude of the competitive effect on the grass layer. However the type, intensity and timing of fire as well as post fire grazing management are critical to achieving sustainable management: fire incorrectly applied, for example in mid-growing season, can result in significant rangeland degradation.

The frequency at which fires should be applied varies depending upon the rate at which fuel accumulates, rainfall, grazing pressure and the inherent sensitivity of the vegetation to burning. In general, to manage savanna structure, fires should be hot, intense, burns applied with high fuel loads in the late dry season. Conversely, to improve pasture condition fires should be relatively 'cool' and applied in the early wet season immediately after the first rains.

Virtually all the information on fire management relevant to northern Australia has been from work conducted in the Northern Territory e.g. (Cook and Williams 1995; Dyer 2002). Consequently, a number of important questions pertaining to the use of fire in the more productive pastoral zone of northern Queensland remain unanswered. These include the optimum fire frequency for different land types, the effects of repeated burning on soil nutrients, the relative effects of patch vs. whole-paddock burning, the interaction of fire with grazing management and the relative effects of different types of fire on a range of biotic and abiotic variables. In particular, major gaps exist in our understanding of the life history characteristics of most northern *Eucalypts* and the response of these trees to fire in terms of mortality, recruitment and regrowth.

## MANAGING FOR BIODIVERSITY

Pastoralism in northern Australia is based on relatively intact ecosystems that are more amenable to conservation of biodiversity than intensively managed agricultural landscapes. However, since European settlement there have been significant declines or losses in flora and fauna in northern Australia (Woinarski *et al.* 2000). Some of the decline in biodiversity is associated with habitat loss, particularly from tree clearing, feral animals and exotic weeds but there is also strong evidence of direct effects of grazing on reducing invertebrate and vertebrate fauna (Fisher 1999, Woinarski and Ash 2002, Woinarski *et al.* 2002).

Ironically, the still relatively good conservation status of northern grazing lands probably places more community responsibility on pastoral land managers to conserve biodiversity through good grazing management than more intensively managed agricultural lands. However, individual landholders cannot be expected to be responsible for the maintenance of all biodiversity on their property and still run an economically viable enterprise. Biodiversity must be protected and monitored at a regional scale and individual properties can play an important role in this regional context. Individual landholders can help promote maintenance of biodiversity by continuing to protect areas of high conservation value or those areas of properties that receive little or no grazing because of physical barriers to movement or because of distance from water points. Land could be set aside for conservation purposes either through voluntary conservation agreements or through land stewardship arrangements, which can be cost effective compared with formal reserves (Maconochie *et al.* 2000). The full costs and benefits of biodiversity management need to be factored into land management decisions so that opportunities to achieve good biodiversity outcomes are not lost because of subjective value judgements about the perceived economic 'cost' of such actions.

## DISCUSSION

The application of these principles at the property level is ultimately limited by the constraints under which properties in the northern savannas operate. In general, most properties are extremely large and have limited infrastructure in terms of roads, fencing and handling facilities. Labour is generally expensive and in short supply. Inputs in terms of feed, vaccines and handling costs are generally low but similarly production per unit beast or per unit area is relatively poor. Consequently, management systems need to be relatively simple, easy to operate, cheap and should not require large investments in terms of either capital or labour.

We believe that provided the principles of conservative utilisation, even use, regular spelling, prescribed fire and maintenance of biodiversity are adhered to, simple, relatively cheap management systems like the three paddock – two herd system (Ash *et al.* 2001) can maintain and improve sustainability in the northern savannas. While more costly, labour intensive systems like cell grazing have been proposed, the benefits and utility of these systems have yet to be convincingly demonstrated in the extensive areas of northern Australia.

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