# GRAZING SYSTEMS AND SPATIAL UNIFORMITY

*D.J. Reid[1*], T.J. Hall[2] and J.G. McIvor[3]*

[1] Dept Primary Industries & Fisheries, PO Box 6014 CQMC Rockhampton Qld 4702,
[2] Dept Primary Industries & Fisheries, PO Box 102 Toowoomba Qld 4350,
[3] CSIRO, 306 Carmody Road St Lucia Qld 4067

Email: david.reid@dpi.qld.gov.au

## ABSTRACT

A four-year, producer-inspired research project, jointly-funded by Queensland DPIF, CSIRO and MLA, is investigating different grazing systems across the northern beef industry. Nine commercial beef properties, each with two or three planned grazing systems (continuous, rotational, cell), were selected covering heavy (higher fertility) and light (lower fertility) soils in northern and southern Queensland. From three to eleven paddocks were selected on each property for soil and pasture measurements. A combined Botanal and LFA recording system based on quadrats located on a set sampling grid was used to assess pasture and soil surface condition following the growing season in 2006 and 2007. Differences in pasture and soil attributes across paddocks are being investigated to assess if spatial uniformity of grazing changes between grazing systems. Preliminary results using a method of spatial analysis by distance indices to assess variation in ground cover are presented as an example of a possible approach.

## INTRODUCTION

Many northern beef producers are concerned with declining cattle productivity and deteriorating condition of grazing lands. Producers have reported that their traditional management practises are not improving, or even maintaining, pasture and land condition. The number of animals is the broadest driver of animal performance, profitability and sustainability and considerable effort has been directed towards developing sustainable carrying capacities and pasture utilisation rates. More recently, attention has shifted to the spatial and temporal distribution of grazing pressure and this has led to interest amongst producers in different grazing systems for controlling the location, duration and timing of grazing.

More intensive rotational grazing systems, such as cell grazing, are being adopted by an increasing number of producers interested in improving their management performance. This interest from producers and their industry organisations prompted a four-year joint research project by a team from Queensland DPIF, CSIRO and MLA to investigate the inputs and outcomes from three main grazing systems used in northern Australia.

Different grazing systems can be considered to lie along a spectrum of increasing management intensity from continuous set-stocking at low stock densities in large paddocks, to cell grazing at high stock densities with large numbers of paddocks and frequent movement of cattle. It is hypothesised that, as grazing system intensity increases, spatial uniformity of grazing will increase. This paper addresses this hypothesis using a method of spatial analysis by distance indices (SADIE; Perry 1995) to assess the degree of spatial uniformity in ground cover for different grazing systems.

## METHODS

Nine properties were selected throughout Queensland which included at least two of the following grazing systems - continuous grazing (larger paddock areas, low management intensity), rotation grazing (moderate intensity) or cell grazing (smaller paddocks, high intensity). The properties covered both northern and southern areas and two important pasture types - brigalow and eucalypt woodlands (including both black speargrass and *Aristida*-*Bothriochloa* native pasture communities). For each property, paddocks in the different grazing systems (e.g. one paddock in a continuous system, two to three paddocks in a rotation and five to ten paddocks in a cell system) with similar characteristics (soil type, pasture, tree cover, topography, etc.) were selected for monitoring.

A combined Botanal (Tothill *et al.* 1992) and LFA (Landscape Function Analysis; Tongway and Hindley 2005) recording system based on quadrats (50 x 50 cm) located on a set sampling grid was used to assess pasture and soil condition following the growing seasons in 2006 and 2007. Data collected at each sample point included pasture yield, botanical composition, species frequency, basal area of perennial grasses, degree of utilisation, cover, tree regrowth, and soil surface condition estimates and ratings to provide LFA indices of stability, infiltration and nutrient cycling.

One aim of the study was to assess spatial uniformity in attributes such as pasture yield, pasture utilisation and ground cover of the different grazing systems. The SADIE methodology detects and measures the degree of non-randomness in the two-dimensional spatial patterns of populations (Perry *et al.* 1995). Briefly, SADIE calculates an index based on the total distance of the sample from a completely regular arrangement by comparing the spatial arrangement of the observed sample with arrangements derived from it such that they are as regularly spaced as possible – a distance to regularity. Although the SADIE methodology was originally developed to assess spatial pattern in count data (Perry *et al.* 1999), it can easily be extended to other forms of data (Perry, pers comm).

Total ground cover measured in the 2007 sampling season for the four properties with all three grazing systems is used to illustrate the SADIE methodology and to demonstrate a proposed summary for comparing the spatial uniformity of the grazing systems. Over the four properties, 23 cell grazing paddocks, 8 rotationally grazed paddocks and 4 continuously grazed paddocks were sampled.

## RESULTS AND DISCUSSION

The ground cover data from one of the four properties is shown graphically in Fig 1.

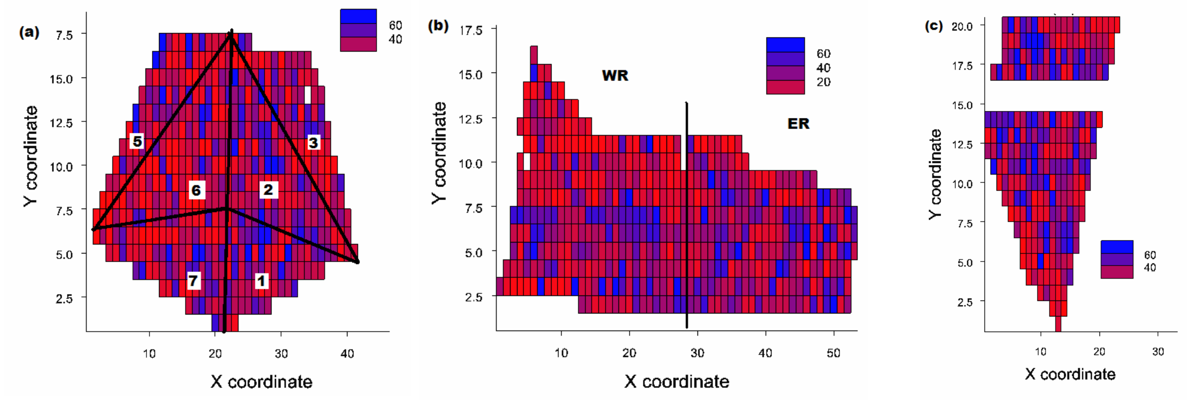


**Figure 1.** Total ground cover (%) for (a) the six cell paddocks, (b) the two rotational paddocks, and (c) the continuously grazed paddock that were monitored on one property.

The spatial pattern of each individual paddock needs to be considered as it will be influenced by how recently a paddock has been grazed, which is particularly pertinent for paddocks in a cell system. Cell paddocks for monitoring were specifically selected to ensure they covered a range from just grazed to having been spelled for some time and about to be re-grazed.

Each paddock was tested for spatial randomness, or spatial aggregation, using the SADIE methodology. For the example in Figure 1, all six cell paddocks (Fig. 1(a)) exhibited randomness, while one of the rotationally grazed paddocks (WR; Fig 1(b)) and the continuously grazed paddock (Fig 1(c)) exhibited aggregation.

How can we compare the systems as a whole? We propose that the results from the individual paddocks be summarised such that we compare the proportion of paddocks in a system for which there is no evidence, at say P=0.05, that the data are not spatially uniform. For the four properties, this approach showed a 70% probability of spatial uniformity in total ground cover for cell grazing, 38% for rotational grazing and 25% for continuous grazing (Table 1).

This could be further refined by considering the proportion of area rather than the proportion of paddocks. Also, spatial attributes such as clustering, could be investigated using the graphical tools provided in the SADIE software (Perry *et al*. 1999) such as 'red-blue' plots.

**Table 1.** The number of paddocks in each grazing system and the number of paddocks (proportion) with no evidence against spatial uniformity at the 5% level for four properties.

| Grazing System | Cell | Rotational | Continuous |
|---|---|---|---|
| Total number of paddocks | 23 | 8 | 4 |
| Number of paddocks with spatial uniformity (%) | 16 (70%) | 3 (38%) | 1 (25%) |

This preliminary analysis suggests that the SADIE methodology may provide a useful approach for comparing spatial uniformity of grazing systems. Further, it suggests that the more intensive grazing systems are more uniform for the cover measure we have tested. However, when interpreting these results a number of issues need to be considered. Firstly, the scale of the sampling grid varies among paddocks. Secondly, only a single scale is used for all measures in a paddock but different measures may vary at different scales so testing at another scale may show a different result. Thirdly, the data from each small quadrat are used to represent larger areas (sometimes more than 1 ha) under the assumption that the area is similar to the quadrat for that measure but, in some cases, there may be as much variation between individual patches in the area as there is between quadrats over the whole paddock.

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