SOME ECONOMIC AND ECOLOGICAL ASPECTS OF A LONG-TERM VARIABLE GRAZING REGIME IN THE BRIGALOW BIOREGION

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INTRODUCTION

Resource managers require a range of financial and ecological information to evaluate rangeland pastoral systems, given the competitive pressures for improving productivity and environmental standards. This paper presents a number of economic performance measures and ecological indicators from a long term grazing regime that formed part of the Brigalow Catchment Study (BCS). The BCS is situated in central Queensland (24.81°S, 149.80°E) and commenced in 1965 to determine the impact on hydrology and resource condition when native brigalow (*Acacia harpophylla*) is cleared for cropping or grazing. An overview of the objectives and outcomes from the BCS to date is contained in Cowie *et al*. (2007). The grazing regime involved the variable stocking of animals to match seasonal forage supply over a period of two decades. Comparatively little research has assessed the implications of such practices on enterprise profitability and ecological stability over the longer term.

Grazing treatment

The grazing regime involved the backgrounding of young cattle over a period of 12 months for further resale as store cattle within the confines of a long term agronomic and scientific study. The fenced grazing area of 17 ha was sown to buffel grass (*Cenchrus ciliaris* cv. Biloela) in November 1982 and grazing commenced in December 1983. Stocking rates were adjusted periodically to maintain a residual biomass of at least 1 t/ha of total standing dry matter with high associated ground cover. Stocking rates fell into two broad categories; they were initially around 1.4-1.7 ha/head and were gradually adjusted in response to changes in forage availability to 2.1-3.4 ha/head at the end of the trial. No animal supplementation, fertiliser or herbicide was applied during the trial.

Twenty-one drafts of 5-12 Brahman-cross beef cattle (steers or females) aged 12-18 months with an initial weight of *c*. 311 kg were grazed for periods of approximately one year, and each animal was weighed before and after grazing to determine live weight (LW) gain. Weighing was conducted after a 1-day fasting period, during which feed was withheld but water was provided. Cattle were placed in the paddock in the middle of the dry season (June-August) each year from 1984 to 1996. From 1997 to 2004, cattle were replaced between January and August each year.

METHODS

Discounted cash flow analysis was used to calculate the net present value (NPV) of the investment to develop the paddock and adopt the variable grazing regime over a 22 year period, assuming a discount rate of 6%. The discount rate reflects the time value of money and a positive NPV implies a project is worthwhile assuming earnings are reinvested at the same rate of interest. The analysis represents a partial budgeting approach by assessing cash flows at a paddock level rather than a whole farm budget. Data from the 17 ha trial were extrapolated to represent a typical 200 ha paddock. Land costs were treated in a number of ways. First, land costs were excluded from the calculation of NPV to estimate a maximum opportunity cost of land while still making the project viable. Second, an indicative range of land costs were used to calculate the internal rate of return (IRR) of the investment. The IRR is the discount rate which results in a zero NPV for a project. An investment is considered worthy if the IRR exceeds the interest cost of using capital in this way.

Capital costs to develop the 200 ha paddock were estimated at $61600, including clearing and establishment ($40000), fencing ($15600) and water infrastructure ($6000). Due to problems with

1983-84 animal records, no trading was assumed in this year. Pasture development was therefore assumed to occur in 1983-84 (year 1) rather than in 1982-83. Capital costs were used in conjunction with annual gross margins over 1984-85 to 2004-05 to calculate the NPV of the project. An annual mustering cost of $1000 for the 200 ha paddock was also included with all costs and prices in 2005-06 dollars. The gross margin from the experimental variable grazing regime was calculated as:

Gross margin ($/ha) = net trading + inventory change – variable costs

Net trading was calculated as the difference between annual livestock sales and livestock purchases net of transport and marketing costs. Annual purchases of young animals were valued using national or Queensland yearling prices (Figure 1). Where available, Queensland prices were used to better represent regional values. Animal sales were valued based on turn-off records and either the Australian weighted price or Queensland saleyard price for medium weight stores (Figure 2). The weighted cattle price is based on yearling, US cow and Japan Ox prices. The weighted price may underestimate store prices to some extent but reflect the general movement in livestock prices. Saleyard prices were obtained from Australian Bureau of Agricultural and Resource Economics (ABARE) and Meat and Livestock Australia market statistics.

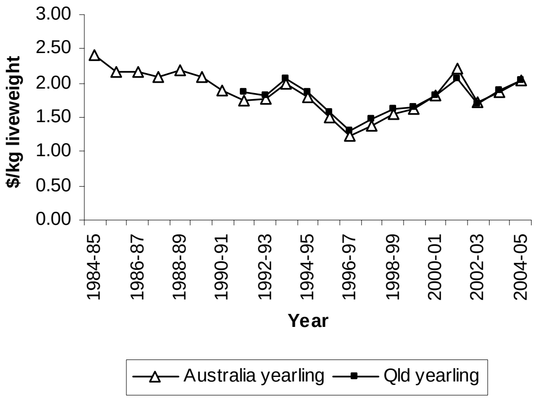

Figure 1. Yearling prices

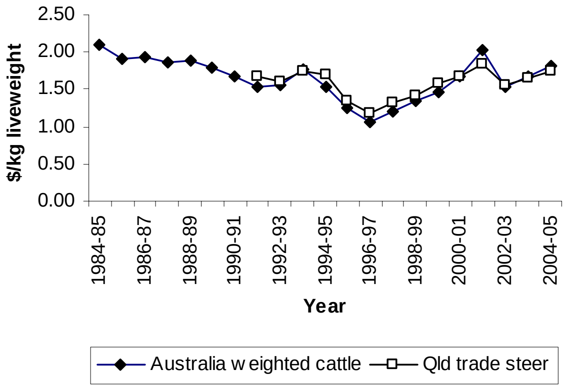

Figure 2. Weighted cattle and steer prices

Inventory changes, being the difference between annual opening and closing stocks, were valued using the yearling purchase price in each year. Variable costs, being the direct cost of livestock materials such as dips and drenches, were obtained from the ABARE annual farm surveys database for the broad acre region 322: Darling Downs and Central Highlands of Queensland. No fodder costs were incurred in the BCS grazing regime.

The ecological condition of the BCS grazing paddock was assessed using a range of indicators, including total standing dry matter, plant botanical composition and ground cover. Ground cover is considered an important attribute of landscape function and health, affecting infiltration, runoff, water and wind erosion (Scarth *et al*. 2006). The monitoring and survey methods for the indicators are described in Cowie *et al*. (2007). Ground cover was measured on site during the first decade of the grazing trial. From 1987 to 2007, remotely sensed data were obtained to describe longer-term ground cover trends based on the Bare Ground Index. The derivation of this index is outlined in Scarth *et al*. (2006) and draws on a Landsat archive of geometrically and radiometrically corrected images.

RESULTS

The mean annual gross margin over the period was $70/ha (SD±72), with 50% of annual returns above $48/ha (Figure 3). The large variation in gross margins is attributed to the sequence of actual trading, whereby cattle purchases were incurred in some years with corresponding sales in the next financial year, together with variability in climatic pasture growth and market conditions. Some woody regrowth has also occurred on the site (refer to highlighted grazing area in Figure 4) which may require future treatment costs to maintain pasture production.

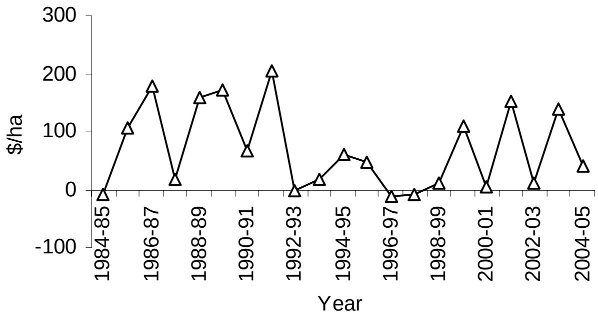

Figure 3. Annual gross margins from grazing

Figure 4. Aerial photo of catchment site, 29/6/07. Source: Queensland Department of Natural Resources and Water.

When gross margin cash flows were incorporated with capital costs excluding land, the NPV of the project amounted to $103000 or $516 per ha (equivalent to an annuity payment of $44/ha). This implies that the investment is worthwhile where the cost of land is less than around $500/ha. For this land type, land costs may be higher based on recent market prices. When indicative costs for undeveloped land of $600/ha and $800/ha were included the NPV was negative. However, the IRR for these land cost scenarios was 4.7% and 2.3% respectively. This implies that the investment would have been viable if the capital used in the activity would have earned less than these rates elsewhere.

The investment scenarios presented above are relevant to the conversion to open pasture of non-assessable (e.g. non-remnant) and approved assessable vegetation as prescribed under the Queensland *Vegetation Management Act 1999.*

Pasture dry matter levels at the start of the trial were high at around 6-8 t/ha following the clearing of brigalow scrub and release of accumulated nutrients. This initial high production also coincided with higher than average rainfall. This had halved 3 years after clearing as pasture levels began to stabilise at around 3-4 t/ha in the early 1990s and stocking rates were adjusted downwards to be no higher than 0.3 to 0.4 head/ha. The lowest pasture dry matter recorded was 1.4 t/ha in November 1991 during a low annual rainfall year (484 mm in 1991). Pasture dry matter levels measured in the latter part of the trial in June 2003 and 2004 were 2.8 and 3.9 t/ha respectively (Figure 5).

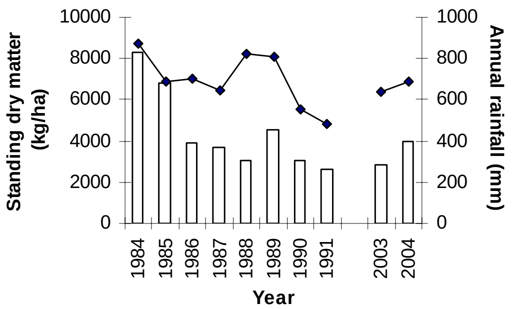

Figure 5. Pasture dry matter on offer (open bars) between October-December. Annual rainfall (line) for calendar years at the Brigalow Research Station.

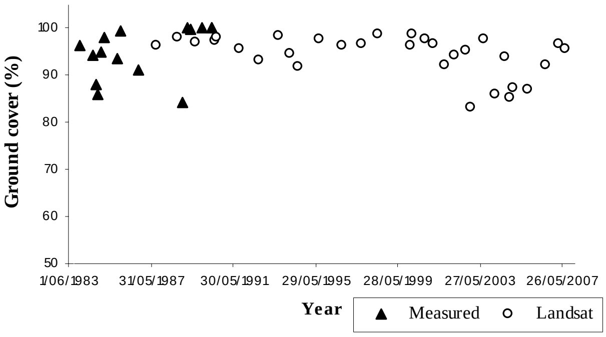

Figure 6. Ground cover measured on site and remotely using Landsat.

The botanical composition of the pasture over the first 9 years reflected a dominance of buffel grass with varying proportions of rhodes grass (*Chloris gayana)* and other native grasses. The mean annual proportion of buffel grass between 1983-1991 was 80% of total dry matter by weight. In the early 1990s, rhodes grass increased to around 20% of total dry matter reaching a maximum of 40% in 1991.

In 2003 and 2004, buffel grass represented over 90% of total dry matter. Vegetation survey data show that prior to land development projected groundcover was consistently greater than 85% (Thornton *et al*. 2007). Since clearing, ground cover has maintained levels in excess of 83% over the duration of the grazing trial (Figure 6).

DISCUSSION

The combined use of economic performance and ecological information has enabled an evaluation of grazing management at the BCS site for a range of objectives. The paddock has been maintained in relatively good land condition with high ground cover and a dominance of buffel grass as a desirable perennial species. The pasture development and grazing regime was also estimated to generate a private rate of return on capital invested of between 2% to almost 5%, depending on underlying land costs. These rates, together with NPV measures, provide a benchmark for comparison with other grazing management or land use options and associated trade-offs between profitability and environmental outcomes. The adoption of a variable grazing regime would also typically require careful management due to climatic variability influencing pasture growth and animal carrying capacity over time.

From a social cost-benefit perspective, consideration of grazing management options or other agricultural land uses would need to take into account non-market values such as biodiversity and the downstream effects from increased water and soil runoff. Thornton *et al.* (2007) estimated that runoff increased from 5% of annual rainfall in an uncleared brigalow state to 11% under cropping and 9% under grazing at the BCS site. More detailed biophysical and economic modelling or multi-criteria assessment procedures would be required when comparing options to assess socially optimal land use. Furthermore, the BCS experiment has involved only one grazing management treatment to date. Future modelling may overcome this limitation where experimental data could be used to calibrate the GRASP pasture growth model (McKeon *et al*. 1990) for the site. This would enable simulation of a range of other variable or fixed stocking rates for financial and pasture condition evaluation.

Finally, the broader social benefits from public investment in long term experiments such as the BCS have not been discussed. These issues and the estimated net benefits from the overall BCS experiment have been investigated elsewhere (e.g. Grains Research and Development Corporation and Land and Water Resources Research and Development Corporation 1998).

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