PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE
Official publication of The Australian Rangeland Society

Form of Reference
The reference for this article should be in this general form;

Author family name, initials (year). Title. *In*: Proceedings of the *n*th Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).

For example:

Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

IMPACT OF A MANAGEMENT INTERVENTION ON THE GREENHOUSE BUDGET OF A QUEENSLAND GRAZING BUSINESS

S.G. Bray[a] *and R. Golden*[b]

[a] DPI&F, PO Box 6014, Rockhampton MC, QLD 4702
[b] 'Potters Flat', Wandoan, QLD 4419

ABSTRACT

The emerging carbon economy will have a major impact on grazing businesses due to significant livestock methane and land-use change emissions. Livestock methane alone accounts for around 11% of Australia's reported greenhouse emissions while livestock industries only contribute around 1% to gross domestic product.

Grazing businesses need to develop an understanding of their greenhouse gas contribution and assess the impact of alternative management options. Development of a property-scale greenhouse budget is one possible tool, however it requires information which is not currently readily available at the region, property, management and land-type scale. This paper presents a simple greenhouse budget for one major land-type '20 year old regrowth brigalow' on an indicative grazing property in the brigalow bioregion of Queensland. The 50 year analysis demonstrates the likely impact of three alternative regrowth management options on the greenhouse budget and livestock carrying capacity: retain regrowth (sequester 71.8 t CO_2-e/ha), clear all regrowth (emit 41.2 t CO_2-e/ha) and clear regrowth strips (emit 4.5 t CO_2-e/ha). Significant assumptions were required to complete the budget due to gaps in current knowledge particularly in relation to the response of woody vegetation and soil carbon to different management options. Improved prediction of livestock methane emissions at the property-scale is also required.

INTRODUCTION

Grazing businesses located in savanna woodlands are responsible for managing a massive carbon store in the soil and vegetation. Globally the soil carbon pool in tropical savannas is estimated at 968 Gt CO_2-e (to 1 m) while the vegetation contains 242 Gt CO_2-e (IPCC, 2000). An assessment of 13 sites in the Brigalow bioregion of Queensland (Harms and Dalal, 2003) indicated a mean soil carbon stock of 330 t CO_2-e/ha and an aboveground vegetation carbon stock of 250 t CO_2-e/ha in remnant vegetation. This equates to a carbon stock of 1.5 Mt CO_2-e for a 4000 ha property with 20% remnant vegetation.

Apart from managing significant carbon stocks in soils and vegetation, grazing businesses are also responsible for significant greenhouse gas emissions, primarily through livestock methane emissions, land use change, fuel and energy use. Australia's reported greenhouse account for 2005 indicate that livestock methane emissions account for 11% (62 Mt CO_2-e) of Australia's emissions, while emissions associated with land clearing (primarily for grazing) were 53.3 Mt CO_2-e (AGO, 2007). Livestock industries however only contribute around 1% to gross domestic product.

Given the context of Australia's reported greenhouse impact of grazing industries, is there any scope for grazing businesses to mitigate their emissions or differentiate their business as having an improved greenhouse outcome? One possible tool grazing businesses can utilise is a property-scale greenhouse budget which assesses all major carbon/greenhouse stocks and fluxes over time and enables prediction of the impact of change in response to different management options.

A current limitation to undertaking a property-scale greenhouse budget are the significant gaps in current knowledge, particularly in respect to the response of carbon stocks and fluxes to management options and their interaction with land types at the property scale. Initial predictions will require a significant number of assumptions until experience and science improves over time.

This paper will use current experience and scientific knowledge to assess the greenhouse impact of three alternative management options for a major land type (20 year old regrowth brigalow) in the

Brigalow bioregion of Queensland. The management options include: 1) retain regrowth, 2) clear all regrowth, and 3) clear regrowth strips. The impact of the management options on livestock productivity (adult equivalent 'AE' carrying capacity) is also assessed. Gaps in current knowledge and assumptions required to complete a property-scale greenhouse budget are documented. This exercise focuses on development of a realistic property-scale greenhouse budget and is not necessarily designed to meet the criteria of eligibility, additionality, permanence and leakage of a contracted 'mitigation project'.

MATERIALS AND METHODS

The analysis is based on data and experience from a 4000 ha property in the Brigalow bioregion of Queensland. The region has been grazed since the mid-1800's. However intensive development began in the 1940's with ringbarking of timber, followed by pulling of the brigalow scrub with bulldozers and chain in the 1960's and 1980's. Blade ploughing is the current preferred timber control method for brigalow regrowth. Retention of regrowth strips has been trialled on a small area. Grazing management on the property is moderate to conservative for the region. Rotational grazing has been adopted in the last ten years to improve grazing management and land condition outcomes.

Twenty year old brigalow regrowth (basal area ~3 m^2/ha at 30 cm) is the largest relatively uniform 'land type' covering a quarter of the property (1000 ha). The impacts of three management scenarios are assessed for this 'land-type' over a 50 year period. The management scenarios are:

1. Retain Regrowth - allow regrowth to continue to grow.
2. Clear all regrowth with blade ploughing in 2^{nd} and 31^{st} year.
3. Clear regrowth strips with blade ploughing in 2^{nd} and 31^{st} year (20 m cleared, 12 m retained).

Table 1 lists 13 significant carbon stocks and fluxes for the grazing business and outlines the assumptions used in the analysis.

Table 1 Grazing business carbon stocks and fluxes and an indication of importance in the current analysis and assumptions

	Stock or flux	Importance and assumptions
1	Live tree biomass	Aboveground biomass change assessed. See Table 2 for tree basal area and time since clearing assumptions. Biomass estimates were based the regrowth data of Scanlan (1991). Belowground biomass assumed no change.
2	Dead standing tree biomass	Assumed zero stock following the original pulling.
3	Coarse woody debris (CWD)	Stock unknown from original pulling (stick raked into unburnt piles), assumed no change.
4	Woody clearing debris	Assessed. Decays over 15 years based on manager observations.
5	Forage biomass	Assumed forage and litter biomass combined
6	Litter biomass	remained 7.3 t CO_2-e/ha.
7	Soil carbon stock to 1m	Assumed no change in response management due to lack of data. Soil carbon 475 t CO_2-e/ha (Site 34 and 35 on actual property; Harms and Dalal, 2003).
8	Livestock carbon and livestock off-take	Assessed livestock carbon stock based on carrying capacity. 1 AE=450kg, 35% DM, 50% C. Off-take not assessed.
9	Livestock methane emissions	Assessed, based on carrying capacity and cumulative. 2.9 t CO_2-e/AE/yr calculated from Kennedy *et al.* (2007).
10	Soil and paddock manure non-CO_2 emissions	Assumed no change to applied management due to lack of data.
11	Livestock transport and processing emissions	Not assessed post farm-gate.
12	Clearing fuel emissions	Assessed, based on land manager data, cumulative. 0.158 t CO_2-e/ha for each clearing event.
13	General property energy emissions (fuel, electricity)	Assessed, based on land manager data, cumulative. 0.0088 t CO_2-e/ha/yr

Table 2 lists tree basal area and livestock carrying capacity values for different regrowth stages which were generated by field measurement and land manager experience. Grazing productivity within the retained strips was assumed to remain 0.2 AE/ha based on experience and the work of Chilcott *et al.* (2006) on the benefits of tree strips.

Table 2 Tree basal area and livestock carrying capacity values for different regrowth stages.

	Tree basal area at 30cm m^2/ha	Livestock carrying capacity AE/ha
Cleared brigalow	0.25	0.4
20 year old pulled regrowth	3	0.2
40 year old pulled regrowth	8	0.05
60 year old pulled regrowth	13	no cattle
30 year old blade ploughed regrowth	3	0.2

RESULTS

The analysis indicated that over 50 years, retaining regrowth strips negated 85% of livestock methane and clearing emissions (emitted 4.5 t CO_2-e/ha), whereas clearing all regrowth emitted 41.2 t CO_2-e/ha (Figure 1). The retain regrowth treatment accumulated 71.8 t CO_2-e/ha over 50 years. However there was negligible livestock carrying capacity for half the period.

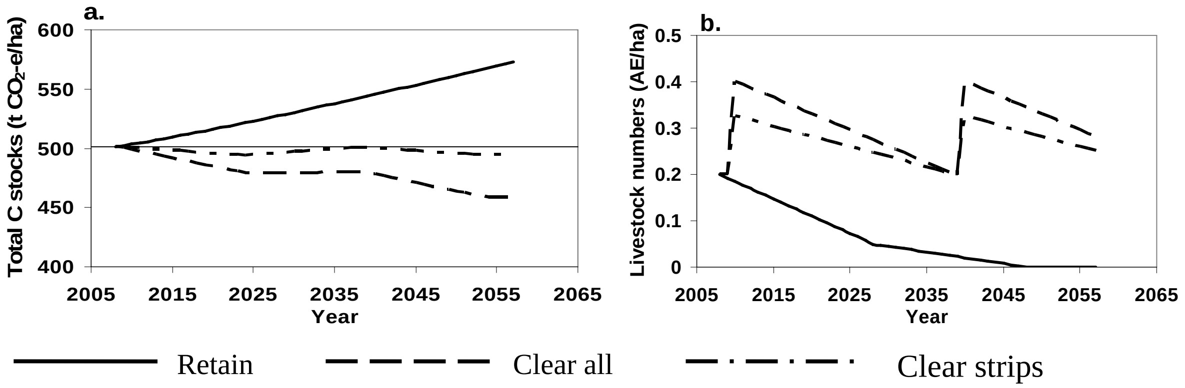

Figure 1 Change in carbon stocks (a.) and change in livestock numbers (b.) with three alternative regrowth management options; retain regrowth, clear all regrowth, and clear regrowth strips.

DISCUSSION

This analysis has demonstrated the potential scope for regrowth management to impact on the 'greenhouse' outcome of a grazing business on a land-type and property scale. However this is not without cost in the form of reduced livestock carrying capacity. Although outside the scope of this paper, the economic implications and trigger prices for carbon and livestock need to be evaluated.

Although we are reasonably confident in the results of this analysis, certainty of the results is hindered by the assumptions in predicting the response of each carbon stock and flux. Key items include:

1. Predicting growth rates and decay of vegetation biomass. The growth rate of regrowth particularly in different regions and after different clearing treatments is poorly understood, with current datasets predicting a substantial difference in growth rates in similar vegetation types (e.g. Scanlan, 1991; Bradley, 2006). The upper limit of biomass accumulation and the effect of intermittent droughts and climate change are also largely unknown at the property-scale. The dynamics of standing dead biomass, coarse woody debris and clearing debris is also poorly understood. These carbon stocks may have potential to be exploited as their longevity is sensitive to management (e.g. fire control) and their presence is not reliant on limited resources such as soil water which drive forage and tree growth.

2. Soil carbon dynamics. Soil carbon dominates the carbon stock (>90%) on grazing land. Unfortunately, there is little data on how soil carbon responds to various management practices. Harms and Dalal (2003) demonstrated a variable, though generally declining soil carbon stock following clearing of remnant vegetation. However, the response of soil carbon to different clearing techniques, clearing regrowth, allowing regrowth to grow or allowing remnant woodlands to thicken requires more investigation. The soil carbon response to grazing management also requires further study as preliminary studies indicate variable and sometimes counter-intuitive results (e.g. Ash *et al.*, 1995; Carter and Fraser, 2007). No change in soil carbon was assumed for this exercise based on moderate to conservative grazing management used on the property, however if the soil carbon stock increased by 5% over 50 years (23.7 t CO_2-e/ha), the retain regrowth strips option would sequester 19.2 t CO_2-e/ha rather than emit 4.5 t CO_2-e/ha.

3. Livestock methane. Livestock methane is a major on-going cumulative emission for grazing businesses and therefore accurate estimates are required in a property-scale budget. Kennedy *et al.* (2007) have developed a preliminary model to estimate emissions for different regions, land-types and herd management. However key inputs are currently uncertain for many situations in northern Australia and further work is required.

The global 'carbon economy' means that grazing businesses will have to balance their greenhouse impact and grazing productivity. A property-scale greenhouse budget is one tool to understand and demonstrate the greenhouse impact of the current business and assess alternative management options. Access to reliable property-scale methodology to measure current carbon stock and predict change with management, particularly soil carbon, livestock methane and vegetation biomass will be essential.

REFERENCES

AGO. (2007). State and territory greenhouse gas inventories 2005. Australian Greenhouse Office, Canberra.

Ash A. J., Howden S. M. & McIvor J. G. (1995). Improved rangeland management and its implications for carbon sequestration. *In*: 5th International Rangeland Congress, Salt Lake City, Utah. pp. 19-20.

Bradley M. (2006) Integration of brigalow (*Acacia harpophylla*) vegetation with dryland cropping in south-east Queensland: agronomic, hydrological, ecological & Goethean perspectives. PhD Thesis, Griffith University, Gold Coast, Queensland.

Carter J. & Fraser G. (2007). 0-5cm Soil carbon trends with removal of domestic stock: An analysis of data from 12 grazing exclosures. RIRDC Report.

Chilcott C., McGrath W., McKeon G. & Paton C. (2006). Assessing the value of trees in sustainable grazing systems. Final Report NBP.316. Meat and Livestock Australia.

Harms B. & Dalal R. (2003). Paired site sampling for soil carbon (and nitrogen) estimation - Queensland . National Carbon Accounting System technical report no. 37.

IPCC. (2000). IPCC Special report on land use, land-use change and forestry. Intergovernmental panel on climate change.

Kennedy P., Stephens M. & Charmley E. (2007). Managing livestock to reduce methane emissions in northern Australia - development of a modelling framework: Final Report Project 0139. Australian Greenhouse Office.

Scanlan J. C. (1991). Woody overstorey and herbaceous understorey biomass in *Acacia harpophylla* (brigalow) woodlands. *Australian Journal of Ecology* **16**, 521-9.