Managing livestock enterprises in Australia’s extensive rangelands for greenhouse gas and environmental outcomes: a pastoral company perspective

D. Bentley\textsuperscript{A,C}, R. S. Hegarty\textsuperscript{B} and A. R. Alford\textsuperscript{B}

\textsuperscript{A}The North Australian Pastoral Company Pty Ltd, GPO Box 319, Brisbane, Qld 4001, Australia.
\textsuperscript{B}NSW Department of Primary Industries, Armidale, NSW 2351, Australia.
\textsuperscript{C}Corresponding author. Email: DBentley@napco.com.au

Abstract. Extensive grazing of beef cattle is the principal use of the northern Australia land area. While north Australian beef production has traditionally utilised a low-input, low-output system of land management, recent innovations have increased the efficiency with which beef is produced. Investment to raise efficiency of cattle production by improving herd genetics, property infrastructure, the seasonal feed-base and its utilisation, as well as promoting feedlot finishing can all be expected to contribute to a reduction in the emissions intensity of greenhouse gases (GHG; t GHG/t liveweight gain). The North Australian Pastoral Company (NAPCO) has adopted these technologies to enhance reproductive and growth efficiency of the herd and has coupled them with changes in other aspects of property operation, such as use of solar energy systems, establishment of introduced perennial pastures and minimum tillage, to achieve production and operational gains, which also reduce the emissions intensity of their pastoral properties. Investments to improve production efficiency have been consistent with both financial and, in principle, environmental objectives of NAPCO. While NAPCO supports the development and implementation of new mitigation strategies, the company requires greater knowledge on pastoral emission levels and clarity on the future position of agriculture in a carbon economy. This information would enable confirmation of current emission levels, modelling of mitigation options and evaluation of the efficacy of potential on-farm carbon sinks. This paper presents NAPCO’s perspective on GHG emissions in the context of its pastoral enterprise, including current and future research and mitigation objectives.

Introduction

The rangelands of Australia cover nearly three-quarters of the land mass and are predominately arid and semiarid, characterised by wide variations in climate, soils, vegetation and land use (NLWRA 2001; Lesslie et al. 2006). Pastoralism is by far the largest land use within the rangelands and occupies some 60% of the entire area (Lesslie et al. 2006). Australia’s 25.5 million beef cattle generate an annual gross value of production of over $7.4 billion but in so doing produce over 47 Mt of greenhouse gas (GHG, expressed as carbon dioxide equivalents; AGO 2007). Australia’s beef production is dominated by the northern rangeland industry, which accounted for almost 70% of the national beef herd in 2005–06 (ABARE 2006).

In a situation almost unique to Australia, large areas of these rangelands are occupied by corporate pastoralists, both publicly owned companies and private operators such as The North Australian Pastoral Company (NAPCO). This company is one Australia’s oldest and largest privately owned cattle enterprises and, from the original granting of the Alexandria lease in 1877, has progressively built up an integrated cattle breeding, growing and finishing operation (Ritchie 1999). The property portfolio now includes 14 cattle stations encompassing an area of ~6 million ha, running about 190,000 cattle (Fig. 1) and operates a 7200-animal feedlot and farm in subtropical south-east Queensland. This paper will detail the company’s perspectives on GHG emissions and efforts to reduce such emissions. It will also provide insight into the motivation behind the company’s commitment to reduce GHG emissions.

Commitment to reducing GHG emissions

NAPCO currently considers the impact of GHG emissions from two angles; the generation of GHG (primarily methane (CH\textsubscript{4})) due to beef production, and the potential implications of climate change on the company’s operations as a result of these emissions.

NAPCO is a partner with the Australian Commonwealth Government in the Australian Greenhouse Challenge Plus program. This provides a framework to identify and to reduce emissions. The two properties currently involved in this program, ‘Wainui’ (4500 ha) and ‘Gordon Downs’ (10,880 ha), have well established reporting systems as a result of being certified to the International Standards Organisation (ISO) 14001:2004 specifications, which assists in the recording and monitoring of GHG emissions. The ISO management system adopted under this certification provides a systematic approach...
Managing livestock enterprises in Australia

**Australian Journal of Experimental Agriculture**

61

PROPERTY LOCATIONS

The North Australian Pastoral Company Pty Limited

AGD 66

This map is not based on surveyed features and should be used as a guide only.

Date Compiled: DC B
Scale: 1:4 000 000
Map NAP2006 A0

---

**Fig. 1.** Distribution of beef cattle production properties owned by The North Australian Pastoral Company. The properties cover a total of 6.4 million ha and support 190 000 cattle.

---

To the assessment and control of resource use and is being implemented across all NAPCO properties.

In northern Australia, enteric \( \text{CH}_4 \) is the principal livestock GHG emission, as loss of volatile nitrogen (N) compounds from manures is relatively low due to low feed N content and rapid drying of manures. While limited data is currently available, across the company’s operations, a range of best practice approaches have been implemented that are anticipated to make major reductions in the emissions intensity, defined as tonnes (t) of GHG per t of liveweight gain (LWG) of cattle (t CH\(_4\)/t LWG). These approaches are: (i) improved herd genetics and property infrastructure, (ii) improved feed-base, (iii) feedlotting and (iv) eliminating low performance animals.

**Improved herd genetics and property infrastructure**

The introduction of tropically adapted cattle breeds in a genetic improvement program has been fundamental in improving fertility and animal growth in Australia’s northern herds (Frisch and O’Neill 1998; Prayaga 2004). NAPCO has developed a composite cattle breed (Millard 2003), which is adapted to the environmental conditions of northern savannas. Advantages of the composite cattle over the Australian beef shorthorn breed (shorthorn), which dominated in northern Australia in the 1980s, include greater disease resistance, heat tolerance, fitness and high reproductive traits. Together these lead to more calves weaned per 1000 cows mated, with calves exhibiting lower birthweight but higher weaning weight (Table 1).

To estimate the impact of genetic improvement on the emissions intensity of beef production, historical data and Australia’s national inventory procedures (AGO 2004), as applied by Alford et al. (2006), were used to calculate the t of \( \text{CH}_4 \) of calves weaned on NAPCO’s oldest and largest breeding property, ‘Alexandria’. Alexandria is located on the plains of the Barkly Tableland in the Northern Territory, with a summer dominant annual rainfall of 382 mm, which supports a Mitchell Grass (\( \text{Astrebla} \) spp.) dominant pasture. In this simulation, \( \text{CH}_4 \) emissions for a cow + calf pair and cows

**Table 1.** Production data provided by the North Australian Pastoral Co. managers, for the previous Shorthorn herd (1981) and the current composite breed herd (2005) grazed on ‘Alexandria’ in the Barkly Tableland of Australia’s Northern Territory

<table>
<thead>
<tr>
<th></th>
<th>Shorthorn</th>
<th>Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow weight (kg LW)</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Calf birthweight (kg LW)</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>Weaning weight (kg LW)</td>
<td>190</td>
<td>220</td>
</tr>
<tr>
<td>Weaning rate (calves/100 cows)</td>
<td>55</td>
<td>80</td>
</tr>
</tbody>
</table>

Weaning rate is the number of calves weaned per 100 cows mated.
emitted which failed to wean calves were calculated for the 1981 herd (shorthorn cows) and the current composite breed cow herd for 2006. The methodologies of the Australian National Greenhouse Gas Inventory (AGO 2004) were used to model the CH4 production of the composite herd and different liveweights (LW) and growth rates of the cows and resultant calves (Table 1).

The AGO (2004) methodology for calculating enteric CH4 production uses the equation of Minson and McDonald (1987) to predict dry matter (DM) intake while daily enteric CH4 emission from cattle grazing tropical pastures is calculated as kg CH4/animal.day = (41.5 x kg DM intake/animal.day – 36.2) x 1000 (Kurihara et al. 1999; AGO 2004).

Pasture digestibility was taken from the AGO inventory values for the Northern Territory pastures, which are 40, 65, 55 and 45% DM digestibility for spring, summer, autumn and winter, respectively. Pasture quality was assumed unchanged between 1981 and 2006. Calving occurs from September to December and the animals are weaned and immediately transported to other properties between April and July. Following the AGO (2004) methodology the feed intake of cows was adjusted for lactation, and a 5% calf mortality rate was included. Therefore, for a weaning rate of 55% for the shorthorn herd for 2006. The methodologies of the Australian National herd (shorthorn cows) and the current composite breed cow herd did not account for the lower emissions accruing from having to carry fewer replacement heifers in the breeding herd as weaning rate is increased.

This improvement in emissions intensity must be balanced against an increase in the total number of cattle able to be grazed on the property and so increased total CH4 emission in 2006 (47 916 breeding cows) relative to 1981 (33 370 breeding cows). This increased capacity has largely resulted from an increase in the number of watering points, which allows a greater proportion of the land area to be grazed. Consequently, the total calculated CH4 produced by the Alexandria cow herd and calf crops in 1981 and 2006 were 4363 t CH4 and 7290 t CH4, respectively.

**Improved feed-base**

Leng (1991) estimated that slow growth of cattle resulting from consumption of low digestibility pastures may lead to an emissions intensity of 1 t CH4/t LWG for the individual. Using tropical Australian grasses, Kurihara et al. (1999) demonstrated this emission intensity could be reduced to ∼0.25 t CH4/t LWG by improving growth rates through improved nutrition. By planting and utilising perennial fodders (such as *Leucaena leucocephala*) and pastures such as buffel grass (*Cenchrus ciliaris*) and legumes (*Stylosanthes* spp.), northern pastoralists aim to reduce seasonal fluctuations in feed supply and improve animal performance. While no field data on effects of these strategies on emissions in the tropics appear to exist, modelling in temperate areas indicates pasture improvements cause a far greater proportional increase in animal production and farm gross margin than they do in CH4 production, thereby reducing the emission intensity of the grazing system (Alcock and Hegarty 2006). In addition, feed supplementation of animals consuming tropical pastures with manufactured products containing N and

| **Table 2. Productivity and enteric methane emission characteristics of shorthorn cattle (1981 data) and composite cattle (2006 data) on ‘Alexandria’ in Northern Australia** |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | Spring          | Summer          | Autumn          | Winter          | Annual          | Spring          | Summer          | Autumn          | Winter          | Annual          | Spring          |
| Cow liveweight (LW) (kg) | 400             | 422             | 444             | 422             | –               | 480             | 507             | 533             | 507             | –               | 480             |
| Cow daily LW gain (kg/day) | –0.24           | 0.24            | 0.24            | –0.24           | –0.29           | 0.29            | 0.29            | 0.29            | 0.29            | –0.29           | –0.29           |
| Weaning rate (calves/100 cows mated) | –               | –               | –               | 0.5             | –               | –               | –               | –               | –0.5            | –0.5            |
| Average calf LW (kg) | 35              | 126             | 190             | –               | –               | 32              | 138             | 220             | –               | –               |
| Calf LW gain (kg/day) | 0.5             | 0.9             | 0.7             | –               | –               | 0.5             | 0.9             | 0.7             | –               | –               |
| Feed digestibility (g/100 g dry matter) | 40              | 65              | 55              | 45              | –               | 40              | 65              | 55              | 45              | –               |
| Cow CH4 production (kg CH4/animal) | 20.5            | 29.6            | 27.4            | 21.5            | 21.5            | 23.8            | 36.9            | 32.7            | 24.8            | –               |
| Calf CH4 production (kg CH4/head/season) | 5.2             | 11.8            | 14.6            | –               | –               | 5.0             | 12.5            | 16.4            | –               | –               |
| CH4/cow + calf pair (kg CH4/head/season) | 25.7            | 41.5            | 42.0            | 21.5            | 21.5            | 28.8            | 49.5            | 49.0            | 24.8            | 24.8            |
| Total t CH4/year per 1000 breeding cows | –               | –               | –               | 1307            | –               | –               | –               | –               | –               | 1521            |
| Emissions intensity (t CH4/t LW weaned) | –               | –               | –               | 1.25            | –               | –               | –               | –               | –               | 0.86            |

*Default values for patterns of seasonal LW change of cows and calves together with seasonal DM digestibility values are from AGO (2004).*
phosphorous, further improves the quality and digestibility of native pastures, and so increases animal productivity (Hennessy et al. 2000).

**Feedlotting**

Due to the market demand for younger slaughter cattle and the challenge of maintaining high growth rates during the pronounced northern dry season, NAPCO finishes ~65% of slaughter cattle in a feedlot. Grain-based, feedlot rations typically support higher rates of growth and lower daily rates of CH4 emissions by cattle than forage does and thus gives a substantially lower emissions intensity (Hegarty 2007). While the emissions associated with grain production and soil cultivation in particular are high (Van der Nagel et al., 2003), they are not included in this measure and the move to minimum-tillage grain production by NAPCO may substantially reduce the carbon cost of its grain production. The low emission intensity of feedlotting in addition to its assured high rates of animal performance underlies the planned expansion of feedlot capacity at Wannu.

**Eliminating low performance animals**

Cattle are monitored for growth performance before feedlot entry and during feedlot finishing. This enables removal of underperforming cattle throughout the supply chain, increases the overall feed-use efficiency and can, therefore, be expected to lower the emissions intensity (of enteric CH4) by the group. Underperforming cattle are usually sold as live store animals to local livestock markets.

These programs exemplify how generic, nutritional and management strategies to improve animal profitability and reduce age of slaughter cattle are consistent with lowering the emissions intensity of beef production. However, several processes involved in the production of beef, particularly in feedlotting, may have off-site GHG emissions embedded in inputs and other environmental impacts, such as soil and biodiversity loss during grain production. Therefore, further emissions reductions and sequestration opportunities are sought in the general farming and grazing operations in the future with the climate change and resultant GHG mitigation by the company. These programs exemplify how genetic, nutritional and management strategies to improve animal profitability and reduce age of slaughter cattle are consistent with lowering the emissions intensity of beef production. However, several processes involved in the production of beef, particularly in feedlotting, may have off-site GHG emissions embedded in inputs and other environmental impacts, such as soil and biodiversity loss during grain production.

What will climate change mean to NAPCO?

While NAPCO seeks to find solutions to GHG emissions, it is also necessary to consider how the company will continue operations in the future with the climate change and resultant ecological change predicted (Hughes 2003).
Coupled with biological manipulation of genetics, the rumen and pastures, other adaptive approaches are required with the industry such as improved efficiency of power generation and transportation, which are the other major contributors to GHG emissions in the pastoral industry. Future decision making about management of physical sources of GHG is, however, largely dependent upon the establishment of a clear and lasting administrative framework for emission management and targets. While industry may offer suggestions, this framework and the legal underpinning which it will require is largely the business of government. Future investment in targeted emissions management by pastoralists like NAPCO may be expensive, so clear and lasting government legislative position is required. In the absence of this, strategies that improve production efficiency and concurrently reduce emissions intensity are more attractive to industry than strategies that reduce emissions without enhancing productivity.

Conclusion

NAPCO considers that on-farm emission of GHG is a serious issue for the northern beef production business. In the context of global climate change, however, managing NAPCO emissions becomes a relatively modest issue compared with managing livestock production in the context of a warmer and more variable climate. This is particularly relevant as pasture-based production systems will directly bear the brunt of any potential climatic change. NAPCO will continue to support approaches to reduce emissions and adapt to climate change through involvement in research and development activities, but requires technical guidance to do so, particularly as there are many scientific issues that cannot currently be resolved without specialist advice.

It is imperative that NAPCO anticipate both the legislative and climatic framework in which the livestock sectors will be operating in future years. Improving reproductive and growth efficiency in the beef herd have provided ‘win-win’ outcomes for the company thus far, increasing the profitability while reducing the GHG emission intensity of the production system. Coupled with the adoption of new infrastructure technologies (e.g. solar power) and farming practices (e.g. minimum tillage), NAPCO has begun to address GHG mitigation and other facets of environmental sustainability in a manner that is consistent with the financial sustainability of the company. It is anticipated that in future, new mitigation or carbon sequestration strategies will continue to be incorporated within the context of enhancing the long-term environmental and economic prosperity of the farming system.

References


