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Climate Clever Beef

On-farm demonstration of adaptation and mitigation options for climate change in northern Australia

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Abstract

This project engaged with beef producers in five regions of northern Australia to identify management options that improve the performance and resilience of beef businesses. The work was done in the context of increasing the resilience of businesses to current climate variability as well as to projected changes in climate. The project also identified potential synergies and conflicts between improved business performance, climate adaptation practices and greenhouse gas emissions management.

Three regions (Qld Gulf, Fitzroy Basin and Victoria River District) evaluated climate adaptation and greenhouse gas mitigation options via a benchmarking and options analysis approach with three “focal” properties. Five indicators of performance were evaluated for each property – profitability, productivity, land condition, climate change risk and greenhouse gas emissions. These detailed business analyses were complemented by demonstration sites in each region. Two other regions (Qld Mitchell grasslands and NT Barkly Tablelands) used on-property demonstration sites to showcase promising climate adaptation practices identified in a previous project.

The focal property approach provided a systematic process for assessing current business performance as well as a ready means of estimating the impacts of management changes. For example, over a 15 year period, the Qld Gulf focal property improved its pasture condition dramatically by stocking around the long-term carrying capacity and undertaking wet season spelling. This, combined with herd management improvements, increased profitability and productivity, reduced greenhouse gas emissions by 15%, and improved greenhouse gas emission efficiency by >100%.

The demonstration sites in each region effectively promoted and documented the benefits of key grazing practices for improving resilience to both current climate variability and potential climate change. For example, on a 16,118km² property in the Barkly, a paddock demonstration has documented initial land condition recovery at old bores, and the reduced risk of overgrazing around new bores, through best practice stocking rate management and wet season spelling.

Qualitative analyses showed that many of the adaptation practices identified for improving resilience are consistent with existing best practice recommendations aimed at improving productivity and sustainability. Furthermore, these adaptation practices appear to have largely neutral implications for greenhouse gas emissions. In contrast, practices and options for reducing greenhouse gas emissions were more likely to create conflicts that leave enterprises more vulnerable to climate change. Examples of the negative consequences of mitigation measures include reduced pasture production associated with increased carbon sequestration in trees (i.e. woody vegetation thickening or regrowth retention) and increased operating costs associated with carbon pricing (if these are not offset with carbon credits).

The project demonstration sites and focal property benchmarking process provided a solid base for focussed extension work targeting the drivers of profit, land condition, greenhouse gas emissions intensity and climate adaptation strategies.

Executive summary

Productivity growth and returns on investment are generally static or declining across much of the northern Australian beef industry. Together with high debt levels and increased costs, these pressures are seriously undermining the resilience of beef businesses to climatic variability and market shocks. That said, recent analysis in the sector has found that some businesses are performing well, which suggests there are opportunities to increase the average performance (and resilience) of the industry. Animal production and land management research in northern Australia has highlighted several areas of opportunity to lift performance in a cost-effective way. However, when faced with an array of choices, it is often difficult for producers to determine which will deliver the best return on investment for their business in the medium to long-term.

This project engaged with beef producers in five regions of northern Australia to identify management strategies that improve the performance and resilience of beef businesses. The work was done in the context of increasing the resilience of businesses to current climate variability as well as to projected future changes in climate. The project also undertook analyses to identify potential synergies and conflicts between improved business performance, climate adaptation practices and greenhouse gas emissions management. Industry engagement was achieved via on-property demonstration sites, case studies and a large number of industry forums, field days and workshops.

Three regions (Qld Gulf, Fitzroy Basin and Victoria River District) evaluated the relative performance of management options using a benchmarking and scenario analysis approach with three “focal” properties. These detailed analyses were complemented by a suite of on-property demonstration sites in those regions. The other two regions (Qld Mitchell grasslands and NT Barkly Tablelands) explored locally-relevant adaptation options using on-property demonstration sites. All sites have been documented in this report and via fact sheets available on the internet (http://futurebeef.com.au/resources/projects/climate-clever-beef/).

The focal property analyses used a systematic process to assess current performance and estimate the likely impacts of locally-relevant management options. Five indicators of performance were evaluated for each property – profitability, productivity, land condition, climate change risk and greenhouse gas emissions. For example, in the Qld Gulf region, potential improvements in business resilience were linked to options that improved overall return on assets, gross margin ratio and overhead ratio. For this region, options that reduced the high cost of supplementation (i.e. better targeted supplementation) also performed well. Poor land condition is an issue on some properties in northern Australia, but the Qld Gulf focal property analysis clearly demonstrated how stocking around the long-term carrying capacity and implementing wet season spelling over a 15 year period led to dramatic improvements in land condition. This improvement in land condition, combined with herd management improvements, increased productivity and profitability, reduced total greenhouse gas emissions by 15%, and improved greenhouse gas emissions efficiency by >100%. The analysis identified additional opportunities to increase productivity and emissions efficiency including the use of foetal aging of cows at pregnancy diagnosis, more efficient feeding of weaners, and use of Near Infrared Spectroscopy (NIRS) to improve supplementation efficiency.

At one of the Qld Gulf demonstration sites, the benefits of infrastructure development and associated improvements in grazing management were assessed and documented with respect to pasture condition, animal production, profitability and greenhouse gas emissions intensity. This analysis showed that over the 5 years from 2007 to 2011, there had been a 68% improvement in gross margin due to higher carrying capacity and higher turn-off rates. Over the same period, total greenhouse gas emissions increased by 14% due to higher stock numbers, but emissions intensity had improved by 21% as a result of lower breeder mortality rates and higher turn-off.

For the Fitzroy region focal property, the business analysis identified that turnover was a key driver limiting business performance. The owners worked with the project team to evaluate a range of options including reducing breeder numbers in order to grow male cattle out to 450kg, using leucaena to increase turnover, and alternative marketing options. The impacts of various brigalow regrowth management options on production and income were also evaluated. Reducing the breeder numbers to grow out male cattle increased the gross margin per adult equivalent (AE) but slightly reduced the gross margin for the herd. This option also reduced total emissions and emissions intensity by 10%. The brigalow regrowth options impacted on the financial performance of the business to varying degrees and were very sensitive to the cost of the regrowth management option selected, carbon price and whether or not livestock methane emissions were accounted for.

The focal property analysis for the VRD showed that there was a need to dilute overheads by improving the amount of live weight turned off and/or improving sales returns. The main opportunities to improve productivity in the VRD include increasing weaning rates, reducing breeder mortality and optimising live weights at sale. Ten improvement options were evaluated. The best performing options (economically) were to grow out and market some or all of the sale cattle on higher quality pastures in Queensland. Early weaning and improved pasture development on-property also performed better than “business as usual” by increasing weaning rates, live weight gains and turn off. These options also reduced total greenhouse gas emissions and emissions intensity. For some properties in the VRD, increasing carrying capacity via infrastructure development is still a high priority. The business analysis showed that the profitability of this option is sensitive to the amount of additional carrying capacity that can be realistically achieved and that total emissions will increase in line with increased stocking rate.

The demonstration sites in the Qld Mitchell Grass and NT Barkly regions provided an effective way of promoting and documenting the benefits of grazing practices that show potential to improve resilience to both current climate variability and potential climate change. For example, on a 16,118km^2 property in the Barkly, a paddock demonstration has documented initial land condition recovery at old bores, and the reduced risk of overgrazing around new bores, via best practice stocking rate management and wet season spelling. Data and observations confirmed that water point development had effectively spread grazing pressure more evenly across the paddock, and that switching bores on and off can be a practical and effective way of spelling country close to water. This management approach kept average stocking rates and average pasture utilisation rates within recommended levels for the paddock despite a range of seasonal conditions. Wet season spelling and stocking rate management were also a strong focus of the demonstrations, case studies and field walks in the Qld Mitchell Grass region

A cross-regional analysis was undertaken to evaluate potential synergies and conflicts between best management practices (for climate adaptation) and greenhouse gas mitigation. A qualitative analysis summarised a number of management options associated with managing stocking rates, production efficiency, woody vegetation management, burning and social/policy issues. Using evidence from the literature, and consultation with producers and advisers, the impacts of these management options on productivity, profitability, environmental sustainability and greenhouse gas emissions were rated as negative, neutral or positive.

Using simulation modelling, a more detailed quantitative analysis was subsequently undertaken for three key practices: (1) adjusting stocking rates to maintain safe utilisation levels, (2) improving land condition from C to B condition; and (3) managing for increased tree carbon stores.

The qualitative analyses suggested that proposed adaptation measures will have largely neutral implications for greenhouse gas emissions. The adaptation measures are also consistent with existing best practice recommendations aimed at improving productivity and sustainability. In contrast, mitigation measures are more likely to create conflicts that leave enterprises more vulnerable to climate variability and climate change. Examples of the negative consequences of mitigation measures for adaptation include reduced pasture production associated with carbon sequestration in trees (i.e. woody vegetation thickening or regrowth retention) and increased operating costs associated with carbon pricing (if these are not offset with carbon credits).

In general, the analysis found that where there are improvements in the greenhouse gas emissions efficiency, there are potential negative risks to the total greenhouse gas emissions balance if stocking rates or throughput of animals are increased to take advantage of faster animal growth rates and earlier turn off. The simulation modelling showed that the effectiveness of mitigation measures in the northern rangelands will be extremely sensitive to future changes in climate (and associated adaptation actions).

In just two years, the network of focal properties and demonstration sites reached a total audience of over 1,100 producers (through media and related communications) and improved the knowledge and skills of at least 350 producers through field days, workshops and paddock walks. More than 90 producers have already made significant practice changes consistent with cost-effective implementation of best practice options. These sites provide a solid base for focussed extension work targeting the drivers of profit, land condition, greenhouse gas emissions intensity and climate adaptation strategies.

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- DAFF Qld - Steven Bray (Project leader), David Phelps (Adaptation components and Mitchell Grass region leader), Joe Rolfe, Bernie English, Kiri Broad and Rebecca Gunther (Qld Gulf region), Byrony Daniels, Peggy Rohan and Mick Sullivan (Fitzroy region) and Rebecca Gowen (bio-economics and economic and herd options analysis)
- NT DPIF - Dionne Walsh (NT leader), Robyn Cowley, David Ffoulkes, Casey Collier, Peter Shotton and Trudi Oxley (VRD-Douglas Daly and Barkly regions)
- CSIRO - Chris Stokes (cross-regional analysis), Ed Charmley (livestock methane), Neil Macleod (bio-economics), Leigh Hunt (VRD-Douglas Daly region modelling).

The project team would like to sincerely thank the participating landholders and property managers who generously shared their experience and business details with the project team. We hope you have been able to gain some additional insight into your businesses through this project to make your businesses more successful into the future.

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1 Background to the Climate Clever Beef project

1.1 The northern Australian beef industry

Due to the relatively low pasture productivity and consequent low stocking rates, northern beef properties tend to be large and have higher average herd sizes than properties in southern Australia (Gleeson *et al.* 2012, Thompson & Martin 2012). The average property size in the Northern Territory, for example, is >3,000km² (ranging from <1,000km² to >12,000km²). In northern Australia, 87% of the beef cattle herd is situated on properties with more than 800 head of cattle and some herds exceed 40,000 head (Thompson & Martin 2012).

Most of the beef from northern Australia is destined for overseas markets. Just over half of the cattle slaughtered domestically are sourced from northern Australia, and 85% of this is exported as frozen or chilled meat (Gleeson *et al.* 2012). Indonesia is Australia's primary market for live cattle exports and accounted for more than 60% of total live cattle exports in 2010-11. Over 90% of cattle for Indonesia are sourced from northern Australian ports (Thompson & Martin 2012). In the past decade, many producers in northern Australia have focussed their production towards the Indonesian trade. This trade is currently undergoing major changes, including enforcement of a 350kg weight limit, the temporary suspension of trade in June 2011 and uncertainty about import quotas. Broader community issues such as land condition, reef water quality, climate change and animal welfare are also impacting on the industry through trade and policy objectives.

1.2 Profitability and productivity

Productivity growth and returns on investment are generally static or declining across much of the northern Australian beef industry. Since 1999-2000 return on assets (ROA) for the northern Australian beef industry have averaged 2.1% (ABARES 2012) and productivity growth has averaged 1.5%. However, the top 20% of producers are consistently achieving ROA over 7% indicating scope for improvement (McCosker *et al.* 2010). Major concerns for the industry as a whole include the increasing cost of production which has led to an average expense ratio[1] greater than 100% in seven of the nine years to 2009 (McCosker *et al.* 2010). This has been partly driven by increasing land values (up to 2009) which allowed producers to continue drawing on equity to increase their borrowings.

The poor profitability and productivity in northern Australian beef businesses is seriously undermining the resilience of beef businesses to climatic variability and market shocks. Research in northern Australia has highlighted several areas of concern (and opportunity). These include:

- Poor reproduction rates (Schatz & Hearnden 2008, Schatz *et al*. 2008, McCosker *et al*. 2010, McGowan *et al*. 2011):
    - wet cow re-conception rates below 10%
    - first lactation female re-conception rates below 20%
    - dry cow conception rates below 70%
    - high losses between pregnancy diagnosis and weaning
- Poor husbandry and stock control practices resulting in suboptimal live weight gain performance and high mortality rates (e.g. Henderson *et al*. 2013)
- Poorly targeted or implemented supplementation programmes (high direct costs and/or sub-optimal productivity gains) (McCosker *et al*. 2010)

[1] Expense ratio is total costs (not including capital expenditure) divided by gross product (total income from livestock sales minus livestock purchases plus the change in the $ value of the herd).

- Overstocking and/or poor distribution of cattle across properties (Hunt *et al*. 2013)
- Poor quality genetics, especially in relation to fertility traits (Schatz *et al*. 2010, McGowan *et al*. 2011)
- Mature frame size of cows too high for the available nutrition (McCosker *et al*. 2010)
- Inter-animal variability in live weight gain performance post weaning (Quigley & Poppi 2013)
- Direct costs rising from $25/LSU (livestock unit) in 1999-2004 to $44/LSU in 2005-2009. This rise in direct costs has not been accompanied by a consequent rise in productivity or sale prices (McCosker *et al*. 2010)

There is clearly an urgent need to implement cost-effective changes in order to increase profitability and resilience in the northern beef industry.

1.3 Land condition

Despite the generally good land condition across northern Australia (Tothill & Gillies 1992), overstocking and continuous grazing has led to a significant decline in 3P (palatable, productive and perennial) grasses and land condition on some land types and in the vicinity of riparian areas and water points. Poor land condition has implications for:

- Forage production, pastoral productivity and profitability
- Offsite impacts such as reef water quality
- Impacts on biodiversity

Strategies for managing land condition in northern Australia were described in detail in a recent MLA-supported project (Phelps *et al.* 2012). The four key strategies are:

- Stocking rate management
- Wet season spelling
- Prescribed burning to manage woody vegetation thickening
- Infrastructure development to improve grazing distribution

1.4 Climate change

Climate change projections have been undertaken by the Queensland Centre of Climate Change Excellence (http://www.ehp.qld.gov.au/climatechange/regional-summaries.html) for various regions across northern Australia. Changes predicted for the Qld Gulf region, for example, indicate a potential increase in temperature of up to 4.4°C by 2070, leading to average annual temperatures well beyond those experienced over the last 50 years. Current projections suggest that by 2070, the number of days over 35°C at Burketown might double (increasing from an average of 102 per year to an average of 222 per year). Average annual rainfall in the Qld Gulf has increased by more than 3% in the past decade when compared to the previous 30 years. Despite this strong trend, this is within the range of natural variability experienced over the last 110 years, which makes it difficult to attribute it to long term climate change. Climate models predict a range of potential rainfall changes, from an annual average increase of 24% to a decrease of 26% by 2070. The 'best estimate' of projected rainfall change shows a decrease under all greenhouse gas emissions scenarios (QCCCE 2010). Projections indicate annual potential evaporation could increase by 7–14% by 2070. The higher temperatures and possibly more variable rainfall may lead to periods of additional cattle nutritional stress (Craine *et al.* 2010), further exacerbating issues with low productivity. Further analysis and discussion of the climate projections for other regions across northern Australia is presented in Section 9 of this report.

Key strategies for adaptation to climate change in northern Australia include:

- Optimising business profitability and having the flexibility to respond to, and survive, periods of climate stress.
- Maintaining good land condition and a high percentage of 3P (palatable, productive, perennial) grasses via stocking rate management, wet season spelling and prescribed burning.
- Maintaining good body condition so that cattle can remain productive during periods of climate stress.

1.5 Greenhouse gas emissions

Northern grazing businesses manage significant carbon stocks (in soils and vegetation) and greenhouse gas (GHG) emissions. Livestock methane emissions, land use change (tree clearing), fuel and energy use are the primary emissions for beef businesses (Australian Government 2013). Australia's reported greenhouse accounts indicate that livestock methane emissions account for 11% of national emissions (Australian Government 2013). The livestock grazing industry is regarded as emissions intensive because the industry accounts for significant reported emissions, although it only contributes around 1% to Australia's gross domestic product. Cattle in northern Australia are believed to emit more methane per head due to the poorer quality pastures and subsequent slower growth rates compared to cattle in more temperate environments (Rolfe 2010).

When considered on a per adult equivalent (AE) basis, Eady (2011) found that GREENHOUSE GAS emissions estimates were similar across the northern Australian pastoral regions (range 2.22-2.48 t CO_2-e/AE). However, when considered on the basis of emissions per tonne of live weight sold, there was considerable variation between regions. Estimates ranged from 14.5 t CO_2-e per tonne of live weight sold in the productive areas of central Queensland up to 31.7 in the Gulf country of Queensland (Eady 2011). This two-fold difference in greenhouse gas emissions per unit of product sold across northern Australia was attributed to the wide variation in rates of reproduction, mortality and growth (Eady 2011).

There is increasing pressure for the industry to reduce greenhouse gas emissions at the property scale and/or improve the emissions intensity of beef production generally. The three main options for improving the emissions performance of the industry are (1) reduce total emissions at the property scale, (2) improve the emissions intensity of beef production and (3) increase carbon sequestration. Fortunately, many of the strategies to improve the emissions performance of beef businesses are complementary to improving livestock productivity. The following strategies have potential to improve the greenhouse gas emissions performance of northern beef businesses:

- Improving breeder herd efficiency
    - Identifying and culling unproductive breeders
    - Genetic selection (for fertility)
    - Effective phosphorus supplementation
    - Heifer management (nutrition and selection)

- Improving diet quality and growth rates
    - Stocking rate management
    - Growing out and finishing animals on better quality country
    - Incorporating pasture legumes and other improved pastures
    - Integrating forage cropping where appropriate

- Improving land condition and associated soil carbon levels
    - Wet season spelling
    - Stocking rate management

  - Prescribed burning

- Increasing carbon sequestration via woody vegetation regrowth management in areas that have previously been cleared.

1.6 Summary

The previous sections highlight the precarious position faced by many beef businesses across northern Australia. The relatively poor financial and productivity performance suggests that the industry is very vulnerable to pressures such as climate variability, climate change, market shocks and the potential need to reduce greenhouse gas emissions. However, there are businesses in the industry that are performing well, and many of the solutions to improving productivity and profitability are already known. The difficulty for many producers is identifying which solutions are relevant to their business and which ones will deliver the best outcome for their investment. In order to provide some guidance to business decision making, the Climate Clever Beef project was established in five regions in Queensland and the Northern Territory (Figure 1.1). The project assessed a wide range of management options and their potential to improve overall business performance and resilience. Each option was evaluated for its potential to:

- Increase profitability
- Increase productivity
- Improve and maintain good land condition
- Reduce greenhouse gas emissions
- Reduce climate change risk

When considered together, the above five elements provide an insight into the relative resilience of pastoral businesses and indicate how adaptable they might be when opportunities or threats arise.

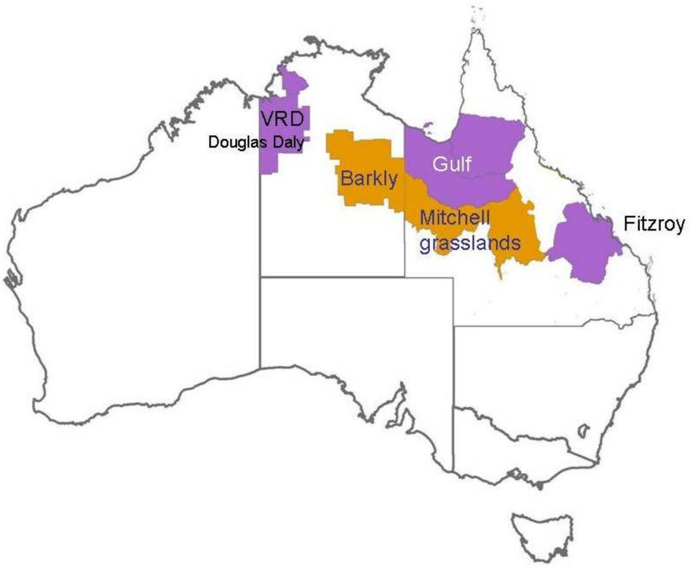


Figure 0.1 Climate Clever Beef project regions.

2 Success in achieving project objectives

2.1 Project objectives

In the Qld Gulf, Fitzroy Basin and VRD-Douglas Daly regions, the project aimed to:

1. Increase producer awareness, knowledge, attitudes and skills in the evaluation and implementation of climate change mitigation and/or adaption strategies through on-farm demonstrations and associated case studies and activities in each region
2. Evaluate the impacts of mitigation and adaptation strategies on resource condition, productivity, economic returns and mitigation at each site in each region using desk-top modelling informed by relevant data sets and any additional data from the site
3. Demonstrate a process in each region by which a cattle enterprise can systematically evaluate and identify the best combination of practices for a range of outcomes including mitigation and adaptation
4. Deliver a producer-oriented booklet or set of fact sheets for each region describing the strategy evaluation process, best practice recommendations and real-world examples of how to implement changed practices and technologies
5. Across regions, analyse the likely benefits, costs, trade-offs and risks presented by interactions between mitigation and adaptation options.

In the Barkly and Qld Mitchell grass regions the project focussed on adaptation options rather than mitigation options, and aimed to:

6. Increase producer awareness, knowledge, attitudes and skills in the evaluation and implementation of climate change and climate variability adaptation strategies through on-farm demonstrations and associated case studies and activities in each region
7. Evaluate the impacts of the possible adaptation strategies on resource condition, productivity, risk and economic returns at each site in each region using desk-top modelling informed by relevant data sets and any additional data from the site
8. Deliver a producer-oriented booklet or set of fact sheets for each region describing the strategy evaluation process, best practice recommendations and real world examples of how to implement changed practices and technologies.

2.2 Success in achieving objectives

The Climate Clever Beef project has been successful in achieving its objectives. Table 2.1 provides a summary of the key issues, the demonstration sites, major events, publications and project impact (practice change, ‘Knowledge, Attitudes, Skills & Aspiration’ - KASA and awareness) for each region. A short summation for each objective is presented below.

2.2.1 Objectives 1 and 6

Increased producer awareness, knowledge, attitudes and skills in the evaluation and implementation of climate change mitigation and/or adaption strategies through on-farm demonstrations and associated case studies and activities in each region.

The communication and evaluation plan developed at the start of the project set realistic targets for each region and provided a guide to monitoring and undertaking the extension activities. The demonstration sites and associated activities enabled the practice change, KASA and awareness targets to be exceeded across all regions (Table 2.1).

2.2.2 Objectives 2 and 7

Evaluation of the impacts of mitigation and adaptation strategies on resource condition, productivity, economic returns and mitigation at each site in each region using desk-top modelling informed by relevant data sets and any additional data from the site.

The business owners and project staff jointly identified the mitigation and adaptation strategies to be assessed. The three focal properties (and to a lesser extent the other demonstration properties) undertook a systematic process to determine the most promising or high interest strategies relevant to their business and region.

Each proposed management strategy was compared to the current (or historical strategy) and analysed to assess the impact on business resilience. Each strategy was evaluated in terms of its potential to:

- Increase profitability
- Increase productivity
- Improve and maintain good land condition
- Reduce greenhouse gas emissions
- Reduce climate change risk

The regional chapters throughout this report present the results of the evaluations for each demonstration site. Generally speaking, every region was able to identify management options that improved profitability whilst having positive impacts on productivity, land condition, greenhouse gas emissions and/or the ability to cope with climate variability and change.

2.2.3 Objective 3

Demonstration of a process in each region by which a cattle enterprise can systematically evaluate and identify the best combination of practices for a range of outcomes, including mitigation and adaptation.

In the Qld Gulf, Fitzroy and VRD-Douglas Daly regions the focal properties (Blanncourt, Jimarndy and Limbunya) participated in a systematic evaluation of their beef business to identify a range of management options to improve business performance. The analysis framework developed and used by the project is described in Section 3, whilst the results for the individual properties are presented in the regional sections (Sections 4 to 8). The steps undertaken with each business included:

- Evaluation of industry and regional issues
- Assessment of the financial and herd productivity of the current business
- Identification of practical management options with the owners/managers
- Comparative analysis and in some cases, trialling of management options
- Review of results and documentation of learning

Several other demonstration sites involved in the project used the analysis tools to understand the current business position and assess future impacts of management decisions.

The Climate Clever Beef analysis process has been very successful at achieving practice change, with all beef businesses making management changes (including changing marketing strategies) and improving record keeping, which will better enable the impact of management changes to be assessed in the future.

2.2.4 Objectives 4 and 8

Produce a producer-oriented booklet or set of fact sheets for each region describing the strategy evaluation process, best practice recommendations and real world examples of how to implement changed practices and technologies.

Each region has exceeded the target for producer-oriented fact sheets and case studies and other publications (Table 2.1). The case studies have been structured to highlight the current business performance and priority issues, and analyse the current (or historic) management against the improved management options. The results are presented in a way that compare the strategies against "business as usual" and documents the expected impact. Assumptions and issues with the different strategies are highlighted.

The fact sheets and case studies (Table 2.2) are an extension legacy of the project and are available from the Climate Clever Beef webpage (http://www.futurebeef.com.au/resources/projects/climate-clever-beef/). Field day notes, power point presentations, links to newsletter articles and conference papers are also available on this webpage.

2.2.5 Objective 5

Across regions, analyse the likely benefits, costs, trade-offs and risks presented by interactions between mitigation and adaptation options.

A cross-regional modelling analysis was undertaken to assess the potential conflicts and synergies of commonly recommended mitigation and adaptation management options (see Section 9). A qualitative analysis was undertaken to evaluate the relative consequences of management and policy options in terms of their impact on:

- Profitability
- Productivity
- Environmental sustainability
- Emissions intensity
- Total greenhouse gas balance
- Climate change adaptation

Generally most mitigation and adaptation options were found to have neutral or complementary effects on business performance and climate resilience. The primary conflict that arose was that increasing productive livestock carrying capacity will increase total emissions, even if emissions intensity is reduced.

A subsequent quantitative modelling analysis was conducted across ten northern Australian regions using three possible future climate scenarios in each region. Three management practices were assessed in more detail:

- Adjusting stocking rates to maintain safe pasture utilisation
- Improving land from poor (C) to fair (B) condition
- Managing increased tree carbon stores.

The results of the quantitative modelling indicated that the effectiveness of mitigation measures will be highly sensitive to future climate change, in part due to the interaction between soil carbon change and livestock methane emissions as carrying capacity changes with climate.

Table 0.1a Summary of the key issues addressed within each of the project regions, the demonstration sites, major events, publications and project impact.

Region	Key issues	Demonstration sites	Major events	Publications	Impact
Summary for project	Production efficiency • Poor forage quality • Reproduction efficiency • High costs • Marketing options Regrowth management Relationship between soil carbon, land condition and management Land condition • Stocking rate management • Wet season spelling • Prescribed burning Sustainable infrastructure development Production efficiency in good seasons	Target 20, Achieved 22 3 focal properties 1 group of 7 properties 16 demonstration sites	Field days , forums Target 20, Achieved 32 Other events Target 18, Achieved 27	Target 11, Achieved 21 Fact sheets, case studies and links to newsletter articles can be accessed on the Climate Clever Beef webpage http://www.futurebeef.com.au/resources/projects/climate-clever-beef/	Practice change Target 65, Achieved 94 KASA Target 152, Achieved 350 Awareness Target 875, Achieved >1168 (direct awareness)

Table 2.1b Summary of the key issues addressed within each of the project regions, the demonstration sites, major events, publications and project impact.

Region	Key issues	Demonstration sites	Major events	Publications	Impact
Qld Gulf	Production efficiency • Poor forage quality • Reproduction efficiency • High costs • Marketing options Stocking rate management Wet season spelling Infrastructure development	Target 2, Achieved 3 Blanncourt (focal) Greenhills Namuel	Field days, forums Target 2, Achieved 11 Blanncourt Station field day Days in collaboration with NGRMG Other events Target 6, Achieved 10 Climate Change session NGRMG Presentation at NBRUC GLM EDGE workshop	Target 2, Achieved 4 Blanncourt case study Greenhills case study Stocking rate factsheet Phosphorus supplementation and greenhouse gas emissions fact sheet	Practice change Target 5, Achieved 20 KASA Target 20, Achieved 197 Awareness Target 130, Achieved 233
Fitzroy	Production efficiency • Reproduction efficiency • High costs • Marketing options Regrowth management Relationship between soil carbon, land condition and management	Target 2, Achieved 3+ Jimarndy (focal) Clarke Creek group (seven properties) Avocet Oaklands Clarkwood Trafalgar (Burdekin)	Field days, forums Target 3, Achieved 7 Jimarndy Clarke Creek group 5 field days with Climate Savvy Grazing project Other events Target 1, Achieved 4 Rising Champions forum and BeefUp Beef 2012 Seminar Stocktake	Target 3, Achieved 5 Jimarndy regrowth modelling Clarke Creek soil carbon results Avocet and Clarkwood herd modelling and GHG emissions Trafalgar carbon farming Clive Feedback Magazine article	Practice change Target 3, Achieved 9 KASA Target 25, Achieved 30 Awareness Target 120, Achieved >164

Table 2.1c Summary of the key issues addressed within each of the project regions, the demonstration sites, major events, publications and project impact.

Region	Key issues	Demonstration sites	Major events	Publications	Impact
VRD - Douglas Daly	Production efficiency • Supply chain, marketing • High costs, debt • Reproduction efficiency • Live weight gain Land condition • Stocking rate management • Wet season spelling • Prescribed burning • Infrastructure development Relationship between soil carbon and grazing management in intensive systems in the Douglas Daly	Target 2, Achieved 4 Limbunya in VRD Midway, Maneroo and Bonalbo in Douglas Daly	Field days, forums Target 2, Achieved 1 NBRUC tour Other events Target 2, Achieved 2 Landcare & NRM Forum GLM workshop	Target 2, Achieved 1 Soil carbon in Douglas Daly Limbunya case study (to be completed in project extension)	Practice change Target 3, Achieved 6 KASA Target 8, Achieved 18 Awareness Target 50, Achieved 146
Mitchell Grasslands	Land condition • Wet season spelling • Stocking rate management Production efficiency in good seasons Infrastructure development	Target 12, Achieved 10 Dunblane demonstration and field day site Nine paddock walk case study sites (Rodney Downs, Loongana, Goodwood, Spoilbank, Wongan, Malvern Hills, Banjoura, Escombe Downs, Rainsby)	Field days, forums Target 12, Achieved 12 Dunblane field day Nine paddock walks Two planning forums (Longreach, Westech) Other events Target 7, Achieved 6 Western RBRC Collaborative DCQ events	Target 2, Achieved 7 (with 8 more in draft stage) 3 fact sheets 1 planning kit 1 Technical Guide 2 YouTube videos 6 written case studies in draft form 2 YouTube case studies in production	Practice change Target 50, Achieved 49 KASA Target 90, Achieved 86 Awareness Target 525, Achieved Nationally 250,000 (Landline) State-wide 33,725 (Queensland Country Life) 8-9,000 regionally (Longreach Leader and ABC regional radio)

Table 2.1d Summary of the key issues addressed within each of the project regions, the demonstration sites, major events, publications and project impact.

Region	Key issues	Demonstration sites	Major events	Publications	Impact
Barkly	Land condition • Stocking rate management • Wet season spelling Sustainable infrastructure development	Target 2, Achieved 2 Alexandria Beetaloo	Field days , forums Target 1, Achieved 1 Barkly Herd Management Forum paddock walk Other events Target 2, Achieved 5 NBRUC conference presentation GLM follow-up day NRM & Landcare Forum NTCA conference Barkly Herd Mgmnt Forum	Target 2, Achieved 8 1 Technical Guide 1 Alexandria Case Study 2 Frontier Mag. articles 3 Barkly Beef articles 1 Paddock walk booklet	Practice change Target 4, Achieved 10 KASA Target 9, Achieved 22 Awareness Target 50, Achieved 148
Cross regional analysis	Conflicts and synergies between mitigation and adaptation management actions Stocking rate Production efficiency Woody vegetation and fire Social and policy	Modelling undertaken in 10 regions across northern Australia. 3 climate scenarios		Fact sheet summarising the modelling will be developed.	

Table 0.2a Publication list from the Climate Clever Beef project. Links to most publications are available on the Climate Clever Beef webpage (http://www.futurebeef.com.au/resources/projects/climate-clever-beef/).

Publication type	Publication list
Conference papers	Bray, S., Walsh, D., Phelps, D. and Stokes, C. (2011). Climate Clever Beef. 1. Improving beef business resilience. Proceedings, Northern Beef Research Update Conference, 2011. NABRC, Park Ridge. 2011 NBRUC proceedings. Improving beef business resilience (poster). Collier, C. (2011). Climate Clever Beef. 2. A pasture spelling and stocking rate demonstration at Alexandria Station. Proceedings, Northern Beef Research Update Conference, 2011. NABRC, Park Ridge. 2011 NBRUC proceedings. A pasture spelling and stocking rate demonstration at Alexandria Station (poster). Daniels. B. and Bray, S. (2011). Climate Clever Beef. 3. Soil health comparisons between remnant forest and cleared pasture in the Fitzroy catchment. Proceedings, Northern Beef Research Update Conference, 2011. NABRC, Park Ridge. 2011 NBRUC proceedings. Soil health comparisons between remnant forest and cleared pasture in the Fitzroy catchment (poster). Broad, K., Bray, S., English, B., Matthews, R. and Rolfe, J. (2011). Adapting to beef business pressures in the Gulf. Proceedings, Northern Beef Research Update Conference, 2011. NABRC, Park Ridge. 2011 NBRUC proceedings. Adapting to beef business pressures in the Gulf (poster). Bray, S. (2012). Producing Climate Clever Beef in northern Australia: reducing emissions, increasing carbon sequestration. 17th Australian Rangeland Conference, Kununurra.
Case studies and fact sheets	• Mitchell grass pasture phases of growth (factsheet) • Land condition in the Mitchell grasslands, Open Downs land type (factsheet) • Mitchell grass seedling development (factsheet) • Estimating dry matter yield in Mitchell grass country (factsheet) • Assessment of a carbon offset project on Trafalgar Station, Charters Towers (Case study) • Evaluation of alternative mature cattle weights considering profitability, land condition and greenhouse emissions efficiency (Case study) • Evaluation of phosphorus supplementation to improve production and greenhouse gas emissions efficiency in northern Australia (factsheet) • Management and Soil Carbon in the Clarke Creek District (factsheet) • Evaluation of regrowth options for livestock productivity and carbon in the Fitzroy region (draft factsheet) • Greenhills Station: improving grazing land management through infrastructure development (Case study) • Lighter Stocking maintains 3P grasses- the backbone of profitable grazing systems (factsheet) • Blanncourt Station: productivity and profitability gains through efficient herd management (Case study) • Alexandria case study • Soil carbon and land management in the Douglas Daly (draft factsheet) • Beetaloo case study (draft)

Table 2.2b Publication list from the Climate Clever Beef project. Links to most publications are available on the Climate Clever Beef webpage (http://www.futurebeef.com.au/resources/projects/climate-clever-beef/).

YouTube videos	• Grazing in the good times. Dunblane field day. (YouTube video) • Mitchell grass paddock walk (YouTube video)
Field day handouts	• Perspective on Pastures Productivity and Emissions (handout) Clarke Creek Field Day, Nov 2011 • Carbon and grazing – finding the balance (handout) Jericho Beefup Forum, March 2012 • Stocking rate and pasture spelling demonstration site (booklet) Alexandria (Barkly) Paddock Walk, August 2011 • Making money in good seasons (handout) Dunblane Field Day, October 2011
Newsletter articles	• Show me the money! Alexandria trial pages 1-3 in Barkly Beef July 2011 • Considering pasture spelling this wet season? Alexandria trial page 6 in Barkly Beef December 2010 • Lessons learnt from soil testing pages 1-2 in CQ BEEF Issue 13 • Producer Profile-Robert and Jane Sherry page 12 in CQ BEEF Issue 12 • Northern Grazing Systems project in the Fitzroy Basin pages 8-9 in CQ BEEF Issue 10 • Climate Clever Beef Alan and Penny Wallace pages 21-23 MLA Feedback Magazine April 2012
Technical guides	• Mitchell grass Northern Grazing Systems technical guide • Barkly Northern Grazing Systems technical guide
Project information	• Climate Clever Beef information flyer

3 Business analysis framework and tool development

3.1 Business analysis framework

The northern beef industry is currently facing a challenging time in its history with significant pressure on profitability, productivity and environmental sustainability, and the threat of future climate change and emissions management. The process for identifying the best options to deal with these challenges starts with identifying strengths and weaknesses at the industry, regional and individual business levels. This is essential to understand the underlying drivers of current performance and to identify regionally-relevant solutions.

A common framework was developed by the project team based on experience from the CQ Beef and $avannaPLAN projects (Figure 3.1). The framework was subsequently used to systematically assess a range of management options for all three focal properties. The project team identified a number of relevant tools to undertake the analyses (Table 3.1). The tools used within the framework were not prescriptive which allowed each regional team to select approaches that were appropriate to the region and the scenarios being tested. Opportunities were taken to increase the skills of staff in using various tools, for example ProfitProbe™ in the Qld Gulf region and Breedcow and Dynama in the Fitzroy and VRD regions. The outputs from the analyses are a range of KPIs (key performance indicators) related to profitability, productivity, land condition, greenhouse gas emissions and climate change risk.

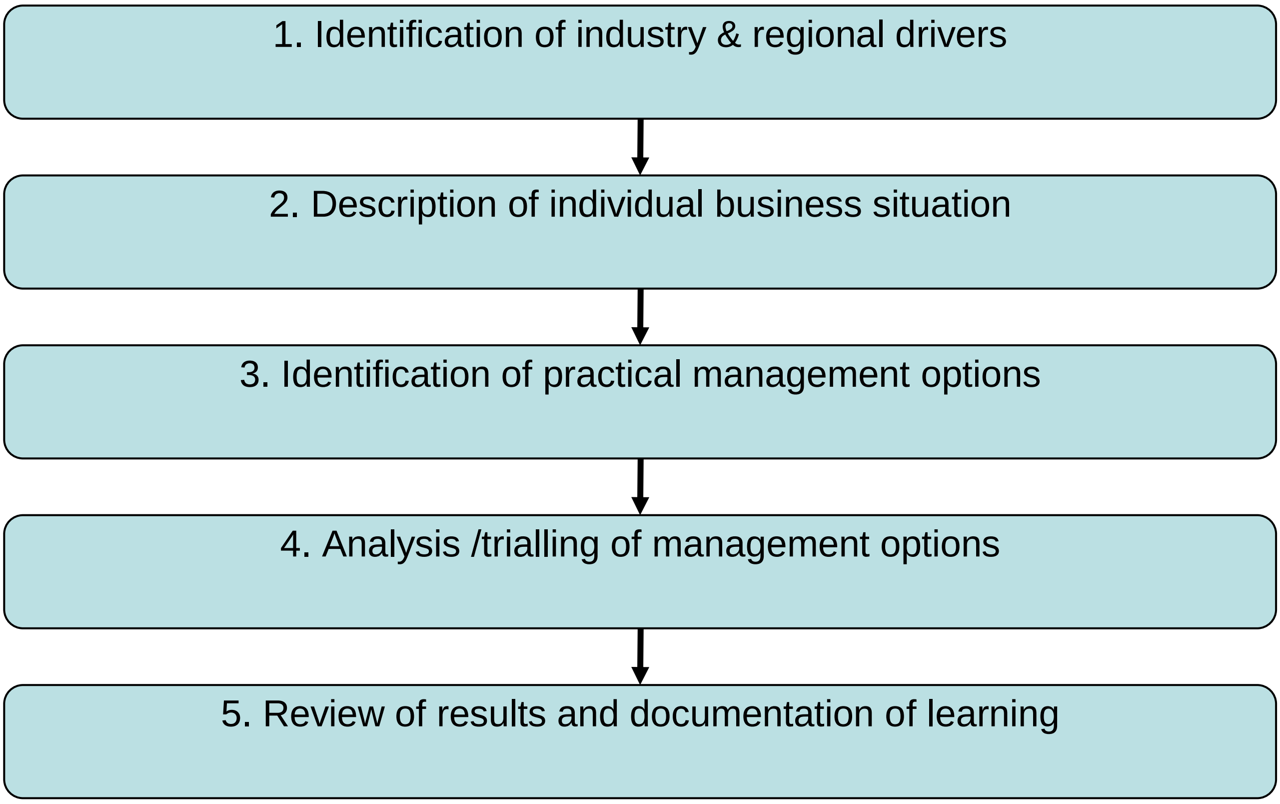


Figure 0.2 Climate Clever Beef framework used to systematically assess the performance of management options for improving business resilience.

Table 0.3 Data, tools and key performance indicators (KPIs) for evaluating business performance in the Climate Clever Beef project. Each team selected tools and KPIs that were most relevant to the region and businesses being evaluated.

Factor	Data	Available Tools and KPIs
Property description and property goals	– Resource description – Labour resources – Climate description including variability – Business history – Property goals or proposed change in direction – Document known/perceived trends and issues	Owner interview Story recording $avanna Plan in Gulf Property mapping land types and water circles
Profitability	– Business performance analysis – Herd records and modelling – Document known/perceived trends and issues	Profit Probe™ or enterprise analysis Breedcow and Dynama Story recording KPI and data units: – Overall Return on Assets % – Gross Margin Ratio – Overhead Ratio – Asset Turnover Ratio – Finance Ratio % – Expense Ratio % – Break even cost ($/kgLW) – Operating margin ($/kg LW)
Productivity	– Business performance analysis – Herd records and modelling – Document known/perceived trends and issues	Profit Probe™ or enterprise analysis Herd modelling (Breedcow and Dynama) Story recording KPI and data units: – Production per hectare (kg LW produced per ha) – Production per adult equivalent (kg LW produced per AE) – Weaning rate (%)
Land condition	– Land condition assessment (pasture, woody vegetation, erosion etc) – ID factors affecting land condition e.g. stocking rates, water placement, fencing, land type preference. – Document known/perceived trends and issues	ABCD land condition framework Satellite land cover (VegMachine) Paddock assessment Story recording KPI and data units: – % of property in ABC & D condition – Minimum land cover – % 3P grasses
Greenhouse gas emissions	– Business fuel, electricity and fire records – Herd records and modelling – Forage and woody biomass – Document known/perceived trends and issues	FarmGas scenario tool Richard Eckard's Beef Greenhouse Accounting Framework. CSIRO's livestock methane model Firescar mapping Forage and woody biomass Story recording. KPI and data units: – Emissions per kg beef sold (net)(kg CO_2-e/kg beef) – Emissions per ha (kg CO_2-e/ha/yr) – Emissions per $ profit (kg CO_2-e/$ profit)

Climate change risk	– Current climate risk strategies, current and proposed management practices impacting on adaptation to climate change – Document known/perceived trends, issues and risks factors to changing climate – financial, labour, production, land condition	Story recording. Document current and proposed climate risk strategies; destocking, feeding, stocking management, pasture resilience. NGS Regional Guides The KPI is a rating of the perceived ability to cope with the climate change risks (good, fair, at risk)
Business resilience and adaptability	Assess all the data from the other factors discussed above. – Productivity – Profitability – Land Condition – Greenhouse gas emissions – Climate change risk	The KPI is a rating of the perceived ability of the business to be resilient and adaptable to challenges and opportunities (good, fair, at risk)

3.2 Interface between Breedcow & Dynama and FarmGAS

One of the limitations of using various pre-existing tools and models is that the input and output data cannot necessarily be easily and efficiently transferred between them. One challenge for the Climate Clever Beef project was to efficiently calculate greenhouse gas emissions using the property data and subsequent herd modelling used to benchmark the current business situation and test alternative management options.

The project team worked co-operatively with the developers of the Breedcow & Dynama (Bill Holmes) and FarmGAS (Patrick Madden) models to build an interface to enable the efficient extraction of herd data from Breedcow & Dynama for inputting into the greenhouse gas emissions model. Sandra Eady (CSIRO) also contributed her expertise to this exercise. Significant progress has been made, however further data compilation and analysis is required for different regions to more confidently predict seasonal live weight gains and losses which are key inputs into the greenhouse gas emissions modelling.

The project team also contributed to scenarios for a report by Sandra Eady assessing greenhouse gas emissions from regional beef herds across northern Australia (Eady 2011). Two scenarios developed in that project were highly relevant to the Climate Clever Beef project:

1. Wet season phosphorous supplementation in northern cattle (e.g. Gulf region & NT)
2. Reduced stocking rates on improved brigalow country (e.g. Fitzroy region)

The wet season phosphorus supplementation scenario has been summarized into a fact sheet (http://cdn.futurebeef.com.au/wp-content/uploads/Phosphorous-factsheet_web.pdf).

4 Queensland Gulf region

Regional team: Joe Rolfe, Kiri Broad, Rebecca Matthews and Bernie English

Table 0.4 Summary of the key issues and demonstration sites in the Qld Gulf.

Key issues	Demonstration sites
Production efficiency • Poor forage quality • Reproduction efficiency • High costs • Marketing options Stocking rate management Wet season spelling Infrastructure development	Blanncourt (focal property) Greenhills Namuel

4.1 Regional drivers and issues

4.1.1 Regional description

The Queensland Gulf savannas cover 20,930,000ha or approximately 17% of the state of Queensland (Figure 1.1). The region has a monsoonal climate with dry winters, wet summers and extremes in temperature and rainfall. Average annual rainfall varies from 500mm in the south to 900mm in the north of the region, with the majority falling from December to March. Variability in rainfall increases from north to south, with extended dry periods more common in the southern part of the region. Conversely, the northern areas experience more regular flooding events. Maximum daily temperatures reaching 40ºC are common across the entire region in the summer while winter temperatures are milder in the north and frosts can be experienced in the south.

Beef enterprises in the Queensland Gulf vary in size from 25,000ha carrying up to 2,000 head to in excess of 500,000ha carrying up to 40,000 head. Ownership is a mix of large corporate organisations, large family companies and smaller family holdings. The region carries approximately 1.43 million head of cattle with a total value of annual turn-off exceeding $220 million.

Enterprises in the region are generally breeder operations with the progeny either sold to backgrounding or fattening operations further south, or transferred to a southern property to complete the next step in the beef supply chain. Store cattle are sold to live export (through Karumba, Townsville and Darwin ports) or to central and southern Queensland backgrounding and feedlot operations. Slaughter cattle mostly go through the export abattoir in Townsville.

For much of the annual production cycle herd performance is constrained by poor forage quality, with protein and dry matter digestibility levels less than 7% and 50% respectively (Table 4.2). This leads to weight loss during the dry season, breeder deaths, low conception and weaning rates and poor weight gain of younger cattle. Stylo pastures (Seca and Verano) are reasonably well established on the Climate Clever Beef demonstration properties. Forest Home data detailing weaner weight gains indicates a significant increase in carrying capacity and annual live-weight gain where stylos were oversown and established with native pastures (Table 4.3).

Table 0.5 Forage quality for different seasons and land condition# (based on extension experience, EDGE* Nutrition notes and Swans Lagoon faecal NIRS^ results). DMD = dry matter digestibility.

	Season	A/B land condition	C/D land condition
DMD %	Summer	58	53
DMD %	Autumn	50	45
DMD %	Winter	47	41
DMD %	Spring	43	40
Protein %	Summer	12.5	11
Protein %	Autumn	9	7.5
Protein %	Winter	6.5	5
Protein %	Spring	4	3
Energy	9.5-10 after rain		
MJ/kg DM	4.8 dry season		

* EDGE is a Meat and Livestock Australia education package. ^NIRS = Near infra red spectroscopy. # Land condition is rated from A (good) through B, C to D (very poor).

Table 0.6 Forest Home Producer Demonstration Site herd production of weaners over 3 years (starting weight 130kg)

Treatment	Weight gain kg/yr
Native pasture 1:4ha	60-120
Improved pasture 1:1.33ha	120-160

Continuous grazing, heavy stocking rates and land in poor condition reduces diet quality and selection and further impacts on herd performance. District 'Producer Demonstration Site' data clearly shows the impact of lighter stocking rates on annual live weight gains, cow weights and branding rates (Table 4.4).

Table 0.7 Namuel Producer Demonstration Site herd production at two stocking rates (1AE per 5ha and 1AE per 7ha)

Herd performance indicator	Stocking rate	Year 1	Year 2	Year 3	Average
Branding rates %	1:5	56	62	70	63
Branding rates %	1:7	67	72	79	73
Growth rate steers kg/yr	1:5	64	87		76
Growth rate steers kg/yr	1:7	96	111		104
Cull cow weight kg	1:5	418	438	358	405
Cull cow weight kg	1:7	497	464	400	454
Wet cow weight kg	1:5	327	378	358	354
Wet cow weight kg	1:7	381	384	400	388

4.1.2 Profitability and productivity

The beef industry in the Queensland Gulf is generally in a state of decline along with much of the northern Australian beef industry with poor return on assets (ROA) and low productivity growth.

Key issues for the Queensland Gulf include many of those identified by McCosker *et al.* (2010):

- Very poor reproduction rates.
- Poor husbandry and stock control practices.
- Poorly targeted or implemented nutrition programmes either making direct costs high or not getting the productivity gains required to fund supplementation.
- Overstocking and poor distribution of cattle across properties.
- Poor quality genetics, especially in relation to fertility traits.
- Frame size of cows too high for the available nutrition.
- Rising direct costs that have not been accompanied by a concomitant rise in productivity.
- Costs are a major issue for the Gulf region with transport to markets often being greater than $70 per head. Supplement transport costs also range from $60 to $90 per tonne.

4.1.3 Land condition

In their 1992 situation statement on the condition and productivity of the grazing lands of northern Australia, Tothill and Gillies estimated that 70% of the northern speargrass region is degraded to some extent with 55% amenable to rehabilitation through management (Tothill & Gillies 1992).

Land condition was assessed across 260 sites in the Northern Gulf region in 2003/04 (Shaw *et al.* 2007). Across all land types they found that 81% of sites were in A/B condition and 17% in C condition, however only 30-60% of the more fertile land types (Frontages, Black Soil, Goldfields and Georgetown granites) were in A/B condition. The extensive areas of C and D condition land have lower densities of 3P (palatable, productive and perennial) grasses, are less productive and less resilient to seasonal and long term climate variability.

4.1.4 Climate change risks

Climate change projections undertaken by the Queensland Centre of Climate Change Excellence (QCCCE 2010) for the region indicate an increase in temperature of up to 4.4°C by 2070, leading to average annual temperatures well beyond those experienced over the last 50 years. By 2070, Burketown may have more than twice the number of days over 35°C (increasing from an average of 102 per year to an average of 222 per year by 2070). Average annual rainfall in the last decade increased by more than 3% compared to the previous 30 years. This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to attribute this trend to climate change at this stage. Models have projected a range of rainfall changes from an annual increase of 24% to a decrease of 26% by 2070. The ‘best estimate’ of projected rainfall change shows a decrease under all greenhouse gas emissions scenarios (QCCCE 2010). Projections indicate annual potential evaporation could increase 7–14% by 2070. The higher temperatures and possibly more variable rainfall may lead to periods of additional cattle nutritional stress (Craine *et al.* 2010) exacerbating issues with low productivity.

Key **strategies for adaptation** to climate change in the region include managing stocking rates and wet season spelling to maintain a high percentage of 3P grasses. Overstocking and continuous grazing has led to a significant decline in 3P grasses on the better land types in the region (Shaw *et al.* 2007). Resilient enterprises into the future will rely on business/herd recording and management systems that constantly improve breeder mortality rates, reproduction rates and annual live weight gains.

4.1.5 Greenhouse gas emissions

The methane emissions of the herds in this region are low per hectare due to the low stocking rates (i.e. 10-25 ha/hd) however the relatively poor quality pasture, slow animal growth rates and low weaning percentages mean the methane emitted per kilogram of product produced will be relatively high (Rolfe 2010). Options to mitigate emissions through woody vegetation management are relatively limited due to the small areas of cleared land available for reforestation, although the extensive remnant savanna woodland is thickening (Burrows *et al.* 2002, Shaw *et al.* 2007) and therefore sequestering carbon. Improving pastoral land condition is expected to have some impact on carbon stocks as pasture biomass increases. Soil carbon levels in the region are relatively low with one study indicating the response of soil carbon to grazing land condition is relatively small and sometimes inconsistent (Bray *et al.* 2010).

4.1.6 Summary of Qld Gulf situation

The precarious position of many beef businesses across northern Australia means that they are not well placed to adapt to additional pressures of climate variability, climate change and the potential need to reduce greenhouse gas emissions. Given the economic challenges for businesses in the region, any new management changes to address environmental and greenhouse issues need to be carefully selected and assessed to ensure they also have appropriate productivity outcomes.

4.1.7 Demonstration property selection

Three demonstration properties were selected in the Qld Gulf region. The focal (Blanncourt) and demonstration (Greenhills and Namuel) properties are all located in the northern Gulf region west of Georgetown. The vegetation is predominately tropical savanna with a pasture layer of C4 native grasses and an open tree layer dominated by eucalypts. The main land types in this region are Georgetown Granite, and relatively infertile gravelly ridges, yellow clays and red earths intersected with more fertile strips of alluvial/frontage country along the major rivers and creeks. The climate is dry tropics with monsoon influences during the summer wet season of approximately four months duration, followed by an eight month dry season (Shaw *et al.* 2007). Median annual rainfall in the district is 779mm.

A business description and the focus of each demonstration property are outlined in the following sections.

4.2 Blanncourt (focal property)

4.2.1 Property description

Glen and Cheryl Connolly operate Blanncourt Station west of Georgetown on the Gilbert River in north Queensland (18,753ha) (Figure 4.1). The current owners purchased the property about 15 years ago, at which point it had been severely overgrazed and both land and cattle condition was poor. Considerable time and effort was spent improving land condition by reducing stocking rates, wet season spelling and pasture improvement. As a result they have increased weaning rates from less than 50% to around 70%, reduced death rates significantly and improved growth rates.

Figure 0.3 Glen and Cheryl Connolly operate Blanncourt Station west of Georgetown in the Gulf region.

4.2.2 Resource description

The property covers an area of 18,732ha and has 8 main land types (Table 4.5; Figure 4.2). Only four land types are regarded as having good grazing value with a combined area of 11,700ha (63% of the property). Fifty four hectares of fertile frontage country is cultivated for silage production.

Table 0.8 Blanncourt land types, area, grazing value, land condition and woodland thickening status. A value of 10 is given to the land types with the highest grazing value. Other land types are rated against the highest ones. Land condition in brackets is the condition 15 years ago. Severity of timber thickening is rated from 0 to 3 with 3 being the most severe.

Land type	Area ha	Grazing Value	A condition %	B condition %	C condition %	D condition %	Severity of woodland thickening
Frontage	3140	10	5 (0)	80 (15)	15 (80)	0 (5)	2-3
Poor alluvial	4611	8	5 (0)	80 (15)	15 (80)	0 (5)	0.5
Better granite	288	8	5 (0)	80 (15)	15 (80)	0 (5)	0
Red sandy	3677	6.5	5 (0)	80 (15)	15 (80)	0 (5)	3
Granite	252	3	5 (0)	80 (15)	15 (80)	0 (5)	1
Yellow clay	3104	3	5 (0)	80 (15)	15 (80)	0 (5)	3
Gravelly ridge	3325	1	5 (0)	80 (15)	15 (80)	0 (5)	0.5
Rock	345	0	5 (0)	80 (15)	15 (80)	0 (5)	0

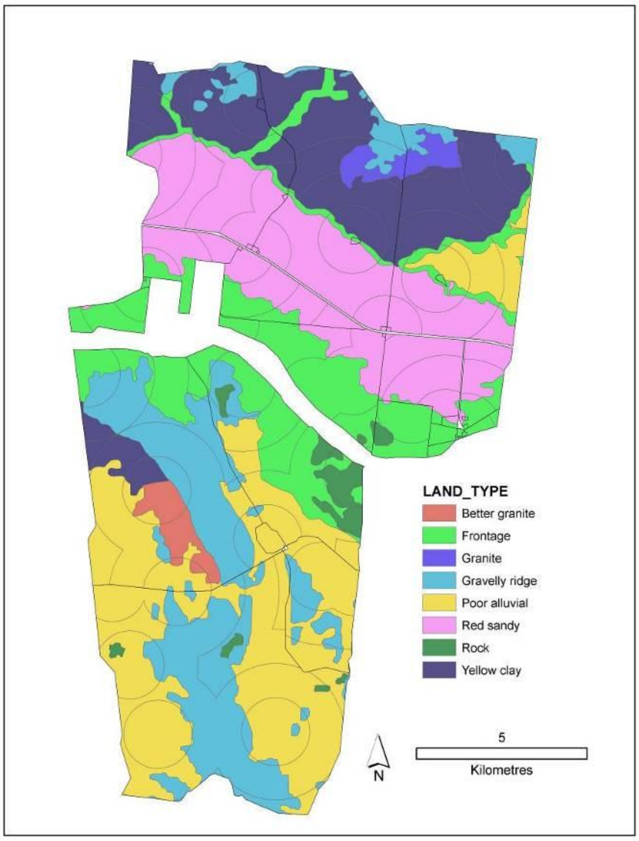


Figure 0.4 Land types on Blanncourt. The Gilbert River runs through the centre of the property.

Labour is provided by Glen and Cheryl, contributing two FTEs per year to land/cattle management, property maintenance and administration. Casual labour is purchased for intensive cattle management operations (e.g. mustering and branding). There is little spare labour capacity.

Infrastructure on Blanncourt is reasonably adequate with 13 paddocks greater than 200ha and approximately 30 water points. Distance to water should not be an issue with 77% of the property within 2km of water and 96% within 3km of water (Figure 4.3). The majority of the property > 3km from water is on the yellow clay land type with low grazing value. Many water points are enclosed within water squares and holding paddocks. Poor wet season access to the southern half the property across the river limits herd and property management options.

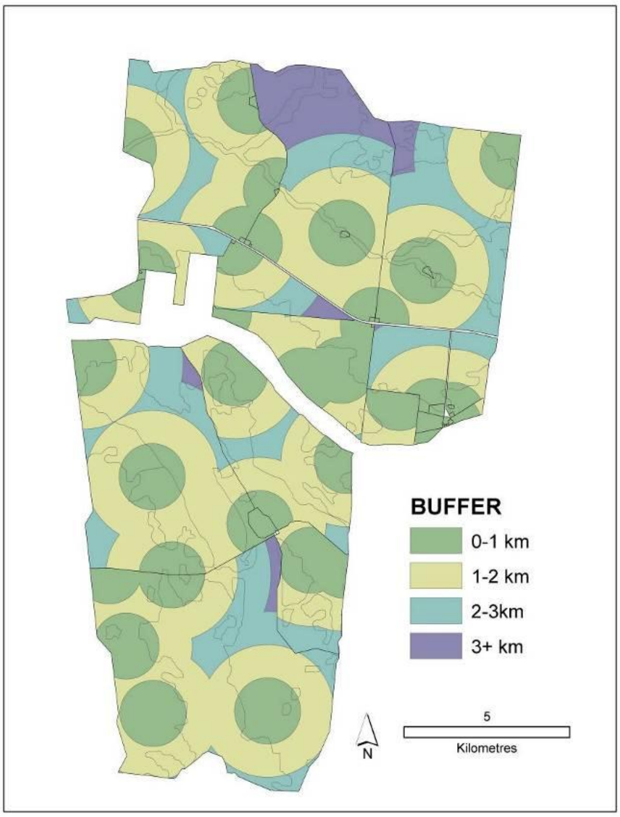


Figure 0.5 Distance from water points on Blanncourt.

Figure 0.6 Fencing and water infrastructure is adequate. Further development to improve herd and land management will depend on available capital in the future.

4.2.3 Herd management

Under current management cows are mated all year round with two main weaning rounds in May and September. Weaners are fed M8U (a urea/molasses supplement) until the start of the wet season and following the end of the wet season they are fed silage until they reach 370-400 kilograms. These cattle are then sent to Barmount feedlot in Central Queensland for 70 to 100 days finishing before slaughter. Cows receive a wet season phosphorous supplement and a dry season urea-based lick.

Cows south of the river are sometimes not accessible for long periods during the wet season. Supplementation would be improving the livestock productivity and greenhouse gas emissions efficiency of the business, but does come at a significant financial cost.

The fertile frontage has been fenced into smaller paddocks. Legume planting is ongoing on the frontage country to enhance wet season live weight gain and allows the weaner paddocks to be spelled over the wet season (Figure 4.5 and Figure 4.6).

Figure 0.7 Weaners on frontage country. Good weaner nutrition is a priority on Blanncourt. Cross breeding is used to meet market specifications.

Figure 0.8 Successful legume establishment on frontages

4.2.4 Profitability

ProfitProbe™ analysis of the business indicated that there was room for improvement, with three key performance indicators of Overall Return on Assets, Gross Margin Ratio and Overhead Ratio of particular concern (Table 4.6). Other areas of concern are discussed in the 'Identification of Options' section, however a key factor is the high cost of supplementation (~$50/AE).

Table 0.9 Blanncourt Key Performance Indicator (KPI) data summary. "White" and "Green" KPI's are outputs from ProfitProbe™. "Blue" KPIs are commonly discussed drivers for productivity. "Yellow" KPI's are greenhouse gas, climate change and land condition indicators. Targets are based on the experience of the ProfitProbe™ consultants and landholder aspirations. Benchmarks were achieved by the top 20% of businesses in northern Queensland who undertook ProfitProbe™. Priority level was based on business results and discussion between landholder and project officers.

Key Performance Indicator	2009- 10		Trend	Benchmark	Priority level
	Actual	Target	Up, Static or Down	2009/10	HML
Overall Return on Assets %	-1	2-3		6	H
Gross Margin Ratio	-4	>55		56	H
Overhead Ratio	31	<25		30	M
Asset Turnover Ratio	9	>15		1	M
Finance Ratio %	0	<25		<16	L
Expense Ratio %	111	<100		73	M
Break even cost ($/kgLW)	1.53			0.98	L
Operating margin ($/kg)	-0.12			0.65	H
(kg LW produced per ha)	12.7	15		43	M
(kg LW produced per AE)	99	102		104	L
Weaning rate (%)	69	72		>75	L
Emissions per ha (kg CO_2-e/ha/yr)	250		Down from 300 15 years ago		L
Emissions per kg beef produced (kg CO_2-e/kg beef)	11.7		Down from 25.1 15 years ago		L
Land Condition (% of property in A or B condition)(% of property in C condition)	85% A/B	95% A/B	Up from 85% C 15 years ago		L
Climate change adaptation indicator e.g. minimum land cover, % 3P grasses	>75% cover	80-90%	Up from <50% cover 15 years ago		L
Distance to water	77% within 2km 95% within 3km				L

4.2.5 Livestock productivity

When the property was first purchased, it had been severely overgrazed and both land and cattle were in poor condition. Considerable time and effort was spent improving land condition by reducing stocking rates, implementing wet season spelling and doing pasture improvement.

Non-irrigated silage is grown on 54ha of frontage country to improve weight for age of steers and heifers (Figure 4.7). Silage yield is 22-29 tonne/ha. Fertiliser application includes Urea at 247 kg/ha (46%N); DAP at 247 kg/ha (18%N and 20%P), and Potash Muriate at 247 kg/ha (50%K).

Figure 0.9 Forage sorghum on frontage country and silage pit.

Weaning rates have increased from less than 50% to around 70%, mortality rates have reduced significantly and growth rates have improved. On a property visit in 2008 it was noted that weight gains were 50-60kg/hd/year when the property was purchased, with current weight gains around 130-150kg/hd/yr, which the owner attributed to improvements in land condition, improved pastures and the cattle feeding program (Figure 4.8).

Figure 0.10 Supplementation and silage feeding boosts herd productivity but is a substantial direct cost on Blanncourt.

Blanncourt provided a good opportunity to accurately analyse the impact of reduced stocking rates on land condition, cattle performance and economic returns. Records from the time of purchase (1996) were used to provide a baseline for comparison to current herd performance. The herd structure assumptions and results are shown in Table 4.7. The baseline herd was a breeder herd of 2,100 producing just over 1,000 weaners with a gross margin for the herd of $102,000 (after imputed interest). The current herd consists of approximately 1,500 breeders producing approximately 1,000 weaners for a herd gross margin of $197,000 (after interest). The improvement in gross margin is primarily due to lower breeder mortality rates (which means additional cull cows to sell) and better weight gains in both breeders and weaners due to improved land condition.

Table 0.10 Blanncourt herd model assumptions.

	1996	Now	Difference
Total adult equivalents	2850	2550	-300
Total cattle carried	3615	2791	-824
Total breeders mated	2157	1503	-654
Total calves weaned	1014	1052	+38
Weaners/total cows mated	47%	70%	+23%
Total cows and heifers sold	218	510	+292
Total steers & bullocks sold	482	518	+36
GM after imputed interest	$102,153	$196,830	+$94,677
GM/AE after interest	$36	$77	+$41

Furthering the analysis above, a discounted cash flow was constructed to examine the costs of the investment that was required to achieve the increases in weaning rates and weight gains seen today (Table 4.8).

Table 0.11 Blanncourt infrastructure and development costs since 1996.

				Operation	Total
Dams		10	@	$9,000	$90,000
Dam squares		10	1.5km @	$9,000	$90,000
Subdivision fence					
	materials	7	km @	$3,000	$21,000
	labour	7	km @	$3,000	$21,000
	dozer			$12,600	$12,600
River fence					
	materials	5.5	km @	$6,000	$33,000
	dozer			$9,000	$9,000
River fence 2					
	materials	6	km @	$6,000	$36,000
	dozer			$10,000	$10,000
Short block fence				$12,000	$12,000
Tree thinning		1140	ha @	$92.80	$105,840
Clearing		650	ha @	$185.50	$120,600
Plant cleared country					
	disc	650	ha @	$72.30	$47,000
	seed and plant	650	ha @	$177.20	$115,200
Total					**$723,240**

4.2.6 Land condition and carrying capacity

Land condition has improved dramatically in the last 15 years with the amount of land in A and B condition increasing from 15% to 85% (Table 4.5). Fifteen years ago most of the land was in C condition following many years of overstocking and continuous grazing. Considerable time and effort have been spent improving land condition by reducing stocking rates, wet season spelling and doing pasture improvement.

Preliminary VegMachine analysis of satellite-derived cover index data between 1987 and 2008 indicates that much of the land south of the Gilbert River has a lower cover index than the average for that land zone across the region, while the land north of the river is similar to the average for that land zone across the region.

On a property visit in 2006, the owner estimated most of the property to be in B and C land condition. During the 2006 visit the red sandy and yellow clay land types were inspected across two paddocks. One paddock had been wet season spelled for two years and there was an obvious difference in pasture composition with the spelled area having a greater proportion of 3P grasses and higher pasture yields.

Woody weeds are an ongoing problem and containment measures include a combination of chemical control and wet season spelling to build fuel loads for fire. This has been very successful in controlling large areas of rubber vine on frontage country, however other weeds such as Calotrope and Breadfruit are now becoming a problem. Glen and Cheryl are committed to continuous improvement in land condition and carrying capacity and use conservative stocking rates. As mentioned previously, they have an ongoing pasture improvement program including the addition of legumes, particularly on the more fertile frontage country (Figure 4.9).

Figure 0.11 The productivity of frontage country has been restored through stocking rate management, wet season spelling and legume establishment.

4.2.7 Climate change risks and adaptation practices

The Blanncourt supplementation and silage feeding program is a strategy to counter seasonal variability and poor quality dry season feed. Glen and Cheryl can extend the length of feeding in response to increased climate variability and longer dry seasons. The enterprise can continue to produce a consistent, saleable line of cattle, however it does come at significant cost (~$50 per AE). Climate change adaptation has also been enhanced over the last 15 years by the improvement in land condition (15% A/B condition to 85% A/B condition) hence making the pasture and production systems more resilient. A future challenge is to continue refining grazing management strategies that improve and maintain land condition.

Figure 0.12 Silage feeding greatly improves weight gain and buffers the business during dry periods. However feeding and supplementation comes at a substantial cost.

4.2.8 Greenhouse gas emissions

Based on the current average herd size of 2,791 head (including 1,500 cows >2 years), 405.7 tonnes of live weight is sold annually. The total livestock emissions and the cropping emissions are 4,740 t CO_2-e/yr. The livestock emissions intensity of the business is currently 11.7 t CO_2-e/t of live weight sold. Fifteen years ago, with an average herd size of 3,615 head (including 2,160 cows >2 years) and 222.6 tonnes of live weight sold, total livestock emissions were 5,598 t CO_2-e/yr and emissions intensity was 25.1 t CO_2-e/t of live weight sold. Thus, total livestock emissions have reduced by 15% and the emissions efficiency has improved by >100% through management changes over the last 15 years (Table 4.9).

Current energy use comprises 30,333L of fuel and 12,065kWh of electricity which released 95.4 t CO_2-e or 2% of the total emissions for the property (Table 4.9). Energy use 15 years ago was assumed to be half of what it is today. Based on changes in land condition (Table 4.5), the carbon in pasture biomass has also increased by approximately 1,594 t CO_2-e per year over the last 15 years (Table 4.10).

Table 0.12 Greenhouse gas emissions for Blanncourt using Qld Gulf specific cattle weights, growth rates, calving times and feed quality (default FarmGAS values in brackets) for 15 years ago and currently.

	Methane t CO_2.e	**Nitrous Oxide** t CO_2.e	**Energy** t CO_2.e	**Total** t CO_2.e	**Emissions per kg sold** t CO_2.e/t LW	**Emissions per ha** t CO_2.e/ha
15 years ago						
Cattle breeding	5,156 (6,713)	394 (711)	48	5,598 (7,472)		
Total	5,156 (6,713)	394 (711)	48	5,598 (7,472)	25.1	0.3
Current						
Cattle breeding	4,209 (4,571)	401 (485)	48	4,658 (5,105)		
Cropping	0	35 (36)	47	82 (83)		
Total	4,209 (4,571)	436 (521)	95	4,740 (5,187)	11.7	0.25

Table 0.13 Average pasture biomass of land in B land condition and C land condition for different land types (based on measurements and experience in the Qld Gulf region)

Land type	Pasture biomass kg/ha B condition	Pasture biomass kg/ha C condition
Frontage	3,000	1,500
Poor alluvial	2,600	1,300
Better granite	2,500	1,250
Red sandy	2,100	1,050
Granite	2,000	1,000
Yellow clay	1,500	850
Gravelly ridge	1,000	500
Rock	0	0

4.3 Identification of options

The owners of Blanncourt consider themselves to be towards the end of the maturity phase of their business cycle (Figure 4.11) after spending considerable time and inputs over the last 15 years improving land condition, increasing weaning rates and improving weight for age of turn-off. These considerable inputs have led to improved gross product and achieved business growth.

The maturity phase of the business cycle is characterised by reaping the benefits of the growth phase. Maximum production is occurring in relation to the inputs and therefore is the most profitable phase for the business. However the business now needs to monitor overhead, maintenance and depreciation costs and gross margins. Thus, the business has reached ‘maturity’ and in-depth analysis is required to ensure it is sustainable.

Figure 0.13 Schematic of a business lifecycle. Y-axis is profit and x-axis is time (Source http://www.proximgroup.com.au/Understanding-The-Business-Life-Cycle-Is-Important-To-Improving-Your-Small-Business-Success.php)

The business analysis reported earlier highlighted that gross margin ratio is a priority area for attention. Direct costs are significant, in particular supplementary feeding, freight and selling costs. The supplementation program helps the business achieve ideal turnoff weights for steers and cull heifers and improves the efficiency of greenhouse gas emissions per kilogram of live weight sold. However current supplementation costs are $0.53 per kilogram of beef produced (~$50 per AE) compared to the regional average of $0.14/kg and the top 20% regional average of $0.06/kg of other businesses who have undertaken ProfitProbe™.

The primary reason for the high supplementation costs is due to the silage production and associated machinery and labour inputs. Although the property has no debt, high operating costs threaten business resilience. Finding an alternative to the current feeding system will require significant changes to the business structure as supplementation is currently required to achieve optimum weight-for-age at turnoff for grain finishing.

The business owners and local beef extension officers thus developed the following program to reduce feeding costs and increase business resilience:

- Introduce full pregnancy-testing including foetal ageing to allow increased culling of sub-fertile females. This will require additional heifers to be joined to allow for later culling but should result in more calves being born during the preferred window (October – December). Calves born during this window are better grown by the end of the wet season and will require less supplementary (silage) feeding than smaller calves.

- Segregate weaners into several groups based on weight and age to better target feeding programs. Older, heavier animals may require only a dry lick whilst smaller animals can be fed higher quality rations such as silage. Strict management including regular weighing is required to ensure that feed is only being consumed by those animals which will provide the greatest benefit.

- Breeders at Blanncourt have access to some kind of supplement all year round. NIRS faecal testing could be undertaken to monitor the decline in protein levels and improve the timing of supplementation, however this was not identified as priority by the business owners.

- Investigate alternative marketing options. Custom feeding cattle is an inherently marginal enterprise due to constantly changing feed costs and narrow margins. Suggestions for alternatives included selling direct to grass finishers in central Queensland or the local store market. The business owners agreed that this would be a good option. Due to the silage feeding on Blanncourt young cattle often appear 'round' and grow outwards rather than upwards which has led to past comments that 'they look great in the sale yards but no one could turn a dollar out of them'. As a result it is suggested that silage feeding be reduced which will lead to slightly lower growth rates and later turn-off but would significantly reduce feed costs.

- Like many producers, the business owners had thought about the possibility of becoming EU accredited to gain access to higher premium markets. They have the information on hand and just need to complete the process. EU accreditation requires that the use of hormone growth promotants (HGPs) is discontinued, something the owners had considered anyway. Accreditation would provide alternative marketing options including private sale to EU grass-finishers in central Queensland or EU grain finishing (Barmount does have limited EU capacity and several other accredited feedlots operate in Queensland).

The Blanncourt case study is available on the Futurebeef website (http://cdn.futurebeef.com.au/wp-content/uploads/Blanncourt_CS_web.pdf).

4.4 Greenhills

4.4.1 Property description

Greg and Carol Ryan operate Greenhills Station west of Georgetown on the Gilbert River in North Queensland (26,000 ha). There are several land types on Greenhills, with the main being frontages and black soils, Georgetown granites, red duplex and sand ridges. The average stocking rate across the property is close to 1 AE to 15-17 hectares.

Greenhills is run as a breeding operation, with steers and cull heifers sold to live export, southern backgrounding and finishing operations. Sale ages range from weaners to three years old, with the maximum age of turnoff being four years. Breeders are high grade Brahman, with some non-Brahman bulls being used more recently in the breeding program to aid marketing of cattle.

Until recently the station was broken into two halves, with the Gilbert River dividing the property. There were only two breeder paddocks, a bullock paddock and some smaller holding paddocks. Patch grazing was occurring, land condition and productive pasture species were in decline and in most years breeders were in poor condition by the late dry season.

Infrastructure on Greenhills is moderate with only 7-8 paddocks on the property. Distance to water is no longer an issue on the southern half of the property, but cattle may still walk up to 4km to water in the northern paddock. Poor access to half the property across the river (northern end) during the wet season limits herd management options, as the house complex is on the southern side of the property.

An infrastructure development program has been implemented on the southern half of the property (Figure 4.12, Figure 4.13 and Figure 4.14). This project divided an 11,475 ha paddock into three paddocks of 4,307, 4,710 and 1,958 ha, which with additional water points has greatly improved pasture utilisation and allowed wet season spelling to be introduced. These breeder paddocks now form part of a rotational grazing system.

Figure 0.14 Greg and Carol Ryan have invested in water infrastructure to open-up ungrazed country, even out grazing pressure and implement a wet season spelling program.

The Ryan’s have also focussed on breeder management (culling empty cows and controlled mating) and improving weaner management. Improvements in land condition and pasture quality have been identified through the use of photo monitoring points and improved cattle live weight gains. Breeder deaths have also halved due to controlled mating practices leading to fewer out of season calves and improved nutrition of breeders. Despite these improvements, weaning rates have not increased from 57%. However, higher stocking rates (due to improved pasture quality and quantity) has increased turnoff and boosted business performance.

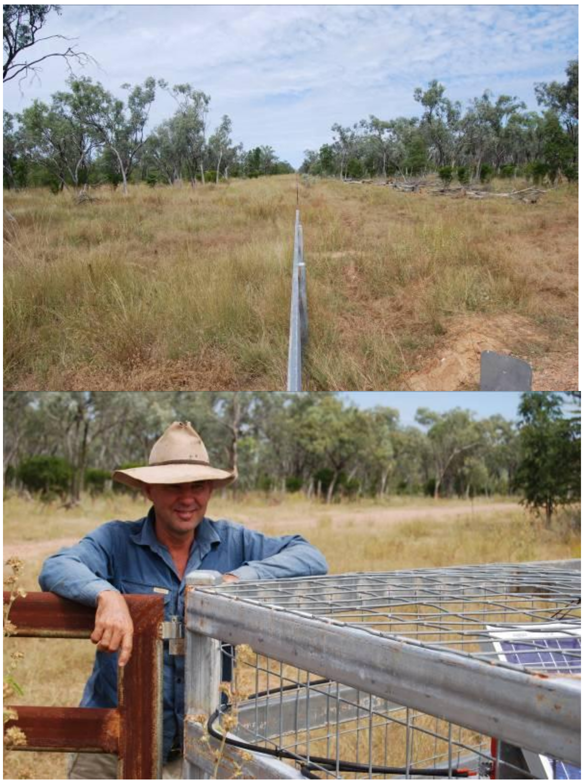


Figure 0.15 Electric fencing costs less than conventional fencing and has been reliable on Greenhills

Labour is provided by Greg and Carol, contributing 2 FTEs per year to land/cattle management, farm maintenance and administration. Labour is purchased for intensive cattle management operations (e.g. mustering and branding). There is little spare labour capacity.

4.4.2 Livestock productivity

In 2007, Greenhills consisted of two breeder paddocks, a bullock paddock and some smaller holding paddocks. Cattle were continuously grazed and all animals were being run together, with the exception of bullocks. Bullocks were generally sold as 3-4 year olds, after being finished on a coastal block at Tully. In order to improve heifer management, NLIS technology is now being used to record heifer weights, with the first weights taken at weaning. Managing weaner performance is now a higher priority as the Ryan's have moved from older bullocks to selling younger cattle and using agistment for growing cattle. Steers are currently on agistment at Capella and will most likely be sold to southern feedlot markets. This arrangement has also freed up a paddock to segregate heifers from the main breeding herd or segregate breeders based on foetal aging. Breeders are currently being pregnancy tested for empties only.

Figure 0.16 Solar panels to power electric fence energisers have proved to be effective on Greenhills.

4.4.3 Herd management

In 2007, breeders and heifers were being fed wet season phosphorus lick, with no dry season lick being fed. Two rounds of mustering were undertaken, the first in April/May and the second in September/October. Weaners were supplemented on proprietary Uramol blocks and were weaned at weights down to 140kg in the 1st round and 120kg in the 2nd round, with the average weaner weighing 175kg. Mating was continuous, with many out of season calves and cows in poor body condition score as a result. Lactational anoestrus was also a major problem with breeders, i.e. failure to resume ovulation while feeding an a calf.

The Ryan's plan to continue to supplement wet season phosphorus to breeders and heifers and use no dry season licks. However, second round weaners are now being supplemented with either straight M8U (larger weaners) or M8U with Rumensin and copra meal (smaller weaners) until the first rains (Figure 4.15). HGPs are not being used on any cattle at Greenhills.

Figure 0.17 All weaners are fed molasses-based mixes and heifers are tagged to track weight gain and performance

Through the use of fencing and waters, the Ryan family have been able to introduce a grazing rotation into the new paddocks on the southern half of the property and 60% of this country is now spelled each year. Cattle are moved twice per year, with the spelled paddock having six months rest period. Breeders in the newly formed paddocks are still run as a single mob, with heifers also run in this herd. Controlled mating has also been implemented (bulls go into breeder paddocks around the 15th January and come out in June) with the aim of reducing the numbers of out of season calves. Bulls used are currently high grade Brahman but bulls with lower tropical content may be utilised in the future to better target southern markets.

All bulls on Greenhills are given vibriosis vaccinations each year prior to mating. Cows are given a 3-year botulism injection and weaners are given a botulism injection (either 3 year or 1 year to stay in line with cow booster injections). All cattle are dipped for ticks twice a year.

4.4.4 Land condition

Ten photo monitoring sites were established in 2009 in conjunction with the infrastructure upgrades, with one site per land type on Greenhills. Site measurements include land condition and pasture quality and include indicators such as ground cover, species composition, pasture yield, soil condition and weed presence. The monitoring sites have also been used to gauge the impact of the rotational grazing system on pasture composition. Early results indicate that 3P (palatable, productive, perennial) species, such as giant speargrass and bluegrass, are returning in the spelled/rotated paddocks (Figure 4.16). The Ryan's will continue to use the monitoring sites to ensure they are achieving the desired land condition outcomes. As a result of the rotational grazing system improving land condition and pasture growth, the Ryan's have observed that their carrying capacity has also increased in recent years.

4.4.5 Climate change risks and adaptation practices

Greg and Carol are focusing on land and herd management to build business resilience in the face of a variable and changing climate. The introduction of the rotational grazing system and wet season spelling now means that 60% of the southern area of Greenhills can be spelled each year. Wet season spelling and safe stocking rates are the best strategies to regenerate and maintain 3P pasture systems which provides resilience during unfavourable seasons. Controlled mating and improved heifer management/selection will combine to lift reproductive performance.

Figure 0.18 The response of 3P grasses to rotational spelling during 2009/10 and 2010/11 wet seasons has been outstanding.

4.4.6 Business analysis

Breedcow analysis was undertaken on the Greenhills cattle business to assess the effects of infrastructure improvements on profitability and productivity (Table 4.11). Herd structure and production parameters from Breedcow were also used in the greenhouse gas emissions modelling.

Breedcow modelling showed that over the five years from 2007 to 2011, there has been an overall increase of 68% in gross margin (Table 4.11). This has mainly resulted from increasing carrying capacity and the overall number of breeders mated. This was achieved through both fencing and water infrastructure and the wet season spelling program. Female death rates have also declined due to improved herd management practices (less out of season calves and better nutrition), which has resulted in higher female sales. Higher turnoff numbers of steers has also been achieved. Average prices received for cattle did not significantly differ over the five year period, showing that turnoff numbers were the main driver of improved profitability.

Table 0.14 Herd performance at Greenhills in 2007 and 2011

	2007	**2011**
Total AE	2,400	2,750
Total cattle	3,130	3,392
Total breeders mated	1,414	1,692
Total calves weaned	806	953
Weaning %	57	57
Breeder deaths	8.7%	3.6%
Female sales/total sales	41%	46%
Total cows & heifers sold	246	390
Total steers & bullocks sold	360	452
Average female price	$327	$339
Average steer/bullock price	$478	$449
Gross margin (herd)	$195,336	$286,509
Gross margin (per AE)	$81	$104

4.4.7 Greenhouse gas emissions

Based on the current average herd size of 3,392 head (1,672 cows >2 years) and 308 tonnes of live weight sold, the total greenhouse gas emissions from livestock were 4,381 t CO_2-e and the emissions intensity was 14.2 t CO_2-e per tonne of live weight sold (Table 4.12). Five years ago with an average herd size of 3,130 head (1,414 cows >2 years) and 223 tonnes of live weight sold, the total livestock emissions were 3,836 t CO_2-e with an emissions intensity of 17.1 t CO_2-e per tonne of live weight sold. Thus, total emissions have increased by 14% with the increase in cattle numbers but the emissions intensity has improved by 21% through management changes over the last 5 years.

Table 0.15 Greenhills greenhouse gas emissions in 2007 and 2011

	2007	2011
Total livestock emissions (t CO_2-e)	3,836	4,381
Livestock emissions per hectare (t CO_2-e per ha)	0.15	0.17
Livestock emissions per AE (t CO_2-e per AE)	1.6	1.6
Livestock emissions intensity (t CO_2-e per t LW sold)	17.1	14.2

The Greenhills case study is available from the Futurebeef website (http://cdn.futurebeef.com.au/wp-content/uploads/Greenhills_CS_web.pdf and http://cdn.futurebeef.com.au/wp-content/uploads/infrastructure_factsheet_web1.pdf).

4.5 Namuel

4.5.1 Property description

Namuel Station (including Cumberland) run by the Beutel family is located in the Gulf region of north Queensland west of Georgetown (Figure 4.17). With the recent purchase of Mount Sullivan to the east of Namuel the combined property area is 24,356 ha. The vegetation is predominately tropical savannas with land types including Georgetown granites, goldfields, loamy alluvials, narrow-leaf ironbark on shallow soils and range soils. The better soils are mostly derived from the Forsayth granites (Webb 1975) while there are skeletal metamorphosed soils on deeply incised landscapes. There are also areas of neutral red duplex soils derived from metamorphic material, small areas of sandy surfaced soils supporting tea trees and some patches of black cracking clays.

Figure 0.19 Kelvin, Georgia and Kelly Bethel of Namuel.

The Forsayth granites are marginally phosphorus (P) deficient for optimal cattle live weight gains with available bicarbonate extractable P (P_B) of approximately 5 mg/kg. Neutral red duplex soils and the black clays have adequate to high P levels (>8 mg/kg) but have been preferentially grazed over a long period. The duplexes in particular are badly scalded. The sandy soils are acutely P deficient with available P_B levels <4mg/kg.

The water and fencing infrastructure is generally adequate across Namuel, Cumberland and Mount Sullivan (Figure 4.18). Cattle control is very good with current infrastructure, excellent weaner management and a strict culling policy on poor temperament.

Figure 0.20 Water infrastructure and grazing distribution is generally good across the Namuel group of properties

4.5.2 Pastures and land condition

Four decades of set stocking and overgrazing have led to a significant decline in native perennial pastures, land productivity and carrying capacity. By mid 2000 soil seed reserves of 3P grasses were critically low across the more productive land types on Namuel. A wet season spelling program was introduced on Bottom Aurora paddock on Namuel in 2007. The paddock consists primarily of Georgetown granites and is part of a five paddock rotation using wet season spelling as a means of rehabilitating land condition and production (Figure 4.19). In 2007 most of the paddock was in C condition (less than half of original carrying capacity). Land condition and productive potential was heavily discounted due to poor soil surface condition and pasture composition.

The area was spelled each wet season but grazed by breeders between June and December every year. Most years the paddock was heavily stocked over the dry season with stocking rates equivalent to a beast per four hectares when annualised. Although end of wet season pasture yields in 2007 and 2011 were similar at 1,474kg/ha and 1,669kg/ha respectively, the key productivity change was the increase in yields of 3P grasses and stylos. These productive species made up 31% of average pasture yield (492kg/ha) in 2007 compared to 58% of average yield (857kg/ha) in 2011.

The experience and learning from this spelling program has been critical in implementing effective rotation programs across Namuel and Mount Sullivan. The restoration of 3P grasses and improving the productivity of paddocks relies on both conservative stocking rates (safe cattle numbers in 70% of years) and a wet season spelling program. Obviously the cattle from the spelled paddock need to go somewhere. If these cattle are not being sold, room has to be found in other paddocks. There is a risk of overgrazing these “load-up” paddocks, which defeats the purpose of spelling. Kelvin Bethel did observe land condition decline across the wet season in ‘load up’ paddocks, particularly on the poorer land types. To minimise the risk of overgrazing ‘load-up’ paddocks, cattle will be run in paddocks that genuinely have spare grazing capacity and/or contain more resilient and productive land types.

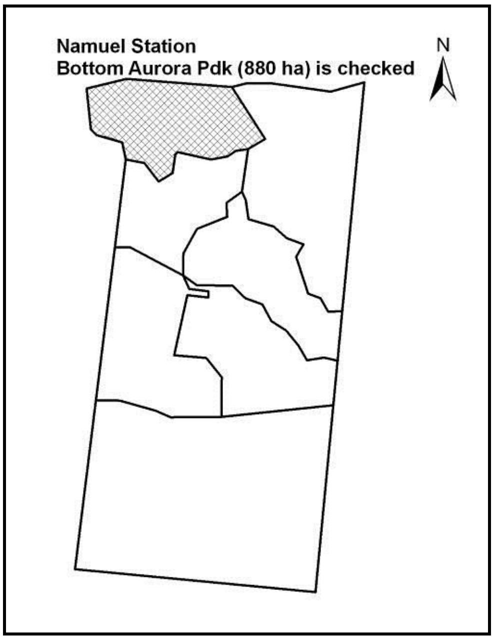


Figure 0.21 Location of the wet season spelled Bottom Aurora paddock

Based on the experiences at Namuel, a grazing management plan has now been developed for Mt Sullivan. The plan will:

1. Rotate Senepol/Charbray cross breeders between Smokeys and Brown Snake paddocks and wet season spell alternate years. The objective is to improve 3P pasture composition, stylos and overall pasture yield.
2. Rotate breeders between Linger, Die and Welby's and wet season spell in alternate years with the same objectives as above.
3. Carefully manage Sandy Creek paddock via light stocking rates and monitor the recovery of 3P pastures and ground cover. A trough near the yards will be opened up to even out grazing pressure. The area will be spelled over the wet season every second year.
4. Continue monitoring the sites that have been established to track recovery of 3P grasses and gauge the success of spelling and stocking rate management (Figure 4.20).

Figure 0.22 Photo monitoring will record improvement in ground cover, 3P grass yield and woodland thickening on this goldfields country

4.5.3 Herd management

Up to three mustering rounds are conducted each year; at the end of the growing season (April), mid-year (June/July) and mid-dry season (September – October) while breeders are still 'strong'. All animals are vaccinated annually for botulism while bulls are also vaccinated for vibriosis. Cows are bang-tailed to identify animals missed at the first mustering round and long tails are vaccinated at the second round. Cows are culled for age at 8-10 years with additional culls due to infertility, temperament or conformation. All calves except those recently born are branded and males castrated at each mustering round.

At the first round muster, calves are weaned down to 120kg live weight while at the second round calves are weaned to approximately 100kg live weight. Calves under approximately 150kg are segregated and fed a protein concentrate at 0.5kg/head/day. Bulls are run at a ratio of 1:33 cows (3%). A herd recording system is slowly being introduced to monitor breeder deaths, weaning rates, annual live-weight gains and direct costs.

During the growing season (December – May) all cattle run on the Cumberland portion are supplemented with phosphorus (P) at approximately 5g P/AE/day. It is fed in open troughs in a 50:50 mixture of Kynophos® (21%P) and salt. Cattle are supplemented with a 30% urea lick during the dry season as needed (based on an assessment of cow condition) and feeding continues until the break of season (Figure 4.21).

Figure 0.23 Supplementary feeding has been scaled down with the move away from bull breeding and the success of wet season spelling.

A recent cross breeding program, including Senepol, Charolais and Charbray bulls, is increasing steer and cull heifer turnoff value (Figure 4.22). The aim is to breed a composite animal with 25% Brahman, 25% Charbray and 50% Senepol. Some Mount Sullivan paddocks will be designated to run heifers until after their second calf. Targeted heifer selection and management will establish ideal calving windows and improve re-conception rates in first lactation females (Figure 4.23). Management of reproductive diseases (pestivirus, vibriosis and leptospirosis) is critical and a vaccination program will be introduced.

Figure 0.24 Cross breeding with Charbray genetics is being used to attract market premiums

4.5.4 Climate change risks and adaptation

The Bethel family is focusing on land and herd management to build business resilience in the face of a variable and changing climate. The introduction of the rotational grazing system and wet season spelling is coupled with a legume (Seca and Verano) program across many paddocks on Mount Sullivan (Figure 4.24). The further establishment of legumes is expected to increase annual live weight gains by 30kg and will be used to maximise weaner weight gain. Wet season spelling and safe stocking rates are the best strategies to regenerate and maintain 3P pasture systems and improve resilience to unfavourable seasons.

Figure 0.25 Heifers will be segregated to improve weight gain, time of calving and re-conception rates.

Good fencing and water infrastructure combined with excellent cattle control/temperament, three weaning rounds and actively selection for fertile breeders positions the business well to cope with a variable and changing climate.

4.5.5 Business analysis

A Breedcow analysis was undertaken on the Namuel cattle business to assess the impacts (actual and predicted) of wet season spelling, wet season phosphorus supplementation, cross breeding, heifer management and breed selection. Over the five years from 2007 to 2011, the herd model shows an overall increase in total gross margin and gross margin/AE (Table 4.13) even when taking into account the recent purchase of Mount Sullivan and a herd build up program to stock this property.

Figure 0.26 Further establishment of Seca and Verano stylos on Mount Sullivan is planned to improve weight gains and subsequent heifer/breeder performance.

Another major change in the enterprise was the move away from the stud breeding operation which required significant feed inputs and substantially raised the bull replacement cost per calf weaned. Female death rates have been reduced due to improved herd nutrition practices and slow improvements in weaning rates are predicted. Each year the Bethel family plan to reduce their supplementary feeding costs as the benefits of wet season spelling and legume establishment flow through. However the current debt level is significant with the purchase of Mount Sullivan prior to the pending sale of a coastal property.

Table 0.16 Namuel herd performance in 2007 and 2011

	2007	2011
Total AE	3,600	5,200
Total cattle	4,094	6,000
Total breeders mated	1,911	2,691
Total calves weaned	1,052	1,548
Weaning %	55	58
Breeder deaths	5%	3.5%
Female sales/total sales	48%	46%
Total cows & heifers sold	380	627
Total steers & bullocks sold	405	743
Average female price	$471	$518
Average steer/bullock price	$618	$685
Gross margin (herd)	$242,805	$595,314
Gross margin per AE	$67	$114

4.6 Success in achieving MER targets – Qld Gulf

Table 4.14 summarises the impact that the Climate Clever Beef project has had in the Qld Gulf region. More details of the activities undertaken (and their impact) are described thereafter.

Tracking industry engagement and practice change
Over the past decade the project team has delivered extension programs across the Queensland Gulf to improve herd productivity as well as management, condition and productivity of the grazing resource. However there are many issues limiting the adoption of these management practices including enterprise scale, cost, enterprise viability and sociological constraints.

Table 0.17 Summary of MER* targets for the Qld Gulf region

Queensland Gulf – beef industry snapshot		
No. of producers	280	
Total area (ha)	20,889,082	
Cattle numbers	1,435,607	
Climate Clever Beef targets - Queensland Gulf		
	Target	**Completed**
Focal and Satellite demonstration sites	3	3
Field days/forums/paddock walks	2	11
Project awareness raising events	3	6
Climate change session with Northern Gulf Resource Management Group/Southern Gulf and beef industry	1	2 (Cloncurry and Mareeba)
Fact Sheets, publications and posters	2	2
Media releases and newsletter articles	4	-
EDGE workshops	2	2 (25 producers)
Queensland Gulf – Outcomes		
Increased awareness	130	233
Increased confidence and KASA	20	197
Practice change	5	20

*MER = monitoring, evaluation and review

To better track adoption rates, a detailed industry database was developed in 2004 to record producer and industry participation in a suite of activities including large forums, demonstrations, programmed learning, neighbourhood days and on-property support. Beyond just numbers participating in extension, the Qld Gulf team uses this database to record indicators of attitudinal and practice change. These indicators include on-property observations, follow-up email/phone contact, formal/informal workshop discussions, anecdotes from neighbours, press articles featuring local producers, radio interviews by producers, participation in training by other providers (e.g. Resource Consulting Services - Grazing for Profit, Grad Link and Executive Link) and observations of attitudinal/practice change by regional bodies such as the Northern Gulf Resource Management Group.

The Climate Clever Beef and Climate Savvy Grazing extension campaigns provided the unique opportunity to 'better sell' the critical herd and land management messages in the context of seasonal variability and climate change. Through these projects and previous programs the team has developed extensive industry networks and has close contact with over 50% of extensive beef properties in the northern Gulf region.

1. Activities to increase awareness of herd and land management practices to cope with seasonal variability and climate change

- *Large industry forums and field days*

The project team regularly partnered with Agforce and NGRMG staff to raise producer and community awareness of Climate Clever Beef themes. From May 2010 to December 2011 six industry forums were run across the region engaging 83 producers from 50 extensive breeding enterprises. Key workshop themes included wet season spelling, stocking rates, break of season cover, flood recovery, herd fertility, herd nutrition and marketing. Grazing/herd management sessions and paddock walks also targeted other stakeholders who service Gulf producers and oversee lease renewal, namely 8 NGRMG, 4 Agforce and 6 DERM (Delbessie) staff.

Over 150 community, agri-business and industry representatives attended the "Cloncurry" and "Beef, Barra and Bulldust" Expos where Climate Clever Beef project activities were discussed with particular emphasis on the impact of stocking rates and breeder management on land condition and profit. Project displays at the Richmond Field Days featured the Climate Clever Beef project and direct contact was made with at least 27 local beef producers.

- *Newsletter and print media articles*.

Herd management, nutrition, stocking rates, fire management and wet season spelling featured regularly in the Northern Muster ("Around the Northern Gulf" and "North West News") and Northern Gulf Grazier ("Beef Team Corner") newsletters. The Northern Muster reaches 2,500 beef producers across north Queensland and the Northern Gulf Grazier targets 315 beef producers and industry stakeholders in the region.

- *Conference papers and posters*

A Climate Clever Beef poster titled "Adapting to beef business pressures in the Gulf" was presented at North Australian Beef Research Update Conference held in Darwin in August 2011. Over 200 beef industry representatives attended the conference.

- *Industry fact sheets*

'Blanncourt' and 'Infrastructure' fact sheets have been produced as a resource for beef producers and other service delivery staff across the region. Hard and electronic copies will be distributed to NRM bodies, Agforce, agribusinesses and property owners.

- *E-learning*

A Camtasia Slidecast "Managing Breeder Condition" was developed for the FutureBeef and NGRMG websites. This Slidecast features stocking rate management and reinforces the use of pregnancy diagnosis to segregate breeders and cull unproductive animals. This also links to the pregnancy diagnosis workshops run in conjunction with Climate Savvy Grazing (CSG) workshops in May 2010.

2. Activities to increase <u>confidence</u> (knowledge, attitudes, skills and aspirations) in implementing herd/grazing management strategies to cope with seasonal variability and climate change

- *EDGE Workshop packages*

The Cloncurry Grazing Land Management (GLM) workshop included 7 producers from 4 properties as well as 2 Southern Gulf Catchments (SGC) staff and 2 DAFF extension officers. Over the three day workshop, references to the Climate Clever Beef project themes were discussed with particular emphasis on stocking rates, pasture improvement and breeder performance. On-property follow up has been conducted with Barnsdale and Werrina in relation to the property mapping and the impact of the prickly acacia infestation on their long term carry capacities, particularly on Werrina. The family has been working closely with Southern Gulf Catchments since the GLM workshop to put together a property management plan for control of Prickly Acacia. In April 2012, they were successful in receiving substantial funding from SGC towards weed control. Follow up with Sesbania focused on the implementation of paddock subdivision and installing extra water points as discussed during the EDGE planning session. An ongoing relationship with Caiwarra since the workshop led to a field day being hosted there in late July 2012 featuring breeder productivity and alternative grazing management strategies.

An EDGE GLM was also run on Gregory Downs for Paraway Pastoral Company in late November 2011 and included 14 participants from six properties plus two senior staff from the Sydney head office. Excellent feedback was received from all participants regarding the value of working on their own property maps during the planning session to develop infrastructure development programs. Applying discount factors to account for distance to water when calculating long term carrying capacities (LTCC) had huge impact. When presenting, everyone commented on the reduction in LTCC due to water point location. In poorly watered paddocks, up to 50% reductions were calculated. The exercise was a positive reinforcement for employees of the well watered properties (Clonagh and Armraynald).

In response to the question *'How will you alter your grazing management as a result of attending this workshop'* the following comments were made by the producers at the workshop -

- Pasture assessment and stocking rate/carrying capacity
- Consider land types and carrying capacity, increase water points which will also increase pasture condition, further asses other options for prickly acacia control and more importantly when to try to attempt to kill the pests - also further focus on prevention of spread.
- Make a lot more calculations on carrying capacity.
- Do more calculations. Research to check current stocking rates/pastures and weed control. Implement a plan and use.

Follow up on Gregory Downs and Armraynald includes faecal testing to refine wet season phosphorus feeding and record keeping using the TSI indicator to identify and record information for individual cattle. Clonagh will host a grader erosion control workshop in May 2012. Spring Vale, a recent acquisition by Paraway Pastoral Company in the channel country is using the GLM tools to define LTCC and is investing in water development to optimize grazing pressure. A property visit to Spring Vale was planned in December 2011 but rain caused cancellation. At the time of reporting, a visit was re-scheduled for when weather and road conditions permitted to assist the manager with calculations. Malvern Hills, also a recent acquisition by the company, approached the project team in March 2012 to discuss pasture budgeting and using RainMan to help establish a green date for the property.

- *On-property demonstrations and case studies*

Climate Clever Beef and Climate Savvy Grazing activities were run on the Flinders (Hughenden) and Richmond producer demonstration sites. Forty people from 26 properties attended the November 2011 Flinders weigh day which included a paddock session on the ecology of Mitchell Grass and wet season spelling.

Twelve people from four properties attended the Richmond weigh day in November 2011. The Climate Clever Beef and Climate Savvy Grazing discussions resulted in lively discussion about current wet season spelling strategies. Follow up relating to herd management and phosphorus supplementation is continuing on Gregory Range as a result of the paddock session.

- *Small field days targeting producers from neighbouring properties*

A total of seven 'neighbourhood' producer forums were run at Blanncourt, Almaden, Croydon, Alehvale, Donors Hill, Cobbold Gorge and Gilberton (Figure 4.25). Over 120 people from 51 properties attended these forums. Producer presentations and paddock sessions included heifer management/selection, controlled mating, pregnancy testing and breeder segregation, pasture budgeting, business management, erosion control, biodiversity, bull selection, the Wambiana grazing trial and fire management.

Figure 0.27 Blanncourt field day in 2011. Producers are more inclined to discuss practical solutions to improve herd/land/business performance in the paddock with a small group of peers.

3. Activities to increase the <u>implementation</u> of herd/grazing management strategies to cope with seasonal variability and climate change

On-property discussions and observations carried out by the project team indicated that 20 producers were actively implementing management and infrastructure programs to improve business management, breeder performance and landscape resilience/productivity.

- *On-property mentoring*

On-property follow up has continued to be delivered to 11 properties who participated in the Climate Clever Beef and Climate Savvy Grazing workshops and industry forums. This includes property mapping (land types and infrastructure) and analysis of current grazing, herd and business management. To date eight of these producers are spelling 10-25% of their properties every wet season and are developing fencing and water infrastructure to better implement rotational spelling systems in conjunction with herd segregation/nutrition programs. Due to financial pressures and lack of fencing and waters, the move to more conservative stocking rates (based on rainfall received in 70% of years) is a gradual process for most of these producers. The use of fire to control woodland thickening (Eucalyptus, Gutta Percha and Tea Tree) and exotic woody weeds is mostly opportunistic when seasons and fuel loads allow.

- *Flood recovery grants to improve grazing management and land condition*

In close partnership with the NGRMG, 17 on-property projects were inspected across the southern and northern Gulf. After paddock inspections and lengthy discussions with landholders each project was reviewed on the basis of aiding in flood recovery and helping the business cope with future seasonal variability. Property cash contributions were combined with devolved grants to fund 12 projects including fencing and water infrastructure to implement wet season spelling. One on one follow up has been conducted with six of these properties to plan paddock layouts, estimate safe stocking rates, design spelling systems and identify/address herd productivity/nutrition issues.

4.7 Legacy and future directions – Qld Gulf

Several benefits have been realised from the Climate Clever Beef project activities in the Qld Gulf region and ongoing work is planned in the region:

- Beef extension programs in the Qld Gulf ($avannaPlan and Climate Clever Beef) indicate the need to improve land management and herd productivity if extensive breeding enterprises are going to embrace a carbon farming future. A Climate Clever Beef follow-on project “Development of a Herd Estimator Tool to Support Carbon Farming Initiative Methodologies for Extensive Beef Production” was submitted to DAFF to build a tool to measure, record and verify the key performance indicators used in estimating greenhouse gas emissions. If the project funding submission is successful three producer trial sites will be established in the Qld Gulf including one company and two family beef enterprises running a total of 30,000 breeders. Current herd and land management will be documented and the herd estimator model will be trialled on these three sites, over three years, to create enterprise KPIs.

- As a result of the Climate Clever Beef business analysis training and on-property investigations a member of the project delivery team can effectively use ProfitProbe™ and herd modelling to identify and analyse options to improve beef business performance. These skills will be critical in future projects requiring analysis of business performance particularly in relation to greenhouse gas emissions and participation in carbon farming programs.

- Climate Clever Beef has been a logical follow on from the soil carbon accumulation study conducted during the “Keys to healthy savannas” project in 2008. Our project partner in the Qld Gulf, the Northern Gulf Resource Management Group (NGRMG), continues to work closely with the Far north and north west FutureBeef team to actively involve the extensive beef industry in future carbon farming initiatives.

- Fitzroy region

Regional team: Byrony Daniels, Peggy Rohan, Rebecca Gowen, Mick Sullivan and Steven Bray

Table 0.18 Summary of the key issues and demonstration sites in the Fitzroy region.

Key issues	Demonstration sites
Production efficiency • Reproduction efficiency • High costs • Marketing options	Jimarndy (focal) Clarke Creek group Avocet
Regrowth management Relationship between soil carbon, land condition and management	Herd management and GHG assessments also undertaken on: Oaklands, Wahroonga Clarkwood and Trafalgar

4.8 Regional drivers and issues

4.8.1 Regional description

The Fitzroy catchment is located in the central Queensland region (Figure 1.1). The climate is subtropical to tropical and can be humid near the coast to semi-arid inland. Traditionally the wet season is in the summer months with frequent flood events after cyclones and monsoonal downpours. River flows are variable and may dry up altogether over the dry season. Brigalow and buffel grass are synonymous with central Queensland but many other land types and native grasses exist in the region. The region supports grazing, irrigated and dryland agriculture, mining, forestry and tourism. Approximately 95% of the catchment is utilised by agriculture, with 87% of this by grazing and 8% by cropping (Cobon and Toombs 2007).

4.8.2 Livestock productivity

The majority of grazing in the region is based around brigalow/buffel pastures for finishing and lighter eucalypt or coastal speargrass areas for breeding cattle. Stocking rates range from 1AE per 4 to 8 hectares and weaning rates average 70%. The biggest opportunity for improving productivity in this region is to increase turnover by turning cattle off younger and increasing live weight gain. This can be achieved through the use of improved pastures, targeted supplementation (including grain assisted finishing) and genetic improvements. Operations on lighter coastal country typically have lower weaning rates (as low as 40%) and slower growth rates. Opportunities exist for these businesses to reduce their greenhouse gas emissions through improved reproductive efficiency achieved through a combination of optimal stocking rates, breeder supplementation and genetic improvement.

4.8.3 Profitability

McCosker *et al.* (2010) in their northern beef situation analysis reported that businesses in the Brigalow region are declining in profitability with an average return on assets for the last five years of 1.5%. Expense ratios are also concerning, with businesses spending 108% (on average) of their income in recent years. The gross margin ratio has also been trending downwards and is now at 36.9% for the average producer. Producers in the region have to contend with high land prices, escalating overheads and little productivity growth (McCosker *et al.* 2010).

4.8.4 Land condition

Figure 5.1 shows cover index data derived from satellite imagery and extracted by VegMachine across four land types in the Isaac Connors catchment. Dry periods experienced in 1993-95 and 2003-4 are evident across all land types with no evidence of a declining or improving trend. The VegMachine data do not provide information on the quality of the cover (i.e. whether the ground cover is grass or weedy annuals like parthenium).

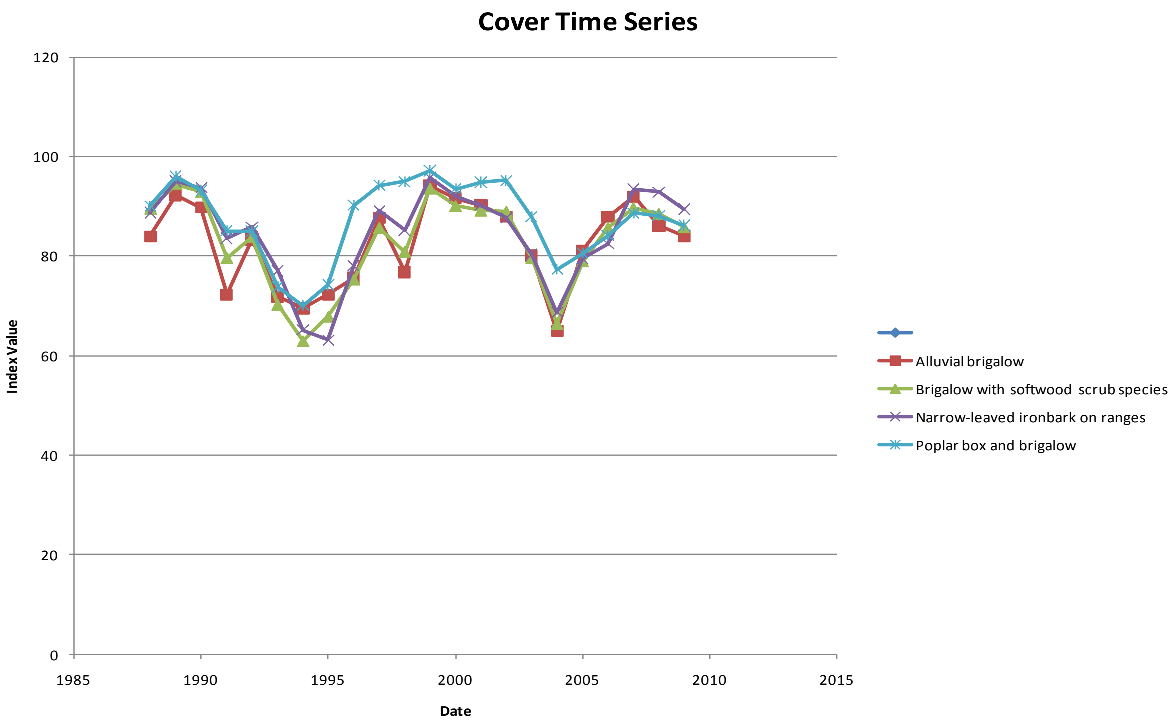


Figure 0.28 Cover index change from 1987 to 2009 for four land types in the Isaac Connors catchment. Data from VegMachine.

4.8.5 Climate change risks

Climate change projections undertaken by the Queensland Centre of Climate Change Excellence (QCCCE 2010) for the region predict an increase in average temperature of 1.0°C by 2030. Annual rainfall is predicted to decrease by 21mm and evaporation to increase by 60-80mm. The modelling suggests that 2070 could see increases in temperatures of 3.2°C, annual rainfall decreasing by 42mm and annual evaporation increasing by as much as 300mm compared to today. The area experiences great variability in climate and rainfall has been above average for the past couple of years. This natural variability makes detection of climate change difficult.

4.8.6 Business resilience and adaptability

Producers have some experience handling climate variability however the economic state of the local industry constrains their ability to manage extended dry periods. Water infiltration into pastures will need to be optimised and ground cover managed accordingly. Fences and stock water improvements have been, and will continue to be, areas for improvement for central Queensland beef producers and will enhance their ability to manage climate change. Marketing, turnoff and herd efficiency improvements will also be important to make the most from the resources available.

Key strategies for mitigation of and adaptation to climate change in the region include:

- Increasing growth rates through nutrition and legume establishment
- Feedlotting of ‘unfinished’ stock to meet market specifications
- Improving conception rates in breeder herds
- Rotational grazing and wet season spelling to improve and maintain land condition

Some producers may be interested in carbon offset enterprises including brigalow regrowth retention on country coloured white on PMAV’s (property maps of assessable vegetation).

Businesses are not well equipped financially to adapt to any additional financial pressures brought about by climate change. A major concern for the local industry is an increase in the costs of inputs.

4.9 Jimarndy

4.9.1 Property description

The Fitzroy region focal property Jimarndy is located in the Clarke Creek district east of Middlemount. Jimarndy is managed by Eric and Narelle Simon in partnership with the family’s Toowoomba-based freight business. The 19,443 hectare aggregation is a mix of brigalow scrub with buffel grass, alluvial flood plains with native grasses plus smaller areas of tablelands and sandy loam soils. The business comprises both a registered Brahman stud and a commercial herd turning off steers from weaners through to finished bullocks depending on seasons and markets.

4.9.2 Profitability

The results of business performance benchmarking indicated that the key area to target for improvement is turnover (Table 5.2). The business had previously undertaken ProfitProbe™ which enabled a trend to be ascertained. The business performance trends indicated that changes are required in the business. The business is now concentrating on holding young cattle longer until at least a 450kg feeder animal. The business will run fewer breeders to do so. Eric and Narelle also see increasing their production off leucaena (Figure 5.2) as a strategy to increase turnover. The impact of regrowth management was also assessed in relation to turnover.

4.9.3 Business improvement options

Option 1: Reduce stocking rates

The business analysis suggested that improving turnover was a priority for improving business performance. Thus, the first herd-related scenario examined was to reduce breeder numbers (and total AE) to allow male cattle to be grown out to higher weights before sale. Under the current management system almost 2,000 breeders are mated each year to produce 1,600 calves. Herd modelling of this scenario estimates a gross margin for the herd of $689,569 (after imputed interest) or $164 per AE. Reducing the breeder numbers to 1,800 and turning male cattle off as finished bullocks would increase the gross margin per AE to $179 but reduce the total herd gross margin by $8,000. Reduced stocking rates might be expected to compensate for this reduction through improved land condition (and thus livestock productivity) over time. The reduced stocking rate would also decrease the total livestock emissions and emissions intensity by about 10%.

Table 0.19 Jimarndy Key Performance Indicator (KPI) data summary. "White" and "Green" KPI's are outputs from ProfitProbe™. "Yellow" KPI's are greenhouse gas, climate change and land condition indicators. Targets are based on the experience of the ProfitProbe™ consultants and landholder aspirations. Priority level was based on business results and discussion between landholder and project officers.

	2009- 10		Trend	3 yr average	Priority
Key Performance Indicator	Actual	Target	Actual	Actual	HML
Overall Return on Assets %	1.9	2-3	Down	2.1	L
Gross Margin Ratio	41	>55	Down	49	M
Overhead Ratio	37	<25	Down	42	M
Asset Turnover Ratio	4.8	>15	Static	5	H
Finance Ratio %	0	<25	Static	0	L
Expense Ratio %	61	<100	Static	58	L
Emissions intensity (t CO_2-e per t LW sold)	9.2	na	na	na	L


Figure 0.29 Cattle grazing in a leucaena paddock on Jimarndy

Option 2: Efficiency and marketing scenarios
Several marketing and productivity scenarios to improve profitability and turnover were evaluated by landholder and the project team:

- Selling cull heifers at one year of age
- Selling cull heifers at two years of age
- EU prices 20 cents above the original price file
- EU prices 30 cents above the original price file
- HGP (hormone growth promotant) steers sold during May at 530kg
- HGP steers sold in July at 583kg

All scenarios kept the total herd size at 3,800AE, thus grazing pressure remained the same. The higher EU market price of an extra 20 cents a kilogram improved the herd gross margin by 13%. Selling cull heifers as yearlings had a higher gross margin than selling as two-year old heifers and carrying the steers an extra three months to increase the sale weight from 530kg to 583kg also had a higher gross margin. Improvements in efficiency and turnoff of cattle would result in increased turnover and lower emissions per kilogram of beef produced.

4.9.4 Regrowth and greenhouse gas emissions

Brigalow regrowth management has implications for turnover. As regrowth thickens less grass grows and less kilograms of beef are produced and sold. Approximately 36% of Jimarndy is covered by regrowth of varying densities with some nearing 10 years of age. Eric and Narelle wished to investigate the effect of different regrowth strategies on the profitability of their business. In doing so they were keen to look at the impact of being paid for carbon sequestered in regrowth and understand the emissions implications of different regrowth management strategies. They were also interested in exploring whether potential carbon price liabilities from their freight company could be offset by carbon sequestered on Jimarndy.

The impact of various regrowth management options on carrying capacity was modelled using data from GRASP, Stocktake and an economic assessment spreadsheet. The analysis was undertaken for a 30 year period for 1,000ha of ten year old regrowth (Figure 5.3). Stocking rates and live weight gains were estimated with input from the manager. The modelling showed that the “do nothing” option would result in a steady decrease in livestock carrying capacity over time. All other regrowth management options maintained current carrying capacity on average over the 30 year period, though some had periods of lower carrying capacity depending on the timing of treatments. The addition of leucaena greatly increased carrying capacity once it was established (Figure 5.3).

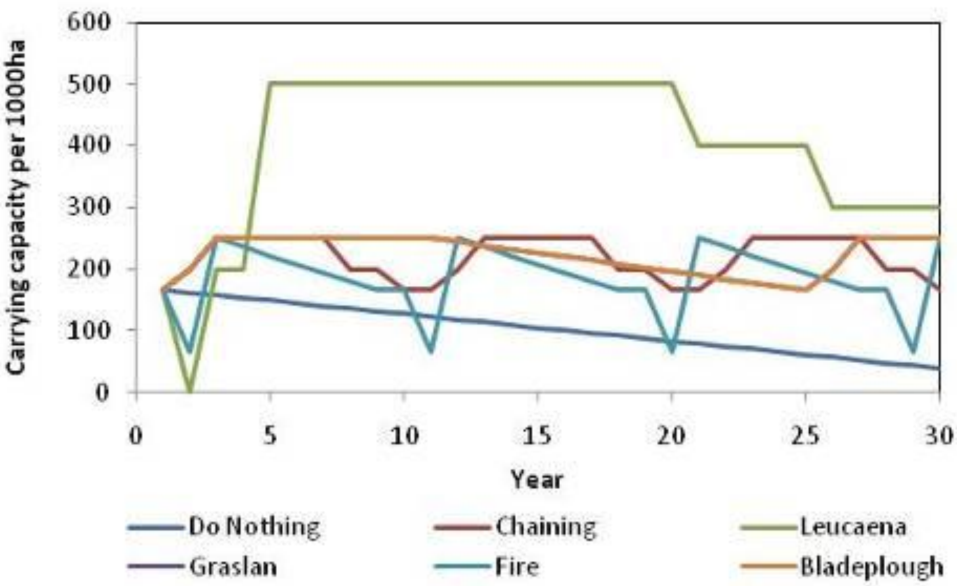


Figure 0.30 Vegetation management options and the impact on carrying capacity over a 30 year period. Do nothing is no clearing (regrowth retention). Bladepough and Graslan were assumed to respond the same and are thus superimposed on the graph.

In order to assess the economic performance of the regrowth management options, net present value (NPV) of livestock income, regrowth sequestration income and costs was modelled using an 8% interest rate and a net carbon price (carbon price minus expenses and risk management costs) of $10 per tonne CO_2-e. The analysis considered:

1. Livestock income only
2. Livestock income and potential carbon income from carbon in regrowth
3. Livestock income, potential carbon income and the potential tax on livestock methane emissions (note that no tax on livestock emissions is currently proposed in Australia)

The ‘no clearing’ option resulted in the lowest livestock income due to reduced carrying capacity over time (Table 5.3). However, if a net carbon of $10 per tonne CO_2-e was received, the no clearing option would be ahead with a NPV of $652,015 for a 1,000ha area over a 30 year period. If the livestock methane emissions liability and carbon emissions from regrowth clearing were was considered, the NPV of most clearing options was greatly reduced.

Table 0.20 Net present value of regrowth management options

Regrowth option and cost of implementation	Livestock income only	Livestock and regrowth sequestration income ($10/t CO_{2-e})	Livestock and regrowth sequestration income ($10/t CO_{2-e}), minus methane emissions liability
No clearing (regrowth retention)	$ 274,664	$ 652,015	$ 625,605
Chaining ($60/ha)	$ 391,549		
Leucaena ($608/ha)	$ 383,785	$ 338,069	$ 253,717
Graslan ($150/ha)	$ 338,413	$ 12,089	-$ 37,418
Fire ($30/ha)	$ 325,363		
Bladeplough ($150/ha)	$ 338,413		

4.9.5 Jimarndy field day

Jimarndy hosted a Climate Clever Beef project field day on the 29th of November 2011. Fourteen graziers and 11 agency and NRM regional group staff attended. The field-day was run in conjunction with the MLA-supported Pasture Rundown project. Handouts from the field day are available form the Futurebeed website (http://www.futurebeef.com.au/wp-content/uploads/2012/04/Jimarndy-field-day-2911111.pdf).

4.10 Clarke Creek Group Soil Assessment

Seven businesses were engaged in an action learning group in the Clarke Creek area in October 2010. The group wished to investigate the link between management, land condition, soil carbon, soil health and vegetation carbon. Nineteen management comparisons were sampled across the seven properties and different landtypes in March 2011 including:

- Narrow leaf ironbark on ranges - undergrazed
- Narrow leaf ironbark on ranges - close to a water point
- Brigalow with softwood scrub - buffel grass pasture
- Brigalow with softwood scrub - buffel, leucaena and grass pasture
- Brigalow with softwood scrub - sorghum crop on cultivation
- Alluvial brigalow - virgin scrub
- Alluvial brigalow - pulled
- Alluvial brigalow - Graslan treated
- Alluvial brigalow – cleared with parthenium infestation
- Brigalow with softwood scrub – cleared with *Urochloa* pasture
- Brigalow with melon holes - blade ploughed and regrowth returning
- Brigalow with melon holes - blade ploughed and Graslan treated
- Brigalow with softwood scrub - nature strip (virgin scrub)
- Brigalow with softwood scrub - pulled and stick-raked
- Brigalow with softwood scrub - pulled and regrowth returning
- Brigalow with softwood scrub - old cultivation returned to pasture
- Brigalow with softwood scrub – pulled and regrowth returning
- Alluvial flooded country - remnant vegetation
- Alluvial flooded country – pulled and sown pasture

In November 2011, some businesses re-sampled sites where there were unexpected results and some new comparisons were sampled including:

- Leucaena drip line and up the middle of the row on brigalow softwood scrub soil
- Forest country burnt and unburnt
- Box country burnt and unburnt
- Two additional brigalow with softwood scrub regrowth sites
- Well grazed and less utilised alluvial brigalow

The field data collected at the twenty-five management comparisons included:

- Photographs
- Current stocking rates
- Pasture species present
- Land type
- Management and history
- Ground cover %
- Soil condition rating as per Stocktake
- Pasture condition rating as per Stocktake
- Pasture dry matter yield (kg/ha)
- % unpalatable yield
- Tree density
- Soil carbon and microbial activity

The group met three times, the first time to determine the group focus and purpose. Presentations on soil health, climate change and greenhouse gas emissions were conducted at this meeting. The second meeting (November 2010) was a Stocktake workshop refresher and also explained the methodology for the field data collection. An above-average wet season saw a break in activities until March 2011 when field data for the nineteen management options were collected. The third meeting presented and discussed the soil carbon and microbiology results from the first round of soil tests. A fourth meeting was planned for June 2012.

Three sites tested marginal for phosphorus in the original sampling. Cattle nutritionist Rob Dixon was a guest speaker during a teleconference where a plan for testing cattle P status was formed. Faecal NIRS tests showed ample phosphorus in the diets and the second round of soil sampling showed higher soil phosphorus results. The difference between the two sets of soil samples could not be explained.

5.3.1 Results and discussion

The Clarkwood property compared remnant brigalow softwood scrub against cleared and stick-raked, and cleared with regrowth on the same land type (Figure 5.4, Figure 5.5, Figure 5.6).

Figure 0.31 Clarkwood remnant brigalow softwood scrub

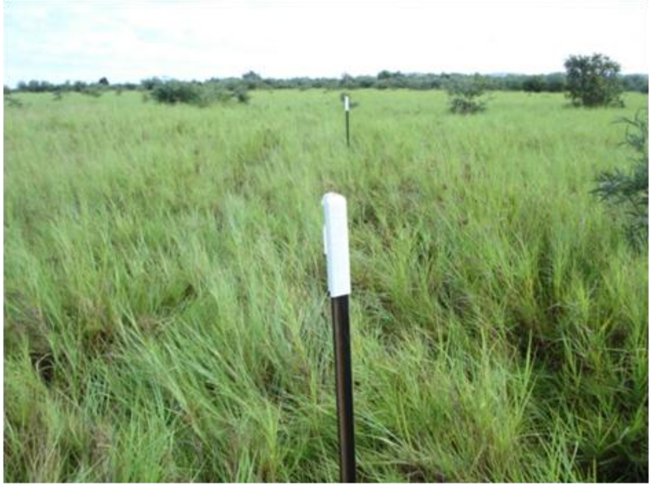


Figure 0.32 Clarkwood cleared and stick-raked brigalow softwood scrub sown to buffel grass

Figure 0.33 Clarkwood cleared with brigalow softwood scrub regrowth sown to buffel grass

The stick-raked country had 7,034kg/ha pasture biomass in March 2011 at the end of the growing season before any grazing had taken place (Table 5.4). After two grazing periods another cut was taken in November 2011 when the pasture biomass was 3,665kg/ha. The regrowth had 3,566kg/ha pasture biomass in March 2011 at the end of the growing season. After two grazing periods the November 2011 pasture biomass was reduced to 2,881kg/ha.

Surface soil (0-10cm) total carbon was lower in the regrowth area (2.81%) compared to the stick-raked site (4.24%). This may be because of reduced pasture growth and turnover in the regrowth area (Table 5.4). When the site was resampled in November 2011 the test came back with the same soil carbon result confirming the difference. The nature strip had a total soil carbon level of 4.01%, similar to the stick-raked site. The landholder was very happy with the result as it demonstrated that his management of the stick-raked country maintained soil carbon levels similar to the nearby nature strip. The desire to justify the grazing businesses environmental credentials is one of the reasons this landholder was involved in the project.

Table 0.21 Clarkwood average pasture biomass, total soil carbon and microbial activity.

	Nature strip	Stick-rake	Regrowth
Pasture biomass kg/ha Mar 2011	39	7,034	3,566
Pasture biomass kg/ha Nov 2011	74	3,665	2,881
Total carbon %	4.01 ± 0.29	4.24 ± 0.89	2.81 ± 0.13
Microbial activity	79.6	89.2	88.6

The microbial activity, total soil carbon and pasture biomass results for six sites on brigalow land types dominated by buffel grass pasture (sites are from different properties) are shown in Figure 5.7, Figure 5.8 and Figure 5.9. There will be some land type effects in these results, however each indicator follows a similar pattern. The total soil carbon pattern is more subtle (i.e. there is bigger variation in the pasture biomass and the microbial activity between sites). This indicates that pasture biomass is correlated with soil carbon, but the more subtle pattern of total soil carbon may be attributed to the slow change in soil carbon over time.

On Yarandoo, three different land uses for the softwood scrub type were compared. Cultivation planted to sorghum was compared to leucaena on previously cropped country and the third comparison was buffel grass with regrowth. The cultivation had a low soil total carbon measurement of 1.43% and poor soil microbial activity at 34.4. The ten-year-old leucaena planted on previously cropped country was showing some improvement with soil carbon of 1.52% and soil microbial activity of 60. The buffel grass with regrowth had a total soil carbon level of 2.48% and a microbial activity of 77.8. When the paddock was resampled in November 2011 the dripline of the leucaena plants and the middle of the row were sampled separately. The leucaena dripline had a higher microbial activity of 55.8 compared to 40.8 down the middle of the row. The soil carbon was 1.94% in the drip line and 1.76% down the middle of row demonstrated greater improvement close to the leucaena row..

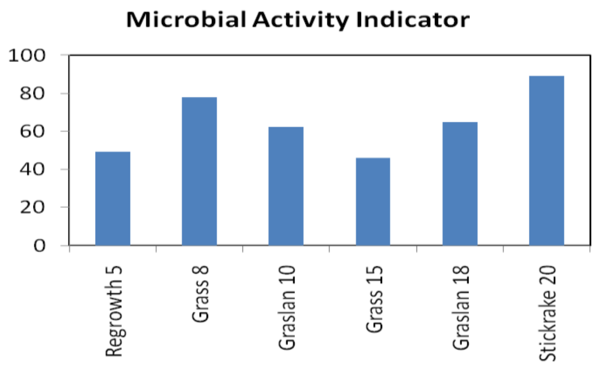


Figure 0.34 Microbial activity from different brigalow land type, buffel grass dominated sites. Y-axis is an index of microbial activity based on CO_2 evolution.

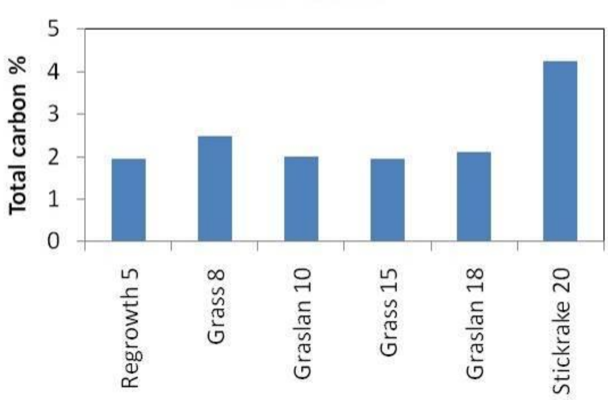


Figure 0.35 Total soil carbon in different brigalow land type, buffel grass dominated sites

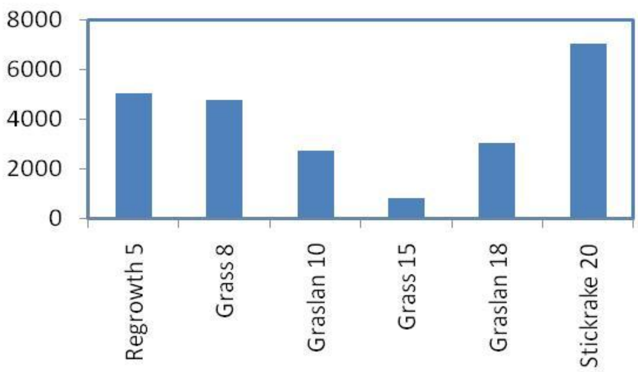


Figure 0.36 Pasture biomass (kg/ha) in different brigalow land type, buffel grass dominated sites

Two businesses used the November 2011 sampling to test the effects of fire after burning in October 2011. Clements Creek tested forest country with the burnt portion returning a microbial activity reading of 58.8; similar to the level recorded in the non-burnt portion (57.6). Soil carbon results were also similar with 1.6% total carbon in the burnt and 1.41% in the non-burnt portion. The finding that fire did not have an effect on soil microbial activity and total soil carbon was replicated at Brigalow. Brigalow tested box country, where the burnt portion returned measurements of 79.6 for microbial activity and 1.24% total soil carbon. The un-burnt portion returned measurements of 77.8 for microbial activity and 1.32% total soil carbon.

The total soil carbon and microbial activity results for the landholder management comparisons was a great way to engage the landholders and stimulate discussion about land management and its impacts. However if results are not as expected potential reasons for the discrepancy need to be openly discussed. The soil sampling results in the Clarke Creek region has been summarised into a factsheet available on the internet (http://cdn.futurebeef.com.au/wp-content/uploads/Soil-factsheet_web.pdf).

4.11 Herd modelling Avocet, Clarkwood and Wahroonga

Herd modelling was undertaken for three properties in addition to the focal property Jimarndy. Clarkwood and Wahroonga undertook the herd modelling after being exposed to the potential benefits for their business during presentations to the Clarke Creek group.

4.11.1 Avocet

Breedcow and Dynama herd modelling was conducted with Hugo Spooner, owner of Avocet, a 4500ha beef cattle property south of Emerald. Hugo made a management decision in 1986 to clear and seed some heavily wooded brigalow country that had previously been unsuitable for grazing. Rather than increase his cattle numbers after opening up more country, he kept his breeder numbers steady. As a result, the herd has experienced an increase in reproductive performance and growth rates and the land condition has improved. The scenarios modelled were (1) the current herd, (2) the pre-1986 herd and (3) the current property configuration but with higher stocking rates (Figure 5.10).

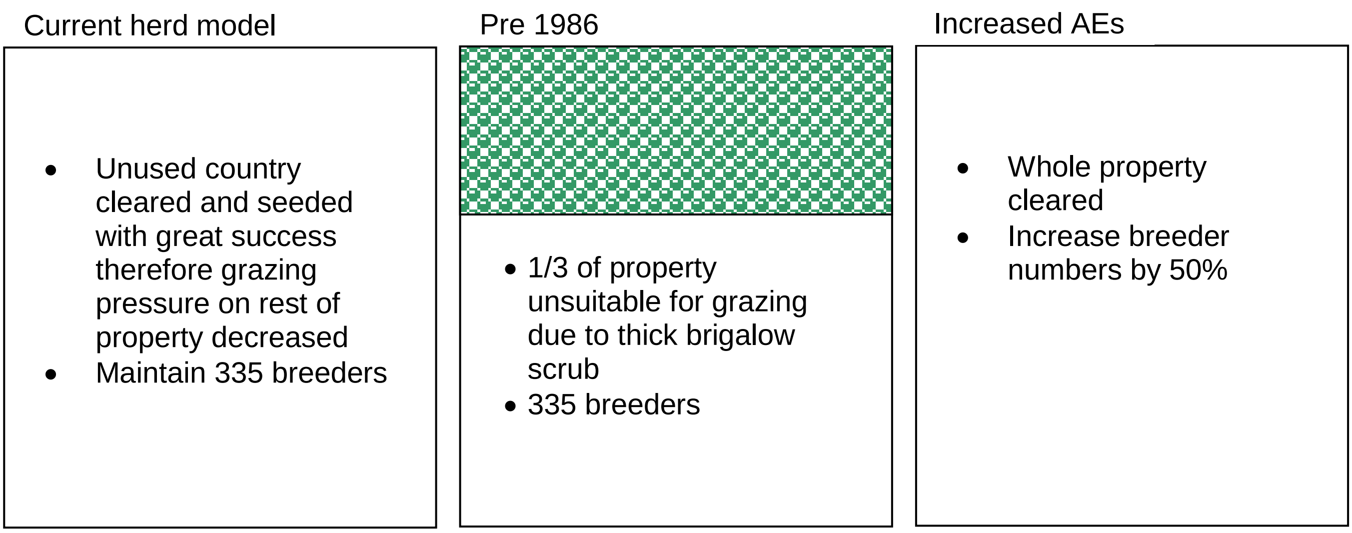


Figure 0.37 The three scenarios modelled at Avocet.

Table 5.5 shows the estimated performance of the Avocet herd. Scenario 1 is the current (2011) herd structure and management. In Scenario 1 there are a total of 335 breeders mated (total herd 763AE) and 290 calves weaned. Heifers are joined at two years of age and the cull heifers (those not selected as replacements) are kept until two years of age and sold when their peers are being joined. This means that the number of weaner heifers retained includes the heifers that are joined as well as the heifers that are culled before their first joining. The majority of steers are sold at approximately 18 months of age, with a few being held over each year and sold as two year olds.

Scenario 2 models the herd before 1986 with 333 breeders mated (total herd 637AE) before more land was cleared and made available for grazing.

Scenario 3 models a herd with 500 breeders mated (total herd 948AE). This model simulates the effect of increasing the herd number in proportion to the increase in grazing area following clearing more land and increasing herd numbers to maintain the historically higher stocking rate (pre 1986).

The pre-1986 recorded weights of all growing cattle were on average 13% lower than current 2011 recorded weights. Furthermore, the weaning rate (weaners/total cows mated) measured before 1986 averaged 75% compared to 86% for the current (2011) herd. The variable costs per AE have been kept constant between the different scenarios along with the price per kilogram for sale cattle and the bull to cow ratio.

The highest gross margin per AE (after interest) is achieved in Scenario 1 (the current 2011 herd model) at $174 with scenarios 2 and 3 achieving gross margins/AE (after interest) of $155. The highest total herd gross margin is achieved in Scenario 3, where cattle numbers are increased with the increase in useable land area. The problem with Scenario 3 is that these cattle numbers are likely to be impacting negatively on land condition and significant supplement costs would be incurred in dry years. Based in the problems with Scenario 3, the current herd model (Scenario 1) appears to be the best option with an overall herd gross margin of $132,595.

On-property photo monitoring sites have confirmed that the current low grazing pressure is improving the land condition and that current cattle numbers are sustainable in dry years. Scenario 2 had the lowest gross margin for the herd despite having the same number of breeders as in Scenario 1. This is due to the smaller land area in Scenario 2 restricting the weight gain of growing cattle and reducing the reproductive performance of the breeding herd.

Greenhouse gas emissions

The FarmGAS tool was used to undertake the greenhouse gas analysis using the herd data from the Breedcow modelling. Only livestock-related emissions were considered in this analysis.

Scenario 1 (the current 2011 situation) had total emissions of 1,464 t CO_2-e which was 16% lower than Scenario 3 (higher stocking rate, same area of useable land) with total emissions of 1,738 t CO_2-e. Scenario 2 (higher stocking rate but smaller area of land) had total emissions of 1,167 t CO_2-e (Table 5.6).

Comparing the emissions intensity of scenarios, Scenario 1 had the lowest emissions per hectare (0.33 t CO_2-e), however all three scenarios had similar emissions per tonne of live weight sold (12.1 t CO_2-e). This similarity may be due to lower stocking rates in the current situation leading to heavier individuals and faster growth stimulating methane emissions which are only proportionally offset by greater live weight sold per adult equivalent.

Note that this analysis did not include greenhouse gas emissions from tree clearing or changes in land condition with the different scenarios.

Table 0.22 Summary of the three scenarios tested for Avocet.

	Scenario 1 Current 2011 herd Low stocking rate, land cleared (4,500ha available) 335 Breeders	Scenario 2 Pre 1986 High stocking rate, 30% uncleared land (3,000ha available) 335 Breeders	Scenario 3 Pre 1986 herd High stocking rate, land cleared (4,500ha available) 500 Breeders
Total adult equivalents	763	637	948
Total cattle carried	764	673	1004
Total breeders mated	335	335	500
Weaners/total cows mated	86%	75%	75%
Overall breeder deaths	1.5%	1.6%	1.6%
Total cows and heifers sold	137	118	176
Two yr old heifer sales	60%	44%	44%
Total steers & bullocks sold	143	123	184
Capital value of herd	$431,794	$347,249	$518,116
Net cattle sales	$192,215	$147,165	$219,590
Direct costs excluding bulls	$17,504	$15,203	$22,684
Gross margin for herd	$175,774	$133,387	$198,387
GM after imputed interest	$132,595	$98,662	$146,576
GM per adult equivalent	$230	$209	$209
GM/AE after interest	$174	$155	$155

Table 0.23 Annual livestock greenhouse gas emissions of the three scenarios tested at Avocet.

	Scenario 1 Current 2011 Low stocking rate, land cleared 335 Breeders	Scenario 2 Pre 1986 Higher stocking rate, uncleared land 335 Breeders	Scenario 3 Pre 1986 herd High stocking rate, land cleared 500 Breeders
Adult equivalents	763	637	948
Land area (ha)	4500	3000	4500
Live weight sold (t)	121.3	97.5	146.9
Stocking rate AE/ha	0.17	0.21	0.21
Total livestock emissions (t CO_2-e)	**1,464**	**1,167**	**1,738**
Livestock emissions per hectare	0.33	0.39	0.39
Livestock emissions per AE	1.9	1.9	1.9
Livestock emissions per tonne live weight sold	12.1	12.2	12.1

Climate change risks

The ability of the business to adapt to climate variability has been significantly enhanced by management decisions made in the past and carried out consistently over the years. Hugo's decision to clear more of his land and maintain breeder numbers despite the extra country being available has meant that the grazing pressure on his property has been significantly decreased. This change in management led to the following benefits:

- Increased reproduction rate
- Increased growth rates
- Earlier turn-off age
- Country maintained in good land condition
- Ability to spell paddocks over the wet season

In recent years the business has proven its ability to withstand both extended dry periods as well as years of above average rainfall and flooding.

Land condition

VegMachine was used to assess Avocet's change in ground cover over time. Figure 5.11 shows the mean ground cover (%) for the period of 2004-2010. The black shaded areas indicate gaps in the satellite imagery due to tree cover being greater than 20%. The dark blue areas represent mean ground cover of 70-100%; most of Avocet fits into this category. Avocet is made up of a number of different land types. Cover time series graphs for the main land types indicate that the ground cover on Avocet follows the general pattern of the land type benchmarks for the region, and in general, Avocet's ground cover index is higher than the benchmark, particularly for the years since January 2004.

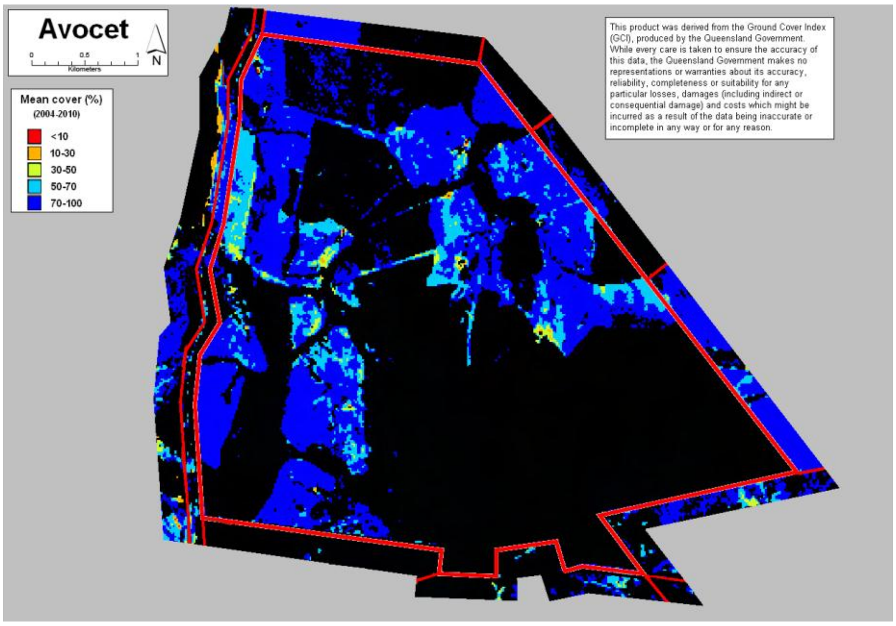


Figure 0.38 VegMachine image of Avocet depicting average ground cover between 2004 and 2010.

The key message from the modelling conducted at Avocet was that there is a tradeoff between GM per AE, total herd GM, land condition and climate risk when adjusting livestock numbers. Long-term decline in land condition is expected to impact future livestock carrying capacity with higher stock numbers.

4.11.2 Clarkwood

David and Elizabeth Hill at Clarkwood, Clarke Creek wished to evaluate the on-ground changes that they have made and continue to make in their business. David and Elizabeth have a breeding to fattening herd which targets the EU market, and have made improvements to water infrastructure and genetics. Fencing of forest country is also planned to improve carrying capacity and management on their lower fertility land types. Management changes are aimed at land condition improvement and evidence shows that this is already happening. Involvement with carcase competitions has made the Hills very aware of the need to produce a product which is both profitable for processors and wanted by consumers. To do this, they are using genetics and herd management to produce more moderate sized cattle, aiming for easier-to-finish cattle (earlier turnoff at 2.5 rather than three years of age).

The scenarios and business improvements evaluated for Clarkwood are summarised in Table 5.7 and the results are shown in Table 5.8.

Even though the same number of adult equivalents are run in the “now” and “future” scenarios (Table 5.8), the future scenario has more cattle of a more moderate size and therefore has more sale animals. This results in more income via increased cattle sales and turnover for the future scenario. A decline in direct costs is also anticipated due to a reduction in supplementary feeding.

Table 0.24 Clarkwood herd modelling scenarios

Scenario 1 2007-2008	High European content of cattle, inefficient in this environment Running breeders on brigalow country Joined later, weaned later
Scenario 2 Now	Water infrastructure developed to run breeders on forest country Tropically adapted *Bos taurus* bulls Moderate sized cattle suited to the environment and targeted production system Lowering the overall AE but increasing actual numbers More rotation of paddocks (6 weeks) 90% ground cover target
Scenario 3 Future Plans (Approx 3-5 years)	More moderate mature sized cattle – lower stocking rate Reduce paddock sizes to better manage grazing pressure Lower direct costs Reduced risk and costs in dry years Easier to finish (fat cover)

Table 0.25 Clarkwood herd modelling results

	Scenario 1 2007/2008	Scenario 2 Now	Scenario 3 Future
Total adult equivalents	865	820	820
Steer live-weight at sale	680kg	650kg	630kg
Total animals sold	205	205	224
GM for whole herd (after imputed interest)	$135,213	$132,251 2.2% decline	$136,189 0.7% improvement
GM/AE (after imputed interest)	$156	$161 3% improvement	$166 6% improvement

The whole herd gross margin for the "future" scenario was similar to that of the 2007-08 scenario demonstrating that profitability can be maintained while running less adult equivalents and improving land condition. Having cattle that can be finished at a more moderate weight allows for flexibility as cattle are more saleable sooner and can be turned off earlier if prices are good or the season is poor. Marketing opportunities are also expanded. For example, if the MSA price exceeds the EU price, carcases will be of a weight that fits MSA carcase specifications.

Greenhouse gas emissions modelling shows the improvements in efficiency also translate to improvements in emissions with total annual livestock emissions decreasing slightly from 1,610 t CO_2.e to 1,578 t CO_2.e. Emissions intensity was similar, dropping from 11.9 to 11.8 t CO_2.e per tonne of live weight sold (Table 5.9). The modelling demonstrated that it is possible to improve profitability and land condition while slightly improving greenhouse gas emissions.

Table 0.26 Clarkwood greenhouse gas emissions modelling.

	Scenario 1 2007/2008	Scenario 2 Now	Scenario 3 Future
Total livestock emissions (t CO_2.e)	1,610	1,543	1,578
Livestock emissions per tonne live weight sold	11.9	11.7	11.8

Figure 0.39 Clarkwood number nought steers in 2011.

The Hills have also used Breedcow and Dynama herd modelling to investigate shifting the joining age of maiden heifers from two years of age to one year of age. They found that even at a 4% heifer mortality rate, yearling mating was the more profitable option. A field day was organised at Clarkwood for October 2012, where cattle reproduction expert John Bertram demonstrated pelvic measuring of yearling heifers.

David Hill presented the herd modelling and soil carbon findings for his property at a seminar at Beef 2012.

4.11.3 Wahroonga

Climate Clever Beef staff sat down with Wahroonga owner/manager Robert Sherry to evaluate the economics of his business using Breedcow and Dynama herd modelling. Table 5.10 shows the results of the two scenarios that Robert was keen to evaluate. The first scenario sells steers off at a maximum age of two. The second scenario shows results for the breeder herd if offspring are sold as weaners. Note there is a difference in AE between the scenarios. Heifers are joined as yearlings.

Table 0.27 Wahroonga scenarios and results

	Scenario 1 Steers sold as 2yo	Scenario 2 Progeny sold as weaners	Compare summaries
Total adult equivalents	1,150	901	249
Total cattle carried	1,208	884	AE Diff
Total breeders mated	747	747	
Weaners/total cows mated	69.6%	69.6%	
Overall breeder deaths	1.1%	1.1%	
Total cows and heifers sold	251	251	
Total steers & bullocks sold	257	260	
Max bullock turnoff age	2	0	
Capital value of herd	$631,659	$502,116	$129,543
Net cattle sales	$328,364	$229,746	$98,619
Direct costs excluding bulls	$26,806	$22,852	$3,954
Gross margin for herd	$286,593	$191,928	$94,665
Herd GM after imputed interest	$223,427	$141,716	$81,710
GM per adult equivalent	$226	$245	
GM/AE after imputed interest	$159	$178	

The gross margin for the herd performed best in Scenario 1 where the steers were sold as two year olds, which is how the business currently operates and affirms the decision for Robert. Robert continues to use the Breedcow and Dynama programs to help with decision making with phone help from Climate Clever Beef project staff.

4.11.4 Oaklands greenhouse gas emissions audit

Colin Dunne, owner of Oaklands, approached the Climate Clever Beef team to undertake an emissions audit on one of his properties. Colin is a “Climate Champion” which is part of an Australian Government initiative to raise awareness of climate change issues 9 http://www.managingclimate.gov.au/climate-champion-program/). Oaklands is in the Fitzroy catchment approximately 50km south of Duaringa. The property is run by a family partnership (Colin, John and Alicia Dunne). Oaklands is a certified organic breeding enterprise turning off weaners to a fattening block. Only bulls are purchased and bought onto the property.

The property is 10,571ha with eight main paddocks. The property has equal proportions of four main land types and is in good land condition (predominately A and B condition). Eight year old regrowth covers approximately 3,170 ha (30% of the property). Around 1,200ha is burnt each year (generally on the poorer land types) to reduce regrowth and remnant woodland thickening (average fuel load of grass and litter 2,500kg/ha). Twenty percent of the property is open pasture with little woody vegetation and 50% is classed as remnant (uncleared) vegetation.

Figure 0.40 Eight year old box regrowth at Oaklands.

The herd

The average herd size over the year is 1,248 head with approximately 900 cows (>2 years) and 110 heifers (1-2 years) mated each year. Approximately 685 calves are born each year (68% weaning rate). Weaner steers and cull heifers are sent to a fattening property. Cull cows are spayed, allowed to fatten and sold direct to the meatworks. Annual turnoff sold (transferred) off-property is 164 tonnes of live weight. Minimal supplementation is used in part due to a lack of suitable 'organic status' supplements.

Greenhouse gas emissions

Greenhouse gas emissions grom livestock, energy and savanna burning were 2,477 t CO_2-e per year (Table 5.11). Greenhouse gas emissions intensity was 15.1 t CO_2-e/t of live weight sold and 0.23 t CO_2-e/ha (Table 5.11). This compares to an evaluation of nine grazing businesses in central Queensland which had an average emissions intensity of 17.2+/-5.0 t CO_2-e/t of live weight sold and 0.61+/-0.28 t CO_2-e/ha (Bray and Gowen unpublished).

Emissions from energy use was 22 t CO_2-e, which is less than 1% of the total greenhouse gas emissions for the business. Emissions from burning 1,200 ha per year was 204 t CO_2-e (or about 8% of total emissions).

Greenhouse gas sequestration

The carbon dioxide equivalents sequestered by the 3,170ha of regrowth over the last eight years since the last clearing event is estimated to be 14,641 t CO_2-e /year (Table 5.11). If left uncleared, this sequestration is likely to continue for some years as the current basal area of the regrowth was 1.5m^2/ha (at 130cm height) while the remnant woodland nearby had a live basal area of 6m^2/ha.

Table 0.28 Annual greenhouse gas emissions and sequestration for Oaklands. Numbers in brackets are the values calculated using default FarmGAS livestock values.

Emissions	
Livestock Methane [a] **(**t CO_2.e)	2,114 (2,293)
Livestock Nitrous Oxide [a] **(**t CO_2.e)	139 (150)
Total livestock emissions [a] (t CO_2.e)	2,253 (2,443)
Energy [b] **(**t CO_2.e)	22
Total livestock and energy emissions (t CO_2.e)	2,273 (2,463)
Savanna burning emissions[c] **(**t CO_2.e)	204
Total livestock, energy and burning emissions (t CO_2.e)	2,477 (2,667)
Emissions efficiency	
Total emissions per tonne live weight sold (t CO_2.e/t LW)	15.1
Total emissions per ha (t CO_2.e/ha)	0.23
Sequestration	
Current regrowth sequestration[d] (t CO_2.e/year)	14,641

[a] From FarmGAS (using Oaklands specific cattle weights, growth rates, calving times and default feed quality values)
[b] DCC methodology
[c] DCC methodology (2,500kg fuel and emissions factor of 0.17)
[d] Calculated using current regrowth biomass (above and below ground) (basal area 1.5m^2 at 130cm, light grey clay land type) and assume eight years since clearing. No penalty applied for historical clearing event.

4.11.5 Carbon offset project assessment on Trafalgar Station, Charters Towers

The Climate Clever Beef project team worked with Roger Landsberg owner of Trafalgar Station to undertake an assessment as part of his Rangelands Australia postgraduate study (Figure 5.14). A case study has been developed and is available on the Climate Clever Beef website (http://cdn.futurebeef.com.au/wp-content/uploads/Trafalgar_CS_web.pdf). Trafalgar is located in the Burdekin catchment, however the collaboration was with the Fitzroy team and is therefore reported here.

Background

Trafalgar station is a 33,000ha pastoral property located 56km south-west of Charters Towers in north Queensland. It is situated in the northern extremity of the Desert Uplands bioregion in the Burdekin River catchment.

Trafalgar has been owned by three generations of the Landsberg family since 1913. The property enterprise is primarily a commercial beef breeding/fattening operation, although a small Brahman stud is also maintained, making a sustainable total herd number of 3,500-4,000AE. The long term mean annual rainfall for Trafalgar is 647mm, but is highly variable within and between years.

The business plan is focused on managing a profitable grazing enterprise while encompassing high conservation values. New technologies, opportunities and threats are comprehensively assessed to determine the potential benefits or impacts for the family business.

Figure 0.41 Roger Landsberg, Trafalgar Station.

Current management

Conservative stocking, wet season spelling and the use of fire are the cornerstones of the grazing strategy at Trafalgar. Pasture is assessed at the end of the wet season and stocking rates are adjusted or planned so that an average of 20 – 30% utilisation of standing feed is achieved. Twenty percent of the property is wet season spelled every year to maintain and improve pasture condition.

Strategic tree clearing of eucalypt and acacia species occurred between the mid 1960's and 1988 resulting in 11% of the property (or 3,630 hectares) of the property developed to more productive pastures. These areas are re-cleared (chained) of regrowth every eight years.

Carbon Farming

Roger recognised that the Australian Government's Carbon Farming Initiative (CFI) may provide an opportunity diversify the income stream at Trafalgar. However, at the date of this case study (May 2012) significant uncertainty still existed on how a carbon farming project might be implemented on-ground in rangeland grazing areas. Additionally, the magnitude of the expenses and processes of risk management are also unknown. This assessment thus attempted to be consistent with the principles of the Carbon Farming Initiative.

Scenario development

The assessment investigated the difference between the emissions/sequestration of the current management (2011) (assumed to be the baseline) versus an alternative management incorporating a 'carbon farming' project. Proposed management changes include:

1. Reduce stocking rates
    - 50% reduction in herd numbers
    - 10% increase in cattle growth rates and 20% increase in branding rate due to lower stocking rates
    - 100% increase in savanna burning due to increased need for wildfire mitigation. Assumed no additional fire impact on tree biomass.

2. Regrowth retention
   - 2,000ha of five year-old regrowth is not re-cleared and is allowed to grow to maturity and retained for 100 years.

Four scenarios were assessed:

1. Current management (2011) (assumed to be the baseline).
2. Reduced stocking rates and regrowth retention.
3. Reduced stocking rates only.
4. Regrowth retention only (livestock stocking rate was reduced by 10% over 20 years to match the anticipated reduction in livestock carrying capacity. The change in livestock emissions was not included in the scenario analysis).

The analyses were run over 20 years. Year to year variability was assumed to have the same impact on all scenarios and was therefore not included. Emissions were calculated using the FarmGAS model for livestock and savanna burning. Regrowth sequestration was calculated using the eucalypt growth models from Donaghy *et al.* (2009).

The financial performance was assessed by calculating the net present value (NPV) of the changes using a discount rate of 4.5%. Cattle income was calculated using a net price after expenses of $1.23 per kilogram of beef sold and 'carbon' income using a range of net prices after expenses (including risk management costs). The breakeven carbon price was calculated to match the baseline income with the alternative management income.

Emissions and sequestration results
Reducing stocking rates halved livestock emissions saving 3,677 t CO_2-e per year while savanna burning emissions doubled, increasing emissions by 487 t CO_2-e per year. Regrowth on the 2,000ha was estimated to sequester 177,900 t CO_2-e over 20 years to average 8,896 t CO_2-e per year.

Financial results
Annual cattle income was reduced by nearly 50% with the halving of stocking rates. The NPV with reduced stocking rates and regrowth retention had a breakeven net carbon price (carbon price minus expenses) of $11.84 per t CO_2-e (Table 5.12). When reduced stocking rate and regrowth retention are considered separately, regrowth retention appears to have potential to be profitable with a breakeven net price of $1.51 per t CO_2-e. A project only reducing stocking rate is less likely to be profitable with a breakeven net price of $44.52 per t CO_2-e.

Future carbon price fluctuations will be a key risk in the financial outcome of a 'carbon farming' project as the projects span many years, particularly where the breakeven price is high.

Table 0.29 Net Present Value ($) and breakeven price of the current business (baseline) and alternative carbon farming project options at four net carbon prices (carbon price minus expenses).

	Net carbon price ($ per t CO_2-e)				
Scenario	**$5**	**$10**	**$20**	**$40**	Breakeven price $
Current/Baseline (cattle income only)	4,465,661	4,465,661	4,465,661	4,465,661	
Reduce stock and regrowth (cattle and carbon income)	3,304,831	4,153,548	5,850,982	9,245,851	11.84
Reduce stock only (cattle and carbon income)	2,681,796	2,907,477	3,358,841	4,261,569	44.52
Regrowth only (cattle and carbon income)	4,900,984	5,524,057	6,770,203	9,262,495	1.51

Factors that should be considered with regrowth retention over the long term are that carbon sequestration will reduce over time as tree growth slows (as the woodland reaches maturity) and the regrowth needs to be retained and protected (e.g. from wildfire) for 100 years. This will limit future management options and require ongoing risk management.

Summary

This assessment has indicated that a 'carbon farming' project based on regrowth retention has potential to be financially viable depending on the net carbon price received. This in turn will be dependent on administration, measurement, verification and risk management costs and market dynamics.

A project based on halving stocking rates is unlikely to be financially viable unless the net carbon price is greater than $45 per t CO_2-e. This scenario also has considerable impact on beef industry productivity, but may be useful for improving land condition on some properties.

4.12 Success in achieving MER targets - Fitzroy

This section highlights the impact that the Climate Clever Beef project has had in the Fitzroy region. More details of the activities undertaken (and their impact) are summarised in Table 2.1.

1. Activities to increase awareness of herd and land management practices to cope with seasonal variability and climate change

CQ BEEF Newsletter articles

- Issue 13 of the CQ BEEF Newsletter included an article on the soil carbon and microbe work of the Clarke Creek group. This proved to be a popular article as indicated on feedback sheets. Feedback also indicated more discussion on soil carbon is required. Further soil information was provided in Issue 16 of the CQ BEEF Newsletter (http://futurebeef.com.au/resources/newsletters/queensland-newsletters/cq-beef/).
- Robert and Jane Sherry from the Clarke Creek group were featured as the producer profile in the 12th issue of the CQ BEEF Newsletter. The Sherry's involvement in the Climate Clever Beef project was highlighted.

- The newsletter has a distribution list of 455 producers and industry organisations.

Field days

- A Climate Clever Beef field day was held on the 29th of November 2011 at the focal property Jimarndy. The field day also included presentations from the Pasture Rundown project. Fourteen graziers attended. Ten NRM and DAFF staff also attended.
- On the 14th of November 2011 project staff attended the Cattle Council of Australia's Rising Champion's tour at Melton, Alpha. Byrony Daniels gave a presentation outlining the Clarke Creek soil carbon results and the Jimarndy regrowth management modelling. Peggy Rohan presented the Avocet Breedcow and greenhouse gas emissions modelling.
- Presentations of the Clarke Creek soil carbon results, the Jimarndy regrowth management modelling and the Avocet Breedcow and greenhouse gas emissions modelling have been made by project staff at three Climate Savvy Grazing field days (Berrigurra Blackwater Dec 2011, Melrose Mornish March 2012 and Rolleston March 2012). Another two field days to feature Climate Clever Beef work were scheduled for June 2012 in Clermont and Alpha.

Field walks

- The Clarke Creek group participated in a refresher of the Stocktake workshop in November 2010. The field walk also featured the methodology of how field data would be collected.

Workshops

- A discussion of the soil carbon and microbiology results from the first round of soil tests was held with the Clarke Creek group in September 2011.

Media releases and coverage

- A media release on the Jimarndy field day was prepared and distributed. The release led to two radio interviews with Zinc Rockhampton Radio and ABC Mackay and an article in the Rural Weekly paper.
- The Queensland Country Life covered the field day in December 2011.

MLA Feedback Magazine

- Alan and Penny Wallace from the Clarke Creek group were featured in the April 2012 edition of Feedback Magazine. The article detailed some of the soil carbon results from their property "Clive".

Beef Australia 2012 seminar

- Project Leader Steven Bray chaired the "How to make a profit in the face of climate change and greenhouse gas emissions" seminar at Beef Australia 2012. Clarkwood grazier David Hill presented the Breedcow and greenhouse gas emissions modelling work detailed in this report. Byrony Daniels presented some of the soil carbon and microbiology results from the Clarke Creek group.

Fact sheets

Four fact sheets are being prepared from this region:

- The Jimarndy regrowth modelling
- Clarke Creek soil carbon results
- Avocet and Clarkwood Breedcow and greenhouse gas modelling
- Carbon offset project assessment on Trafalgar

Climate change session

- The first meeting of the Clarke Creek group included a presentation on climate change and predictions presented by Steven Bray.

2. Activities to increase confidence (KASA - knowledge, attitudes, skills and aspirations) in implementing herd/grazing management strategies to cope with seasonal variability and climate change

Knowledge, awareness, skills and attitude changes evident as a result of the Climate Clever Beef project include, but are not limited to:

- Breedcow analysis of how mating as yearling heifers would affect business economics.
- More routine weighing of animals, particularly weaners.
- Change in enterprise – growing out cattle that would have been previously sold as weaners.
- Land use change from cropping/cultivation to pasture and butterfly pea.
- Soil nutrition analysis of cropping country and applications of N fertiliser.
- Applications of N and P fertiliser to leucaena.
- More thought given to the effectiveness and likely benefits of compost tea treatments.
- Investigations into legume establishment.

4.13 Legacy and future directions - Fitzroy

The Climate Clever Beef work in the Fitzroy region will have an ongoing legacy. Members of the Clarke Creek group, for example, are keen to re-test soil carbon levels in the future to monitor changes. The carbon testing has been of particular interest to many producers in central Queensland. Producers directly involved in the project and other producers have reckonesed the benefits of collaboration between producers and the Department of Agriculture Fisheries and Forestry. The Climate Q project is also expected to foster ongoing work with the Clarke Creek group.

The Clarke Creek group intends to use the Climate Risk Matrix (http://www.longpaddock.qld.gov.au/products/pdf/matrix_factsheet.pdf) to prioritise future activities. Already the group is aware of two future activities they wish to host. Clarkwood investigated the effect that mating yearling heifers rather than two year old heifers would have on their business using Breedcow and Dynama herd modelling. Even factoring in an increase in the heifer mortality rate to 4%, this management option improved gross margin by 12%. David and Elizabeth Hill are keen to host a field day where pelvic measurement of heifers is used to determine their ability to safely deliver a calf. This field day was held in October 2012 when reproduction specialist John Bertram visited the area for other business. It has also been suggested that the group run a day where fat scanning instruments are showcased.

Producers will have ongoing access to the fact sheets produced from the demonstration sites and case studies via the Climate Clever Beef webpage (http://futurebeef.com.au/resources/projects/climate-clever-beef/). The Fitzroy project team has also contributed to the development of grazing best management practice (BMP) modules on greenhouse gas management, soil carbon and fire as part of the Grazing BMP project.

Improvement in the skills of staff using the Breedcow and Dynama model is also evident.

5 Victoria River District (VRD) and Douglas Daly regions

Regional Team: Dionne Walsh, David Ffoulkes, Peter Shotton, Trudi Oxley and Steve Petty

Table 0.30 Summary of the key issues and demonstration sites in the VRD and Douglas Daly regions.

Key issues	Demonstration sites
Production efficiency • High costs and debt • Reproduction efficiency • Live weight gain • Supply chain, marketing	Limbunya in the VRD Midway, Maneroo and Bonalbo in the Douglas Daly
Land condition • Stocking rate management • Wet season spelling • Prescribed burning	
Infrastructure development	

5.1 Regional drivers and issues

5.1.1 Regional description – Victoria River District

The Victoria River District (VRD) is about 85,700km² in size and is situated south-west of Katherine in the Northern Territory. The region has a semi-arid monsoonal climate and experiences two distinct seasons. The wet season typically occurs from October to April and the dry season from May to September. Rainfall is highly variable from year to year, but there is a distinct gradient of decreasing mean annual rainfall ranging from 1,000mm in the north to 400mm in the south (Kraatz 2000). Mean daily temperature maximums range from about 27ºC in July to almost 40ºC in November (Kraatz 2000).

The main vegetation types in the region include *Eucalyptus* woodlands with tall-grasses, cracking black clays supporting productive grasslands, shrublands and open woodlands, and uplands and rugged stone country with spinifex and arid short-grasses (Kraatz 2000). In the north of the district, the country tends to be rugged and hilly, with valleys of tropical tall-grass and bluegrass plains (Oxley 2004). The middle to southern parts of the district have large areas of gently undulating country supporting productive Mitchell grass plains.

Pastoral settlement in the VRD began in the late 1880s. Today, the average property size is about 3,300km² (with a range of ~1,000 to 12,000km) and property herd sizes range from several hundred to more than 20,000 head (Kraatz 2000, Oxley 2004). Ownership is a mix of large corporate companies, large family companies and smaller family holdings. The region typically carries >480,000 head (ABARES 2012). When VRD producers were asked to nominate a current carrying capacity for their property in 2004, the average was about 21,500 adult equivalents (Oxley 2004). Many producers feel that there was capacity to increase herd sizes on their properties with further infrastructure development.

Harsh environmental conditions demand that cattle need to have a high *Bos indicus* content and Brahmans are therefore the dominant breed (Oxley 2004). There is an ongoing trend towards improving animal performance through genetics, cross-breeding and improved husbandry practices. The majority of properties are breeder operations turning off young stock (at about 18-24 months of age) to the live export trade, but some of the larger properties also finish cattle. The predominant market is feeder steers for the live export trade to Indonesia. Spayed cows and export heifers are also significant turn-off classes whilst a small number of producers sell cattle directly to abattoirs, re-stockers or backgrounders (Oxley 2004). Recent enforcement of the 350kg weight limit for live export cattle going to Indonesia has seen producers trying to source alternative domestic markets for heavier cattle such as cull cows.

Properties in the VRD have relatively large paddocks (average 130km²) and the average number of paddocks per property is about twenty (Oxley 2004). The average number of man-made water points per property is about fifty (Oxley 2004). In 2004, it was estimated that about 68% of the total district was within 5km of permanent water points. Over 70% of producers surveyed in 2004 thought that the ideal maximum distance that cattle should have to walk to water was between 3km and 5km (Oxley 2004). Water point development and paddock subdivision are high priorities for many producers, however installation and maintenance costs are constraining the rate of development (Walsh 2009).

Continuous grazing is the most common grazing strategy used in the VRD, but other approaches such as rotational systems and opportunistic spelling are also used (Oxley 2004, Walsh 2009). The typical approach to managing stocking rates is through trial and error and experience rather than formal assessments of carrying capacity or forage budgeting.

Some producers in the VRD undertake prescribed burning. The reasons for burning include wildfire prevention, removing rank pasture, providing green pick, controlling woody vegetation thickening and managing pasture composition (Oxley 2004, Walsh 2009). Woody vegetation thickening is an issue for many producers in the region, with the main impacts being reduced pasture growth, increased mustering costs, erosion due to poor pasture cover and damage to fences (Oxley 2004). A significant number of producers actively suppress wildfire to protect the pasture resource.

5.1.2 Livestock productivity

At the regional and property level, animal productivity is constrained by poor forage quality for much of the year. During the dry season, crude protein and dry matter digestibility levels often fall below 10% and 50% respectively (Northern Territory Government 2009). This can lead to weight loss, declines in body condition, suboptimal conception and weaning rates, increased mortality rates and low rates of annual live weight gain.

At the industry level, productivity gains in the northern beef industry have averaged about 1.3% per annum since the 1970s (Gleeson *et al.* 2012). In contrast, direct costs per head have increased by more than 70% since the early 2000s and average cattle prices have remained fairly static during the same time period (Gleeson *et al.* 2012). Together with equity and trade pressures (described below), it is no surprise that VRD producers have told us they need to run high cattle numbers and have every bit of their country in production to service debt and/or remain economically viable (Walsh 2009).

This raises a question about where future productivity gains will come from. In the VRD, recommended stocking rates range from <2AE/km^2 (50ha/AE) for poor quality spinifex country through to ~21AE/km^2 (4.8ha/AE) for productive black soil country in good land condition (Pettit 2011). However, local data show that pasture utilisation rates within 3km and 5km of water are at, or exceed, safe recommendations on more than 50% of properties (Hunt *et al.* 2013). This suggests that stocking rates are too high for the amount of water point development on those properties. Opportunities to significantly lift stocking rates at the regional level are somewhat constrained because over 90% of the productive black soil country is fully developed on a 5km watered area basis (Hunt *et al.* 2013). The majority of under-developed country in the VRD is made up of less productive pasture types which may not be economic to develop at present. That said, the situation does vary on individual leases and there is still opportunity to significantly increase carrying capacity via infrastructure development on some properties (Steve Petty, *pers. comm*., Hunt *et al.* 2013).

As mentioned previously in this report, McCosker *et al.* (2010) described the impact of extremely poor breeder herd productivity on profitability as “alarming”. Branding rates are typically lower and more variable in northern Australia than in southern Australia, reflecting temporal and spatial variation in the quantity and quality of the pastures, the harshness of the environment and the extensive management systems in place (O’Reagain *et al*., in press). Large property and paddock sizes and remoteness from supplementary feed suppliers can make practices such as short-term feeding to manage poor seasonal conditions less cost effective than in southern Australia (Thompson & Martin 2012). Research in northern Australia has highlighted several areas of concern (and opportunity) with regards to livestock productivity (see Section 1). The research suggests there is significant potential to lift productivity via improvements in breeder performance, nutrition and genetics across northern Australia.

5.1.3 Profitability

McCosker *et al*. (2010) stated that the northern beef industry is generally unprofitable and unsustainable in its current state. Their analysis found low return on assets (averaging less than 2%), a figure consistent with recent ABARES data (Thompson & Martin 2012). McCosker *et al.* (2010) concluded that the main drivers of poor business performance in the northern beef industry were:

- High land prices (up to 2009)
- High debt servicing impacting on business cash flow
- Very poor productivity of extensive breeder herds
- Small enterprise scale in some regions
- A long period of below-average rainfall in some regions
- Increasing overhead costs, but static beef prices

However, McCosker *et al*. (2010) also noted that the top 20% of industry performers were travelling reasonably well. These businesses were characterised by:

- Larger scale (both land area and herd size)
- Slightly better production per head
- Slightly lower stocking rates
- Significantly lower overhead costs

- More efficient use of plant and equipment

Interestingly, the top performers did not receive consistently higher sale prices for their cattle. Instead, they appeared to use resources more strategically to optimise enterprise scale, animal productivity and control overhead costs (McCosker *et al*. 2010).

Some businesses in the VRD are under significant financial stress. In recent years, several large holdings have changed hands and >25% of properties in the district are currently for sale in what has typically been a tightly-held region. Property values have fallen sharply since the global financial crisis and live export trade issues, with a resultant erosion of equity (Frank Peacocke, Herron Todd White *pers. comm*.). This is impacting most noticeably on producers who borrowed heavily to buy properties when land prices were high.

ABARES data confirm that the average debt for beef enterprises in northern Australia almost tripled between 2000-01 and 2006-07 (Thompson & Martin 2012). This has been attributed to several factors but the ones relevant to the VRD include producers taking advantage of the lower interest rates to expand their land holdings and develop infrastructure (Thompson & Martin 2012). Across northern Australia, debt to fund land purchases increased by 260% in real terms between 1990–91 and 2010–11, whilst borrowing to fund property development increased by 90% during the same period (Thompson & Martin 2012). Alarmingly, the debt servicing ratio (the percentage of net cash flow needed to pay interest) increased from <20% in the early 2000s to >90% in 2009–10 in the live cattle export regions of northern Australia (Gleeson *et al.* 2012).

The enforcement of the 350kg live weight limit to Indonesia has impacted heavily on the cash flows of many beef businesses that are remote from domestic markets (Steve Petty, *pers. comm.).* Indonesia's policy of achieving self-sufficiency in beef and the tightening of quotas for live cattle and boxed beef has led ABARES to predict that farm cash incomes for businesses dependent on the live export trade will continue to decline in the near term (Gleeson *et al*. 2012). In the NT, this will be felt heavily in the Top End, Gulf, VRD and Katherine regions where the majority of businesses derive more than 70% of their income from live export sales (Gleeson *et al*. 2012).

5.1.4 Land condition

Much of the grazing land in northern Australia is in good condition (A/B on the ABCD scale – see Chilcott *et al.* 2005) and data collected in the 1990s confirms that this is true of the VRD (Karfs & Trueman 2005). The most recently published NT Pastoral Land Board figures indicate that about 93% (n=130) of Tier 1 monitoring sites in the VRD were in good or fair land condition in 2007/08 (Pastoral Land Board 2010). Whilst vegetation cover, forage productivity and species composition appear to be steady or improving under the seasonal conditions experienced in the VRD in recent times (Karfs and Trueman 2005), there is extensive anecdotal and scientific evidence to show that woody vegetation cover and density have increased in the VRD since pastoral occupation (Lewis 2002, Fensham and Fairfax 2003, Sharp and Whittaker 2003, Bastin *et al.* 2003). It is believed that a combination of factors including higher rainfall, reduced competition from pasture species due to grazing, reduced fire frequency and increasing atmospheric carbon dioxide have led to woody vegetation thickening.

Some producers and industry advisors are starting to express concern about land condition in the VRD (see White & Walsh 2010a). Cattle numbers have risen on many properties in the past decade in response to the financial and productivity pressures described earlier. This has been aided by a long run of favourable seasons. A major challenge facing managers in the VRD is how to optimally use a seasonally variable feed supply for production whilst maintaining good land condition. In good years, high stocking rates typically allow increases in animal production per hectare, but high stocking rates in poor years can result in poor animal production and pasture degradation (Hunt *et al.* 2013). For managers with land in poor condition, the dilemma is how to manage animal numbers to minimise periods of feed shortages whilst trying to improve land condition.

Maintaining good land condition will be essential for achieving climate change resilience and adaptability in the VRD (Whish *et al.* 2012). However, VRD producers have said they still need convincing that the stocking rate and spelling recommendations arising from the recent Northern Grazing Systems (NGS) initiative are economically viable (Walsh 2009, White & Walsh 2010a). On properties that are approaching full development, strategies that will allow producers to limit stocking rate increases, whilst maintaining or improving turn-off will be a pre-requisite to adoption of current recommended practices. Two options for achieving this in the VRD are improving breeder herd performance and increasing cattle growth rates. Notably, both of these options also have positive implications for the management of greenhouse gas emissions in northern beef businesses.

5.1.5 Climate change risks

In the northern parts of the NT, both temperature and rainfall are predicted to increase with climate change, the monsoon is likely to bring heavier rainfall events and increased flooding and the wet season could extend in length and latitude (Hennessy *et al*. 2011).

The predicted impacts of climate change on livestock carrying capacity in northern Australia depend mainly on the amount of rainfall projected for each future climate scenario, and partly on the productivity and land condition of the land types in a region (Whish *et al.* 2012). A recent analysis of climate change projections indicated that future average annual rainfall totals in the VRD and Top End of the NT range from about 20% less to about 20% more than current rainfall depending on which model is used (Whish *et al.* 2012). The impact of projected climate change on average annual rainfall totals in the VRD and Top End are considered to be relatively benign compared to other regions across northern Australia (Whish *et al.* 2012). Higher atmospheric concentrations of carbon dioxide will have a positive impact on pasture productivity by increasing plant growth. However, the increased production of dry matter will likely result in lower digestibility and lower protein content due to the dilution of nitrogen (Cobon *et al.* 2009).

Prolonged higher temperatures are expected to increase heat stress in livestock and adversely affect reproductive performance and mortality rates (Cobon *et al.* 2009). Heavier rainfall and flooding is likely to cause extensive soil erosion and expand the range of some weeds, pests and diseases (McKeon *et al.* 2009).

5.1.6 Business resilience and adaptability

Priorities for on-ground research and demonstration in the VRD to enhance business resilience and adaptability have recently been identified using two main sources:

- The first phase of the Northern Grazing Systems (NGS) initiative ['Enhancing adoption of improved grazing and fire management practices in northern Australia: Bio-economic analysis and regional assessment of management options' B.NBP.0578 (Phelps *et al.* 2010)] and;
- A review of current and best management practices for the region. Sources for the review included local best practice manuals, the Katherine Grazing Land Management course, the NGS Synthesis report (McIvor 2010), outputs of the two regional NGS workshops and the NGS technical guide for the VRD.

McIvor (2010) identified and described the key grazing land management issues impacting on the profitability, sustainability and resilience of the northern pastoral industry. These are stocking rate management, wet season spelling, infrastructure development and prescribed burning. Producers in the VRD region considered all four issues to be relevant and important priorities for further research and demonstration (Walsh 2009, White & Walsh 2010a, Walsh & Cowley, in press). The following sections summarise current management approaches and identify priority issues for enhancing business resilience and climate adaptation in the VRD region. The implications for greenhouse gas emissions mitigation are discussed thereafter.

1. Stocking Rate Management

Annual stocking decisions are typically determined using the knowledge and experience of the manager. Company properties with Rangeland Officers are doing forage budgets however these are implemented to different degrees due to commercial demands and cautiousness surrounding the methodology used to derive them. Several research studies in northern Australia suggest that a long-term conservative stocking strategy is probably the most practical and profitable to achieve sustainable rangeland management (see O'Reagain *et al.* in press). However, there is scepticism amongst producers in the VRD region that conservative stocking is an economically viable strategy (White & Walsh 2010a). There is significant scope to provide more training and extension in sustainable stocking rates in the context of land type, land condition and watered area. This need is currently being serviced via Grazing Land Management workshops. However, feedback from industry indicates that more local evidence of profitability is required to increase industry adoption of economically viable and environmentally sustainable stocking rates (White & Walsh 2010a).

2. Wet Season Spelling

Pasture spelling is promoted as a tool to manage pasture quality, composition and bulk, and to accumulate fuel for prescribed burning. In the VRD, pasture spelling is a relatively uncommon practice. Continuous grazing and continuous grazing with opportunistic spelling are the most common practices (Oxley 2004). Participants at the NGS workshops noted that they understood the benefits of spelling and would like to do more of it, but they lacked the land, infrastructure and knowledge to do it. In the VRD, most properties have large paddocks that producers can't afford to "lock up". One participant at the first NGS workshop commented that "these days you can't afford to have any country out of production". Ongoing paddock and water point development may increase opportunities for pasture spelling, rotational grazing and fire management whilst improving paddock utilisation.

3. Prescribed Burning

Producer attitudes to fire have changed in the VRD from negative to positive in recent years (Sullivan *et al*. 2006). In the northern VRD, prescribed burning is now largely considered to be a useful tool for managing woody vegetation structure, pasture quality and for preventing wildfire. The increased use of prescribed burning has been attributed to the increase in infrastructure development (which means that fires can be better controlled and more paddocks are available to hold stock) and the use of steel posts and strainers rather than timber ones. In the southern VRD, prescribed burning for pasture management purposes is less common because the wet season is not as reliable. Most producers who use prescribed burning mainly target red soil country. Only a small number burn black soil country. A lot of the spinifex country in the VRD burns frequently (sometimes annually) because it is inaccessible or unmanaged and fires are difficult to extinguish. Opinions on the timing, frequency and intensity of burning vary but there are broad rules of thumb recognised by industry depending on the desired outcome. Late dry season fires of moderate to high intensity are considered to be useful for woody vegetation management on red soils. Early wet season or early dry season (low to moderate intensity) fires are used to reduce wildfire risk, improve pasture composition and quality, and rectify patch grazing. Despite the increasingly positive attitude towards burning, fire frequency is still lower on pastoral lands than other tenures in the VRD, particularly on the more productive land types (Cowley *et al.* 2012). This may be because the long-term economic implications of burning (or not burning) can take many years to become apparent (Dyer *et al*. 2003).

4. Infrastructure Development

The rate of adoption of best practice infrastructure development depends on reaching an appropriate balance between increased paddock utilisation and the cost of installation and maintenance. Closer development via increased subdivision fencing, more water points and/or piping water is occurring (particularly on the better soils types), and is driven by the need to make more effective use of the land available. The fencing of riparian country and the use of technology to manage infrastructure are relatively recent trends. In contrast to many other rangeland regions, fencing dissimilar land types into the same paddock is desirable due to the difficulty of stock and station staff being able to access black soils in the wet season. There is general consensus from producers that more cost-effective development and maintenance solutions are required (Walsh 2009).

5.1.7 Greenhouse gas emissions

Greenhouse gas audits conducted during the Climate Clever Beef project showed that the majority of emissions in a pastoral business are attributable to enteric fermentation (e.g. see the Oaklands case study in Section 5 and the Douglas Daly case studies this chapter). Thus, any changes in stocking rate directly influence total emissions. Whilst *total* emissions can rise under some practices, those that improve efficiency per head or per hectare will reduce emissions *intensity*. Such practices are usually beneficial to the business because improvements in animal productivity flow through to improved profitability (so long as costs do not exceed the benefit).

Research across the NT (including the VRD) has demonstrated that there is significant scope for improving reproductive performance via genetic selection (e.g. trait selection in bulls, culling underperforming females and cross-breeding), nutrition management (via stocking rate management, managing heifer growth, weaning to preserve breeder body condition and supplementation) and reducing breeder mortality rates. The practices influencing animal nutrition (e.g. stocking rate management) also have a role to play in improving individual animal live weight gains on native pastures.

The improved pastures of the Douglas Daly (and Top End generally) provide a strategic and complementary opportunity to lift animal productivity and relieve stocking rate pressure in the VRD by separating components of the supply chain to capitalise on the strengths of the different locations. Due to the relatively low pasture productivity and high freight costs, it can be argued that extensive areas (such as the VRD) are best suited to breeder operations, whilst areas of improved pastures can be best used for growing out young cattle. The benefits of transferring cattle from extensive breeder properties to improved pastures closer to port include:

- Higher growth rates due to better diet quality, allowing earlier turn-off to live export compared to native pastures.
- The ability to support large numbers of animals on a relatively small land area (efficient production per unit area).
- Closer monitoring and management of animal weights to ensure they do not exceed export weight restrictions.
- Greater accessibility to the port during the wet season. (As Ramadan advances closer to the wet season in coming years, more cattle will need to be held near all-weather access routes).
- Removing weaners and/or reducing stocking rates on the extensive properties preserves the body condition of breeders, improves re-conception rates and provides opportunities to manage land condition.

There is an increasing trend towards sending young cattle from the extensive areas of the NT (like the VRD) to the Douglas Daly, other Top End properties and more productive country in Queensland to capitalise on these advantages.

5.2 VRD focal property

5.2.1 Securing a focal property collaborator

The NT project team experienced delays in finding a producer collaborator in the VRD due to the high level of economic duress being experienced in the region. The project team twice secured collaborators only to lose them due to the properties being offered for sale. Subsequent efforts to secure a third collaborator coincided with the suspension of the live export trade. Due to the reliance of VRD businesses on this trade, producers were hit hard and the team felt that it was inappropriate and potentially damaging to the success of the project to approach producers during this time. Once the live export trade resumed, the NT team was able secure a focal property collaborator (Limbunya Station) and met with the manager in early November 2011 to develop a work plan. The delays described above impacted on the timely delivery of some components of the project, so the NT team was given an extension of time to complete the business analysis work with Limbunya. This extension aimed to ensure that the collaborator and local industry got value from the project investment in the region.

The current owner of Limbunya is relatively new to the VRD, and as a result, the NT team did not have an established extension relationship with him. Given the confidentiality and sensitivity of the data being collected, the NT DPIF engaged the services of an agribusiness consultant to conduct the business benchmarking aspects of the project. This approach ensured that there was a satisfactory level of confidentiality for Limbunya whilst allowing the NT project team to conduct the agreed project activities. Several other advantages of this approach have subsequently been realised:

- The established trusted relationship between the consultant and property owner expedited the benchmarking and scenario testing process.
- A subsequent long-term commercial relationship has developed between the consultant and the property owner and the consultant.

- The results and reporting are commercially-focussed and highly relevant to the business.
- The consultant's experience in the region has ensured that the results have high relevance to the broader industry.

5.2.2 Property description

Limbunya Station was purchased by the current owner in 2010. The property is 5,275km² and situated in the south west part of the VRD (Figure 6.1). The property has traditionally been a breeder operation producing feeder cattle for the Indonesian live export market. In light of the recent uncertainty in live export, the current owner has started moving towards finishing cattle on improved pastures on his properties in central Queensland. Given that the market for older breeders has been poor, the owner has been retaining these females on Limbunya to increase herd size.

The long term average annual rainfall (1923-2011) for Limbunya is 634mm, with the majority of rainfall received between January and March (Figure 6.2). During the past ten years, the average has been 738mm, in keeping with a marked increase in annual rainfall totals in the region since 1970 (Figure 6.3). At nearby Victoria River Downs Station, the highest maximum temperatures are typically experienced in November, with a long term average of 38.4ºC (1965-2012). The coldest month is July, where the long term average maximum is 29.2 ºC and the minimum is 10.9ºC (1965-2012).

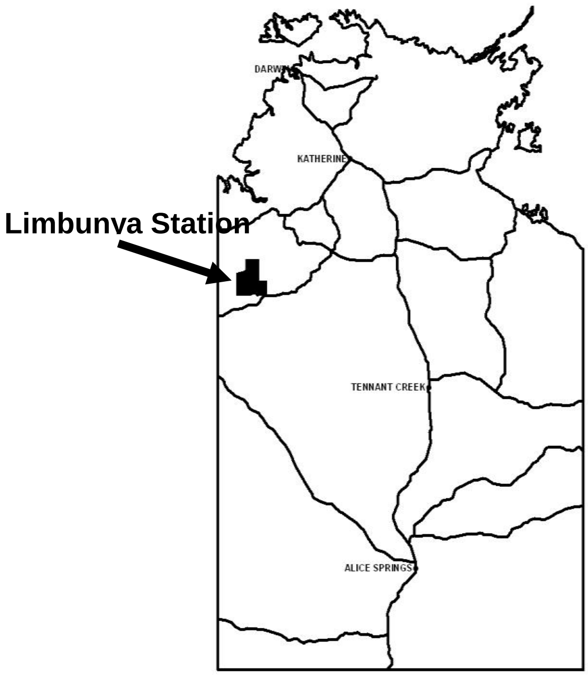


Figure 0.42 Location of Limbunya Station in the Northern Territory

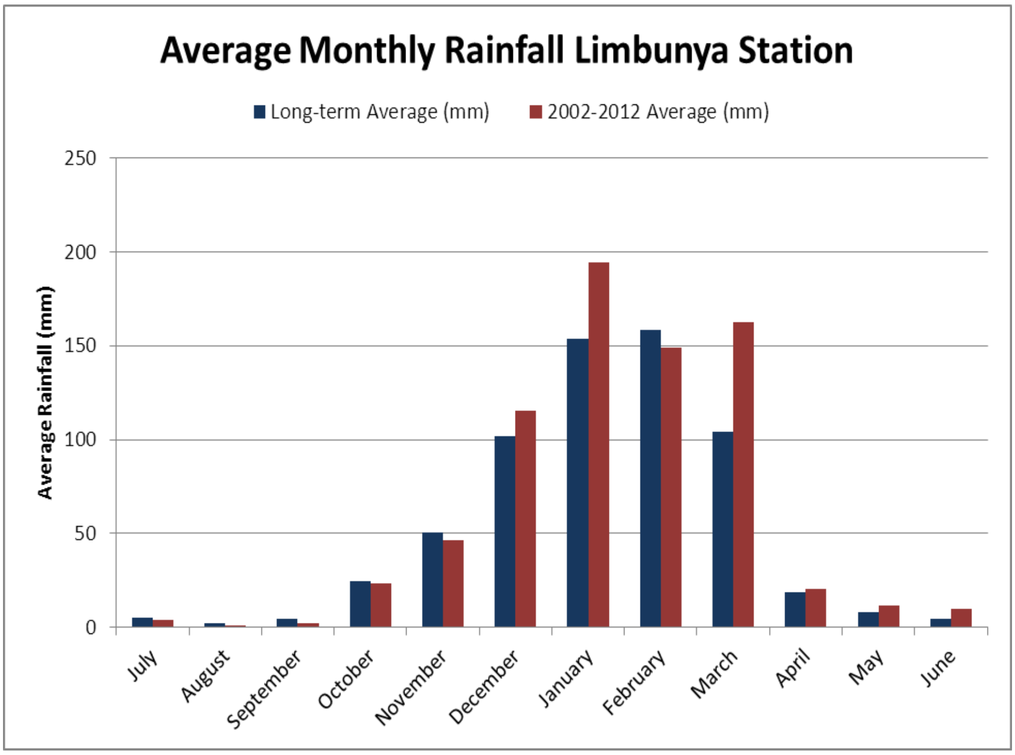


Figure 0.43 Average monthly rainfall for Limbunya Station, Bureau of Meteorology (1923-2011).

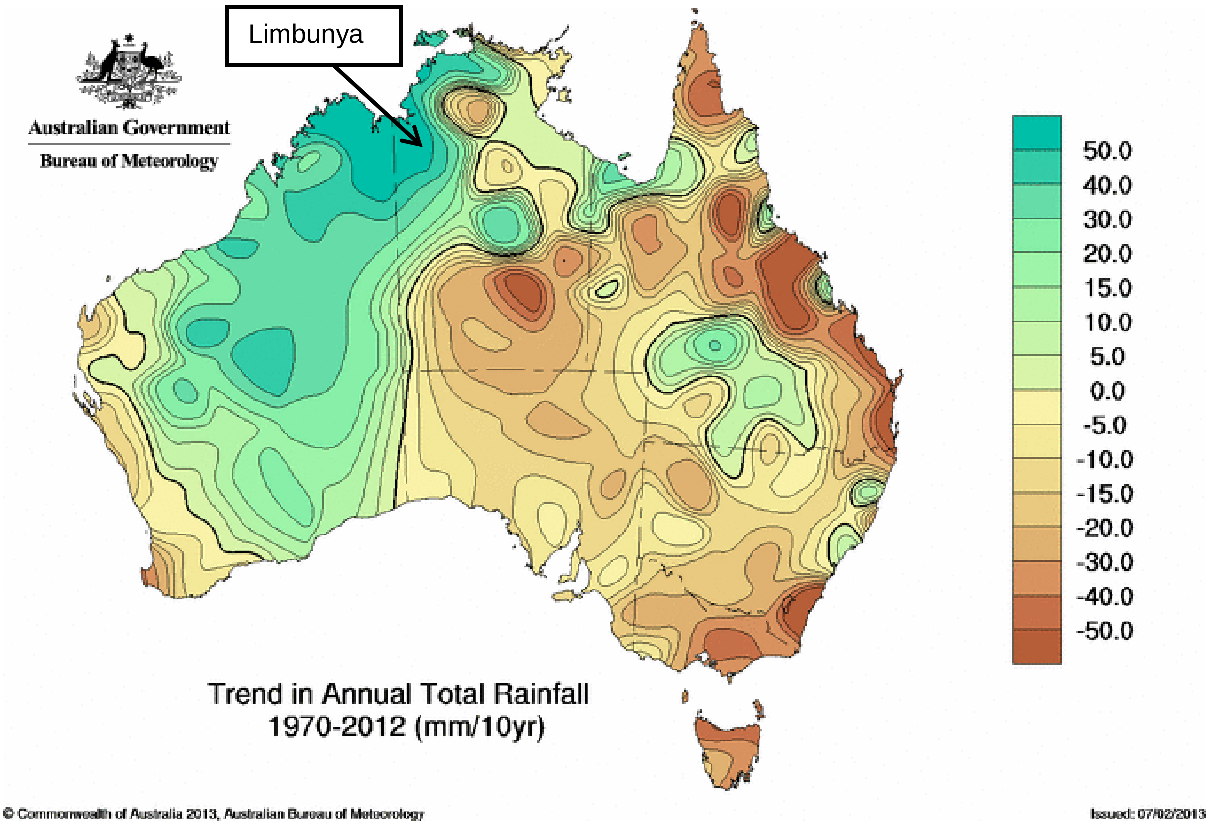


Figure 0.44 Change in annual total rainfall since 1970. The VRD region has experienced up to a 50mm increase in annual rainfall per decade since 1970 (Bureau of Meteorology http://www.bom.gov.au/cgi-bin/climate/change/trendmaps.cgi?map=rain&area=aus&season=0112&period=1970**)**

5.2.3 Resource description

About 45% of Limbunya is made up of moderate to high pastoral value land types (Table 6.2). The most productive land types are Wave Hill and Inverway land systems, which make up about 14% of the property. Rugged land types with inaccessible areas (such as Humbert and Wickham land systems) make up about 41% of the property area. The mix of land types is fairly typical of properties in the VRD.

5.2.4 Land condition and carrying capacity

As is typical for most properties in the VRD, the land condition at Limbunya tends to be mostly fair to good but some areas around older waters show signs of historical overgrazing due to insufficient water point development. The NT DPIF and the agribusiness consultant engaged by the project have both calculated estimates of the potential carrying capacity of Limbunya. The actual figures are not presented here for confidentiality reasons. Although a similar methodology was used by both parties, some of the assumptions for median pasture growth and safe utilisation rates differed for some land types. The NT DPIF estimate is more conservative and is based on median pasture growth estimates derived from the last 100 years of rainfall records (i.e. the full range of seasonal variability).

Limbunya is testing the potential to increase carrying capacity and productivity via legume augmentation of native pastures. The goal is to increase the nitrogen content of the pastures at Limbunya and to pre-condition the grower cattle for finishing on leucaena in central Queensland. The owner and manager are trialling the augmentation on different parts of the station. On the heavy basalt black soils of Wave Hill land system they have aerially sown butterfly pea (*Clitoria ternatea* cv Milgarra). On red soils they have aerially sown a mix of stylos (*Stylosanthes scabra* cv Siran and *S. hamata* cv Amiga) and grasses. The paddocks augmented so far range in size from 2800 to 5600ha with sowing rates of about 3kg/ha and 30% coverage. In addition to these augmentation trial paddocks, they are establising a 354ha leucaena paddock which was direct drilled in February 2012. One of the business improvement scenarios described later in this chapter investigates the costs and benefits of a pasture improvement strategy covering most of the property.

Table 0.31 Land systems on Limbunya Station.

Land system	***Description (Stewart et al. 1970)***	***Area (km²)***	***% of property area***	***Relative pastoral value (based on carrying capacity)***
Antrim	Hilly country associated with intermediate and basic igneous basalt rocks, Spinifex on the hills and rocky black soil plains with Mitchell Grass and panic grasses	1361	26	Moderate
Franklin	Low hilly country. Laterite-capped mesas and dissection slopes; gravelly red soils with snappy gum sparse low woodland over soft spinifex, brown loams with bloodwood- southern box sparse low woodland over Tippera mid-height grasses	283	5	Moderate
Geebee	Soft lateritic spinifex plains. Gravelly red soils; snappy gum sparse low woodland over soft spinifex	717	14	Low
Gordon	Arid short grass plains. Undulating country on limestone and shale; shallow calcareous soils; bloodwood- southern box sparse low woodland over arid short grasses	24	<1	Low
Humbert	Hilly limestone country. Ridges, hogbacks, cuestas, and structural plateaux on dolomite; rock outcrops and boulders; bloodwood- southern box sparse low woodland over arid short grasses	712	14	Low
Inverway	Barley Mitchell grass plains on tertiary alluvia; cracking clays; nearly treeless high-level black soil	50	1	High
Wickham	Rugged stony country formed on sedimentary rocks	1442	27	Low
Wave Hill	Gently undulating basalt hills with black soil pastures, including Mitchell Grass, bluegrass and panic grasses	685	13	High

5.2.5 Benchmarking & scenario testing approach

Due to the relatively recent acquisition of Limbunya, the owner and manager are still familiarising themselves with the land, animal productivity and management needs of the property. The engagement of an agribusiness consultant familiar with the region has thus been valuable for benchmarking their current situation and identifying profitable options for improving the performance of the business. The consultant used the following process with Limbunya:

1. Collated current herd and financial data during a property visit.

2. Summarised the current production parameters for the property.
3. Developed a list of practical business improvement options with the input of the owner and manager.
4. Tested these options using a herd and financial model.
5. Provided a summary of the analyses, together with recommendations on the most profitable options, to Limbunya and NT DPIF.

After documenting the current herd structure and productivity, the consultant built a base herd model to simulate the current business. The Northern Development Company (NDC) herd and economic model, which is similar to Breedcow and Dynama, was originally developed with Eynesbury Beef using >200,000 head of cattle over 15 years and has been shown to provide consistent and accurate predictions for extensive beef herds in the VRD region (Steve Petty, *pers. comm*.). Whilst the NDC model gives similar results to Breedcow and Dynama for standard analyses, the consultant finds that it is more powerful for evaluating more complex management scenarios for his clients.

Once the base model was built, it was systematically adjusted to evaluate ten “business improvement” options identified jointly by the owner, manager and consultant. The consultant performed both static and dynamic analyses of herd and economic performance. The static analyses provided the economic position and herd structure assuming the business had been stabilised in a given management option for a number of years. This represented the optimum level of productivity under the management option without explicit consideration to how the herd progressed from the current base (Steve Petty, *pers. comm*.). The dynamic analyses used the current herd structure (as at 2012) and assessed how the herd and economics would evolve over the ensuing five years given the particular management option/s applied.

The impact of each business improvement option on Earnings Before Interest and Tax (EBIT) and Return on Invested Capital (ROIC) was compared to the current herd and management approach (“business as usual”). In each analysis, the current stocking rate was maintained with the exception of the “increase carrying capacity” option. The findings of the modelling were presented to the owner and manager for discussion. The owner subsequently engaged the consultant independently to develop a detailed business plan and a medium to long-term funding proposal to implement the preferred strategies. Involvement in this project has thus delivered a meaningful and long-term legacy for the business.

For the purposes of the Climate Clever Beef project, the consultant subsequently provided the NT project team with a modified set of herd and financial data. The herd and financial data were sourced from several properties in the VRD including Limbunya. This approach had several advantages including:

- Protecting the privacy of Limbunya
- Overcoming the limitations of the short duration of the Limbunya data
- Ensuring the data were representative for a wide range of VRD properties
- Allowing the NT DPIF to obtain relevant and recent herd and financial information to build a meaningful herd model

These data were used by the NT project team to build a base herd model in Breedcow and Dynama. The business improvement options identified for Limbunya were subsequently simulated in the NT DPIF Breedcow and Dynama models using the cost and productivity assumptions from the NDC simulations. The outputs from

Breedcow were then imported into the FarmGAS model to evaluate the greenhouse gas emissions performance of the base model and business improvement options.

5.2.6 Description of the NT DPIF base herd model

The model property is a breeder operation 2,400km² in size, with an average stocking rate of 8.5AE/km². When simulated in Breedcow, the NT DPIF base model achieved a stabilised herd of 16,600AE (~19,000 head).

This NT DPIF base model was systematically modified to simulate the business improvement options identified by the consultant, owner and manager of Limbunya. The NT DPIF also built an additional base scenario to simulate the current conditions being experienced by many family-owned operations in the VRD that are facing lower than average cattle prices and high debt levels.

5.2.7 Profitability

The key performance indicators of the current enterprise (also called the base scenario) are shown in Table 6.3. The alternative base scenario ("low cattle prices, high debt levels") is also presented and serves to highlight the difficulties being experienced by some enterprises in the region.

Table 0.32 Business performance measures of the NT DPIF current (base) enterprise derived from Dynama analysis. Figures are average annual performance 2012-2021. The target benchmarks have been derived from regional benchmarks, expert opinion and business aspirations for this district. NA = not available.

Key Performance Indicator	Base Scenario	Base Scenario (Low Prices, High Debt)	Target Benchmark
Overall Return on Assets	1.7%	-1.3%	NA
EBIT ($/AE)	$52	$38	NA
Herd Gross Margin (after imputed interest)	$1.7M	$1.5M	NA
Gross Margin/AE (after imputed interest)	$101	$87	NA
Gross Margin Ratio	71%	68%	>55%
Overhead Ratio	38%	42%	<25%
Asset Turnover Ratio	14%	13%	<20%
Finance Ratio	20%	35%	<25%
Expense Ratio	92%	114%	<100%
Equity Ratio	57%	27%	>65%

The gross margins per AE were $101 for the base scenario and $87 for the "low prices high debt" base scenario. This compares to figures published by Eady (2011) of $114 for the VRD-Katherine region and $92 for the Barkly, Top End and NT Gulf regions.

The modelling shows that the return on assets, overhead ratio, expense ratio and equity ratio are areas of concern for this business. Although the asset turnover ratio performs well, the high overhead ratio and expense ratio indicate a need to decrease overhead costs and/or increase gross product (net liveweight produced * price received). Although there are opportunities to reduce some overhead costs, the overheads in this business are already relatively lean. This suggests that gross product needs to increase to dilute the overheads. For many businesses in the VRD, this could be addressed via increasing weaning rates, reducing mortality rates, optimising live weight at sale and increasing the sales return. For some properties, increasing carrying capacity would also be a way of increasing the kilograms of beef produced and diluting the overheads. Debt is also impacting heavily on this business (as shown by the equity ratio and expense ratio).

5.2.8 Livestock productivity

The productivity parameters of the base herd are shown in Table 6.4.

Table 0.33 Herd performance measures of the current (base) enterprise.

Key Performance Indicator	
Adult equivalents carried	16,600
Breeder herd size	9,583
Joiners as a % of total breeders	15%
Weaning rate (on breeders kept)	67%
Male to female turnoff ratio	1.2
Mortality rate (whole herd)	5%
Annual live weight sold (tonnes)	1,837
Turn off percentage (# sold/#carried)	34%
Turnoff per breeder >3 years age (t live weight)	0.23
Kilograms live weight turned off per ha	7.7
Kilograms live weight turned off per AE	111

The turnoff per breeder older than three years is slightly higher than figures reported by Eady (2011) for the NT (ranging from 0.14 tonnes live weight in the Top End and NT Gulf to 0.21 in the Barkly).

Together with the business performance indicators presented earlier, the herd productivity figures confirm that there are opportunities to increase weaning rate. Although the nominal herd mortality rate was 5%, it is difficult to estimate mortality rate in extensive herds due to difficulties with mustering, paddock security and the impact of natural disasters and seasonal conditions. A recent study from northern Australia suggests that mortality rates are highly variable and probably higher than many producers realise (Henderson *et al*. 2013).

5.2.9 Greenhouse gas emissions

The livestock emissions of the base herd are presented in Table 6.5. These were estimated via the Breedcow to FarmGAS macro program using the NGGI equations and liveweight gain figures appropriate for the VRD.

The estimated emissions per AE are lower than those reported by Eady (2011) for the VRD-Katherine region (2.24 t CO_2-e/AE/year) and Top End, Gulf and Barkly regions (2.22 t CO_2-e/AE/year). Similarly, the emissions per tonne of liveweight sold were lower than those reported in the NT but fall within the ranges Eady (2011) reported for northern Australia (14.5 to 31.7 t CO_2-e/tonne live weight sold).

Table 0.34 Livestock emissions measures of the current (base) enterprise.

Key Performance Indicator	
Total emissions (t CO_2-e/year)	31,558
Emissions per AE (t CO_2-e/AE/year)	1.90
Emissions per ha (t CO_2-e/ha/year)	0.13
Emissions per tonne live weight sold (t CO_2-e/tonne LW)	17.2

5.2.10 Business improvement options for a typical VRD property

The preceding sections identified that there was a need to increase gross product (net live weight produced * price received) in order to dilute the overheads. For many businesses in the VRD, this could be addressed via improving weaning rates, reducing mortality rates, optimising live weight at sale and increasing sales returns. For some properties, increasing carrying capacity is also an option to increase the kilograms of beef produced.

A number of strategies along these lines were identified by the owner, manager and consultant during the benchmarking work done at Limbunya. These scenarios were subsequently evaluated for their practicality and their potential to markedly increase productivity and profitability. The improvement options and strategies identified at Limbunya (in no particular order) were:

1. Improve herd productivity via:
   - Early weaning (including strategic supplementation)
   - Increased heifer fertility (including strategic supplementation)
   - Improved pastures (via augmentation of native pastures)
   - Improved genetics (particularly for fertility)
   - Increased branding rates through strategic culling for fertility in aged breeders (i.e. keeping those breeders that would otherwise be culled for age if they are successfully weaning calves)

2. Increase sales return via:
   - Maximising the average sale weight and price for live export
   - Identifying alternative markets for some or all of the sale cattle

3. Reduce the operating costs

4. Increase the carrying capacity (through infrastructure development)

The performance of these strategies was evaluated initially by the consultant using the NDC herd model and a summary of the assumptions used in his modelling are presented in Table 6.6. The goal of the NDC modelling was to simulate the macro impacts of the scenarios on the economic and herd performance of the business. Once the best performing options were identified, the consultant subsequently completed more detailed economic analyses and evaluations of combinations of practices for Limbunya under a separate commercial arrangement.

The NT DPIF evaluated the same business improvement options by applying the assumptions in Table 6.6 to the base Breedcow and Dynama models described previously.

5.2.11 Profitability

Of the ten options evaluated using the NT DPIF models, three did not improve the return on assets when compared to “business as usual” (Table 6.7). These were reduced operating costs, improved genetics and increased carrying capacity. This result is in contrast to the specific modelling done for Limbunya which showed increasing carrying capacity was the best performing option. The Limbunya modelling had a much greater increase in potential carrying capacity compared to the DPIF model property. This result highlights that business analyses are highly sensitive to the assumptions and data used and that care should be taken when extrapolating any findings to other businesses.

In the NT DPIF evaluations, growing out and marketing 100% of the sale cattle in Queensland was the best performing option, with a return on assets of 4.5% and an EBIT of $67/AE. This option comprised trucking weaner cattle to Blackall and growing them out on improved pastures, before feedlot finishing to 600kg for the Japox/Korean markets. The herd gross margin for this scenario was $1.9M and gross margin per AE was $117 (Table 6.7). This scenario also improved the overhead ratio, finance ratio, expense ratio and equity ratio compared to the base scenario. It should be noted that the cattle prices used for both the Queensland marketing options were based on long-term averages and the modelling was completed prior to the mid-2013 decline in cattle prices.

Other options that performed well for many metrics included marketing 50% of the cattle to Queensland, early weaning, improved pastures, optimising weight and price of live export cattle, increasing heifer fertility and strategic culling of aged cows for fertility. However, several of these had poorer herd and per AE gross margins than the base scenario (but retained a similar gross margin ratio).

It should be noted that both of the “marketing cattle to Queensland” options forgo significant cattle sales income in the first year of implementation because the cattle are grown out for an extra 12 months. In the model, this resulted in a $1.8M negative cashflow in Year 1 for the 100% option and a negative cashflow of $586,000 for the 50% option. Despite this, these options still outperformed the other options over a 10 year period.

The analyses showed that none of the options achieved a return on assets in excess of 6% (the long term government bond rate). It is unlikely that any given improvement strategy would be implemented in isolation. A carefully considered combination of complementary options would be expected to deliver a significantly greater return and this is what the consultant is now investigating in his commercial arrangement with Limbunya.

Table 0.35a Assumptions for each of the business improvement scenarios for the VRD property. Assumptions from the NDC modelling are shown in black. The application of these assumptions in the NT DPIF models is shown in red.

		Assumed impact on production parameters			
Business improvement option	**Strategies**	**Branding %**	**Mortality %**	**Live Weight Gain**	**Operating Costs**
Improve herd productivity	Early weaning	+10% on all breeders except joiners Applied 65% to the second calvers and 77% to all mature cows	-2% on all breeders except joiners Applied 3% to all breeders except joiners	0	+ $120,000 for early weaners supplement and extra labour Applied as $12.60 per head for weaner supplement = $81,300 and $38,700 in additional labour
	Increase heifer fertility	+10% on second calvers Applied 65% to the second calvers from year 2 onwards	0	0	+ $56,000 for supplementation Applied $3.50 per head in heifer supplement for second calvers in Huscosts
	Improved pastures	+5% on all breeders including joiners Applied 5% increase to all breeders from Year 2 onwards	-1% on all breeders including joiners Applied 1% lower rate to all breeders from Year 2 onwards	+10kg per head per year on all sale cattle Applied to all cattle apart from weaners from Year 2 onwards	+ $210,000 per year for seed, freight and planting for 5 years (cost to do the whole place and get the production gains specified) Applied as additional overheads for first 5 years
	Improved genetics	+1% per year over ten years on all breeding stock Applied 1% increase to all breeders	+1% per year over ten years on all breeding stock (due to reduction in *Bos indicus*/tropically adapted content) Applied 1% increase to all breeders, bulls and spays	+5kg per head per year on all sale cattle Applied to all cattle apart from weaners from Year 2 onwards	+ $85,000 (+$1,000 per bull per year) Applied as +$1,000 per bull per year
	Increase branding through strategic culling for age breeders	+10% on breeders more than 10 years of age Applied 77% to cows >10 years of age	+2% on breeders more than 10 years of age Applied 7% to cows >10 years of age	0	+$10,000 to pregnancy test and spay aged breeders Applied as $10,000 as additional overheads in Dynama because can't split out age classes in Huscosts in Breedcow

Table 6.6b Assumptions for each of the business improvement scenarios for the VRD property

		Assumed impact on production parameters			
Business improvement option	**Strategies**	**Branding %**	**Mortality %**	**Live Weight Gain**	**Operating Costs**
Increase sales returns	Maximise average sale weight and price for export	0	0	+20kg per year on 50% of the export cattle Applied this by averaging old and new weights for sale heifers and steers in Prices. Also incorporated wet season export prices due to improved port access in wet season ($2.00/kg for heifers, $2.10 for steers). Average between old and new prices was also applied as per weights in Prices.	+ $80,000 for 4 months agistment on 1800 head of sale cattle (= $44/AE) Applied at AE rate to 2314 sale cattle = $103,000 in DPIF model
	Identify alternative markets – 50% of the sales	0	0	+$100/head net increase in sale value for 50% of the sale cattle due to increased sale price. Applied to net price in Prices. Only half the income in first year at normal price because 50% of sale cattle are being grown out for another year	$0 (freight, agistment, feedlot costs taken off gross sale value)
	Identify alternative markets – 100% of the sales	0	0	+$100/head net increase in sale value for 100% of the sale cattle due to increased sale price. Applied to net price in Prices but no income in first year (all sale cattle being grown out for another year)	$0 (freight, agistment, feedlot costs taken off gross sale value)

Table 6.6c Assumptions for each of the business improvement scenarios for the VRD property

		Assumed impact on production parameters			
Business improvement option	**Strategies**	**Branding %**	**Mortality %**	**Live Weight Gain**	**Operating Costs**
Reduce operating costs		-5% (due to less mustering) Applied to all breeders including joiners	0	0	-10% for reduced mustering of some paddocks and lower staff numbers Applied by reducing overheads by 10% (reduction was not applied to replacement capital figure)
Increase the carrying capacity of the property	Increase the carrying capacity	0	0	0	Direct costs increase with increasing herd size Applied by moving herd size from 16,600AE to 18,360AE (90% of the potential carrying capacity of 20,400AE) by retaining heifers. Development costs applied as $250/AE x 1760AE ($440,000) over 3 years

Table 0.36 Business performance measures of the NT DPIF business improvement options derived from Dynama analysis in order of return on assets. Figures are average annual performance 2012-2021. The target benchmarks have been derived from regional benchmarks, expert opinion and business aspirations for this district. NA = not available.

Key Performance Indicator	Target Benchmark	Base Scenario (Low Prices, High Debt)	Reduce Operating Costs	Improved Genetics	Increase Carrying Capacity	Base Scenario	Strategic Aged Cull Cows	Increase Heifer Fertility	Increase Weight and Price for Export	Improved Pastures	Early Weaning	Alternative Markets for 50% of Cattle	Alternative Markets for 100% of Cattle
Return on Assets	NA	-1.3%	1.2%	1.6%	1.7%	1.7%	1.8%	1.9%	2.7%	2.8%	3.2%	3.2%	4.5%
EBIT ($/AE)	NA	$38	$52	$55	$54	$52	$51	$52	$63	$54	$52	$59	$67
Herd Gross Margin	NA	$1.5M	$600K	$707K	$819K	$1.7M	$1.7M	$770K	$971K	$989K	$971K	$1.3M	$1.9M
Gross Margin/AE	NA	$87	$37	$43	$45	$101	$101	$46	$59	$58	$55	$81	$117
Gross Margin Ratio	>55%	68%	69%	70%	71%	71%	71%	71%	74%	74%	71%	75%	78%
Overhead Ratio	<25%	42%	37%	38%	36%	38%	38%	37%	38%	37%	33%	32%	28%
Asset Turnover Ratio	<20%	13%	13%	14%	14%	14%	14%	14%	15%	15%	16%	17%	20%
Finance Ratio	<25%	35%	22%	20%	18%	20%	20%	19%	18%	18%	17%	16%	14%
Expense Ratio	<100%	114%	95%	95%	88%	92%	91%	90%	86%	85%	83%	76%	68%
Equity Ratio	>65%	27%	56%	57%	63%	57%	57%	58%	64%	58%	60%	60%	63%
Cost of Production ($/kgLW)	NA	$0.91	$0.90	$0.94	$0.90	$0.91	$0.93	$0.92	$0.95	$0.93	$0.93	$0.92	$0.92

5.2.12 Productivity

The two best performing options benefit the business through better sale prices rather than productivity gains per se. Table 6.8 shows the key performance indicators for two of the better performing productivity-related options. The early weaning and improved pastures options benefit the business through higher weaning rates (allowing a smaller breeder herd) and higher overall beef production.

Table 0.37 Herd performance measures for two productivity-related options compared to the current (base) enterprise.

Key Performance Indicator	Base Scenario	Early Weaning	Improved Pastures
Adult equivalents carried	16,599	16,600	16,596
Breeder herd size	9,583	9,213	9,367
Joiners as a % of total breeders	15%	14%	15%
Weaning rate (kept breeders)	67%	76%	72%
Male to female turnoff ratio	1.2	1.2	1.3
Mortality rate (whole herd)	5%	4%	5%
Annual live weight sold (tonnes)	1,837	1,887	1,862
Turn off percentage (# sold/#carried)	34%	35%	34%
Turnoff per breeder >3 years age (t live weight)	0.23	0.24	0.23
Kilograms live weight turned off per ha	7.7	7.9	7.8
Kilograms live weight turned off per AE	111	114	112

5.2.13 Greenhouse gas emissions

The livestock emissions of the two best performing options (alternative markets for 50% or 100% of the cattle) are the same as the base scenario because herd productivity and herd size was kept the same. In a practical sense, however, the removal of these cattle would be expected to create an opportunity to reduce stocking rates and improve land condition and individual animal productivity. The emissions of the two productivity-related options presented previously show small improvements in total emissions and emissions intensity (Table 6.9).

Increasing carrying capacity via infrastructure development is currently a high priority for many businesses in the VRD. This option was evaluated by increasing the carrying capacity from 16,600AE to 18,360AE (i.e. to 90% of the potential) for the NT DPIF model property. As expected, this modest increase in herd size increased total emissions and emissions per hectare compared to the base scenario (Table 6.9).

Table 0.38 Livestock emissions measures of the current (base) enterprise compared to two increased productivity options and the increased carrying capacity option.

Key Performance Indicator	Base Scenario	Early Weaning	Improved Pastures	Increase Carrying Capacity
Total emissions (t CO_2-e/year)	31,558	31,151	31,296	34,904
Emissions per AE (t CO_2-e/AE/year)	1.90	1.88	1.89	1.90
Emissions per ha (t CO_2-e/ha/year)	0.13	0.13	0.13	0.15
Emissions per tonne live weight sold (t CO_2-e/t LW sold)	17.2	16.5	16.8	17.2

5.2.14 Business resilience and adaptability

The two base scenarios highlighted the serious situation faced by many businesses in the VRD. Producers are grappling with ever increasing input costs whilst cattle prices and livestock productivity remain static or are in decline. Debt levels are also unsustainably high for many businesses, which exposes them to market, climate and other business shocks.

With the assistance of Limbunya, the project team was able to evaluate a range of business improvement scenarios that are considered by producers to be practical for this region. The analyses showed that many of these practices would not significantly improve business performance if implemented unilaterally. However, it is likely that several of these practices could be practically implemented together to significantly lift performance.

Removing some or all of the sale cattle from the VRD and growing them out and marketing them elsewhere performed well. In a practical sense, this would also reduce stocking rates for much of the year on extensive VRD properties, thus creating opportunities to improve live weight gain, body condition and reproductive performance in the breeder herd. It would also increase options to improve land condition and manage seasonal risk, thus increasing resilience. Removing the younger cattle may also reduce the duration of supplementation, which is a major cost to most VRD businesses.

Most of the business improvement options evaluated kept greenhouse gas emissions the same or reduced them slightly. The exception to this was the option to increase carrying capacity. Increasing carrying capacity is a high priority for many businesses in the VRD which are still in a property development phase. The business analyses confirmed that diluting overheads by increasing turn-over and/or sales return is a high priority. For many VRD businesses, ongoing property development to increase herd size or spread grazing pressure could be considered to be “business as usual” and will be essential for long-term business survival. The consequent increase in total emissions is unlikely to be an important consideration for these businesses, but improved efficiency will always be a goal.

5.3 Douglas Daly case study properties

5.3.1 Regional description

The Douglas Daly district is located west of the Stuart Highway mid-way between Katherine and Darwin. The district name refers to the confluence of the Douglas and Daly rivers which are flanked by riparian vegetation consisting of pandanus, paperbark and swamp mahogany. The rivers pass through an undulating plateau of *Eucalyptus* woodland and understorey grasses (savanna woodland) with occasional rocky outcrops (Wilson *et al.* 2006). The dominant soil type is a deep well-drained red earth consisting mainly of sandy and loamy soils and to a lesser extent skeletal, seasonally-wet and riparian soils (Aldrick and Robinson 1972, Wilson *et al.* 2006).

Seventeen freehold properties and three larger pastoral holdings form a hub of mixed farming and pastoral production, with beef cattle production from improved pasture being the main activity. Other farming activities include hay production, turf, irrigated peanuts, dry land sorghum, pasture seed production, melons and agroforestry. Of the 215,000ha of land that had been cleared in the district for agriculture only about 25% has been developed into perennial improved pasture or is used for cropping, while the remainder has reverted back to native vegetation (Jolly 2010). In 2002, annual turnover for agriculture in the Douglas Daly region generated $10.2 million (Table 6.10) and by 2009 this figure had almost tripled to $27 million, mainly from beef production (NTCA 2004). The main market for cattle production is the south east Asia live export trade for 350kg feeders and more recently PTIC (pregnancy tested, in-calf) heifers. As a result of the suspension of live exports to Indonesia in May-June 2011, some cattle were sent to South Australia for slaughter. Hay, grain and seed produced in the region is used on-farm or sold locally. A recent high investment in mahogany and sandalwood forestry is likely to see a land use change for much of the area in the future. The timber companies are targeting both domestic and international markets.

Table 0.39 Gross annual turnover from the Douglas Daly region (2002). Excludes tourism and the three large pastoral leasehold properties

Farming Activities	Production	$ M
Cattle	16,750 head	7.620
Fully improved pasture	16,500 ha	
Semi improved pasture	3,100 ha	
Hay	8,500 t	1.449
Irrigation		0.634
Grain & Seed		0.448
	TOTAL	**10.234**

5.3.2 Case study properties

Three freehold Douglas Daly cattle properties were selected for case studies for the project – Bonalbo, Manneroo and Midway Stations. In contrast to the extensive pastoral areas further south, these Douglas Daly freehold stations are relatively small holdings, ranging between 3,000 and 6,500ha in size. All three grow out young Brahman steers mainly for the live export trade using intensive rotational grazing management on improved pastures. One property grows out progeny from an 800 head breeder herd and produces hay and seed, and the other two properties are focussed on growing out weaners and yearlings from affiliated breeding properties or from purchased stock. Two of the properties use native pasture in the wet season to carry extra stock at 1 beast to 3-4ha (wet season) and 10-20ha (dry season).

Data for the case studies were collected by conducting two separate interviews with the property owners covering enterprise activities and performance in 2010 and 2011. The data sets for each year were similar for each property and were used to produce a model for each property. Financial data were only collected in the second interview and market prices were used across all property livestock, hay and seed sales.

Table 6.11 presents details of enterprise operational targets (provided by the producers) for each property. The names of the properties have been removed to ensure the privacy of the collaborating producers.

Table 0.40 Enterprise operational targets for each case study property in the Douglas Daly

	Property 1	Property 2	Property 3	Average
Total area (ha)	3,000 (+400)	5,700	6,500	6,100
Native pasture (ha)	1,500	3,400	3,800	2,900
Improved pasture (ha)	1,500	2,360	2,700	2,187
Pasture species	Buffel, Leuc/Jarra	Buffel, Jarra, Sabi	Buffel	Mostly Buffel
No. x paddock size (ha)	30 x 30-50 ha	24 x 20 ha	50 x 25 ha	35 x 28 ha
Stock (head):				
- wet season	3,050 [1]	2,000 [2]	2,500 [2]	2,500
- dry season	500	1, 600	1,500	1,800
Stocking rate (head/ha)				
- wet season SR / rotation	1.75 / 30 days	2.7 / 48 days	2.4 / 40 days	2.3 / 39 days
- dry season SR / rotation	0.4 / 90-120 days	2.7 / 24 days	0.4 / 100 days	1.2 / 75 days
Supplementation:				
- wet season	P based	P / salt lick	18%P / 3% Urea	P
- dry season	Urea based	30% Urea lick	Copra/6% Urea	Urea
Turnoff (head/yr)	3,050	650	2,500	2,067
Hay/seed Production (ha)	15 (Tully)	400 (Cav), 200 (Jarra)	140 (Jarra)	250

[1] Breeder herd and followers. [2]Feeders for export. SR = stocking rate. Leuc = Leucaena, Cav = Cavalcade.

According to the producers, the protein content of the improved pastures ranges from 7-9.5% in the wet season and 2-4% in the dry season. Actual measurements of crude protein and dry matter digestibility of plucked samples of pasture were taken in May/June (onset of dry season) (see Table 6.12). A range of seasonal nutritional values for improved pastures and pasture legumes used in the region are also given in Table 6.14 (see O'Gara 2008).

All properties provide phosphorous and nitrogen supplementation to cattle in the wet and dry seasons respectively.

5.3.3 Livestock productivity

One property produces stores from a breeding herd of 800 cows and 40 bulls, producing around 640 calves (80% calving rate) of which 580 are weaned (72.5% weaning rate). Of these progeny, 200 heifers are used as replacement breeders and the remainder are raised as stores or PTIC heifers for live export. The other two properties bring in young store cattle (steers and heifers) with live weights of 180-250kg. Weaners arrive in May and yearlings arrive in October for growing out during the wet season and for turning off from the mid-dry season (June/July) at 350kg. According to the producers, daily growth rates range from 0.7-0.9kg during the wet season and 0.2-0.3kg in the dry season. The heavier steers/heifers gain about 110kg live weight over nine months (150kg/yr) and weaners gain 180kg live weight over 15 months. This performance compares favourably with improved pasture trials at the nearby Douglas Daly Research Farm in which similar classes of stock averaged 151kg live weight gain per year over three years at continuous grazing stocking rates of 2.5 animals/ha (Lemcke and Shotton 2008).

Table 0.41 Nutrient value of grab samples of pasture from each case study property taken at start of dry season and seasonal values for improved pastures grown in the Douglas Daly region.

Nutrient Parameter	Property 1			Property 2	Property 3	Nutrient Value of Pasture Species		Nutrient Value of Pasture Legumes	
	Buffel	Jarra	Wynn	Jarra	Buffel	Jarra	Sabi	Cav	Wynn
DM (%)	39.9	38.7	34.3	34.0	38.9				
CP (%)	8.1	6.2	10.8	7.5	6.9	2-12	2-13	7-16	3-13
NDF (%)	67.4	63.6	54.0	64.3	67.7				
DMD (%)	53.4	57.1	55.0	50.2	45.1	48-54	48-58	39-68	43-55
ME (MJ/kg DM)	7.6	8.2	7.8	7.0	6.1	6-10.5	6.5-8	7-9	6-8

DM (Dry Matter); CP (Crude Protein); NDF (Neutral Detergent Fibre);
DMD (DM Digestibility); ME (Metabolisable Energy); MJ (Megajoules)
Cav (Cavalcade); Wynn (Wynn Cassia)

Table 6.13 and Table 6.14 show optimum seasonal numbers of stock classes on each property (derived over 2 years), estimated seasonal live weights and daily gains of each stock class, and net turnoff per annum. Table 6.14 also provides default seasonal values of CP and DMD respectively for pastures in the region, estimated from the range of values in Table 6.12.

Table 0.42 Seasonal numbers of stock classes on each Douglas Daly property.

Stock Numbers	Oct-Dec (Wet)	Jan-Mar (Wet)	Apr-Jun (Dry)	Jul-Sep (Dry)	Annual Turnoff[1]
Property 1					
Steers >1yr	1,500	1,000	750	125	1,485
Heifers 1-2yrs	1,500	1,000	750	125	1,485
Cows >2yrs	50	50	-	-	50
Property 2					
Bulls >1yr	42	42	42	42	-
Steers >1yr	310	310	150	75	307
Steers <1yr	320	320	320	320	-
Heifers <1yr	320	320	320	320	-
Heifers 1-2yrs	310	310	100	50	208
Cows >2yrs	800	800	800	800	100
Property 3					
Steers >1yr	-	2,470	1,000	500	2,455
Steers <1yr	2,500	-	1,000	1,000	

[1] Net turnoff after mortality - steers/heifers <1yr (3%), >1yr (1%)

Table 0.43 Estimated seasonal live weight (LW) and average daily gains (ADG) of different classes of cattle on the case study properties, and the feed value of improved pastures. (Bracketed numbers are the corresponding default values from DCCCE 2011).

	Oct-Dec (Wet)	Jan-Mar (Wet)	Apr-Jun (Dry)	Jul-Sep (Dry)
LW (kg)				
Bulls >1yr	560 (620)	620 (650)	600 (670)	570 (660)
Steers >1yr	240 (280)	310 (260)	340 (300)	360 (285)
Steers <1yr	80 (210)	150 (100)	180 (160)	200 (190)
Heifers <1yr	60 (190)	130 (90)	160 (140)	180 (170)
Heifers 1-2yrs	220 (275)	280 (240)	310 (280)	330 (290)
Cows >2yrs	400 (360)	450 (380)	435 (400)	400 (380)
ADG (kg)				
Bulls >1yr	-0.1 (-0.44)	0.65 (0.33)	-0.2 (0.22)	-0.3 (-0.11)
Steers >1yr	0.45 (0.22)	0.80 (0.55)	0.35 (0.44)	0.20 (-0.16)
Steers <1yr	0.55 (0.22)	0.80 (0.80)	0.35 (0.66)	0.20 (0.33)
Heifers <1yr	0.35 (0.22)	0.75 (0.80)	0.35 (0.55)	0.20 (0.33)
Heifers 1-2yrs	0.45 (-0.16)	0.65 (0.55)	0.35 (0.44)	0.20 (0.11)
Cows >2yrs	0 (-0.22)	0.55 (0.22)	-0.15 (0.22)	-0.40 (-0.22)
Feed Value				
CP (%)	5 (4)	9 (12)	7 (7)	3 (5)
DMD (%)	45 (40)	55 (65)	50 (55)	40 (45)

5.3.4 Profitability

Sales from live export feeders from two of the properties return 83-98% of total income and the third property generates 75% of its income from hay and seed production. Other income sources include agistment services and contract work (see Table 6.15). Average cattle prices in 2011 were $2.40/kg LW for purchases of light cattle and $2.05 for sales of feeder cattle and $1.65 for medium culled cows (PMU 2011). Grass and legume hay were marketed for $180 and $210 per tonne respectively, and seed for $15.80 and $10.90 per kilogram respectively. These prices were used across all properties to estimate income sources and gross margins.

Table 0.44 Income sourced from different operational activities and estimated gross margins for cattle production.

	Property 1	Property 2	Property 3
Income Source: Cattle	98% (stores)	25% (breeding)	83% (stores)
Hay/Seed	1%	75%	14%
Other	1%	0%	3%
Gross Margin (Cattle):			
Per ha	$108	$157	$184
Per head (AE)[1]	$324	$220	$195
Per head (AE t/o)	$145	$523	$106

[1] Adult equivalent (AE) = 420kg. t/o = turn-off

Estimated average gross margins for cattle production on each property ranged from $157-$184 per hectare, $195-$324 per AE and $106-$523 per AE turn-off per annum for the 2010-2011 period. The average gross margins per AE across the three properties was $246 and the highest gross returns came from the breeding component of one of the properties compared to the core business of growing out feeders (beef stores) for export on the other properties. The high gross margin for Property 2 reflects the targeting of the high value PTIC heifer market.

5.3.5 Greenhouse gas emissions

Full farm emission calculations for each case study property were estimated using an adapted version of the Beef Greenhouse Accounting Framework (Eckard 2008) updated in December 2010. The inventories covered on-farm stationary and transport energy (diesel, petrol, aviation fuel and LPG), enteric fermentation and excreta, agricultural soils (manure, fertiliser, legume crops and soil losses), prescribed burning and land clearing.

The calculation of emissions from enteric fermentation and excreta were based on seasonal numbers and average live weights of stock classes and their performance and the nutritional value of grazed pastures reported above. Component emissions from energy and agricultural soils were calculated from the inventories of fuels, fertiliser, stock numbers and cropping areas for each property. Clearing and burning emissions were estimated separately from total farm emissions as they are considered one-off development activities. An inventory of emissions from each property is shown in Table 6.16.

Average total farm emissions over 2010/11 (not including clearing) was 3,150 t CO_{2-}e. Emissions for clearing have not been included as these are considered one-off development activities. Enteric emissions ranged from 74 to 81% of total farm greenhouse gas emissions across the three properties (averaging 2,473 t CO_{2-}e across the properties). The next biggest contributor was agricultural soils at 453 t CO_{2-}e. The latter value spiked for the property that cultivated legume forage for hay production. Enteric emissions per tonne of live weight turned-off averaged 2.61 t CO_{2-}e for the two beef store enterprises and 10.51 t CO_{2-}e for the breeding enterprise.

Table 0.45 2010 energy and agricultural inventory emissions for each case study property in the Douglas Daly

GHG Emissions ($t\ CO_2$-e/annum)	Property 1	Property 2	Property 3	Average
Stationary/transport energy	84	166	192	147
Enteric fermentation	2,230	2,513	2,675	2,473
Manure emissions	50	47	57	52
N-fertiliser losses	0.3	7	2	3
Manure leaching/volatisation	52	48	58	53
Fertiliser leaching/volatisation	0.1	8	1.9	3
Legume pasture/hay N losses	226 (10%)	610 (26%)	194 (5%)	343
Prescribed burning	94 (80 ha)	18 (15 ha)	118 (100 ha)	77 (60 ha)
Total emissions	**2,736**	**3,417**	**3,298**	**3,150**
Per hectare	**0.81**	**0.50**	**0.51**	**0.60**
Per AE	**2.42**	**2.54**	**2.97**	**2.64**
Per tonne live weight sold	**2.58**	**14.30**	**3.84**	**6.91**
Clearing (one-off dev. activity)[1]	18,656 (140 ha)	21,321 (160 ha)	26,651 (200 ha)	18,833 (167 ha)

[1.] FullCAM estimate for 13^{o}S, 133^{o}E (Midway) of Eucalypt woodland carbon store = 30.7tC/ha (113 t CO_2-e)

5.3.6 Soil carbon

Historical measurements of soil organic carbon in the uncultivated Blain soils of the Douglas Daly region have found carbon densities ranging from 7.5 t C/ha at 0-10cm depth to 0.3 t C/ha at 90-100cm. Soil samples were taken on each case study property to compare carbon stocks in soil within cell grazing paddocks and the adjacent bush (uncultivated) land. The sampling method used a 3 x 2 grid spaced at 100m (see Figure 6.4) and three core samples per land type and divided into 5 depth increments to one metre. Organic carbon was analysed by CSIRO Analytical Laboratories, South Australia (LECO method). The results are shown in Table 6.17.

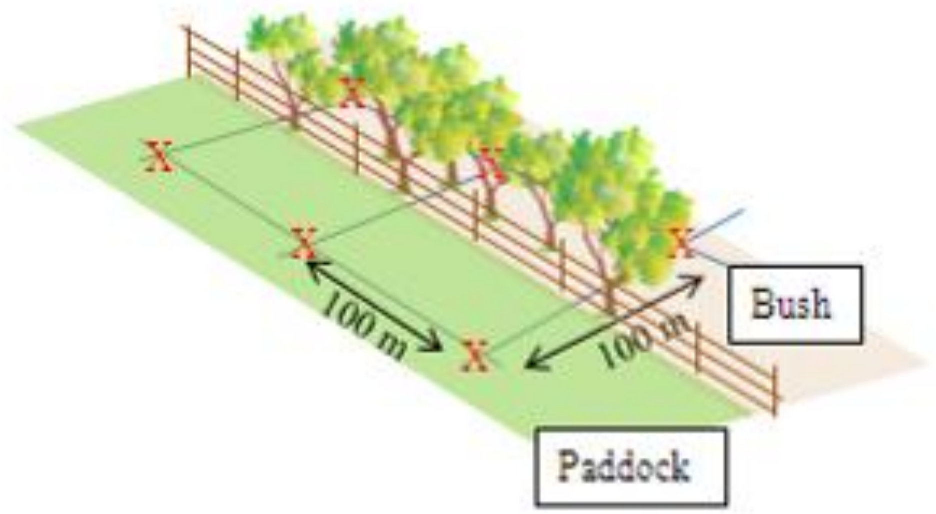


Figure 0.45 Sampling method for comparing bush and paddock carbon stocks.

Table 0.46 Values for carbon stocks for each depth layer (t C/ha of soil) for cell grazing paddocks and adjacent uncultivated bush land on each Douglas Daly property.

	Property 1		Property 2		Property 3		Average	
Soil depth (cm)	Pdk	Bush	Pdk	Bush	Pdk	Bush	Pdk	Bush
0-10	10.8	14.3	10.6	16.1	13.9	10.2	11.8	13.5
10-20	7.7	8.4	8.6	9.1	7.7	6.9	8.0	8.1
20-30	5.4	4.9	5.9	5.5	5.7	5.2	5.7	5.2
30-60	2.9	2.7	3.8	3.4	3.5	3.0	3.4	3.0
60-100	1.5	1.5	2.5	2.7	1.9	1.5	2.0	1.9

The results for the soil carbon stocks in samples taken across the three properties were considerably higher at each depth than historical values. The Walkley-Black method used to determine soil organic carbon (SOC) in the historical samples is known to underestimate SOC results (O'Rourke and Holden 2011) compared with the LECO method. The results show that on two of the properties carbon stocks at 0-10 cm depth in paddocks were 30% lower than the adjacent bush. On the other property, carbon stocks were 36% higher in the paddock than the adjacent bushland. Soil organic carbon levels were similar between locations with increasing soil depth.

During land-use change, in this case from savanna woodland to improved pastures, there has been a release of soil carbon. The extent to which soil carbon can recover to pre-clearing levels in established pastures is uncertain and will require ongoing measurement. This question is currently being examined at the nearby NT Government Douglas Daly Research Farm (DDRF) as part of a long term study of different grazing management systems and stocking rates.

5.4 Summary – VRD & Douglas Daly

- The economic and herd performance at Limbunya were found to be typical of other businesses in the VRD, which provided a sound basis from which to build realistic herd and economic models.
- The economic analysis suggested that there was a need to improve turn-off and/or increase sales returns.

- The most promising options to improve the economic performance of the VRD model property were to grow out and market the sale cattle elsewhere (e.g. on improved pastures).
- Productivity options that performed well included early weaning and augmenting native pastures with legumes.
- Increasing the carrying capacity of properties via infrastructure development is a high priority for many producers in the VRD. This is likely to improve economic performance (through higher turn-off rates) but also total increase greenhouse gas emissions.
- The main prospects for improving the emissions performance of enterprises in the VRD is by improving production efficiency (e.g. by higher reproduction and growth rates, better nutrition and grazing management, lower stocking rates).
- Many of the options evaluated would not markedly improve the performance of the business if implemented in isolation. A carefully considered combination of the most promising strategies would be expected to deliver a significantly greater return.
- Collaborating with three different properties in the Douglas Daly region allowed a good cross-section of enterprises and management approaches to be benchmarked. This has given us a more complete picture of business performance in the district.
- Total farm emissions per hectare for the Douglas-Daly properties averaged 0.6 t CO_{2}-e which is higher than 0.34 t CO_{2}-e estimated for the whole of the Queensland beef industry (Bray and Willcocks 2009) but significantly lower than the 3.9-5.2 t CO_{2}-e/ha for intensive beef production systems in Victoria (Browne 2010).
- In terms of beef production, the Douglas Daly breeding herd had the highest emissions per tonne live weight turn-off at 14.3 t CO_{2}-e compared with the average of 3.21 t CO_{2}-e for the beef store production properties. In northern Australia, turn-off values range from 14.5-32 t CO_{2}-e (Eady 2011) for extensive cattle production systems. Feedlot production emissions in NSW are 5.2 t CO_{2}-e/t LW gain (UNSW 2010).
- With the introduction of a carbon price of $23, potential total emissions liability for the Douglas Daly properties ranged from $63K to $79K or an average of $61 per AE. This would reduce the gross margin for AE turn-off by 25% if agriculture was included in the emissions trading scheme (ETS).
- It should be noted that the soil carbon stocks datasets are the results of one sampling in May 2011 and should be treated with some caution. The extent to which soil carbon can recover to pre-clearing levels in improved pastures is currently uncertain and is the subject of ongoing scientific measurement in the Douglas Daly.

5.5 Success in achieving MER targets – VRD and Douglas Daly

This section highlights the impact that the Climate Clever Beef project has had in the VRD and Douglas Daly regions. More details of the activities undertaken (and their impact) are summarised in Table 2.1.

1. Activities to increase <u>awareness</u> of herd and land management practices to cope with seasonal variability and climate change

- 6 producers and one consultant received detailed briefings about the project during the search for suitable VRD and Douglas Daly demonstration sites.

- 6 producers were briefed about project progress at two meetings of the Katherine Pastoral Industry Advisory Committee.
- 15 industry advisers and government staff from the NT and Qld visited the Douglas Daly region, including one of the case study properties prior to the Northern Beef Research Update Conference.
- 120 delegates at the 2011 NT NRM & Landcare Forum and >500 listeners of the NT Country Hour heard about the climate change risks to the northern beef industry and the activities of the project.

2. Activities to increase <u>confidence</u> (KASA - knowledge, attitudes, skills and aspirations) in implementing herd/grazing management strategies to cope with seasonal variability and climate change

- 16 producers and 2 NT government staff demonstrated increased knowledge and skills related to grazing management options to manage seasonal variability and potentially reduce greenhouse gas emissions.

3. Activities to increase the <u>implementation</u> of herd/grazing management strategies to cope with seasonal variability and climate change

- 6 producers were directly involved in implementing the management practices on the VRD and Douglas Daly demonstration sites.

5.6 Legacy and future directions – VRD and Douglas Daly

- Collaboration with DAFF QLD has strengthened the capacity of NT DPIF staff and allowed access to other resources and information sources that can be used with the industry in the NT.
- The project has involved producers that have not been involved in previous NT DPIF demonstration activities.
- Engaging an agribusiness consultant to work with the VRD focal property resulted in several benefits for the project and the collaborating producer.
- The Douglas Daly producers showed a keen interest in the carbon footprinting and emissions inventories of their farming operations. A fact sheet is being developed to provide more detail on estimations of total emissions of agricultural enterprises and on ways to reduce these.
- Ongoing measurements are required to study soil carbon sequestration and to gauge maximum sustainable carbon levels under different regional land-use activities such as cattle grazing management systems. There are already indications that soil carbon levels under improved pasture in the Douglas Daly are within 70% of levels in adjacent uncleared bush which is assumed to be the maximum level for that landscape.
- Under intensive rotational grazing management it may be possible to increase soil fertility over time to the extent that soil carbon levels may achieve or even exceed levels under natural vegetation. Any detection of significant upward movement of carbon levels in the ongoing research trial at DDRF could be incorporated into a farming system model as a mitigation factor which could provide carbon offset opportunities in conjunction with ongoing monitoring.
- There is a growing amount of baseline data on greenhouse gas emissions for different farming systems and this could be used to incentivise producers to reduce their carbon footprint. For example, if the average annual emissions per hectare for properties (< 10,000ha) in the Douglas Daly are 0.60 t CO_{2}-

$_e$/ha, this could be used as a benchmark to give financial concessions for further abatement or possibly a case for carbon offsetting.

- The information generated during this project and at the demonstration sites has been incorporated into industry fact sheets, the VRD Northern Grazing Systems Technical Guide and the VRD Grazing Land Management workshop materials.
- The industry has told us they want to see the economic implications of any grazing land management recommendations. The Climate Clever Beef project has developed a whole-of-business analysis approach that can be applied in future grazing land management research.

6 Qld Mitchell grass region

Regional team: David Phelps and Ian Houston

Table 0.47 Summary of the key issues and demonstration sites in the Mitchell Grass region.

Key issues	Demonstration sites
Land condition	
• Wet season spelling	Dunblane
• Stocking rate management	Tarrina
Production efficiency in good seasons	Rio
Infrastructure development	

6.1 Regional drivers and issues

6.1.1 Land types and climate

The Mitchell grasslands are dominated by perennial native Mitchell grasses (*Astrebla* spp.) on generally treeless undulating clay soil downs. There are other country types associated with these downs, including timbered gidyea, boree and mulga woodlands, flooded country and spinifex sandplains. These other land types comprise approximately 30% of the Mitchell grasslands bioregion.

The Mitchell grasslands are predominantly within semi-arid to arid environments with high rainfall variability. Mean annual rainfall ranges from 200–550 mm. There is a distinct summer wet season, with the first summer rains generally starting in late December and finishing by May. The growing season usually lasts for 8–10 weeks during the summer.

6.1.2 Land condition

Observations indicate that approximately 40% of the open Mitchell grass land types in Qld are in good (A or B) condition, 50% in C condition and 10% in D condition (Figure 7.1). Land in C condition has about half the gross margin (GM) of production as country in B condition and may be unprofitable in the long term.

In the open Mitchell grassland land types, spacing of Mitchell grass tussocks is a key indicator of land condition. The soils, being self-mulching clays, are generally resilient and rarely show signs of erosion. These land types are open in nature and so there are generally no significant impacts of tree basal area on pasture growth. The wooded land types, especially gidyea and boree, can have high tree basal area which impacts on pasture growth and hence productivity. Gidyea can invade open downs land types.

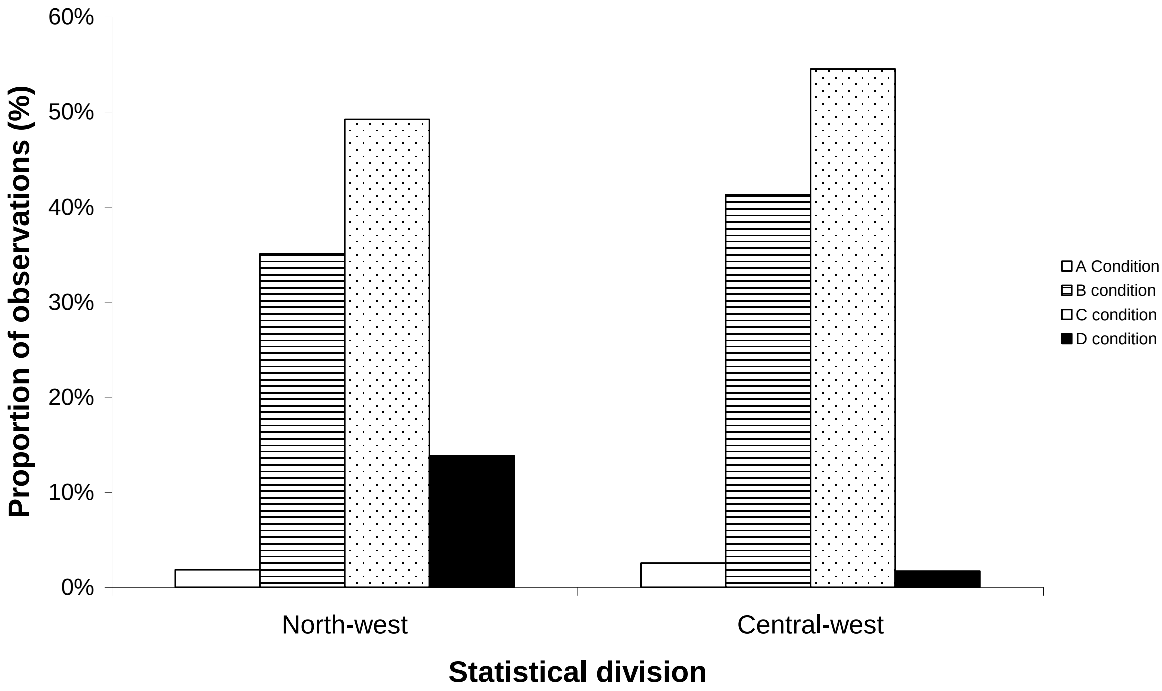


Figure 0.46 Proportion of A, B, C and D condition classes in 2006 within the north and central-western amalgamated shire divisions (Phelps *et al*. 2007).

6.1.3 History of grazing use

Western Queensland was opened up for pastoralism in the late 1860s, with most of the suitable lands being grazed with Merino sheep or cattle under private ownership by the late 1880s. Severe and extended drought in the late 1890s through to 1902 saw many properties change ownership and search for more reliable water supplies. Drilling for water became common by the 1920s, with flowing water suitable for stock discovered at depth in the Great Artesian Basin. As water became more reliable, government settlement schemes created smaller properties from the large private company holdings that had dominated ownership for the first 40–50 years.

Wool production from medium-micron Merino sheep run on family-operated properties dominated the pastoral industry until about 1995, with a peak of sheep numbers and production in the 1950s. This was in response to high wool prices. Severe drought in the 1960s and low wool prices in the 1970s led to lower sheep numbers. The wool enterprise was based on a core flock of breeders to ensure natural replacement of sheep as they were culled and sold. Between the 1960s and late 1990s sheep prices were generally lower than the cost of transport of sheep to market—often leading to delays in de-stocking.

Cattle prices were also low during the 1970s and graziers struggled to find the best mix of livestock enterprises for the Mitchell grasslands. By the early 1980s, however, the northern Mitchell grasslands (e.g. Julia Creek and Richmond districts) were starting to be dominated by cattle production—generally breeding operations—but with some backgrounding operations.

Strong beef and cattle prices in the late 1990s, coupled with low wool prices, hastened the decline in sheep numbers, with wool growing being replaced by cattle enterprises. By 2010, very few wool sheep remained north of Longreach. Some graziers have substituted meat sheep breeds such as Damara and Dorper or goats for the wool producing Merino.

The increase in cattle numbers was coupled with an increasing number of property sales and increasing land prices as many wool producing families sought to exit the industry when offered good prices. In many cases, third or fourth generation wool producing families exited the region completely—also taking their skills and experience of land management with them.

Land values now generally exceed the capacity of the country to pay back debt based on production alone.

6.1.4 Property development with fences and waters

Infrastructure is continuing to change from that needed for sheep production to cattle production. This means the loss of shearing sheds, the conversion of low-set stock troughs or bore drains to higher-set troughs for cattle access. Fences have changed from five plain and one barb wire or netting to more cost effective three barb or similar designs.

It was common practice for water to be reticulated from a flowing bore through open bore drains from the 1920s onwards. However, the issue of high evaporation and seepage from bore drains and a subsequent loss in pressure, water flows and water levels in the Great Artesian Basin was recognised by the 1980s. Government schemes to phase out bore drains in preference for piping water to tanks and troughs have been in place since the late 1980s. The altered water placement has changed the pattern of grazing use from linear piospheres (areas of grazing impact around waters) to point piospheres. Unfortunately, the replacement of bore drains has not always included planning of the optimal placement of water for livestock access within paddocks.

6.1.5 Stocking rate management

Stock numbers are generally adjusted as feed becomes scarce. The lack of browse from trees or shrubs in Mitchell grass country means that the pasture is the only natural source of fodder. The only options once the pasture starts to become limiting are destocking, supplementary feeding or substitution feeding.

Breeding enterprises often have limited options compared with Merino wether or cattle backgrounding enterprises, which rely on buying and selling rather than natural increases and decreases.

Total grazing pressure is an important consideration in the Mitchell grasslands, with many areas having large populations of kangaroos. Eastern grey kangaroo numbers have increased since the 1960s and wallaby numbers more recently, as water sources have become more reliable. Kangaroos are now in high densities, especially in country that offers both shade and water, and comprise a significant proportion of the grazing pressure on the landscape. Red kangaroos were present at the start of pastoralism—there is no firm evidence for an increase in their numbers. Localised areas have populations of wallabies, wallaroos and euros in high densities. Grazing pressure can be high in localised areas from feral goats and to a lesser extent from feral pigs.

6.1.6 Pasture rest

There is considerable interest in pasture rest (also called spelling), but few graziers use it as a defined management tool. Many landholders have practiced opportunistic rest, but generally not as part of a strategy. A key problem in implementing pasture rest is uncontrolled grazing from kangaroos, especially in—or adjacent to—wooded land types.

6.1.7 Prescribed burning

There is very little interest in using fire as a management tool in the Mitchell grasslands. Potential roles of fire include control of thickening gidyea and boree on wooded land types, control of encroaching gidyea and boree into open land types, restoring B/C condition country dominated by feathertop wiregrass to A condition, the removal of moribund pasture to improve grazing, and as a wildfire suppression tool. However, the problems with patch burning attracting high grazing pressure from kangaroos with associated high risks of land degradation, the high value placed on standing dry feed as a drought reserve and previous bad experiences with wildfire (especially during the 1950s) discount the potential benefits for most landholders.

As a result, management of fire is basically limited to the suppression of wildfire during seasons of adequate fuel load.

6.1.8 Current issues and trends

In 2012 the Mitchell grasslands face the issues of:

- Increasing pressures to repay debt—generally leading to increases in cattle numbers on individual properties.
- The continuing change from Merino sheep to cattle or other sheep breeds—often with poorly understood potential grazing impacts.
- A high proportion of cattle graziers with less than 10 years experience in managing Mitchell grassland country.
- A loss of practical expertise and knowledge of natural resource management through the exit of multi-generation land owners.
- Increased total grazing pressure from kangaroos and feral animals.
- Massive increase in established weed populations—such as prickly acacia, parkinsonia and mesquite—in response to three consecutive above-average rainfall summers.
- Increase in emerging weeds such as parthenium and sticky florestina—in response to three consecutive above-average rainfall summers.
- A limited ability to manage for animal diet quality due to highly variable seasons resulting in variable livestock productivity and variable profitability.
- Declining terms of trade in the cattle industry, often leading to increased cattle numbers in an attempt to maintain profitability.
- Areas of poor land condition masked by high pasture yields of lesser quality plants in response to three above-average rainfall summers in a row.
- Rehabilitation of D condition lands such as scalded areas and areas where dense prickly acacia has been removed.

The Climate Clever Beef project aimed to demonstrate practices that had been identified as increasing business resilience in the Mitchell grass region.

6.2 Dunblane demonstration property, Barcaldine

6.2.1 Demonstration property profile

David and Genevieve Counsell currently run 10,000 Merino sheep and agist 500 cattle on Dunblane, 10km west of Barcaldine in central-western Queensland (Figure 7.2). The 15,400ha property is mostly open Mitchell grass country with an average annual rainfall of 488mm, growing approximately 2,300kg/ha of pasture in an average rainfall year.

Dunblane is named after the Scottish town of the same name, as are many of the properties in the Barcaldine district of central-western Queensland. Settlers moved from southern Australia to take up holdings in the wide open landscape of the Mitchell grasslands from the late 1860s onwards. Many of these settlers had Scottish roots and brought names of towns, locations and landmarks from the Old World with them.

Figure 0.47 David and Genevieve Counsell and family in a Mitchell grass paddock on Dunblane.

Dunblane is now owned and managed by David and Genevieve Counsell, who are the third generation of the Counsell family. David and Genevieve took over from David's parents in 2009. They have a young family and are progressive thinkers, making use of technology, comparing options for their future income and enterprise mix and are willing to invest in different enterprises to diversify their income (e.g. they have installed solar panels and sell the excess power generated into the grid).

The Counsell's take opportunities to enhance their management skills, having attended Grazing Land Management and Stocktake training delivered by DAFF and also the BusinessEDGE training workshop. They have business and grazing management plans, monitor their pastures and land condition, benchmark their long term carrying capacity, use forage budgeting principles to adjust stocking rates and photographic evidence to help with de-stocking decisions. They also use economic benchmarking to decide on short and long-term enterprise strategies and stocking rates. Stocking rate—and therefore their pasture condition—is the key profit driver in their grazing business.

6.2.2 Land types, climate and pasture growth

Dunblane is predominantly open Mitchell grass country (Open and Ashy Downs land types). About 15% of the property is covered with gidyea and boree trees, varying from scattered trees to dense stands in some areas. These land types are Boree Wooded Downs and Soft Gidyea.

The rain at Barcaldine predominantly falls over the summer months from October through to March. Rainfall variability is high, with the lowest summer rainfall of 101mm recorded over 1901/02 to a high of 761mm over 1889/90. The 2009/10 and 2010/11 summers were both close to the highest on record, with 722 and 740mm rainfall respectively. Barcaldine has suffered six extended periods of drought since the 1880s (Figure 7.3), including the Federation drought of 1896-1906, during the Depression years, the 1940s, the 1960s, 1980s and 1990s and the Millennium drought of 2002-07. The current period of recovery started in 2008-09 for the Barcaldine district, leading into the well above average summers of 2009/10 and 2010/11.

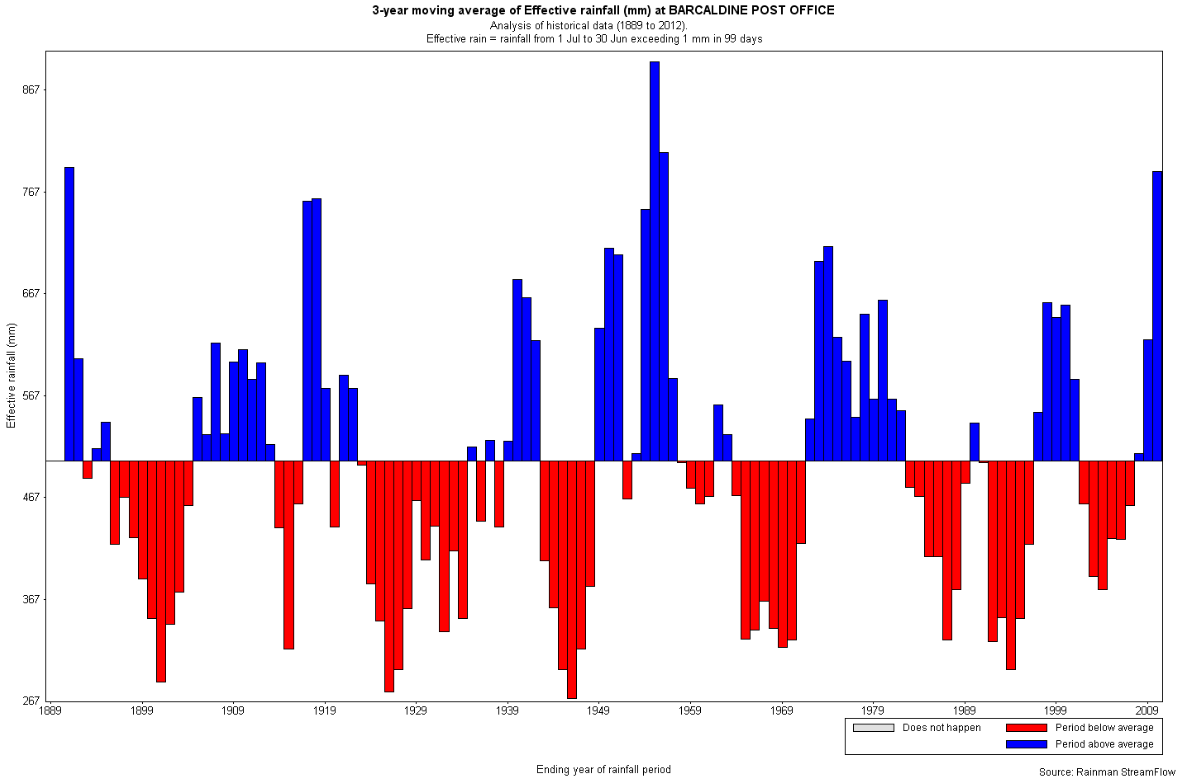


Figure 0.48 The 3-year moving rainfall average at Barcaldine (for the 12-months from July to June).

The calculated average Total Standing Dry Matter (TSDM) at Barcaldine is 2,300kg/ha of dry matter averaged across all land types (Figure 7.4). This calculation is based on historical records of rainfall and growing conditions such as evaporation, soil moisture, humidity and temperature.

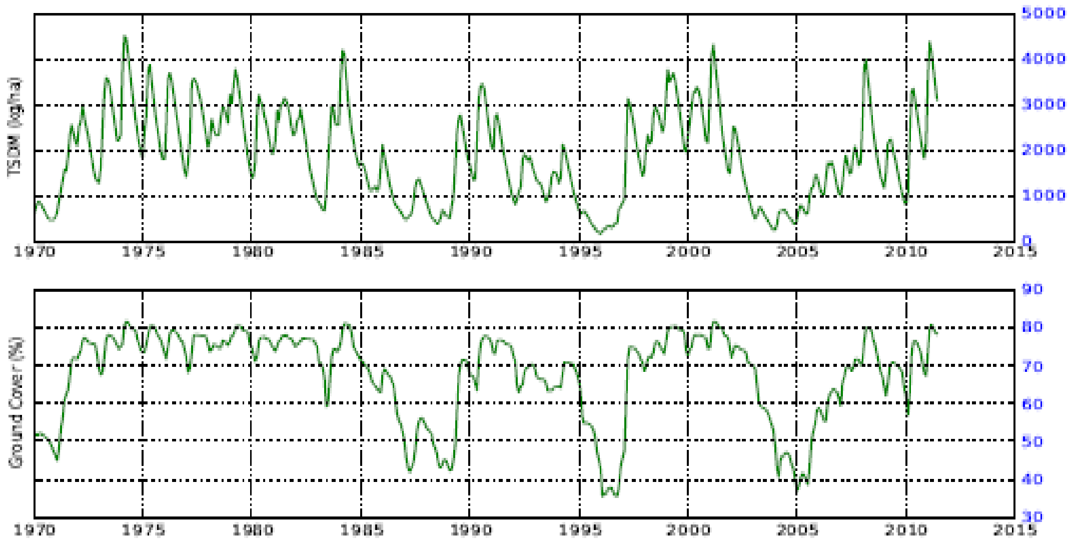


Figure 0.49 Calculated Total Standing Dry Matter and ground cover for Barcaldine from 1970 to 2011.

6.2.3 Property development with fences and waters

Dunblane is divided into 19 main paddocks ranging in size from 300 to 1,400 ha (Figure 7.5). There are six smaller and holding paddocks (from 20 to 120ha). The property has approximately 180km of fencing.

Waters have a history of being located in corners or along fence lines to allow watering of multiple paddocks from a single point. This placement was traditionally used on extensive properties to reduce infrastructure costs and also reduce the time needed to check, clean and maintain waters. Over time, however, it has become apparent that this leads to uneven grazing across larger paddocks with two consequences: the potential grazing area is reduced thus reducing overall productivity; and the areas closer to water become degraded as stock congregate there and concentrate their grazing closer to water. This also leads to reduced productivity in the long-term. Waters have been progressively re-located to more central areas in conjunction with paddock sub-division (Figure 7.5) to improve productivity and land condition.

Figure 0.50 Dunblane paddock and water layout

6.2.4 Stocking rate management

Dunblane has traditionally run sheep at relatively stable numbers with no planned use of pasture rest. The property currently runs a mix of cattle and sheep which is typical of the central-western Mitchell grasslands from Longreach to Tambo.

The long-term carrying capacity ranges from 1.2 dse/ha on Mitchell grasslands down to 0.2 dse/ha in thick gidyea country with an average of 0.97 dse/ha. Historically, stocking rates average 0.7-0.9 dse/ha overall.

6.2.5 Pastures are David's business

David has a formal business grazing plan for Dunblane, which includes breeding, animal health, financial, workplace health and safety, training, natural resource and grazing goals. His key grazing strategies are:

- Having a summer rest grazing system in place to allow designated pastures to recover
- To graze all paddocks to achieve production targets whilst ensuring the long-term health of the pastures
- Reducing and minimising the amount of land that is lost to tree encroachment
- Reducing the total grazing pressure from native animals
- To invest in water system infrastructure that will allow better grazing pressure across the paddocks
- To maintain a rigorous pasture monitoring and per paddock stocking rate system

- To achieve a status whereby wool and meat products can be sold recognising the environmental credentials of the management system.

A key business goal for David is ‘to maintain the long-term productivity and sustainability of the pastures on Dunblane whilst reducing the risks and threats to the pasture system.’

David has set up his own spreadsheet that is used to calculate the key costs based on impaired productivity—the issues that prevent Dunblane from reaching its grazing potential. David’s background as a consultant in southern Australia provided him with the necessary business skills to do this.

David’s spreadsheet is based on the long-term carrying capacity and annual pasture growth estimates in Stocktake. This allows David to compare the potential long-term carrying capacity for Dunblane with his current ability to stock paddocks, especially due to sub-optimal distance to water, kangaroo impacts, feathertop and tree encroachment. He uses the gross margin per dse value to calculate the financial cost of not being able to graze to Dunblane’s potential.

‘I’ve calculated that ‘roos are my worst problem – they reduce my grazing potential by 8%. Having waters too far apart costs me 6% of my potential production and feathertop another 5%. That’s 19% overall before I even consider over-grazed ridges and areas close to trees that are in poor condition. If I can get a handle on these issues I can really improve my profits’ (David Counsell *pers. comm.).*

We worked with David to identify paddocks that can safely carry more stock based on the long-term carrying capacity, the historical average annual stocking rate, current feed availability and projected growth based on soil moisture levels at the end of winter. He then benchmarked the performance of each paddock based on actual stocking rates, photographic evidence and annual Stocktake monitoring. ‘I take a photo every month in key paddocks and judge the feed availability and get an idea of feed quality. That’s been great as a tactical guide to how the pasture is travelling compared with the monthly stocking rate. It’s really helped me develop a good objective idea of the expected performance for each paddock’.

6.2.6 Analysis and results

The overall objective on Dunblane was to demonstrate improved resilience through maximising the area of land in good condition and maximising opportunities for improved profitability.

Making the most of above-average pasture growth

The long-term carrying capacity for Dunblane was used as a benchmark for increasing stock numbers in response to the well above average rains received, and feed budgeting used to guide the increase in individual paddocks. Based on computer simulation modelling, we decided it was safe to increase the overall property stocking rate to 30-40% above the long-term carrying capacity. Stock numbers increased from about 16,000 dse in 2010 to peak at 25,500 in 2011 (Figure 7.6). We projected reduced stock numbers over 2102 in anticipation of reduced rainfall.

Tactical decisions at the paddock level were made according to paddock land condition, feed budgeting, livestock needs and infrastructure capacity. This led to four-times the long-term carrying capacity in some individual paddocks for 3-6 months whilst others were being spelled. Even in these instances, there were no adverse effects on land condition or livestock performance.

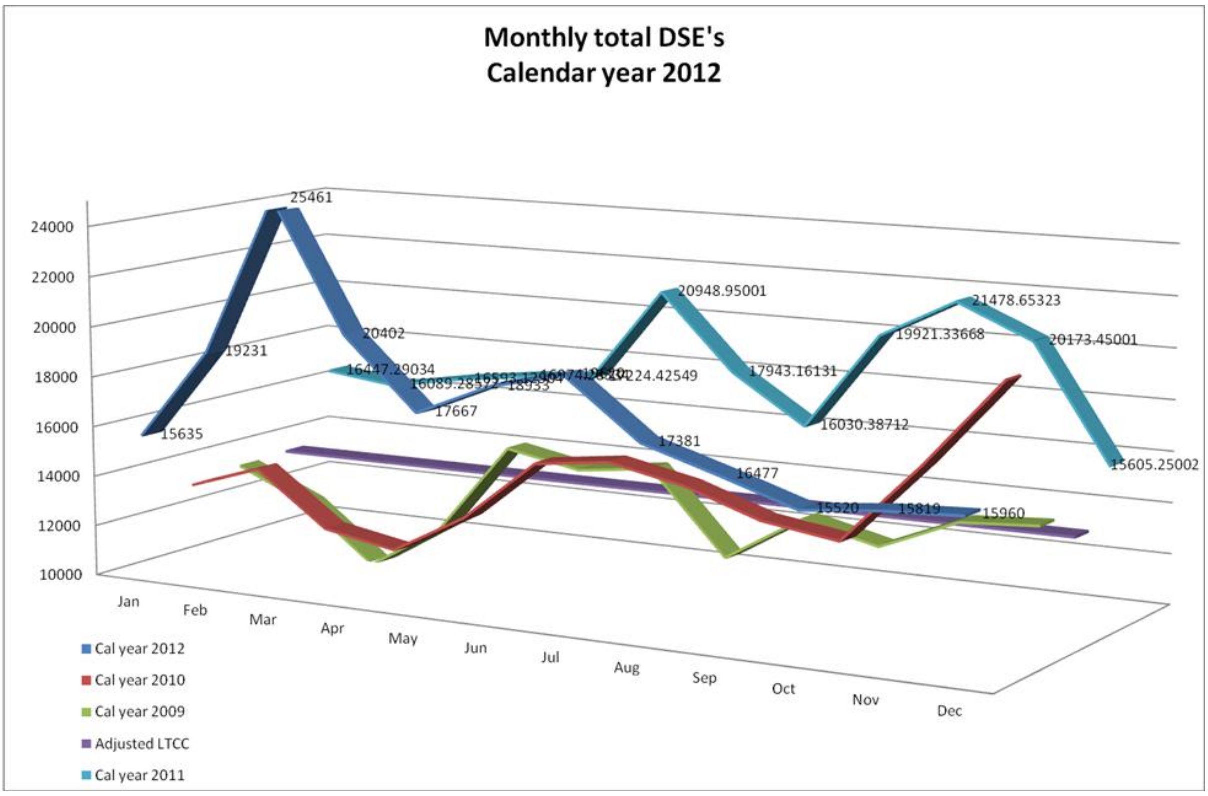


Figure 0.51 Calendar year total stock numbers for Dunblane, expressed as dry sheep equivalents (dse) for 2009, 2010, 2011 and projected for 2012 compared with the long-term carrying capacity.

It was decided to use cattle as the short term strategy to increase stock numbers, as decreasing cattle numbers would not impact on David's core wool-production business. The decision then needed to be made if cattle should be purchased or agisted in. It was decided that the risks of over-capitalising, increasing debt levels, increased exposure to interest rate movements, exposure to a fluctuating cattle market and of losing money on trading and tying up cash flow were too high to consider purchasing cattle in 2010. Instead, agisting cattle in was used as the key short-term strategy to increase stock numbers. David already had a smaller-scale agistment enterprise, with existing clients. These were approached to increase their cattle numbers on Dunblane, and new clients sought. Dunblane's location close to sale-yards in Barcaldine, Longreach and Blackall, en-route to Roma and Gracemere saleyards, and with bitumen access from the Landsborough Highway and Barcaldine-Aramac Road, make it an attractive location for agistment.

Breeding up of the sheep flock is the longer term strategy to increase stock numbers. Sheep prices are currently the highest in decades, with limited numbers of quality animals available. Purchase of sheep to increase numbers in the short-term was not an economically viable option. Agisted cattle will be the first stock to be removed once below-average rainfall seasons return. This provides business flexibility and contributes strongly to the project objective of increasing resilience through improved land condition and business profitability.

We are discussing the potential to use cattle to reduce the well-above pasture yields in some paddocks through dry-season grazing to reduce plant competition, coupled with wet season spelling to promote pasture growth. Previous research (e.g. Orr 1986) has shown that high grass projected foliage cover prevents the germination of the broad-leaf plants which are high in diet quality (Lorimer 1978). Long-term studies also demonstrate that sheep grazing can deplete the seed reserves of nutritious non-grass plants through selective over-grazing. Our concept is to (a) graze the pasture down to a safe 1,200kg/ha by the end of the dry season in 1-2 paddocks, (b) spell over the early wet and (c) re-commence grazing from March with improved diet quality pastures.

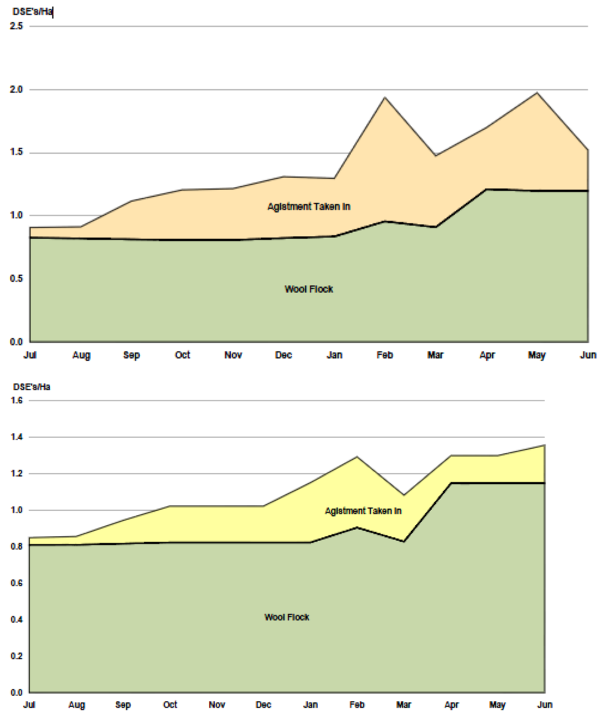
The business analysis for Dunblane, conducted by Holmes and Sackett, shows the change in stocking rate as cattle increased substantially over 2010-11, following our decision to take on more agistment cattle (Figure 7.7). We effectively made better use of the land area through the increased proportion of cattle (Figure 7.8).

Towards the end of 2011 we held a field day at Dunblane to promote the collaborative work that we were doing. David Counsell made the comments that:

- ‘We’re travelling at about 138% of our LTCC (long-term carrying capacity)’
- ‘We’re still feeling pretty damn good about this but its only when I’ve got down the other side into a dry spell and I’ve managed to de-stock well that I know I’ve managed it well’
- ‘With agisted cattle, I know I will have to manage people’s feelings and expectations well, to make sure I get the destock right’
- ‘We’ve made an extra $50,000 out of the agistment, at a Gross Margin of about $18/ha – that’s help set our business up for the future’.

Overall, we improved business resilience by improving productivity and profitability with no deleterious impact on land condition. We did this through a low-risk strategy of taking on agistment cattle, which provide a steady cash income and allows for rapid de-stocking if necessary. Pastures and land condition were monitored monthly to ensure there was no decline in resource condition.

We learnt to have faith in the objective tools available such as long-term carrying capacity benchmarking, feed budgeting and short to medium-term rainfall outlook (SOI and SST) rather than relying solely on historical stocking rate figures for Dunblane. We also learnt that the conservative nature of many graziers, and their reliance on experiential stocking rates, is likely to be limiting their capacity to build business resilience (e.g. there is often a reluctance for graziers who maintain land in good condition to increase stock numbers in good seasons). Conversely, many graziers who have land in poor condition have unrealistically high expectations of the number of stock that can be carried, which erodes resource condition, the value of the asset and cash reserves through an over-reliance on feeding and/or forced sales of livestock under low market value during drought. Land needs to be in good condition to take advantage of the good seasons through increased stock numbers.



a) b)

Figure 0.52 Dunblane stocking rate (dse/ha) and the contribution from the Merino wool flock compared with cattle taken on agistment over a) 2009-10 and then b) 2010-11 following the decision to increase cattle numbers.

Figure 0.53 Change in effective use of the land area of Dunblane from a) 2009-10 to b) 2010-11 following the decision to increase cattle numbers.

Improving land condition through wet season spelling

Two paddocks (Reserve and Far Reserve) were identified as having areas of poor land condition that needed improving. David had already conducted a wet-season spelling program in one paddock (MacBrides) prior to our project commencing, having identified this paddock as an issue following GLM and Stocktake training. We analysed the results of this programme through remote sensing using the VegMachine software.

Towards the end of 2010, we decided to conduct wet season spelling in:

- Two paddocks (Reserve and Far Reserve) from November 2010 to March 2011 to improve over-grazed, poor condition ridges
- Six paddocks which showed reduced Mitchell grass vigour to reduce the risk of decline to C condition from November 2010 to January 2011
- Two paddocks (Far Middle and Tank paddocks) to ensure recovery from bushfires in Spring 2011 across an estimated 1,000ha from November 2011 to January 2012.

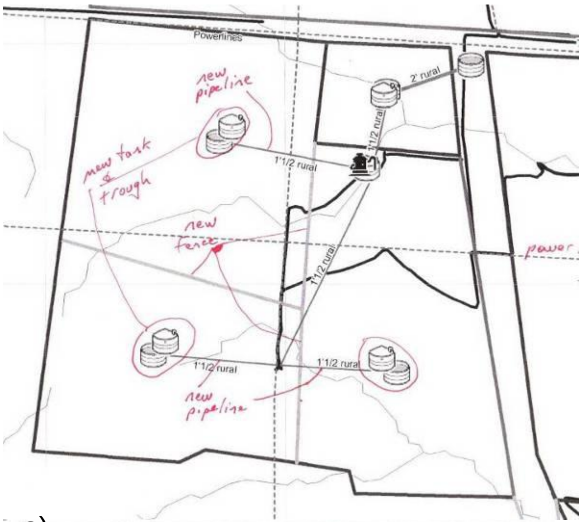
Additional paddocks were spelled over the 2011-12 summer to reduce the risk of decline to C condition.

Reserve and Far Reserve paddocks
Reserve and Far Reserve were spelled from November 2010 to March 2011, under ideal pasture growing conditions. The poor-condition ridges changed from being dominated by the undesirable perennial sub-shrub *Ocimum tenuiflorum* (wild thyme), with annual ridge grasses (e.g. *Enneapogon avenaceous*, bottlewashers) and other herbage to being dominated by the grazing desirable perennial grass *Pennisetum ciliare* (buffel grass). These ridges are now stabilised and have reduced run-off and erosion risk. An adjacent un-spelled paddock, with the same type of ridges in poor condition, failed to show the same improvement.

Photographs were taken at the paddock fixed point photo-sites featured in David's regular paddock monitoring. These photographs demonstrated useful trends but did not capture the detail required. The poor condition patches were also too small for change to be adequately demonstrated through remote-sensing (LandSat satellite, with a pixel size of 25m). We did detect trends, but there was a lag in data supply which was a further constraint. These highlight the need establish additional on-ground sites in the hot-spots of interest, even if these are only temporary additional sites, rather than relying on existing paddock monitoring sites or on current-technology remote sensing techniques.

David had determined that MacBrides paddock had poor condition Mitchell grass and wooded country, as well as erosion along a creek line, due to sheep and kangaroos concentrating their grazing closer to the shaded portion of the paddock (Figure 7.9). There were:

- Major areas of over grazing on sensitive land types and other areas ungrazed (patch grazing and under-utilisation)
- Loss of perennial grass species
- Increasing erosion and perennial pasture damage
- Fence damage and major gully erosion occurring
- Reduced stocking rates and paddock productivity
- Inability to manage the situation with current infrastructure without significant reduction in production
- The situation was continually worsening over time



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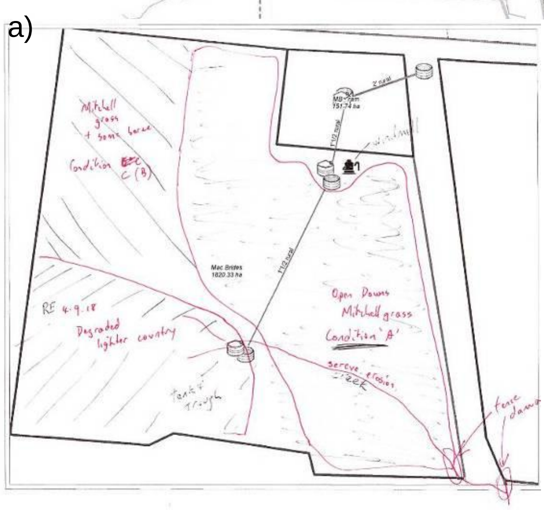

Figure 0.54 MacBrides paddock on Dunblane showing a) areas of poor land condition and infrastructure in 2008 and b) fencing and water placement to improve land condition.

Wet season spelling was needed to improve land condition and address the other issues. However, to achieve spelling from both sheep and kangaroos, David:

- Installed infrastructure
  - Fenced to land type by dividing the paddock into three (Kensington, Samford and MacBrides)
  - Re-located water points to minimise water distance, using existing pipelines
- Implemented wet season spelling by de-stocking, culling kangaroos under mitigation permits and turning off water points
- Reduced the long-term stocking rate to 85-95% of the long-term carrying capacity
- Managed to achieve ground cover targets on light soil types
- Implemented an on-ground monitoring system to understand/detect changes
- Implemented an 'office' monitoring system
  - Record monthly stocking rates in all paddocks
  - Set stocking rate targets at commencement of dry (feed budget) and graze to targets by end of dry (~1,000kgDM/ha by end of Feb)

David's results included:

- Significant increase in ground cover in Kensington (the new paddock comprising poor condition Wooded Downs)
- Significant erosion/loss of fences due to severe floods in 2010 but far less in 2011
- Massive increase in basal area of 3P grasses in Samford (the new paddock of poor condition Open Downs) and Kensington
- Significant encroachment of buffel/trees
- Consecutive wet seasons led to good grass establishment in many areas.

The photo-monitoring sites demonstrated between 2009 and 2011 an increase in perennial grasses density and cover, and increased total ground cover, as a result of spelling over the 2009-10 and 2010-11 wet seasons (Figure 7.10). It is doubtful if a similar recovery would have resulted if kangaroo densities had remained high.

VegMachine analysis of ground cover trends supported David's concerns that land condition in the Wooded Downs and an area of Open Downs was declining compared with other areas of the paddock (Figure 7.11). The Wooded Downs land type consistently had the lowest ground cover in the paddock and was consistently lower than the district average from 1994 onwards. The area of Open Downs identified as poor condition had consistently lower ground cover than the area of good condition, but was actually better than the district average for most of the time between 1986 and 2010. The improvement from wet season spelling is evident as the ground cover improved to the same value in all three areas in 2010.

Figure 0.55 Improvement in land condition on Kensington paddock (Wooded Downs land type) from a) 2009 b) 2010 and c) 2011, following infrastructure development to allow wet season spelling.

6.2.7 Summary of Dunblane land condition

In summary David has commented that:

- 'We managed to spell about 80% of those [paddocks we wanted to spell over the 2010/11 wet season]'
- 'If country is in poor condition, I recommend conservative stocking and wet season spelling in the good seasons, to improve land condition and LTCC'

Issues not addressed within the time-frame of this project included:

- High macropod grazing pressure associated with shaded areas, leading to areas of C (poor) condition within some paddocks
- Feathertop wiregrass invasion leading to low B condition and substantially reduced productivity in some paddocks and increased risk of decline to C condition

- Invasion from gidyea and boree presenting a long term problem with reduced productivity and increased risk of soil erosion, pasture decline and overall decline to C condition
- Poor livestock performance due to a low density of highly nutritious non-grass plants in the pasture.

At the time of reporting, a written publication about the demonstration site was in draft stage. A YouTube video was produced and released in early 2012 (http://futurebeef.com.au/resources/projects/climate-clever-beef/climate-clever-beef-publications/). This has proven to be popular, with 348 views by early May 2012. This has reached a larger than expected audience, and has guided increased efforts into the production of more YouTube educational videos.

6.2.8 Dunblane financial outcomes

Benchmarking was conducted by Holmes and Sackett for the 2009-10 and 2010-11 financial years based on records provided by David Counsell. Analysis of 2011-12 will be conducted in June 2012. The reports included a whole property and enterprise analysis, but not paddock analysis, which constrains our ability to determine the benefits of the spelling strategies.

The Key Performance Indicators (KPIs) indicate that more than double the number of agisted cattle were run in 2010-11 compared with 2009-10 (Table 7.2), following our decision to increase that enterprise based on objective measures of the forage availability and risk. This resulted in reduced total liabilities, from $78/ha to $74/ha and increased equity from 79% to 82%, hence building business resilience. The return to assets managed/owned also increased, as did the return to equity. The gross margins and net profits for both sheep and cattle agistment enterprises improved from 2009-10 to 2010-11 (Table 7.3), indicating that overall profitability would have improved if either the numbers of sheep or cattle increased.

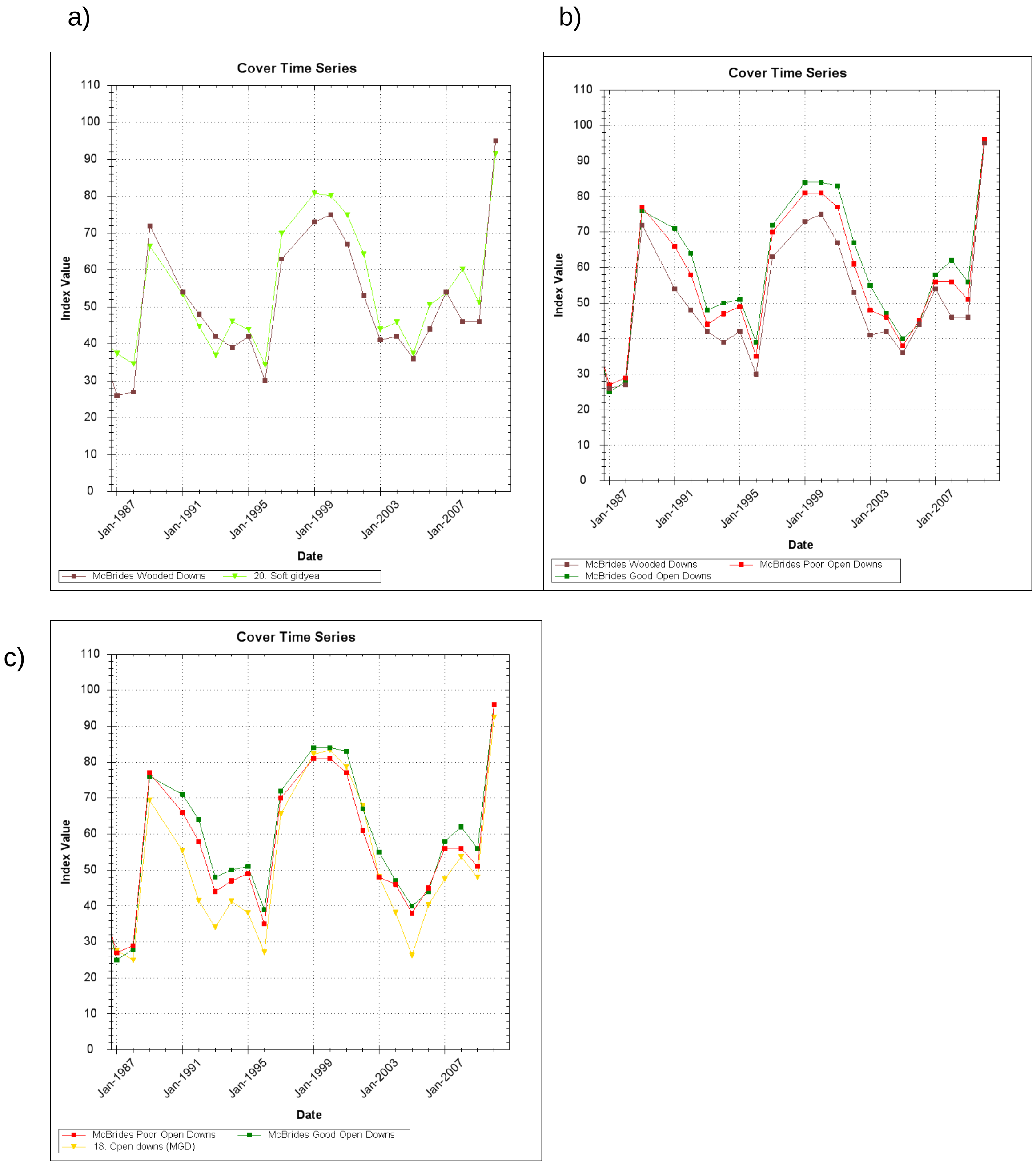

Figure 0.56 VegMachine ground cover analysis of ground cover index change between 1986 and 2010 for a) MacBrides poor condition Wooded Downs and poor and good condition Open Downs land types b) MacBrides poor condition Wooded Downs compared with the Land Types district average c) MacBrides and good condition Open Downs compared with the Land Type district average

Table 0.48 Property and enterprise Key Performance Indicators (KPIs)

Key Performance Indicator	2009-10	2010-11
Assets ($/ha)		
• Land value managed	325	325
• Plant and equipment	9	9
• Livestock/wool	33	65
• Total asset managed	367	401
• Land value managed ($/dse)	296	236
Liabilities		
• Total ($/ha)	78	74
• Average equity (%)	79	82
• Interest/land lease ($/ha)	6	6
Financial		
• Return to assets managed	4.6	4.8
• Return to assets owned	4.6	4.8
• Return to equity	3.9	4.0
• Profit % of gross income	48	48
• Profit ($/ha)	17	19
• Fixed costs/ha	11	12
• Fixed costs as % of total costs	60	59
• Interest as % of gross farm income	16	15
Wool flock KPI		
• Wool costs of production ($/kg clean)	5.63	6.48
• Wool price record ($/kg clean sold)	9.72	11.37
• Price as % of micron indicator	91	108
• Wool production (kg clean/adult shorn)	2.8	2.7
• Average adult fibre diameter (micron)	18.9	19.9
• % income from wool	64	57
• Wool production (kg clean/ha)	2	2
• % dse as wethers	17	13
• Dse/labour unit	7,082	7,273
• Enterprise size (annual av. dse)	13,985	14,361
Agistment taken in KPI		
• Income/dse/week	0.26	0.24
• Enterprise size (annual average dse)	2,930	6,839

Table 0.49 Enterprise performance gross margin and net profits ($/ha) for 2009-10 and 2010-11

	Wool flock	Agistment	Wool flock	Agistment
	Gross Margin		Net Profit	
2009/10	28	15	16	9
2010/11	38	17	22	12

6.2.9 Dunblane learnings

We easily increased the overall stocking rates to 130% of the long-term carrying capacity for Dunblane from November 2010 to October 2011. The recommended minimum residual pasture yield of 1,500kg/ha was achieved in all paddocks with the exception of a 1,000ha paddock burnt at the end of October which will be spelled over the 2011/12 summer. Other paddocks still had 2,000-3,500kg/ha of residual pasture as of mid-October and all paddocks had high ground cover. Due to rain on the day that DAFF staff visited the paddocks to be spelled in late 2010, there are no pre-spelling photographs. We hope this can be overcome through the use of VegMachine ground cover analysis. David Counsell has observed that poor condition scalded ridges within the spelled paddocks have improved in condition, particularly through buffel grass increase. However, an adjacent grazed paddock has shown improvement, so it is not possible to quantify the benefits of spelling per se until VegMachine analysis can be conducted. David, however, estimates a 2-5% gross margin return on spelling these two paddocks.

Increasing the stock numbers was initially daunting, with a lot riding on the feed budget process and estimates of pasture growth based on the high soil moisture at the end of 2010. However, by increasing stock numbers in consideration with the long-term carrying capacity, and monitoring rainfall and pasture growth percentiles (David was using Pastures from Space, we were checking Forage) we became increasingly comfortable with the decision to increase stock numbers. As a result, more agistment cattle were taken on over 2011. David estimates a total benefit to be in excess of $50,000 income.

David has both re-stocking and de-stocking strategies leading into the 2011/12 wet season, mainly being able to remove agistment cattle should the season be late or fail.

David cites his main learning to date as ‘learning to live by the numbers and leaving ‘JUST gut feel’ behind’.

Other Grazing Land Management (GLM) and Stocktake graduates that have come to Northern Grazing System events have also been implementing feed budgets as a primary management tool to adjust stock numbers. Other younger progressive graziers are also expressing a strong desire to use quantitative tools for both management and to demonstrate their duty of care - and possibly to provide a market advantage.

There is now a need to use the bio-economic modelling skills to estimate utilisation rates based on our feed budget rules (e.g. retaining a residual of 1,500kg/ha). Ideally, we could implement an easy annual utilisation calculator in conjunction with the Stocktake approach to ensure the safe utilisation rates are not being exceeded. There may be opportunities through the Precision Pastoral Management System (PPMS) project (being run by the Cooperative Research Centre for Remote Economic Participation) to do this.

6.3 On-property extension

The overall extension strategy was to enhance adoption of management practices to build resilience to a variable and changing climate, focussing on wet season spelling and stocking rates. The strategy combined five main elements:

1. A demonstration site at 'Dunblane' Barcaldine to evaluate, improve and extend grazing management strategies (adjusting stocking rates, wet season spelling to improve poor land condition, address patch grazing and recover burnt country, burning to enhance land condition through the control of Feathertop wiregrass).
2. A written and comprehensive case study will be produced based on the demo site and a field day was held to promote awareness, KASA and adoption.
3. A wet-season spelling in Mitchell grass country paddock walk series in target areas to promote KASA and adoption (especially targeting GLM and Stocktake graduates as attendees). These provided a relaxed learning environment to promote discussions between peers and scientists and highlight forage budgeting, land condition and stocking rates in the context of wet season spelling.
4. Readily available on-line resources (e.g. videos and publications) to support the on-ground activities.
5. Magazine, media, newsletter and on-line articles.

6.3.1 Assumptions

- Graziers are more likely to implement plans that have been developed in conjunction with successful peers and with direct access to scientific advice.
- Graziers attending these workshops will have already thought about, planned or begun to implement wet season spelling and will be seeking information and practical solutions.
- People are more likely to adopt a practice that they have the opportunity to trial, even if that trial is paper-based or a desktop exercise (e.g. planning using their own property maps in a workshop).
- Follow-up support is required to maximise the likelihood of adoption.
- Successful implementation of wet season spelling will promote uptake by more graziers over time via peer demonstration and diffusion.

6.3.2 Targets

The overall targets for the strategy were:

- Field day - improved awareness amongst 50 graziers, KASA amongst 30 graziers and uptake by 10 graziers
- Paddock walks - improved KASA amongst 60 graziers and uptake by 40 graziers
- Planning sessions - improved KASA amongst 10 graziers
- On-line resources – support mechanism with no defined targets
- Magazine, media, newsletter articles - improved awareness amongst 355 graziers

6.3.3 Description of the activity concepts

A 'traditional' *field day* that incorporated case study information (e.g. economics, evidence of land condition improvement, evidence of ease of implementation) with land-holder testimonial and promoted the use of the on-line tools.

A hands-on *paddock walk* incorporating:

- A practical case study (a NGS group member host property) including real-time testimonial and advice
- A paddock session
- Immediate access to the science behind the concepts

- A relaxed learning environment for participants to question, discuss and learn from their peers and the science.

A 'hands-on' *planning workshop* that incorporated:

- A planning session using participants' own property maps
- Immediate access to the science behind the concepts
- A relaxed learning environment for participants to question, discuss and learn from their peers and the science.

The priority management action promoted within the Mitchell grasslands was wet season spelling, based on:

- Computer simulation that indicated that wet season spelling can enhance improvements in land condition (this is also supported by research into Mitchell grass drought recovery).
- Strong industry interest in wet season spelling during the Northern Grazing System workshop phase.
- Broad industry interest in wet season spelling, based on discussions with graziers at various events over 2009-2011.
- Success in recovering land on the demonstration site.
- Reported success from GLM workshop graduates.
- Timing of rains and abundant forage for 2011-12.
- The large number of fires during the 2011 dry season, which required rest to recover the country.

6.3.4 Paddock walks

Paddock walks to promote wet season spelling were held during 2011 with:

- Rick and Anne Britton, Goodwood, Boulia
- Rod Shannon, Rodney Downs, Ilfracombe
- John and Joanne Milne, Loongana, Longreach
- John and Judy Sedgewick, Spoilbank, Longreach
- Doug and Fiona Nicholson, Wongan, Winton
- Geoff and Linda Wearing, Banjoura Hughenden
- Jay Simms, Malvern Park, Richmond
- Peter Ashman, Escombe Downs, Corfield
- Bill and Diane Alford, Rainsby, Hughenden
- Existing groups (e.g. Nelia Prickly Acacia control group, the Flinders and Richmond beef challenge groups).

The hosts were selected based on their success in using wet season spelling, so that they could relate their own story to their peers and stimulate discussion and learning. This experience was combined with the scientific knowledge of the DAFF presenters to achieve improved learning for all participants and presenters. The grazier participants were offered a follow-up planning service, as well as a wet season planning kit on the day.

Participant practice change was evaluated through a longitudinal survey one month after the paddock walks to assess improved knowledge, attitude, skills, and aspirations (KASA) towards spelling, and then at the end of the wet season to determine how many had implemented a change. Details are reported in the MER section in Table 2.1.

6.4 Case study properties

Paddock walk hosts were approached to become case study properties. Those who agreed were:

- Doug and Fiona Nicolson (Wongan, Winton). Doug is on the WQRBRC (Western Queensland Regional Beef Research Committee) and is a RCS and GLM graduate. He has adapted his approach to wet season spelling to suit a short growing season, where he grazes for about two weeks per paddock and ensures that most paddocks receive an early wet season spell. He has observed a substantial improvement in land condition over time. He trades cattle and aims to maximise carrying capacity.
- Rick and Anne Britton (Goodwood, Boulia). Rick is a GLM graduate and has already been a case study within our GLM publication. He now routinely spells 70,000 acres of country. Rick is a conservative stocker.
- Peter Ashman (Escombe Downs, Corfield). Peter is a GLM graduate who has been trialling wet season spelling.
- John and Judy Sedgewick (Spoilbank, Longreach). John and Judy are long standing and respected land holders in the district who manage for drought by spelling (de-stocking) and use wet season spelling to improve land condition. They have recently improved their overall carrying capacity by re-treating gidgee country and establishing buffel pastures, which provides an opportunity to discuss the tree-grass balance.
- Jay Simms (Malvern Hills, Richmond). Jay is a past chair of the WQRBRC and has a small holding out of Richmond. He has been using wet season spelling to hasten drought recovery, and has a career in managing large properties and campdrafting. As such, he may be very influential with people we would not normally reach.

Written case studies for each property are in the late draft stage and YouTube case studies are nearing completion for Wongan and Goodwood. Our paddock walk at Goodwood featured on ABC TV's Landline program, reaching an audience of approximately 250,000.

6.5 Success in achieving MER targets – Mitchell Grass

1. Activities to increase <u>awareness</u> of herd and land management practices to cope with seasonal variability and climate change

Awareness was improved for 117 graziers attending the following collaborative events with DCQ and Blueprint for the Bush (Table 7.4).

- Erosion & groundcover management workshop series held at Tambo, Prairie and Boulia
- Mitchell grass forum bus tour conducted in the Longreach district.

Table 0.50 Collaborative events with DCQ and Blueprint for the Bush

Event	Location	Graziers	Professionals / advisors
Erosion & groundcover management workshop	Greendale Station, Tambo	20	12
Erosion & groundcover management workshop	Railview Station, Prairie	38	(no new advisors)
Erosion & groundcover management workshop	Marion Downs, Boulia	39	2
Mitchell grass forum bus tour	Bandon Grove, Yuruga and Upshot, Longreach district	20	9
Total		117	33

2. Activities to increase <u>confidence</u> (KASA - knowledge, attitudes, skills and aspirations) in, and implementation of herd/grazing management strategies to cope with seasonal variability and climate change

KASA and practice change was promoted at 11 events with 124 attendees, 91 of whom were from properties (Table 7.5).

One field day held at Dunblane on 11 October 2011; 20 attendees (10 graziers from 5 properties). All attendees rated day as highly useful and relevant.

Workshop plan was altered to paddock walk plus offer of follow up planning session, based on further consultation and local knowledge to suit currently limited landholder availability.

Eight paddock walks conducted up to end October 2011 (Rodney Downs, Ilfracombe; Loongana, Longreach; Goodwood, Boulia; Spoilbank, Longreach, Wongan, Winton, Malvern Hills, Richmond; Banjoura, Hughenden; Escombe Downs, Corfield) with a total attendance of about 50 people from 20 properties (only counting the main holding - most participants have multiple properties). All participants indicated days to be valuable with learning more about feed budgeting, land condition, Mitchell grass management and wet season spelling. The majority of participants have indicated they a) learnt something new b) will change the way they manage their pastures (either start spelling, or refine what they are doing spelling).

Individual follow-up property visits to Rio, Longreach and Tarrina, Tambo to further develop feed budgeting skills and spelling plans.

Two planning sessions held at Longreach and Westech field days with seven participants. Westech presence lead to two radio and one newspaper (QCL) interviews and to one new paddock walk location. Limited interest in follow-up planning sessions but all participants interested in taking planning kits for use at home.

Table 0.51 KASA and practice change events, locations and attendance

Event	Location	Graziers	Professionals / Advisors
Demo property field day	David and Genevieve Counsell, Dunblane, Barcaldine.	9	4
Paddock walk	Doug and Fiona Nicolson (Wongan, Winton).	7	1
Paddock walk	Rick and Anne Britton (Goodwood, Boulia).	13	5
Paddock walk	Geoff and Linda Wearing (Banjoura, Hughenden).	11	2
Paddock walk	Peter Ashman (Escombe Downs, Corfield).	13	3
Paddock walk	Rod Shannon (Rodney Downs, Ilfracombe).	8	3
Paddock walk	John and Joanne Milne (Loongana, Longreach).	8	3
Paddock walk	John and Judy Sedgewick (Spoilbank, Longreach).	6	0
Paddock walk	Jay Simms (Malvern Hills, Richmond).	2	2
Planning session	Longreach DAFF.	5	0
Planning session and promotion	Westech field days, Barcaldine.	9	10
Total		91	33

Publications

Three new fact sheets and one wet season spelling property planning kit (including an updated distance and area scale conversion table and updated water circles) distributed to 80 event attendees.

Three new PowerPoint presentations delivered at Dunblane field day, from David Counsell and David Phelps, including economic analysis of the management strategies. One set of detailed paddock notes prepared for Dunblane field day.

Technical guide released to regional NRM groups, other Agency staff and Agribusiness. Fact sheets developed from wet season spelling information.

Media releases

One pre- and one post-field day local media article (Longreach Leader) with circulation of 2,375 and estimated readership of approximately 8,100 covering the Central-West Mitchell grasslands region (http://www.ruralpresssales.com.au/detail.asp?state=QLD&region=9&paper_id=152).

Two pre-field day regional radio interviews (4LG commercial radio, ABC Western Qld) with approximately 9,000 listeners throughout western Qld.

Paid pre-event advertising for Dunblane field day, Westech field days, and paddock walks (Longreach Leader, North-west Star, Charters Towers Miner, Flinders Whisper, Julia Creek community newsletter, Winton Herald).

Pre-event community announcements on ABC regional radio and advertising on ABC and Desert Channels NRM group events calendars. Pre-event notices through NRM and Departmental email distribution lists.

One National post-event television article on Landline based on Goodwood, Boulia, paddock walk; average 250,000 viewers (http://www.abc.net.au/landline/).

One State-wide post-event article in Queensland Country Life, based on Dunblane field day; circulation of 33,725 of whom 1,610 are within the Central-and North-West Mitchell grasslands region (http://publications.ruralpress.com/publications/pdf/104/ratecard.pdf).

One YouTube promotional video based on first three paddock walks (http://www.YouTube.com/watch?v=22HRXYqACkQ) with 121 views as of end October 2011.

Filming conducted at majority of paddock walks to compile an information documentary; at Dunblane field day to expand the field day audience and on location at various locations (e.g. the long-term grazing study at Julia Creek) to produce video ‘fact sheets’.

One FaceBook page established to promote discussion (David ‘Mitchell grass’ Phelps) with 54 friends.

One MLA Frontier Magazine Mitchell grass article completed September 2011, readership of 9,000 contributing to awareness.

Our paddock walk dates are all being posted on the ABC radio events calendar http://www2b.abc.net.au/EventCentral/View/Search.aspx?p=13&ci=0&pm=2&StateID=4&RegionID=89

6.6 Legacy and future directions – Mitchell Grass

On-line engagement and follow-up was envisaged to be an efficient option given the limited timeframe of this project.

A Facebook page was created with the intent of creating a discussion forum. This was not the most appropriate platform, and discussion has not resulted.

YouTube was seen as an option to support learning and expand the audience beyond those who could attend the field day and paddock walks. The two YouTube videos loaded in late 2011 and early 2012 have been an unexpected success, with over 600 views. The video summarising the Dunblane field day promoted very good feedback and discussion, including from people who were unable to attend the event. Based on this success, we have commissioned a YouTube feed budgeting training video and staff have received training in filming and editing so we can continue to produce information and training videos beyond the scope of this project.

The products produced (e.g. case studies and factsheets) are being made available online through the FutureBeef website (http://futurebeef.com.au/resources/projects/climate-clever-beef/climate-clever-beef-publications/) and YouTube.

7 Barkly region

Regional Team: Dionne Walsh, Casey Collier, Jodie Ward and Jane Douglas

Table 0.52 Summary of the key issues and demonstration sites in the Barkly region.

Key issues	Demonstration sites
Land condition	
• Stocking rate management	Alexandria
• Wet season spelling	Beetaloo
• Prescribed burning	
Infrastructure development	

7.1 Regional drivers and issues

7.1.1 Regional description

The Barkly region is more than 240,000km² in size and is situated in the central part of the NT abutting the Queensland border. The region has a semi-arid monsoonal climate and experiences two distinct seasons. The wet season typically occurs from October to April and the dry season from May to September. Rainfall is highly variable from year to year, but there is a gradient of decreasing mean annual rainfall from the north (in the Gulf district) to the south (near Tennant Creek).

The main vegetation types in the region include *Eucalyptus* and *Acacia* woodlands with tall-grass understoreys in the north (i.e. the Gulf district) and spinifex grassland understoreys in the south (i.e. Tennant Creek district), treeless cracking clays supporting productive Mitchell and Flinders grasslands (i.e. Barkly district) and various shrublands and open woodlands (Bubb 2004).

Beef property ownership is a mix of large corporate companies, large family companies and smaller family holdings. The largest holding is 12,212km², with the average property size being about 6,750km². Corporate properties tend to be bigger than privately held properties (Bubb 2004). The region typically carries >600,000 head (ABARES 2012). Property herd sizes range from about 1,000 to >50,000 head (Bubb 2004). When producers were asked to nominate a current carrying capacity for their property in 2004, the average varied depending on district and ranged from about 14,500 adult equivalents in the Gulf and Tennant districts and about 32,200 in the Barkly district (Bubb 2004). Many producers feel that there is capacity to increase herd sizes on their properties with further water point development in order to capitalise on potential carrying capacity that is not being realised (Bubb 2004, Scott 2009).

The majority of properties on the Barkly are breeder operations, but some properties also fatten stock. Brahmans are the dominant breed by property (70% of properties), with Santa Gertrudis, Brahman crosses, Composites, Wagyu and Angus making up the remainder (Bubb 2004). There is an ongoing trend towards improving animal performance through genetics, cross-breeding and improved husbandry practices. The predominant markets targeted by producers on the Barkly are live export, abattoirs, re-stockers and backgrounders. Queensland and south-east Asia are the most significant destinations by number for Barkly cattle (Bubb 2004).

Properties on the Barkly have relatively large paddocks (average of 150-360km² depending on district) and the average paddock number per property is between 12 and 24 (Bubb 2004).The average number of man-made water points per property is about 55 and producers surveyed in 2004 thought that the minimum limit for cattle to walk to water should be 3-5km and the maximum limit 8-12km (Bubb 2004). Water point development and paddock subdivision are high priorities for many producers, however, installation and maintenance costs are limiting the rate of development on many properties (Scott 2009).

7.1.2 Land condition

NT Pastoral Land Board figures indicate that about 88% (n=77) of Tier 1 monitoring sites in the Barkly district and 67% (n=28) of sites in the Tennant Creek district were in good or fair land condition in 2007/08 (Pastoral Land Board 2010). Poor land condition was noted on about 12% (n=77) of Tier 1 monitoring sites in the Barkly district and 29% (n=28) of sites in the Tennant Creek district in 2007/08 (Pastoral Land Board 2010).

The challenge facing managers in the Barkly is how to optimally use a seasonally variable feed supply for production whilst maintaining good land condition. In good years, high stocking rates typically allow increases in animal production per hectare, but high stocking rates in poor years can result in poor animal production and pasture degradation. The dilemma facing managers with land in poor condition is how to manage animal numbers to minimise periods of feed shortage whilst trying to improve land condition.

7.1.3 Research and demonstration priorities in the Barkly to enhance business resilience and climate adaptation

Priorities for on-ground research and demonstration in the Barkly region were informed by the first phase of the Northern Grazing Systems (NGS) initiative [‘Enhancing adoption of improved grazing and fire management practices in northern Australia: Bio-economic analysis and regional assessment of management options’ Meat & Livestock Australia Project B.NBP.0578].

That project identified and described the key grazing land management issues impacting on the profitability, sustainability and resilience of the northern pastoral industry. Producers in the Barkly region considered the issues in Table 8.2 to be most relevant and important priorities for further research and demonstration (Scott 2009, White & Walsh 2010b).

Table 0.53 Priority issues for Barkly producers and priority management actions

Priority Issue for Barkly Producers	Priority Management Actions
The challenge of matching pasture supply to animal demand on land in generally good land condition.	- Match stocking rate to long-term carrying capacity. - Use forage budgeting to adjust stocking rate to seasonal conditions. - Implement pasture spelling. - Implement prescribed burning.
Managing pastures in poor (C) land condition.	- Use pasture spelling to increase the density and vigour of 3P grasses. - Use forage budgeting to adjust stocking rate to seasonal conditions. - Use prescribed burning to manipulate grazing and reduce undesirable species (in selected cases).
Ungrazed pastures distant from water.	- Install more water points in large paddocks. - Reduce paddock size.

To determine which priorities to focus on, a review of current and best management practices was completed for the region. Sources for the review included local best practice manuals, the Barkly Region Grazing Land Management course materials, the NGS synthesis report (McIvor *et al.* 2010), outputs of the two regional NGS workshops and the NGS technical guide for the Barkly. The following paragraphs summarise current management approaches and the rationale for the demonstration and extension activities delivered during this project.

1. Stocking Rate Management

Annual stocking decisions are predominantly determined using the knowledge and experience of the manager. Company properties with Rangeland Officers are doing forage budgets however these are implemented to different degrees due to commercial demands and cautiousness surrounding the methodology used to derive them.

Several research studies in north Australia suggest that a long-term conservative stocking strategy is probably the most practical and cost-effective way to achieve sustainable rangeland management (see O'Reagain *et al.* in press). Anecdotal and recent research evidence from the Barkly region indicates that better rates of cattle live weight gain and reproductive performance can be achieved through the use of conservative (safe) stocking rates. However, there is still some scepticism amongst producers in the Barkly region that conservative stocking is an economically viable strategy. Bio-economic modelling undertaken during B.NBP.0578 indicated that higher (but still safe) stocking rates in conjunction with pasture spelling may be a promising option for optimising land condition and animal performance.

Feedback from industry suggests there is scope to provide more training and extension in sustainable stocking rates in the context of land type, land condition and watered area. This need is currently being serviced via Grazing Land Management workshops and the Barkly Herd Management Forum but more local data (including evidence of economic performance) is needed to strengthen the messages.

2. Wet Season Spelling

Pasture spelling is promoted as a tool to manage pasture quality, composition and bulk and to accumulate fuel for prescribed burning. In the Barkly region, pasture spelling is a relatively uncommon practice. Industry feedback during B.NBP.0578 confirmed that continuous grazing and continuous grazing with opportunistic spelling are the most common practices. Many producers are aware of the positive effects of spelling from their observations of holding paddocks and laneways. These areas, which tend to get very heavily grazed for short periods during the dry season are usually destocked during the wet season. Under this regime, the paddocks and laneways respond very well to rainfall and rest and are often in better land condition and have a larger body of feed per hectare than nearby paddocks that are continuously grazed. Participants at the NGS regional workshops noted that they understood the benefits of spelling and would like to do more of it, but they lacked the land, infrastructure and knowledge to do it. In the Barkly, most properties have large paddocks that producers can't afford to totally "lock up". However, a recent rise in the rate of paddock subdivision and water point development may increase future options for pasture spelling, rotational grazing and improving paddock utilisation.

Producer experience in the Barkly suggests that spelling should commence before the start of the wet season and continue until seed set is complete. Producers at the NGS workshops felt that a six-month spelling period offers the best compromise between pasture recovery and animal management, but the duration should be modified depending on the individual wet season experienced. Producers agreed that a practical method for achieving early wet season spelling or full wet season spelling is to remove cattle from the paddock during the second round muster. In terms of spelling frequency, producers thought that the ideal frequency will depend on the starting land condition. They felt that to recover poor condition land, spelling should initially be for a minimum of two consecutive wet seasons, and when the desired condition is attained, country should be spelled for one wet season every five years (White & Walsh 2010b). At the second NGS workshop, a producer recounted his experience of an area that was dominated by galvanised burr for the first two wet seasons it was spelled but then returned to Mitchell grass/Flinders grass dominance with further spelling. This experience, together with the results of modelling from the region, highlights that hard evidence is needed in order to convince some producers to "hang in there" with spelling if immediate results aren't forthcoming.

3. Infrastructure Development

Recent research by the NT DPIF (Walsh & Cowley 2011) indicates that pasture utilisation rates within 3km and 5km of water are probably exceeding safe recommendations on many properties in the Barkly, which suggests that stocking rates are too high given the amount of paddock development. In contrast to the Victoria River District further north, where over 90% of the productive black soils are fully developed, there are still significant opportunities to increase the watered area of productive land types in the Barkly. The rate of adoption of best practice infrastructure development is dependent on finding an appropriate balance between increased paddock utilisation and the cost of installation and maintenance. Closer development via increased subdivision fencing, more water points and/or piping water is occurring and is driven by the need to make more effective use of the land available.

In summary, priority questions for the Barkly include:

1. How does the strategy of "low (safe) stocking rates without spelling" compare to "higher stocking rates with spelling" for optimising animal production, economic performance and land condition?
2. Is wet season spelling an economically viable practice for improving and maintain land condition?
3. What practical options are available to implement spelling in the region (e.g. paddock rotation, water point rotation etc)?

4. What level of infrastructure development is optimal for balancing animal production, economic performance and land condition?
5. What are the pros and cons of paddock subdivision (via fencing) versus water point "infilling" as strategies to reduce the amount of under-utilised country?

To realistically apply the resources available for conducting demonstrations in the Barkly, we focussed on two sites. The first of these (at Alexandria Station) is an on-ground demonstration site assessing the land condition and economic performance of a "water point infill" development strategy in conjunction with wet season spelling and safe stocking rates on productive Mitchell grass country. The second activity (at Beetaloo Station) is an on-ground demonstration site documenting the costs, benefits and practicalities of the alternative infrastructure development strategy (closer paddock subdivision) and rotational grazing for managing land condition and animal performance.

7.2 Alexandria Station demonstration

7.2.1 Site description

In October 2010 a demonstration site commenced on Alexandria Station, about 280km east of Tennant Creek. Together with Soudan and Gallipoli, Alexandria is 16,118km² in size and has been owned by The North Australian Pastoral Company (NAPCO) since 1877. It is primarily a breeder operation producing weaner cattle for finishing on other properties in the Queensland Channel Country. The manager (Ross Peatling) has been at Alexandria since 1991 and has been implementing judicious stocking rate management and pasture spelling during his tenure. He is also implementing a major infrastructure development program across the property.

The purpose of the demonstration site is to measure changes in land condition at three bores of different ages in East Ranken paddock under the current stocking rate management and wet season spelling regime. The goal is to document land condition recovery at old bores and demonstrate how stocking rate management and spelling can prevent sacrifice areas developing around new bores. Spelling is achieved by turning bores on and off rather than by using subdivision fencing. Stocking rate data and pasture data are being collected at the site every year and utilisation rates are calculated. The NT DPIF is committed to maintaining the East Ranken demonstration for at least ten years. As the demonstration progresses, an analysis of development costs, management costs and animal performance (predominantly branding rates) will be completed. Once we have a good understanding of the pasture dynamics of the paddock, we will be able to use bio-economic modelling to predict land condition recovery rates and animal and economic performance in the longer-term.

The demonstration is being managed by a small group comprising Ross Peatling (Alexandria) and Casey Collier and Dionne Walsh (NT DPIF) with oversight from the Barkly Research Advisory Committee (BRAC).

7.2.2 Demonstration design

The 700km² paddock is comprised entirely of grey cracking clays supporting Mitchell grass pastures (Barkly 1 and Barkly 3 land systems). The following information is being collected:

(a) Paddock history

- Information relating to the history of paddock use: establishment date of bores, stocking rates over time, costs of bore installation and repairs and maintenance, and stock management in relation to the spelling regime. This information helps to describe the history of the site and to assess the costs, benefits and economic performance of the spelling and stocking rate regime.

(b) Management information

- Dates that bores are in use/not in use, stock movements (stock numbers & class of stock into and out of the paddock and which bores are involved). This information allows the calculation of stocking rates and utilisation rates, which are known to have a strong bearing on the success of pasture spelling.
- A paddock-level economic assessment of the spelling and stocking rate regime will be completed using data on effective stocking rates, pasture utilisation rates and branding percentages once the demonstration has been running for long enough to have sufficient data.

(c) Pasture and land condition data

- Monitoring is being done at three bores of different ages. No. 10 bore was drilled in 1910, and apart from a wet season spell in 2008 and 2009, has been grazed continuously. No. 124 bore was drilled in 2004 and has not yet had a wet season spell, while bore No. 153 is a new bore that was first used in 2010.
- A transect has been established at each of the three bores being monitored. Changes in land condition are being measured via assessments of % ground cover, pasture yield and species composition at 13 distances from water starting at 100m from water out to 5km from water.

7.2.3 Analysis and results

Bio-economic modelling

Exploratory bio-economic modelling for the Barkly showed that the best performing (and most practical) option for improving land condition from C to B for Mitchell grass pastures on the Barkly, is to use safe stocking rates and spell for six months over the wet season, every four years. In model simulations, this spelling regime led to improved pasture composition (Figure 8.1) and higher cattle live-weight gains (Table 8.3). The modelling also demonstrated that low stocking rates (without spelling) can also lead to improved land condition, but with lower live-weight gains per hectare than spelling in combination with safe stocking rates. Although the scenario was developed for the purposes of demonstrating improvements in C (poor) condition land, it also serves to highlight the benefits of spelling for maintaining pastures in good condition. At moderate to high stocking rates (>9AE/km^2), good land condition could only be maintained long-term if spelling was included in the simulations.

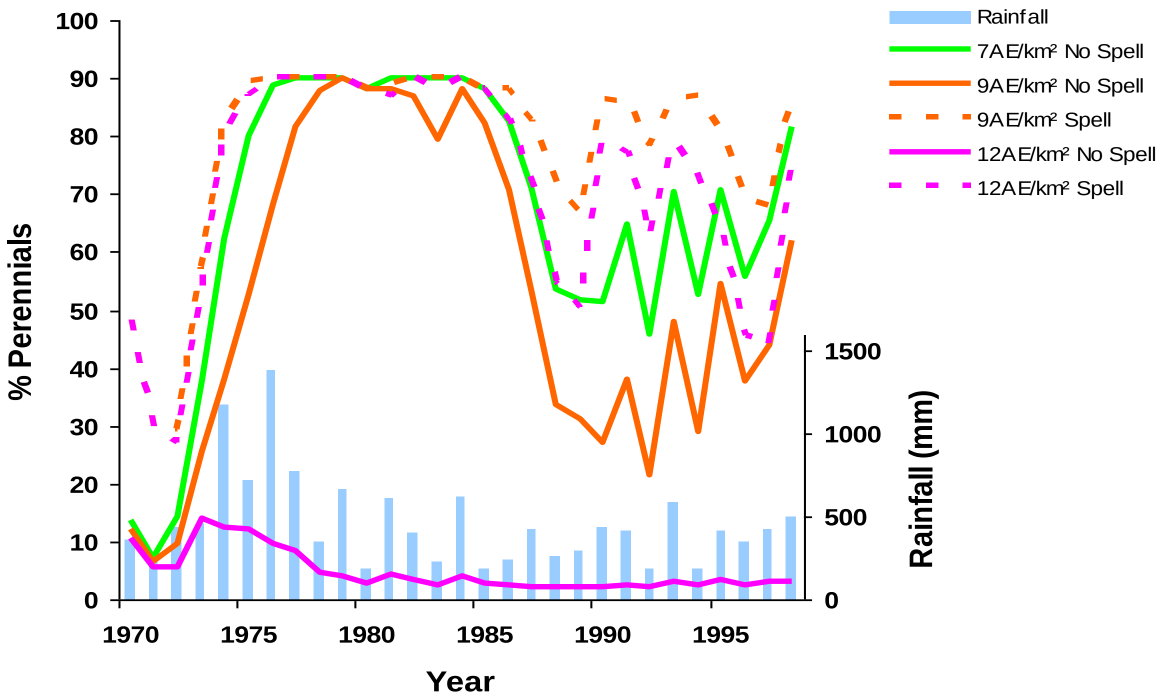

Figure 0.57 Example GRASP analysis of wet season spelling and stocking rate management for a grey cracking clay supporting Mitchell grass pastures on the central Barkly. Percentage of perennials in the pasture is used as a proxy for land condition, with a level of 52% indicative of the boundary between C and B condition.

Table 0.54 Model simulation results of average live-weight gain per hectare for the above stocking rate and spelling scenarios (1970-1998) for a grey cracking clay on the central Barkly.

Stocking rate and spelling scenarios	Average live-weight gain (kg/ha)
7AE/km² (no spelling)	5
9AE/km² (no spelling)	3
9AE/km² + 6 month wet season spell every four years	7
12AE/ km² (no spelling)	-8
12AE/km² + 6 month wet season spell every four years	5

Change in watered area over time

The total area of East Ranken paddock is 700km². Figure 8.2 shows how the watered area (at both a 3km and a 5km grazing radius) has increased since 2005 due to the water point development program in the paddock. Currently, 52% of the paddock is watered on a 3km grazing radius basis and 95% watered on a 5km grazing radius basis (Figure 8.3). Management considers this paddock to be fully watered now and the development program for East Ranken is complete. Using a 5km grazing radius as the basis for the water point infill strategy has been a conscious decision by management to balance the cost of development with achieving additional carrying capacity and is typical of current practice on Mitchell grass country on the Barkly.

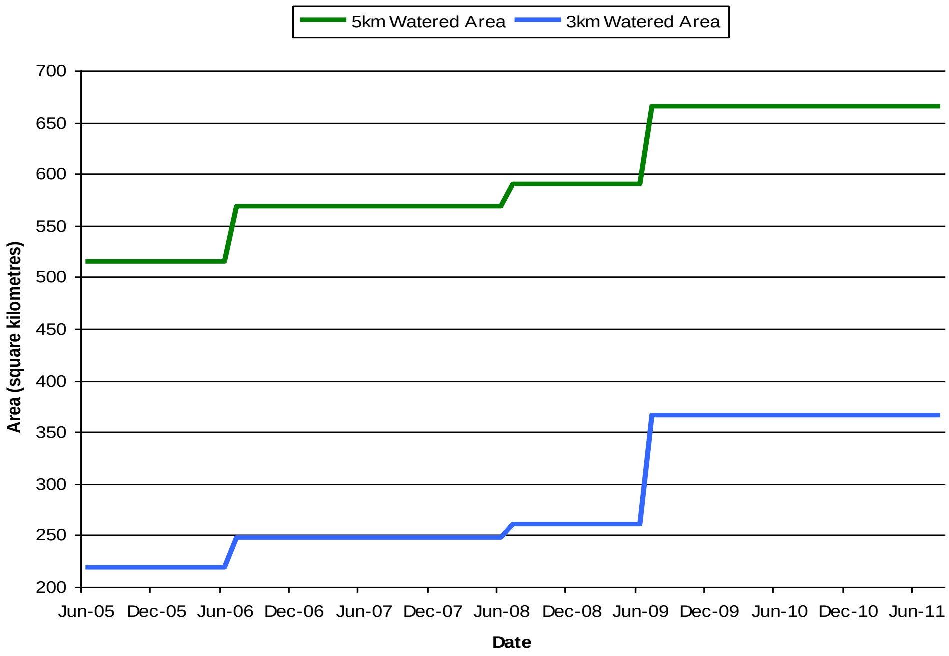

Figure 0.58 Change in watered area of East Ranken paddock since 2005.

Stocking rates and utilisation rates

At the recommended utilisation rate of 25% (Walsh & Cowley 2011), stocking rates for Mitchell grass country in good land condition on the Barkly range between about 4 and 15 adult equivalents per square kilometre (depending on rainfall). The stocking rates in East Ranken since 2005 have been within this range when considered on a whole paddock and 5km watered area basis (Figure 8.4). When considered on a 3km watered area basis, stocking rates have sometimes been higher than recommended, but the average is within the recommended range. Table 8.4 shows the pasture utilisation rates for East Ranken paddock each year since October 2000. Annual utilisation rates have varied between 5% and 80% due to the wide variation in annual pasture growth (which is determined primarily by wet season rainfall). The average pasture utilisation rate of 15% on a 5km watered area basis is well within the 20-25% recommended for this land type (Walsh & Cowley 2011) and has maintained the good land condition observed throughout this paddock.

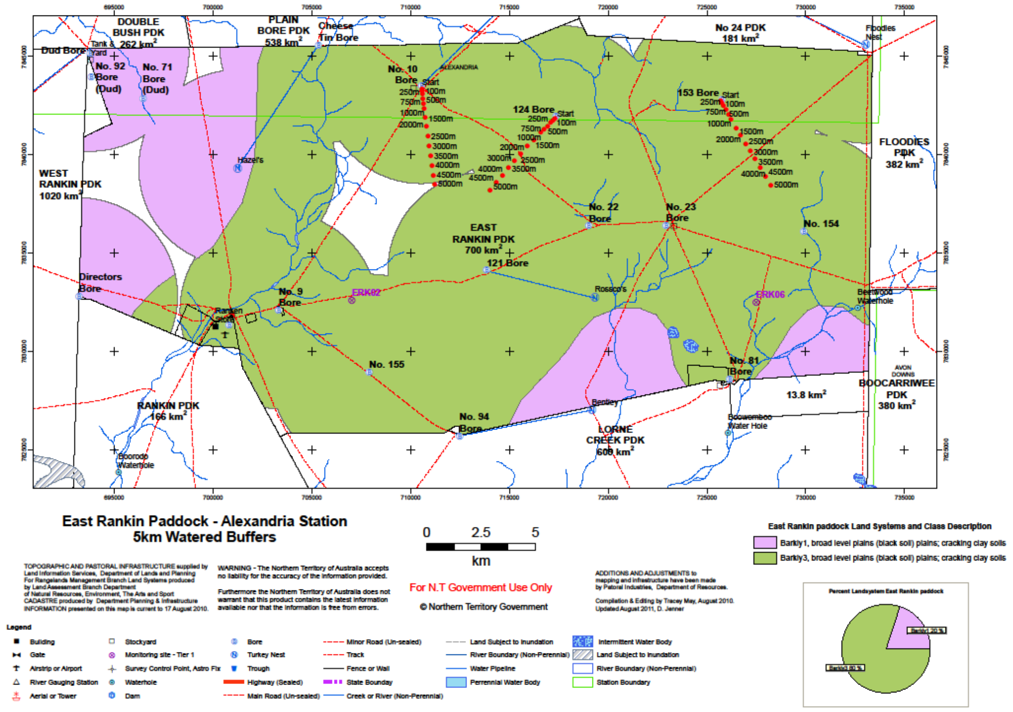

Figure 0.59 Watered area of East Ranken paddock on a 5km grazing radius basis as a 2011.

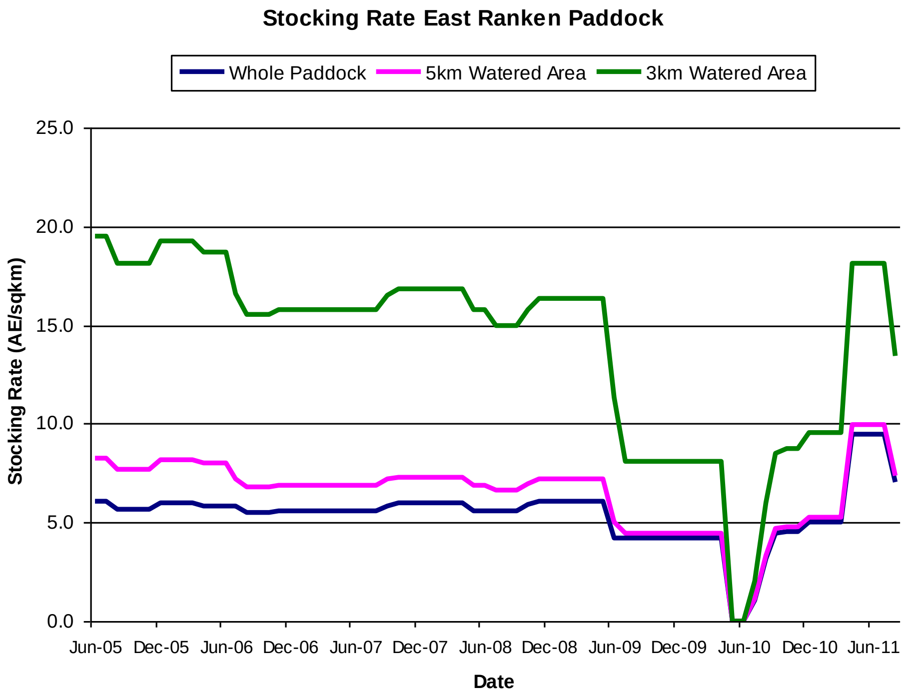

Figure 0.60 Stocking rates in East Ranken paddock on a whole of paddock, 3km and 5km grazing radius basis since 2005.

Table 0.55 Annual and average pasture utilisation rates on a whole paddock and a 5km watered area basis. Note that the durations of the wet seasons vary based on wet season onset date. Wet season onset date is defined as the first day of the first 14 day period after September 1st where ≥50mm rain fell.

		Utilisation Rates	
Wet Season	Rainfall (mm)	Whole Pdk	5km Watered Area
Oct00-Dec01	1247	4%	6%
Dec01-Dec02	320	5%	6%
Dec02-Dec03	334	4%	5%
Dec03-Dec04	338	6%	9%
Dec04-Dec05	308	11%	15%
Dec05-Jan07	614	5%	6%
Jan07-Dec07	425	10%	12%
Dec07-Nov08	168	67%	80%
Nov08-Dec09	203	8%	8%
Dec09-Dec10	514	4%	5%
Averages	**447.1**	**12%**	**15%**

Pasture yields & palatability data - 2011

At the time of reporting, the 2012 pasture data had only just been collected and were yet to be analysed, so only the 2011 results are presented. Figure 8.5 shows the average amount of standing biomass at different distances from water at the three bores in the study as at June 2011. No. 10 bore (which has been in use for >100 years) shows a general increase in pasture as the distance from water increases. No. 124, which has been in use for six years has lower pasture biomass close to water but it increases quickly away from water. No. 153, which has only been in use for a year has high pasture levels close to water. The dip at the end of the graph for No. 153 is probably due to the overlap with the grazing radius of another bore (No. 154). Figure 8.6 shows that palatable species dominated the pasture yield at all three bores.

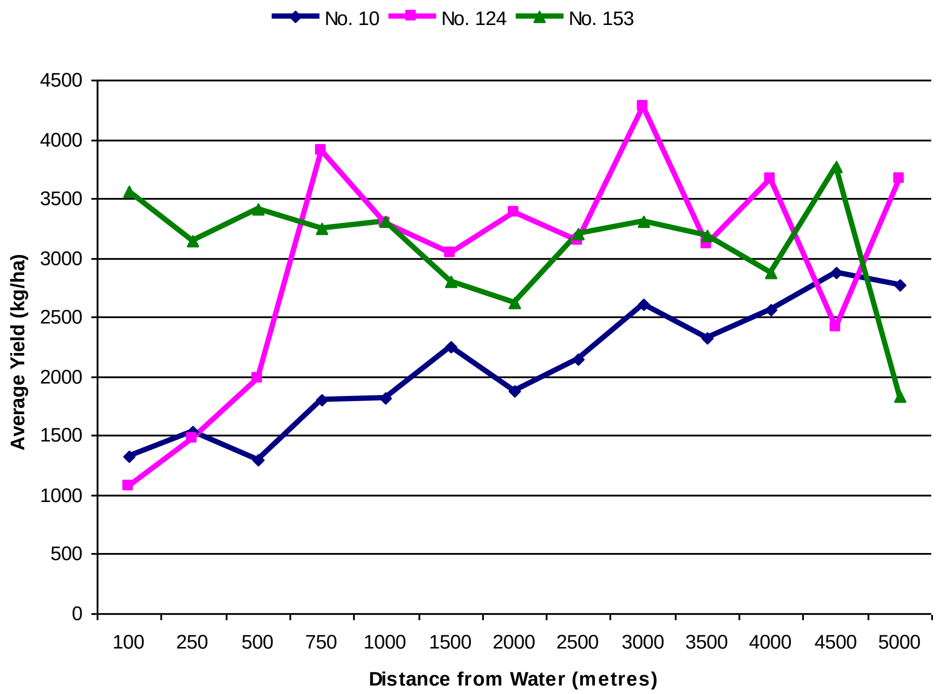

Figure 0.61 Average dry matter pasture yield (kg/ha) with distance from water for the three demonstration bores in East Ranken paddock in June 2011.

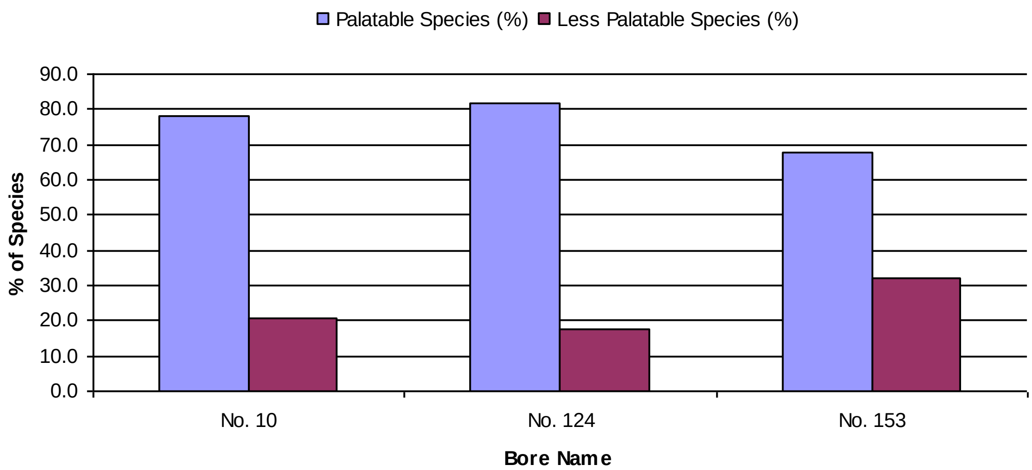

Figure 0.62 Palatability of the pastures at the three demonstration bores in East Ranken paddock in June 2011.

7.2.4 Summary of findings to date

- Since 2005, the progressive “water in-fill” development strategy has increased the watered area to the point where 95% of the paddock area is now within 5km of water.
- Rather than being used to markedly increase cattle numbers, water point development has been used to spread grazing pressure more evenly across the paddock.
- The manager has found that switching bores on and off is a practical and effective way of spelling country close to water.

- Average stocking rates and average pasture utilisation rates are within recommended levels in the paddock.
- Even under skilful management, pasture utilisation rates can vary widely from year to year due to large variations in pasture growth, which confirms previous results found on Barkly properties.
- The stocking rate and spelling management has maintained the dominance of palatable species in the pasture.
- The oldest bore being monitored (>100 years of age) still shows the effect of historical long-term grazing despite being spelled for two consecutive years. The manager has already noticed a large improvement in land condition close to this bore but further improvements in pasture yield are likely to occur as the demonstration continues.
- The extension and communications activities associated with this site are detailed in Section 8.4 - Success in achieving MER targets.

7.3 Beetaloo Station demonstration

7.3.1 Site description

The second demonstration activity in the Barkly is focussed on an alternative approach to increasing carrying capacity and improving grazing management and animal performance. The owners of Beetaloo and Mungabroom Stations are increasing the watered area of their properties via relatively intensive water point development and paddock subdivision and managing grazing via an intensive rotational grazing strategy.

Beetaloo Station is about 280km north of Tennant Creek and Mungabroom is situated adjacent to its southern boundary. The properties have been owned by the Dunnicliff family for ten years. The properties are primarily breeder operations producing cattle for the live export trade. The owners have been implementing a major infrastructure development program across both properties which has been informed by their successful experiences elsewhere including the Kimberley and in the dairy industry.

Much of the impetus for the development program has been to address animal production issues and increase carrying capacity. The owners are very concerned about the poor weaning percentages achieved under set stocked management. Whilst they attribute some of this to the lateness of maturity in the current Brahman herd, they feel that their battle to keep weight and body condition on the breeders during the dry season is also having a negative impact. As is typical for many operations in northern Australia, the feed gets eaten out close to water in some of the set-stocked paddocks and the breeders end up being too light to re-conceive. Part of the goal of the rotation strategy is to have a good body of standing feed available for these breeders in July in order to keep their weights and body condition scores up.

Initially, the Beetaloo experience was going to be written up as a low-key case study for this project. However, the enthusiasm of the owners and a subsequent collaboration with the Barkly Landcare & Conservation Association has led to the commencement of a long-term demonstration covering a broader range of issues. The purpose of the demonstration is to document the benefits and costs associated with smaller paddock development and the use of large herds and short-duration rotational grazing to manage land condition and animal performance. The demonstration is monitoring grazing management, herd productivity, land condition, soil carbon sequestration, biodiversity and water use efficiency. Some of this work is being funded by a successful Caring for our Country application submitted by the partners.

During the Climate Clever Beef project, the NT DPIF has started to document existing animal performance, carrying capacity, stocking rate and land condition records to determine a baseline. We have also started documenting the practical experience of the owners in implementing the development and grazing management program. Land condition change and animal performance (live weight gain) are being compared in a set of rotation paddocks and adjacent set stocked paddocks on Mungabroom (the "Peabush Area"). The first land condition measurements were completed in April 2012. As the demonstration develops, development costs, management costs and animal performance (predominantly live weight gain) will be analysed to elucidate the costs and benefits. Once we have a good understanding of the pasture dynamics and animal performance for the Peabush area, we will generate updated bio-economic modelling using the representative property developed during B.NBP.0578 in order to predict land condition recovery rates and animal and economic performance in the longer-term.

The NT DPIF is committed to monitoring the Beetaloo-Mungabroom demonstration for at least three years, and longer if ongoing funds can be sourced. The demonstration is being managed by a small group comprising John and Trish Dunnicliff and Jane and Scotty Armstrong (Beetaloo), Naomi Wilson (Barkly Landcare) and Jane Douglas and Dionne Walsh (NT DPIF). The Barkly Research Advisory Committee (BRAC) and Barkly Landcare Conservation Association committee endorsed the demonstration and are regularly kept informed about its progress.

7.3.2 Demonstration design

The Peabush rotation paddocks are situated on grey cracking clays supporting Mitchell grass pastures (predominantly Creswell land system with a small area of Joanundah land system). The following information is being collected:

(a) Paddock history

- Information relating to the history of paddock use: establishment date of water points, stocking rates over time, costs of water point and fence installation and repairs and maintenance, and stock management in relation to the rotation (spelling) regime. This information will help to describe the history of the site and to assess the costs, benefits and economic performance of the stocking rate and rotation regime.

(b) Management information

- Dates that paddocks are in use/not in use, stock movements (stock numbers & class of stock into and out of the paddocks). This information allows the calculation of stocking rates and utilisation rates, which are known to have a strong bearing on the success of pasture spelling and land condition.
- In time, an economic assessment of the spelling and stocking rate regime will be completed using data on development and maintenance costs, stocking rates, pasture utilisation rates and live weight turned off.

(c) Pasture and land condition data

- Botanal monitoring is being done throughout the Peabush rotation paddocks and in three adjacent set-stocked paddocks.
- Changes in land condition are being measured via assessments of % ground cover, pasture yield and species composition.

7.3.3 Analysis and results

Grazing Management

- Two main grazing systems are operating on Beetaloo and Mungabroom – the majority is run as a relatively low development, set stocked regime (i.e. traditional Barkly management). The area under intensively watered rotation totals about 400km². There are about 400 waters in operation across the properties, with a goal of 600 once development is complete.
- In the rotation, water and fence development has been done on a "4km grid", with a tank and trough at most waters. This spacing is based on the owner's observations over many years that cows with calves will only graze out to about 1.6km from water if given the choice. The development gives a grazing area of roughly 16km² per water that the owners initially calculated could carry about 200 large stock units (LSU) for a year (where one LSU = 1 cow or 1.5 heifers). This equates to about 73,000 LSU days a year available per paddock when used in a short duration rotation with large herd sizes (e.g. at the end of the most recent wet season, there were about 7,000 immature bulls being run as a single mob and these were shifted about every 3-14 days). The stocking rate figures are under constant review by management based on observed cattle performance and land condition.
- When converted to annualised stocking rates using standard NT DPIF methodology, the current stocking rate across the whole rotation is consistent with current recommended carrying capacity figures for Mitchell grass country in good condition in the northern Barkly.

Cattle Information

- The majority of calves are born in September, October and November, with about 20-30% born across the remaining months of the year. All breeders were preg-tested in 2010 and put back out into groups of similar gestational stage to achieve tighter calving. This was an expensive exercise.
- Heifer weaners (3-8mo) go into a 120,000 acre (~485km²) paddock which is continuously grazed. The younger heifers are run together for joining whilst the older ones are put into paddocks with mature cows for joining.
- Male calves are not castrated and these are run separately in rotation paddocks (including the Peabush area) before being sold to live export.
- Beetaloo has weight for age data for their live export cattle. Most are nil to 2-tooth when they go to Indonesian feedlots and cattle of 355-360kg at the station normally sneak under the 350kg limit once they arrive in Darwin. The weight of the cattle on arrival at the overseas feedlot has averaged about 312-320kg in recent years.

Development Costs

- The development costs for waters and fences combined are currently running at about $300 per LSU, which is still cheaper than buying additional land.
- Water point installation costs are currently about $45,000 each. The owners estimate that the water development costs are recouped within about four years.
- In order to gain more control over the cattle and feed supply (and to achieve cleaner musters), the owners are currently considering further subdivision of the existing rotation paddocks.

Land Condition

- The first land condition and pasture sampling was completed in late April 2012 and the analysis is still being finalised.

- Observations indicate that the Peabush area is generally in C land condition due to historical management rather than current management.
- There is currently very high cover and yield in the rotation paddocks, but the pasture is dominated by less palatable perennial species. The use of large herds in a short duration rotation, followed by long rest (up to 12 months per paddock) is expected to benefit the recovery of the more palatable species in the pasture.
- Average pasture yields and ground cover were lower in the set stocked paddocks compared to the rotation paddocks.

7.3.4 Future analyses

The demonstration at Beetaloo-Mungabroom is in its early stages. As the demonstration progresses, the following information will be collected, analysed and communicated to industry:

- How total live weight turned off from the rotation per year compares to the current performance under set stocked conditions.
- Herd projections/scenarios using Breedcow Dynama to predict how herd productivity and financial performance might change under intensive rotational management vs “traditional Barkly management” (including the costs of development and management).
- Changes in carrying capacity and stocking rates over time.
- An analysis of the interaction between stocking rate, pasture utilisation rates and cattle performance.
- Calculation of the pasture utilisation rates in the paddocks based on station cattle records and NT DPIF estimates of pasture growth.
- Changes in land condition over time between the rotation paddocks and adjacent set stocked paddocks.
- A cost-benefit analysis comparing carrying capacity and cattle performance benefits to development and ongoing running costs.
- An analysis of the pros and cons of intensive water point development and paddock subdivision as a strategy to enhance business resilience and climate adaptation in the Barkly.

7.4 Success in achieving MER targets - Barkly

All communication and extension activities delivered during the project are summarised in the MER table in Table 2.1. A summary of the main activities in the Barkly region is shown below.

1. Activities to increase awareness of herd and land management practices to cope with seasonal variability and climate change

- 14 producers and 5 industry advisers endorsed the Barkly demonstrations and heard updates about the project at two Barkly Regional Advisory Committee meetings.
- 14 producers attended a paddock walk at the Alexandria demonstration site and rated the event as useful or very useful.
- More than 50 local listeners and 5,000 total listeners were exposed to two radio interviews on the ABC Country Hour about climate change adaptation and the Alexandria demonstration site.
- 19 Barkly producers received a copy of the information booklet prepared for the Alexandria demonstration site.

- 17 producers and 10 industry advisers attended a presentation on "Pasture Dynamics" at the 2011 Barkly Herd Management Forum. This presentation included information arising from the project and promotion of the demonstration sites in the Barkly.
- A MLA Frontier Magazine featuring an article about the Alexandria demonstration site was circulated to 9,000 readers.
- 3 Barkly Beef articles about the project and demonstration sites were circulated to at least 28 local readers.
- Five presentations were given throughout the NT at industry and community forums that included information about project activities in the Barkly.

2. Activities to increase <u>confidence</u> (knowledge, attitudes, skills and aspirations) in implementing herd/grazing management strategies to cope with seasonal variability and climate change

- 12 producers that attended a paddock walk at the Alexandria demonstration site demonstrated increased knowledge about stocking rate management, carrying capacity and wet season spelling in a post-event survey.
- 7 producers who attended a Barkly GLM follow-up day demonstrated increased knowledge about stocking rate management, carrying capacity and wet season spelling in a post-event survey.

3. Activities to increase the <u>implementation</u> of herd/grazing management strategies to cope with seasonal variability and climate change

- 3 producers who attended the paddock walk at the Alexandria demonstration site subsequently commenced a spelling program and/or undertook carrying capacity and forage budgeting assessments.
- 7 producers were directly involved in implementing the management practices on the Barkly demonstration sites and are managing them long-term.

7.5 Legacy and future directions - Barkly

- The NT DPIF is committed to maintaining activities at the Alexandria demonstration site for at least 10 years.
- The NT DPIF is committed to maintaining activities at the Beetaloo demonstration site for the next three years, and longer if further funding can be sourced.
- A new collaboration was formed between the NT DPIF and the Barkly Landcare & Conservation Association to conduct a project of mutual benefit for industry.
- The industry has told us they want to see the economic implications of any grazing land management recommendations. The Climate Clever Beef project has developed a whole-of-business analysis approach that can be applied in future grazing land management research.
- Collaboration with DAFF Qld has strengthened our capacity and exposed NT DPIF staff to other resources and information sources that can be used with the industry in the NT.
- The project has involved producers that have not been involved in previous NT DPIF demonstration activities (e.g. the Beetaloo project).
- The findings from this project have helped to overcome the lack of local data and examples in some of the Barkly Grazing Land Management workshop materials.

- All the information generated during this project and at the demonstration sites has been regularly incorporated into industry fact sheets, the Barkly NGS Technical Guide, Barkly Herd Management Forum presentations and the Barkly Grazing Land Management workshop materials. This will continue after the current project ends.

8 Identification of conflicts and synergies between mitigation and adaptation management options

Prepared by Chris Stokes

Table 0.56 Summary of the key issues and model 'sites' in the cross regional analysis.

Key issues	Demonstration sites
Identification of conflicts and synergies between mitigation and adaptation management actions	Modelling undertaken in 10 regions across northern Australia.
Stocking rate	3 climate scenarios
Production efficiency	
Woody vegetation and fire	
Social and policy	

8.1 Background and context of analysis

Dealing with climate change will require both mitigation (reducing greenhouse gas emissions that contribute to climate change) and adaptation (measures to cope with residual change that does occur). The two are intimately linked in that greater up-front effort in mitigation to reduce climate change will lessen the amount of adaptation that needs to occur, while delaying mitigation measures will lead to a requirement for greater adaptation later on. Early approaches to tackling climate change anticipated that the primary response would be strong, early mitigation to limit the amount of potential climate change, with adaptation playing a more minor role in dealing with any residual climate change that did occur. It now seems much more likely that appreciable climate change will occur, requiring simultaneous mitigation and adaptation responses. Although adaptation and mitigation strategies are meant to be broadly complementary, there is no guarantee that there won't be conflicts and trade-offs for individual adaptation or mitigation actions. Furthermore, mitigations actions that may seem effective when planned under the current climate may prove to be less so in the future as the climate changes (and could even exacerbate future emissions).

Thus there is a need in adaptation and mitigation planning to anticipate, and avoid, potential perverse outcomes that could arise if unintended consequences are not considered. For example:

1. Measures taken to mitigate greenhouse gas emissions could leave industries more vulnerable or less able to adapt to climate change.
2. Adaptation measures meant to cope with the impacts of climate change could negatively affect greenhouse gas emissions.
3. Carbon stores that are increased or non-vulnerable under the current climate may prove vulnerable to climate change (particularly warming, drying and/or fire).

4. There could be other unintended negative consequences on productivity, profitability or sustainability/environment.

If such conflicts are to be avoided or managed, then it is important that adaptation and mitigation measures are systematically evaluated to anticipate any such conflicts. However, at this early stage of development, mitigation and adaptation strategies have occurred largely in isolation of each other. Before individual adaptation and mitigation measures are further developed and promoted, it would be sensible to ensure that such measures are complementary.

This chapter begins with a qualitative overview of trade-offs among various best management practices (BMPs) related to adaptation and mitigation. A set of three key practices were subsequently selected for more detailed quantitative analysis, using simulation modelling, across the northern grazing lands. The aim is to highlight potential synergies and conflicts among adaptation and mitigation options, and to identify those options that might be susceptible to future climate change.

8.2 Qualitative overview of synergies and conflicts

The starting overview draws on a range of best management practices that have recently been evaluated in relation to mitigation (this project and Bray and Willcocks 2009, Cook *et al.* 2010, Eady 2011, Eady *et al.* 2009); climate vulnerability and adaptation (associated NGS projects, B.NBP.0616 (Phelps *et al*. 2012) and B.NBP.0617 (Stokes *et al.* 2012, and Crimp *et al.* 2010; Stokes *et al.* 2010b) and a prior overview of adaptation-mitigation interactions in agriculture more broadly (Stokes and Howden 2010a; Stokes and Howden 2010b). We scored each practice for its likely implications in four areas: productivity (and profitability after considering the cost of the management option), environment/sustainability, greenhouse gas balance (both intensity as methane per unit of beef product, and total emissions), and climate change resilience/vulnerability (Table 9.6).

This overview suggests that proposed adaptation measures will have largely neutral implications for greenhouse gas emissions, and tend to reinforce many existing best practice recommendations, aimed at improving productivity and sustainability. This likely reflects the fact that climate adaptation is the most recent aspect of grazing enterprise management to be considered, so adaptation options have been developed (and filtered) from the start with consideration of potential negative consequences for mitigation and existing best management practice (e.g. Projects B.NBP.0616 (Phelps *et al.* 2012) and B.NBP.0617 (Stokes *et al.* 2012), Howden *et al.* 2008; McKeon *et al.* 2009; Stokes *et al.* 2010a). In contrast, mitigation measures are more likely to create conflicts that leave enterprises more vulnerable to climate change. Adaptation measures with potential negative greenhouse gas outcomes include greater use of fire to control woody vegetation and forage quality (and, to a lesser extent, greater energy consumption for cooling or inputs, such as feed supplements). Negative consequences of mitigation measures for adaptation include loss of pasture production associated with carbon sequestration in trees, and increased operating costs associated with pricing emissions (if these are not offset with carbon credits). In general, wherever there are improvements in the (greenhouse gas) efficiency of production, there are potential negative risks to the environmental and total greenhouse gas balance if stocking rates or throughput of animals are increased to take advantage of faster animal growth rates. The greatest areas of synergy include improving land condition, measures to improve resource use efficiency (particularly herd management and use of supplements), improving capacity of pastoralists in business management skills, and options that overlap strongly with existing best practice recommendations.

Table 0.57 Qualitative assessment of the consequences of a range of management and policy options showing potential synergies and conflicts between mitigation, adaptation, environmental and production/profitability objectives. '+' indicates a benefit, '-' a negative effect, '(...)' a qualified potential effect that depends on other management actions. 'Profitability' considers not only changes in 'Productivity', but also the associated cost of achieving the gain and implementing the management option. 'Emissions Intensity' is the livestock methane (CH_4) emitted per unit of beef produced, whereas 'Total GHG Balance' includes the effects of changes in stocking rate and other greenhouse gas emissions.

Management Option	Consequences						Comments
	Productivity	Profitability	Environment	Emissions Intensity	Total GHG Balance	Adaptation	(Category comment, in shaded area, applies generally to all options in category)
Stocking rate							Where overgrazing has caused pasture degradation, there is a trade-off between the short-term economic loss of reducing stocking rates and the long-term benefits of improved animal and pasture productivity.
Matching stock numbers to "safe carrying capacity" or less (conservative stocking)	+	(+)	+	+	+(/-)	+++	Reducing overstocking would reduce CH_4 emissions and could restore soil C over time. There is a CH_4 emissions and profit trade-off between reduced stock numbers and having larger stock (more selection/higher quality diet) with more calves. Matching stocking rates to changing (+/-) productivity under climate change will have a large effect on GHG.
More even spatial utilisation / stock distribution	+	(+)	(+/-)	(+)	(-)	(+)	If extra infrastructure to improve livestock distribution is economically viable it could be profitable but, if stocking rates increase, so could emissions and over-utilisation. Benefits could increase under warming climates, as livestock travel less distance from water.
Managing for seasonal variability and forecasts (responsive strategies)	+	+	+	=	(=)	++	Managing for climate variability can reduce the impacts of droughts and take better advantage of more productive years. Managing climate variability also provides a starting point for monitoring and responding to trends in changing climates.
Improving land condition (e.g. wet season spelling)	++	(++)	+++	(+)	++	+++	Short-term economic challenges in the transition to improve land condition (and productivity). In the longer-term, good condition land is generally more productive, more environmentally healthy, stores more C and is less sensitive to climate change.

Table 0.2 continued.

Management Option	Consequences: Productivity	Profitability	Environment	Emissions Intensity	Total GHG Balance	Adaptation	Comments (Category comment, in shaded area, applies generally to all options in category)
Production efficiency							Potential GHG and environmental benefits from improved production efficiency could be lost if stocking rates (AEs) are increased to take advantage of faster growth rates.
More effective P supplementation (cows)	++	++	(+/-)	+	(+/-)	++	Livestock maintain productivity or are in better condition to cope with adverse seasons, boosting productivity per AE. Faster growth and turn-off could reduce overall grazing pressure, unless replacement rates are also increased.
More effective N supplementation (growing)	+	+	(+/-)	+	(+/-)	+	Faster growth and turn-off could reduce overall grazing pressure, unless replacement rates are also increased. Supplementation will become more important if forage quality declines with climate change.
Improved turn-off strategies and herd structure	+	+	(+)	+	(+)	(+)	Herd efficiency can be improved by removing less productive animals (infertile cows, excess bulls, older slower growing animals). Faster growth and turn-off could reduce overall grazing pressure, unless replacement rates are also increased.
Livestock emissions efficiency (rumen modifiers, breeding, feeding legumes)	+	(+)	(=)	++	+	(+)	Some of these options are still in development and their economic potential is not known yet. It is not yet known whether the genetics of breeding for reduced CH_4 emissions will be compatible with the requirement for greater heat tolerance under climate change.
Breeding for improved heat tolerance, adopting hardier breeds	=	(-)	=	(=)	(=)	++	As above, but there will also be challenges in maintaining meat quality while breeding for greater hardiness (heat tolerance and disease resistance).

Table 0.2 continued.

Management Option	Consequences: Productivity	Profitability	Environment	Emissions Intensity	Total GHG Balance	Adaptation	Comments (Category comment, in shaded area, applies generally to all options in category)
Woody vegetation and fire							Woody vegetation stores large amounts of C at the expensive of pasture productivity and profitability (unless the trees provide a commercial product).
Woody regrowth retention	--	(--/++)	(+)	=	+++	(--/++)	Increases woody C stores at the expense of pasture production. There are risks of pasture degradation if stock number are not reduced to match pasture supply, otherwise regrowth of native vegetation would likely have biodiversity benefits. Commercial species and C credits may contribute to profitability.
Active tree planting for C credits	(--)	(--)	(+)	=	+++	(--)	The harsh and variable climates of northern grazing lands are generally not conducive to actively planting trees, so this would likely only be an economically-viable option in very limited situations. Trade-offs for pasture productivity would be as above (for regrowth).
Controlling spread of native and exotic woody vegetation	+	(+)	=	=	=	(+)	As the cost of tree clearing and control rise, the economic effectiveness of these options is declines. The need may increase where changing climates favours shifts to a greater woody plant:grass vegetation balance.
Use of fire to control woody vegetation	(+)	(+)	=	=	-	+	There is a short-term cost in the use of fire associated with building up and forgoing grazing of forage required to fuel the burn. There are associated risks of replenishing the forage supplies if follow-up rains are late (or drought). There may be greater benefit and opportunity to use fire in the future in situations where altered climate both increases the spread of woody vegetation and produces larger quantities of lower quality forage.
Use of fire to improve forage quality and livestock distribution	+	+	=	+	-	+	If future wetter climates produce excess, low quality forage, this will provide greater opportunities (and requirements) for the use of fire. If a drier climate occurs, fuel loads will be less but fire risk greater. Trade-offs for risks and supply of forage are the same as above.
Reduce use of fire	=	=	(+)	=	(+)	=	Frequent (> 1 in 3 yrs) burning from controlled or wild fires is more likely to occur outside of grazing lands, and is only an issue for commercial grazing in restricted locations.

Table 0.2 continued.

Management Option	Productivity	Profitability	Environment	Emissions Intensity	Total GHG Balance	Adaptation	Comments
Social and policy							
Develop strategic business skills and networks	+	++	+	+	+	+++	Improving business and planning skills and management capacity would have widespread benefits across all aspects of enterprise performance, particularly profitability and the capacity to adapt to future challenges and opportunities.
Pricing emissions	(=)	(+/-)	=	=	+	(-/+)	In short-term, pricing emissions will have an indirect negative effect on input costs. It may be possible to offset these or generate income from emerging carbon markets.
On-farm renewable energy and fossil fuel substitution	(=)	(=)	(=)	=	(+)	(=)	This option has yet to be evaluated, but costs of solar panels etc. are coming down. Energy consumption is a relatively minor component of pastoral emissions, but would be a more important consideration for feedlots.
Product substitution (less emissions intensive)	(=)	(=)	(=)	(+)	(+)	(=)	Kangaroo is sometimes raised as a potential non-ruminant (lower emissions) alternative to beef. However the market for kangaroo meat is too small for this to be a broadly viable option (in addition to other logistic and animal welfare/ethics issues). There are limited opportunities for pastoralists to substitute lower-emissions inputs and outputs.
Improved distribution (reduced food waste and transport emissions)	=	=	(+)	=	(+)	=	Given the limited opportunities to reduce agricultural emissions while increasing production for a growing population, it will be important to also consider other parts of the supply chain.

8.3 Quantitative cross-regional analysis

Of the various management practices covered above, three were selected for more detailed quantitative analysis, based on the relative potential for synergies and conflicts, and the tractability of evaluating these within simulation models. The three practices selected were:

- adjusting stocking rates to maintain safe utilisation levels in response to changing pasture production;
- improving land condition from C to B condition; and
- managing for increased tree carbon stores (either by passively allowing woody vegetation to expand, or actively planting).

The simulations were conducted using the GRASP model in a cross-regional analysis using 10 NABRC (North Australian Beef Research Committee) regions across the northern grazing lands (Figure 9.1). The methodology is documented in detail in the related project, B.NBP.0617 (Stokes *et al.* 2012), where analyses focussed on evaluating climate change vulnerabilities and adaptation options. In this project we used the model output to quantify associated changes in soil carbon stores, tree carbon stores and animal methane emissions, to determine the interacting influences of management actions and climate change on the greenhouse gas balance.

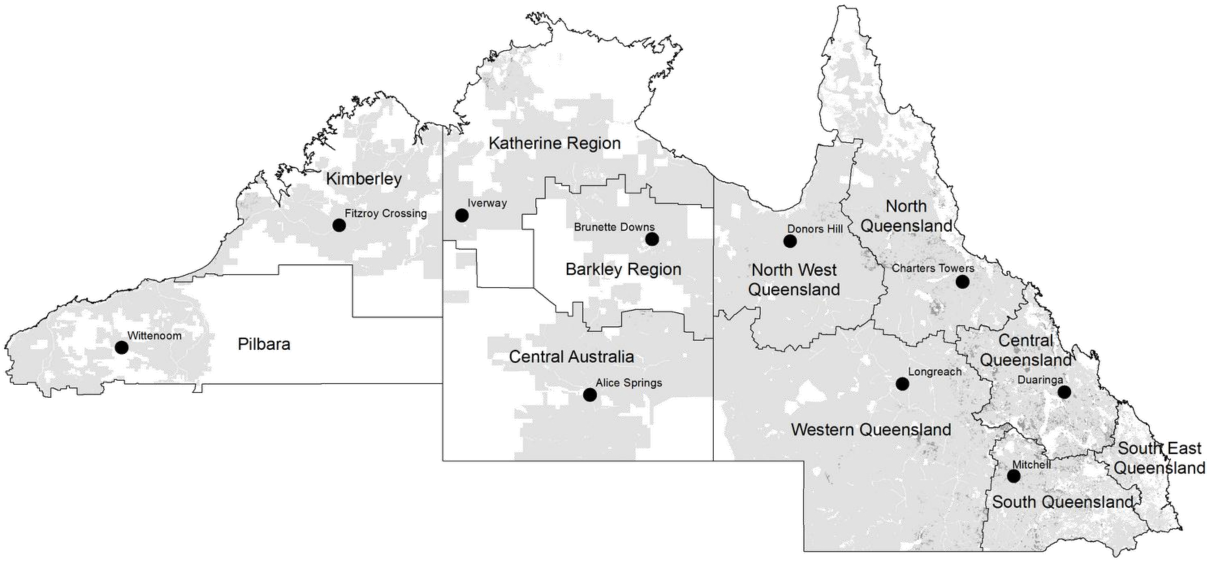

Figure 0.63 Agro-ecological zones used in the cross-regional analyses follow the North Australian Beef Research Council (NABRC) regions. Marked points indicate the locations used for weather station data and climate change projections.

8.3.1 Modelling approach

Briefly, the analysis involved the following three steps (covered in detail in the B.NBP.0617 final report, Stokes *et al.* 2012):

1. Climate scenarios used to drive the simulations were summarised as the envelope of uncertainty in climate change projections for each region (Figure 9.2.1) with reference to gradients of temperature change, emphasising three reference scenarios. We obtained climate projections from the OzClim database (http://www.csiro.au/ozclim, Page and Jones 2001) for 22 Global Climate Models (GCMs), 3 emissions scenarios (A1FI, A2, and A1B) and 4 future dates (2030, 2050, 2070 and 2100). For each location we summarised

the bounds of uncertainty in terms of the relationship between projected changes in rainfall and changes in temperature. For each projection date we calculated the mean projected temperature increase and the associated 10th, 50th, and 90th percentile projected changes in rainfall. We then plotted the 10th (red), 50th (grey) and 90th (blue) percentile trajectories of changes in rainfall over time, relative to the associated projected temperature change for each NABRC region.

Three key reference scenarios were selected for emphasis, to assist later in interpreting impacts and the effectiveness of management options. These scenarios were the baseline of current climate (1990, black diamond), and the average projected temperature for 2070 with the associated 90th (2070H, blue diamond) and 10th (2070L, red diamond) percentile rainfall projections (Figure 9.2.1 and Figure 9.3). For each scenario the associated atmospheric CO_2 level was calculated from the average CO_2 projection for the 3 IPCC emissions scenarios used (A1FI, A2, and A1B) on the projection date (Nakicenovic and Swart 2000). Baseline weather data obtained from SILO (www.longpaddock.qld.gov.au/silo/) for each site was then adjusted to reflect the climate change scenarios, following the approach described in B.NBP.0617 (Stokes *et al*. 2012).

2. Modelling was used to determine the associated impact envelopes along these gradients of climate change (on pasture growth, carrying capacity, live weight gain, greenhouse gas balance etc., Figure 9.2.2) and how various land/vegetation characteristics affect sensitivity to climate change. Ten NABRC regions were used to represent regional variation across northern Australia. Variation within regions was represented by differences in land condition, tree density, soil fertility and soil water storage characteristics (details below).

3. Broad management responses were considered in terms of the effects of improving C-condition land to B condition, and increasing tree density (as described below). The effects of these management actions were represented graphically as vertical arrows (for the size of the management effect, relative to no action, on various indicators of productivity and greenhouse gas balance) along the gradients of climate change (Figure 9.2.3).

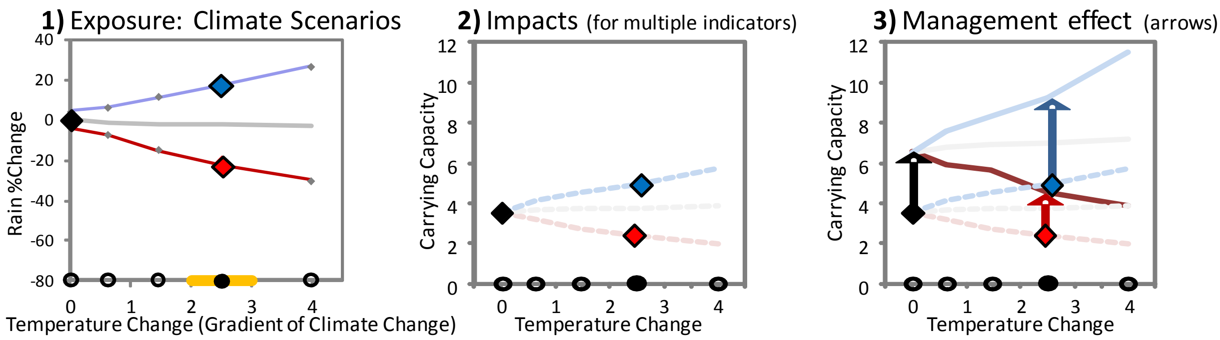

Figure 0.64 Approach using envelopes of uncertainty along gradients of climate change to express: 1) climate change scenarios (including 3 reference scenarios marked with diamonds); 2) impacts of climate change; and 3) effects of a management action (impact is indicated as arrows for the 3 reference scenarios marking the change from the impacts without management action to the impacts after action has been taken).

The simulations were run using the pastoral production model GRASP (Rickert *et al.* 2000), across a set of model runs that included factorial combinations of the following factors:

Climate Change
Climate scenarios: Three reference climate scenarios (1990, 2070L and 2070H) were used for each region following the approach described above. (To generate full response curves along gradients of climate change, intervening scenarios were used to cover all the projections for 10^{th}, 50^{th} and 90^{th} percentile rainfalls) (Figure 9.3).

Variation between regions
NABRC regions: the diversity of extensive grazing environments across northern Australia was covered using 10 NABRC (excluding the more intensive and fragmented SE Queensland region). GRASP parameter files for a representative pastoral land type for each region (provided by the B.NBP.0616 modelling team, based on parameter sets from their property-level simulations). No bio-economic parameters were available for the Pilbara so those for the most similar region, Alice Springs, were used instead. The base parameter set for each region was then modified to represent variation within each region. (This controlled factorial approach allows independent evaluation of how each factor contributes to resulting responses, which is not possible when using different mixes of land-types where contributing factors co-vary and are confounded);

Variation with regions

- Land condition: four land conditions to represent A, B, C and D condition;
- Trees density: The base tree density was contrasted against a situation with extra trees (the greater of +2m^2/ha or +~50% basal area) that could occur either by uncontrolled, CO_2-stimulated woody thickening, or management-facilitated changes for carbon credits.
- (Fertility and soil water storage characteristics were also altered, but made little difference to the greenhouse gas results, so are omitted here for simplicity. Their implications for climate vulnerability and adaptation are discussed in the B.NBP.0617 final report.)

Each simulation was run over a 120-year period (using historic and climate-scenario-adjusted daily weather data for the location), with dynamic land degradation turned off, and stocking rates adjusted each year to target a safe percentage forage utilisation.

As an important caveat it should be noted that confidence in this modelling is greatest for eastern NABRC regions (in Queensland), declining westwards and is greatest for simulations of pasture production, declining as these are followed through to live weight gain and enterprise/herd economics. This relates to the availability and quality of data sets to validate and parameterise the models.

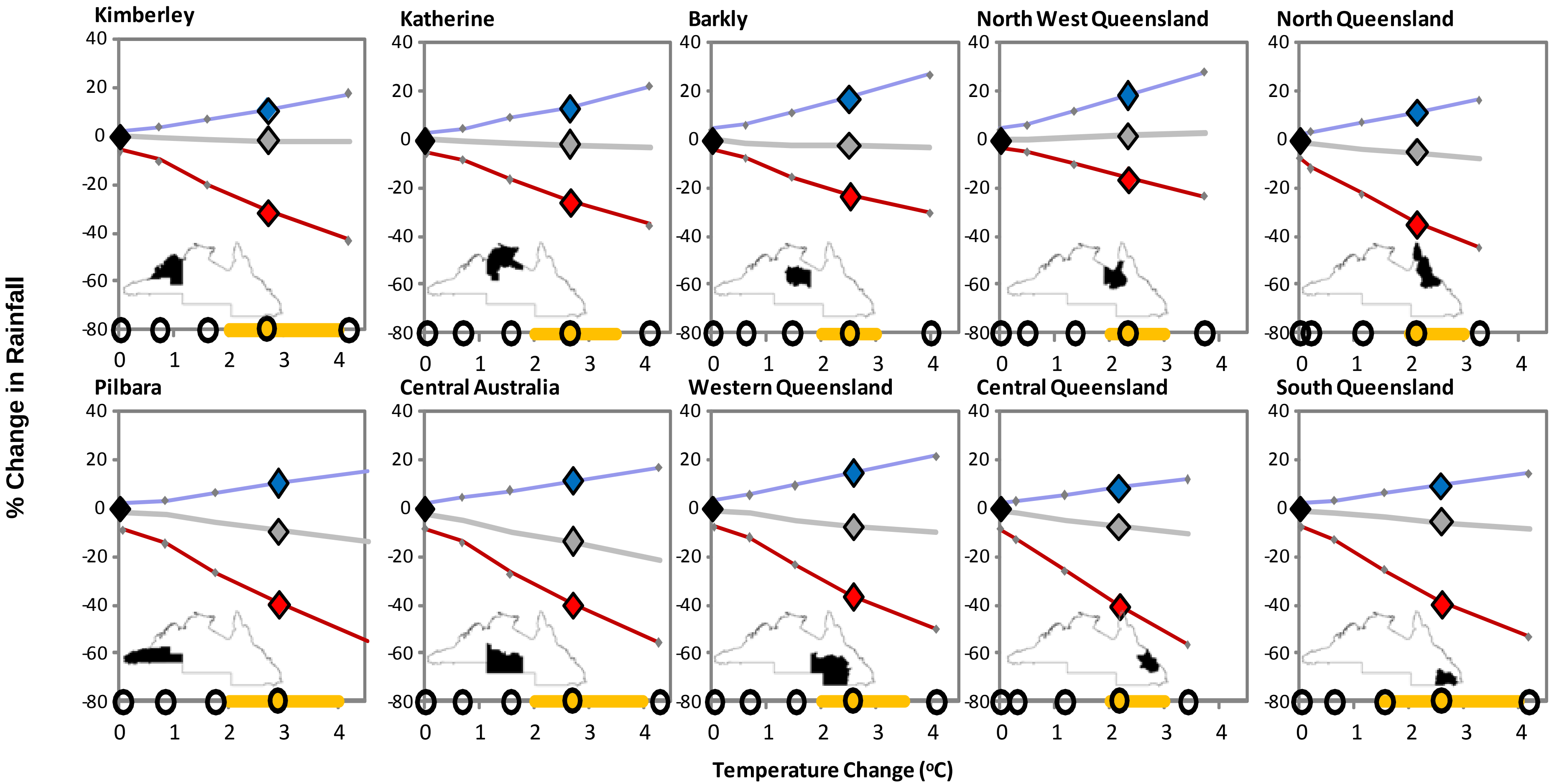

Figure 0.65 Climate change exposure envelopes summarise the uncertainty in climate projections as the trajectory of rainfall projections along a gradient of climate change (projected change in temperature) for each NABRC region. The upper blue line follows the 90th percentile rainfall against the average temperature projection for each date, the grey line the median rainfall projection, and the red line represents the trajectory of the 10th percentile rainfall projection for each date. The diamonds mark the key reference scenarios: the baseline of current climate (1990, black), and the average projected temperature changes for 2070 with the associated 90th (2070H, blue) and 10th (2070L, red) percentile rainfall projections. Circles mark the progressive average warming for 2020, 2030, 2050, 2070 and 2100 along the x-axis, and the yellow bar the projected range for 2070.

8.3.2 Quantifying greenhouse gas balance from GRASP output

The analyses of climate impacts and adaptation effectiveness on enterprise productivity, profitability and vulnerability are provided in the B.NBP.0617 final report (Stokes *et al*. 2012). In this project, we added an analysis of the corresponding implications for greenhouse gas mitigation by developing methods for quantify changes in the components of greenhouse gas balance (livestock CH_4 emissions, tree C stores, and soil C stores) from the GRASP output.

Recent experimental work has quantified methane emissions from northern Australian livestock as 19.6 g CH_4 ,or 0.3724 kg CO_2-e, per kg dry matter forage intake (Kennedy and Charmley 2012). This was used to convert modelled forage intake into methane emissions.

To model changes in woody C stocks, we used the approach of Burrows *et al.* (2002), calibrated from northern Australian TRAPS sites. This approach quantified aboveground woody biomass as 6.286 t/m^2 basal area (where basal area is measured at 30cm above ground, as in GRASP, rather than the forestry tradition of 'breast height'). Using carbon content for this woody biomass of 0.5 t C/t woody biomass and a root:shoot ratio of 0.26, gives an overall method of estimating woody C stocks as 3.96 t C, or 14.51 t CO_2-e, per m^2 tree basal area. This was used to convert modelled changes in tree basal area to changes in C stocks. These in turn were converted into annual fluxes (emissions or sequestration) by dividing by the 80-year period (1990 – 2070) between modelled scenarios.

Changes in soil C stocks were modelled based on the principles of the SOCRATES soil organic carbon model (SOC) (Grace *et al.* 2006). Based on the decay rate functions in this model, the steady state SOC is proportional to net primary production (NPP) and inversely proportional a temperature factor (TF) and a moisture factor (MF). The steady-state SOC for a given model run can therefore be calculated as:

$$SOC' = SOC_0 * TF_0/TF' * MF_0/MF' * NPP'/NPP_0$$

where:

- TF = temperature factor = 0.177 exp(0.069 T)
- MF = moisture factor = 0.0598 P ^ 0.279
- T = average annual temperature in ^{o}C
- P = annual rainfall in mm
- X_0 = parameter X for baseline
- X' = parameter X for modified model run

$$\therefore \quad SOC' = SOC_0 * \exp(0.069 * -(deltaTmin + deltaTmax)/2) * (P_0/P')\text{^}0.279$$

Baseline SOC values were obtained from spatial pre-settlement estimates (to 30cm depth) from Webb (2002). Temperature and rainfall values were taken from model input parameters. NPP was taken from modelled grass production, but some simplifying assumptions had to be made. There is no data to separate the woody- and grass-derived components of SOC, and there are no 'good' models of tree productivity (aboveground and below-ground litter inputs) in northern Australian rangelands to be able to model the two components of SOC separately. To address this we had to make the simplifying approximation that changes in the relative abundance of trees and grasses, all other factors being equal, do not change the combined NPP inputs to soils. To convert the change in soil C stocks to a flux (emission or sequestration), we considered that 90% of the change in stock would occur over the 80-year period between modelled scenarios.

Beyond those mentioned above, a number of additional caveats need to be noted in the greenhouse gas analyses. The animal components of GRASP, particularly live weight gain in western grazing lands, are less robust than forage production modelling, so the approach is not ideal for measuring greenhouse gas intensity (emissions per unit production). Furthermore, there is insufficient information to include the effects of climate change (e.g. heat stress, grazing patterns, changing diet quality) on livestock performance and herd productivity, which are likely to negatively impact emissions intensity in the future. Trees are not dynamically modelled, so there could be additional emissions if drier future climates reduce the tree biomass, while wetter climates may make woody vegetation more difficult and costly to control, leading to greater increases in trees than used in our model runs. Where changes in land condition occur, the nature of this degradation will influence soil carbon stores. If degradation involves a loss in overall vegetation productivity (e.g. loss of nutrients, loss of topsoil, or reduced retention of rainfall in landscapes) then soil carbon would be expected to decline. This is the type of degradation considered in the models. However agronomic degradation can also occur by a shift in vegetation composition, where losses in pasture production may be partially offset by increases in production of other types of vegetation (e.g. shrubs and trees). In such cases our approach to modelling soil carbon would under-estimate carbon inputs and over-estimate resulting carbon emissions. In addition, changes in litter quality are not considered. Drying climates would likely reduce litter quality (and reduce maximum potential decay rates) and wetting climates would likely improve litter quality which, combined, would likely slightly reduce the overall modelled sensitivity of SOC to changes in rainfall. Finally, emissions from fire are not considered. (Only a small proportion of commercially grazed pastures is burnt each year.) The biggest influence on fire emissions (N_20 and CH_4) is likely to be changes in pasture productivity (and the quantity of ungrazed pasture that is burnt). Under wetter climate scenarios, there may be greater need and opportunity to use fire, both to control woody vegetation and to burn off excess low-quality forage. Carbon stores, particularly in trees, would also be susceptible to changes in fire regimes.

8.3.3 Results and implications

All the results show that effectiveness of mitigation measures in northern rangelands will be extremely sensitive to future changes in climate (and associated adaptation actions). This is shown graphically, along gradients of climate change, for both soil carbon stocks (Figure 9.4) and livestock methane emissions (Figure 9.5). To interpret Figure 9.4, one of the key indicators is the solid red line, which follows the decline in soil carbon stocks under the drying climate scenarios after land has been improved to B condition (the black arrow showing the initial effect, under current climate, of improving land from C to B condition). The steeper the red line drops off (along the gradient of increasing climate change), the more susceptible soil carbon stocks in that region are to climate change. The differences in susceptibility between regions correspond strongly with the climate sensitivities of pastoral productivity (reported in the adaptation analyses in B.NBP.0617), with the northern parts of Queensland showing the greatest resilience. Any gains in sequestering carbon at present (black arrows) would be threatened not only by drying climate scenarios (solid red lines) but also by median-projected climate change (grey line) where little change in rainfall occurs (Figure 9.3), i.e., warming alone is a threat to soil carbon stocks. SOC stocks appear particularly vulnerable for C condition land in northern coastal NABRC regions (dashed lines for top panel of graphs in Figure 9.4), showing projected declines even under wetter scenarios.

Methane emissions are also highly sensitive to the combined effects of climate change and adaptation (including the basic adaptation of adjusting stocking rates to maintain safe utilisation levels as pasture production changes) (Figure 9.4). Summarised across regions, carrying capacities and methane emissions show similar responses with similar chances of increasing (averaging about 40% increase under 2070 wetting scenario) and decreasing (about 35% decrease under drying scenario), magnifying average projected changes in rainfall (-32% to +12%: Figure 9.3). In contrast, the risk for carbon stocks is biased strongly towards decreases (-53% under drying scenario vs +12% under wetting scenario). When converted to carbon fluxes over an 80-year period, changes in soil carbon emissions/sequestration under climate change outweigh increases in stocking rate (to match changes in pasture productivity) (Table 9.3.1), with the net effect that total greenhouse gas emissions would increase under drying climate scenarios (soil emissions are greater than decreases in livestock emissions) and increase under wetting scenarios. If additional management action was taken to improve land condition (Table 9.3.2), sequestration of soil carbon would outweigh increases in livestock emissions (over 80 years, associated with the increased carrying capacity of better condition pastures). Actions to sequester soil carbon (and reduce net reductions in greenhouse gas emissions) were more effective under the wetting scenarios (relative to 1990 baseline) and less effective under the drying scenarios (Table 9.4.2). In the drying scenario, carbon sequestered by improving land condition is insufficient to offset SOC losses associated with the direct impacts of climate drying (Table 9.4.2 vs Table 9.4.1). Doubling tree density (Table 9.4.3) stored more carbon than improving land condition (from C to B), but at the substantial cost of a permanent decline in productivity (about 30% decline), which contributed further to overall net reductions in emissions (from associated declines in livestock emissions).

Overall, these results indicate that wetting climate scenarios are likely to improve both productivity and net greenhouse gas emissions (because increases in SOC stores outweigh increases in livestock emissions over an 80-year period). Improving land condition is a net benefit to both productivity and greenhouse gas emissions (again, because SOC increases outweigh increased livestock emissions), but any increases in SOC stores under current climate conditions are at risk from future climate warming (and at additional risk if the climate becomes drier). This potential benefit is probably greatest for land in C condition where it is possible to recover pastures by improvements in grazing management. It would be less viable in degraded pastures requiring more intensive and expensive forms of remediation (as is usually the case for D condition land) or for pastures already in good condition (where there is little further potential to increase SOC stores). Doubling tree density showed greater potential for sequestering carbon than improving land condition, but at the substantial expense of a permanent decline in productivity (about 30% decline). This option would likely only be viable in specific limited situations where most of the following conditions are met: areas where climates and soils are suitable for establishing additional trees (usually very difficult in north Australian grazing environments) or where cleared trees can be allowed to regrow; parts of properties that are currently poor sources of forage (where the negative impacts of trees on pastures will have less effect on overall property productivity); and the woody vegetation provides an alternative economically viable product. Furthermore, woody carbon stores would be susceptible to declines (with consequent net greenhouse gas emissions) if the climate becomes drier or fire regimes change.

It is also important to note that some of the components of greenhouse gas balance would not be accountable (nationally) or tradeable (at the property level). Only those changes that are a result of a change in management practice are generally accountable. To be traded (or to receive carbon credits at the property scale) there is the additional requirement that economically viable methods are available to certify and market any carbon sequestration (a challenge in grazing lands, where changes in SOC would likely be small, spatially diffuse and patchy). This would restrict the potential situations where sequestration activities would be viable to those locations where suitably-cheap methods of verification and marketing are proven to work (with likely strong methodology-related limitations).

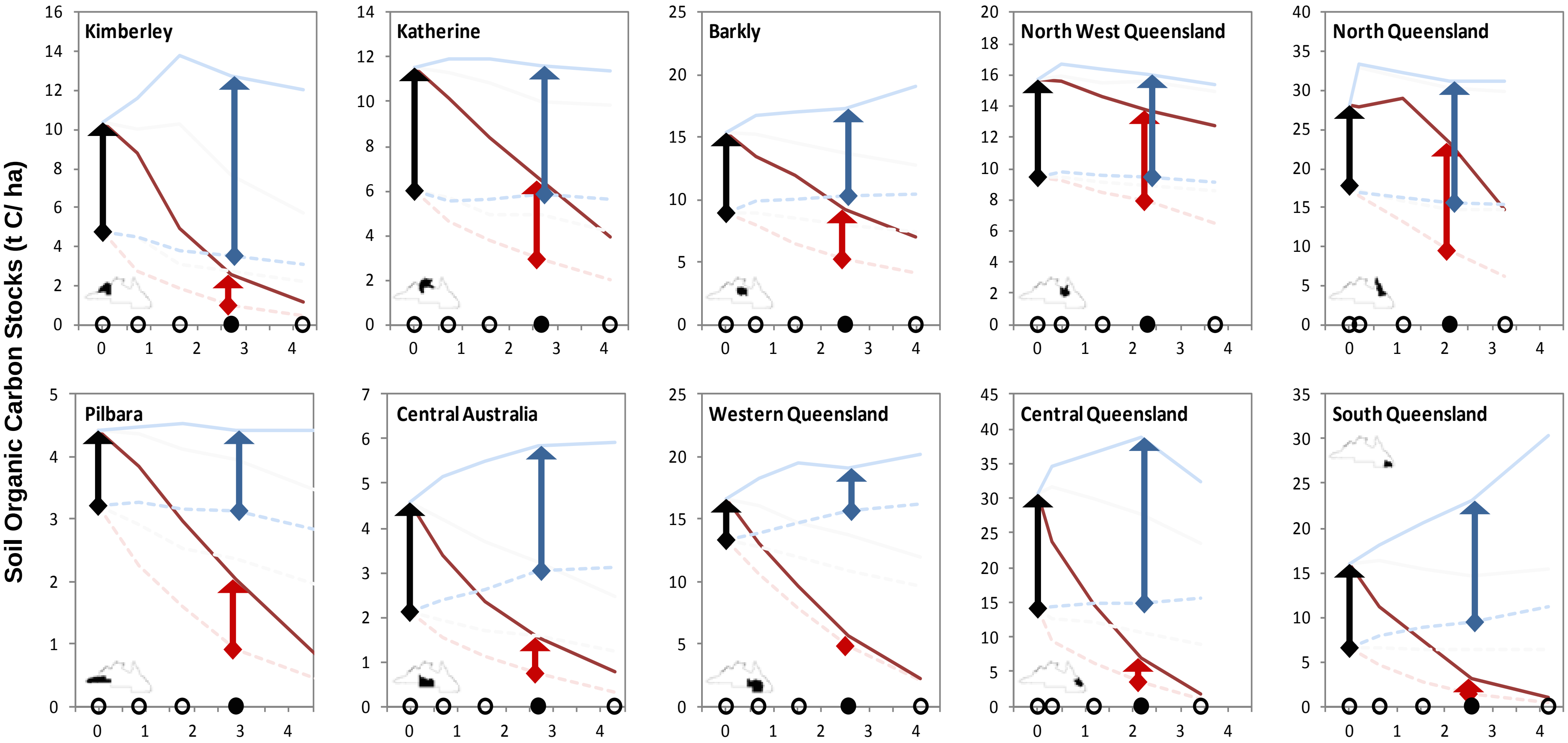

Figure 0.66 Variation in the impacts of climate change and the effectiveness of management action (improving land condition) on soil organic carbon (SOC) stocks across northern Australia. Arrows compare the effects of the management action under three reference climate scenarios: the current climate (1990 - black) and 2070 projected temperatures with associated 10th (2070L - red) and 90th (2070L - blue) percentile rainfall projections. The base of each arrow represents each scenario on 'C condition' pastures, while the arrows show the response if pastures were improved to 'B condition'. Responses are shown in relation to projected temperature change (x-axis). Circles along the x-axis mark progressive projected average warming for 1990, 2030, 2050, 2070 and 2100 respectively. Dotted lines cover the full time series of climate scenarios for 'C condition' pastures and solid lines the improved ('B condition') pastures for 10th (red), 50th (grey) and 90th (blue) percentile rainfall projections. Declines in SOC indicate net emissions and increases indicate net sequestration.

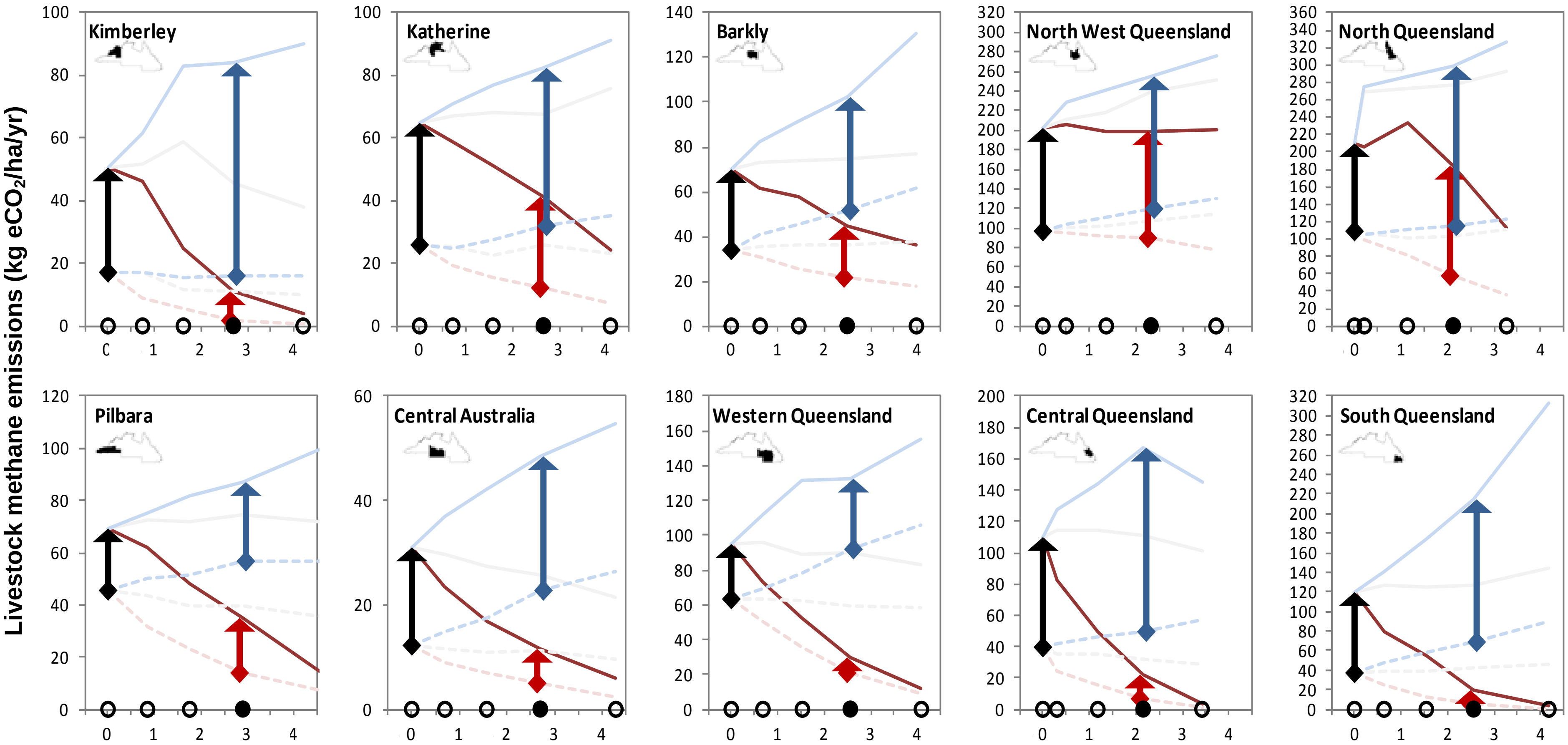

Figure 0.67 Variation in the impacts of climate change (and associated changes in stocking rate) and the effects of management action (improving land condition) on livestock methane emissions across northern Australia. Arrows compare the effects of the management action under three reference climate scenarios: the current climate (1990 - black) and 2070 projected temperatures with associated 10th (2070L - red) and 90th (2070L - blue) percentile rainfall projections. The base of each arrow represents each scenario on 'C condition' pastures, while the arrows show the response if pastures were improved to 'B condition'. Responses are shown in relation to projected temperature change (x-axis). Circles along the x-axis mark progressive projected average warming for 1990, 2030, 2050, 2070 and 2100 respectively. Dotted lines cover the full time series of climate scenarios for 'C condition' pastures and solid lines the improved ('B condition') pastures for 10th (red), 50th (grey) and 90th (blue) percentile rainfall projections.

Table 0.58 Effects of climate change (including associated adjustments in stocking rates) on soil carbon stocks, livestock methane emissions, and safe carrying capacity showing regional variation in impacts, and how differences in land condition affect sensitivity to climate change. Effects are expressed as the percentage change for two 2070 scenarios (2070L: 10th percentile rainfall, 2070H: 90th percentile rainfall) relative to current conditions (1990 baseline). Results for each region are for B condition pastures.

	Soil C Stocks		Cattle Emissions		Carrying Capacity	
Scenario >>	2070L	2070H	2070L	2070H	2070L	2070H
1 By Region (B Condition)						
Kimberley (B)	-76%	24%	-78%	66%	-71%	58%
Katherine (B)	-44%	1%	-36%	27%	-34%	27%
Barkly (B)	-40%	13%	-36%	46%	-31%	42%
NW Qld (B)	-12%	2%	-2%	27%	0%	25%
N Qld (B)	-17%	11%	-12%	43%	-8%	43%
Pilbara (B)	-54%	0%	-50%	25%	-48%	27%
Central Aus (B)	-67%	27%	-63%	56%	-64%	55%
W Qld (B)	-66%	15%	-69%	39%	-63%	33%
Central Qld (B)	-77%	26%	-80%	52%	-73%	50%
S Qld (B)	-81%	45%	-84%	79%	-78%	74%
Avg (B)	-51%	18%	-42%	44%	-38%	42%
2 By Land Condition (Averaged across regions)						
Avg A Condition	-53%	12%	-43%	35%	-40%	34%
Avg B Condition	-51%	18%	-42%	44%	-38%	42%
Avg C Condition	-56%	6%	-51%	30%	-47%	26%
Avg D Condition	-56%	10%	-52%	36%	-47%	31%
Average	-53%	12%	-45%	37%	-41%	35%

Table 0.59 Effects of management options on greenhouse gas emissions (change as kg CO_2-e/ha/yr for 80 years of management action vs no action) and safe carrying capacities (percentage change in stocking rates). Positive changes in greenhouse gas balance represent increased emissions and negative changes represent decreases or sequestration. Results are averaged across NABRC regions and are for B condition land (unless otherwise noted). As a point of reference, the modelled 1990 baseline is 102 kg CO_2-e/ha/yr livestock emissions (with management that maintains stable soil and tree carbon stocks).

Scenario >>	1990	2070L	2070H
1 Matching SR (trees & condition unchanged)			
Soil C	0	+325	-112
Tree C	0	0	0
Cattle CH4	0	-42	+45
Total GHG	**0**	**+282**	**-67**
Stocking Rate	**0%**	**-38%**	**+42%**
2 C-> B Condition (ADDITIONAL Mgmt Effect)			
Soil C	-277	-150	-368
Tree C	0	0	0
Cattle CH4	+54	+36	+85
Total GHG	**-222**	**-114**	**-283**
Stocking Rate	**+104%**	**+136%**	**+131%**
3 Extra Trees (ADDITIONAL Mgmt Effect)			
Soil C	0	0	0
Tree C	-390	-390	-390
Cattle CH4	-29	-18	-53
Total GHG	**-419**	**-408**	**-443**
Stocking Rate	**-28%**	**-29%**	**-35%**

8.4 Conclusions

The links between mitigation, adaptation and climate change are particularly strong in extensive grazing industries because:

1. Carbon stocks in soils and trees are large (both nationally, with grazing lands covering the majority of the continent, and at the enterprise level, in terms of carbon stocks per unit of production, relative to other industries).
2. These carbon stores are very sensitive to changes in management and climate (and could decline from climate warming alone, even if rainfall does not decline).
3. Methane emissions mean ruminant meat production is inherently emissions-intensive, and this large source of greenhouse gas emissions is very sensitive to changes in climate (through changes in pasture production and hence stocking rates).
4. Both methane emissions and carbon stocks are closely related to production efficiency and sustainability.

Adaptation measures are likely to have largely neutral implications for greenhouse gas emissions, and tend to reinforce many existing best practice recommendations, aimed at improving productivity and sustainability. This reflects the fact that climate adaptation has only recently emerged as a management consideration, so adaptation options have been developed (and filtered) from the start with consideration of potential negative consequences for mitigation and best management practice (e.g. Projects B.NBP.0616 (Phelps *et al.* 2012) and B.NBP.0617, Howden *et al.* 2008; McKeon *et al.* 2009; Stokes *et al.* 2010a). In contrast, mitigation measures are more likely to create conflicts that leave enterprises more vulnerable to climate change.

Adaptation measures with potential negative greenhouse gas outcomes include greater use of fire to control woody vegetation and forage quality (and, to a lesser extent, greater energy consumption for cooling or inputs, such as feed supplements). Negative consequences of mitigation measures for adaptation include loss of pasture production associated with carbon sequestration in trees, increased operating costs associated with pricing emissions (if these are not offset with carbon credits), and potential liabilities in having to maintain sequestered carbon stores at their enhanced levels in perpetuity (in the face of threats from changing climate or fire regimes). The greatest areas of synergy include improving land condition, measures to improve resource use efficiency (particularly herd management and use of supplements), improving capacity of pastoralists in business management skills, and options that overlap strongly with existing best practice recommendations.

Carbon credits would only be earned while carbon stocks are increasing, but thereafter there would be a continuing obligation, without further payment, to maintain the increased store (otherwise there would be no net greenhouse gas benefit). Any mitigation actions aimed at sequestering carbon in grazing lands therefore need to ensure that, once the increased carbon stores stabilize, producers are left with an asset (enhanced sustainability, productivity and/or an alternate agricultural product) rather than a liability (e.g., lost productivity and/or ongoing costs/risks of maintaining a non-productive enhanced carbon store). One of the barriers to adoption of best management practices, particularly improving land condition, is the short-term cost of changing management (especially lost revenue from lower stocking rates) before land condition, productivity and profitability improve in the longer term (Landsberg *et al.* 1998). If targeted with appropriate supporting policy, carbon credits could provide an interim source of income to assist this transition process and otherwise enhance capacity to cope with existing and emerging climate challenges (which may be a more be a more useful approach to carbon credits than seeking to provide a long-term supplementary income stream).

Building broad considerations of unintended consequences into early stages of developing adaptation and mitigation strategies will help to ensure that these parallel strategies are complementary, that conflicts are minimised, and that actions remain effective as the climate changes in the future.

9 Impact on meat and livestock industry – Now and in five years time

The recent financial crisis and Australian carbon policy decisions have meant that climate change and greenhouse gas emissions issues are now lower on the political agenda for directly impacting beef businesses. However, there is no escaping the facts that the beef cattle industry:

- Emits substantial quantities of greenhouse gases (through direct livestock emissions and meat processing)
- Is likely to be impacted by climate change particularly through extended dry periods.
- Is responsible for the custodianship and land condition of much of Australia.
- Will be impacted by higher input prices (exacerbated by carbon taxes).
- Will eventually be in the community and political spotlight again in the future.

The Australian Government is keen to see that the beef industry is operating under “world’s best practice” and operating efficiently.

The Climate Clever Beef project, using an improvement framework, identified options for current beef businesses to benchmark and improve their business resilience in terms of profitability, productivity, land condition, greenhouse gas emissions and climate change risk. Ongoing implementation and monitoring of these strategies will help these businesses be in a good position to cope with future business stress.

The Climate Clever Beef project has undertaken a number of analyses of options that may be possible under the Australian Government’s Carbon Farming Initiative. These analyses will help beef businesses understand the impact and opportunities under this initiative.

By undertaking the benchmarking exercise of the current business, these beef enterprises will be able to monitor and demonstrate improvements in their business over time to the community and Government.

10 Conclusions and recommendations

10.1 Conclusions

The northern Australian beef industry is under financial stress. Improving business resilience through assessing the relative merits of options to improve profitability, productivity, land condition, greenhouse gas emissions and climate change risk will enhance the ability to cope with business stress.

The Climate Clever Beef project used a successful 'participatory' model of development and extension and a business analysis framework to engage individual beef businesses and groups to:

- Identify key regional and specific business issues.
- Assess the current performance of businesses against five factors - profitability, productivity, land condition, greenhouse gas emissions and climate change risk.
- Identify alternative management options and assess their potential performance against the five factors.
- Work with business owners to begin implementing new strategies.

Application of this methodology enabled the project to be highly successful in engaging beef businesses, stimulating practice change and enhancing business resilience. Significant achievements have also been made in producer KASA (knowledge, awareness, skills and attitude) and general awareness amongst the broader beef industry.

Key legacies from the Climate Clever Beef project include:

- Increased skills of extension and development staff across northern Australia.
- Improved business resilience and knowledge for the beef businesses engaged in the project.
- Fact sheets and case studies available on the FutureBeef website (http://www.futurebeef.com.au/resources/projects/climate-clever-beef).

10.2 Recommendations

The combination of participative research and development and whole property analysis should inform and influence ongoing extension activities that target profitability, land condition and other environment issues (for example greenhouse gas emissions).

The case for building on existing sites and activities should be explored to avoid loss of momentum and/or opportunities to further improve industry practices. At least six additional businesses engaged through the extension activities are keen to be involved in subsequent Carbon Farming Futures projects.

The effectiveness of mitigation measures in northern rangelands will be extremely sensitive to future changes in climate (and associated adaptation actions). For example, any gains in sequestering carbon will be threatened not only by drying climate scenarios but also by scenarios where little change in rainfall occurs (i.e. warming without an increase in rainfall is a threat to soil carbon stocks). Such examples strongly indicate the need for caution and careful scenario analysis, especially where actual trading of carbon stocks is being considered. Sequestration through increased tree stocks can be a more significant and reliable option but comes with major costs to livestock productivity and long term liability and risk.

A key area of research to enable the effective modelling of livestock methane output under different management scenarios is the compilation and analysis of regional livestock weight gain data for use in greenhouse gas emissions modelling.

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