# final report

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# Modelling Greenhouse Gas Emissions Abatement Options for Beef and Sheep Farm Businesses

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**Abstract**

The Carbon Farming Initiative (CFI), introduced by the Australian Government in 2011, has been developed to provide an opportunity for Australian farmers to undertake greenhouse gas (GHG) abatement projects on farm, and to generate revenue from the sale of carbon credits generated by such projects. While a substantial research effort is underway to better understand the technologies and management systems that may be available for farm businesses to abate GHG, only very limited research has been carried out on the financial implications of the adoption of these options, especially when integrated into a multi-enterprise farm business, and especially over the long timeframes that will be associated with sequestration options.

Using a comparative case study approach, this project developed marginal abatement cost curves (MACC) for specific farm enterprises so that comparisons could be made between similar farms within a geographic region, and between different production regions. This preliminary analysis identified that six key areas of the farm management scenarios assessed have the potential to consistently reduce overall farm GHG emissions with four of these main scenarios also providing a positive financial return. The four main scenarios include faster beef cattle turn off, changing the enterprise mix, improving beef cattle genetics and implementing earlier weaning.

## Executive summary

Meat and Livestock Australia (MLA) commissioned the Australian Farm Institute (AFI) in collaboration with the Australian Centre for Sustainable Business and Development, University of Southern Queensland to evaluate the impact of different farm management scenarios on Greenhouse Gas (GHG) emissions and farm business performance. The aim of the project was to provide a greater understanding of the potential GHG emissions abatement options available to farmers.

The assessment was undertaken using five case-study broadacre beef, sheep and mixed livestock and cropping farms located in eastern Australia. Twelve different farm management scenarios were evaluated, including;

- Improving pasture quality;
- Improving the genetic potential of beef cattle to produce less methane;
- Implementing early weaning strategies;
- Improving reproductive efficiency;
- Matching sheep enterprise feed demand with optimal pasture supply;
- Increasing the rates of beef cattle turnoff;
- Grain finishing cattle;
- The use of hypothetical methane inhibitors in the gut of ruminant animals;
- Improving fertiliser use efficiency;
- The use of nitrogen inhibitors in conjunction with fertiliser applications;
- Implementing enterprise change; and
- The planting of environmental tree lots.

The GHG emissions associated with the potential implementation of each management scenario and the broader sub-scenarios were evaluated using the *FarmGAS* tool, developed by the AFI (see *Figure E1*). The long-term financial implications of each scenario for the case-study farm businesses was assessed by calculating the net present value (NPV) of the capital and operating costs and future revenue stream arising from each scenario, using industry cost and revenue data. The results of the GHG emissions modelling and financial analysis were used to develop Marginal Abatement Cost Curves (MACCs), which provide a visual perspective of both the amount of abatement available for each scenario, and the marginal cost of each unit of abatement. The financial analysis and MACCs were generated by the University of Southern Queensland (USQ). The assessment was designed to provide a preliminary evaluation of the performance of each of the potential GHG emissions abatement scenarios, rather than to accurately quantify their GHG emission or financial benefits in a commercial situation.

This preliminary analysis identified that six key areas of the farm management scenarios assessed have the potential to consistently reduce overall farm GHG emissions with four of these main scenarios also providing a positive financial return. These main scenarios include faster beef cattle turn off, changing the enterprise mix, improving beef genetics and implementing earlier weaning (see *Figure E2*). The hypothetical use of methane inhibitors in the guts of ruminant animals and environmental plantings such as tree lots also showed promising results for GHG emissions abatement but preliminary information on the capital costs associated with implementing these scenarios suggests that they are not financially viable.

The commercial relevance of the beef genetics, early weaning and methane inhibitor scenarios was assessed through a process of seeking feedback from industry experts. This feedback indicated that these scenarios and the modelled outcomes were generally consistent with that which would occur under commercial conditions.

**Table E1: Annual average GHG emissions percentage change achieved under the scenarios modelled for each case study farm when compared with baseline farm GHG emissions.**

| Case study farms emissions modelling | | Sthn* Farm 1 | Sthn Farm 2 | Nthn* Farm 1 | Nthn Farm 2 | Nthn Farm 3 |
|---|---|---|---|---|---|---|
| Baseline emissions (tonnes $CO_2e$*) | | 4,290 | 6,164 | 3,487 | 1,099 | 2,093 |
| Scenario (brief description of assumptions) | Sub-Scenario Number | Percentage annual average change from baseline emissions | | | | |
| District average | | -3% | -5% | 2% | 7% | 11% |
| **1.0 Improved pasture** | | | | | | |
| Legume content and liveweight gain increased | 1.1 | 7% | 5% | 7% | 6% | 9% |
| As per sub-scenario 1.1 and young/trade cattle sold earlier | 1.2 | 5% | 4% | 1% | 3% | 7% |
| As per sub-scenario 1.1 and total livestock numbers increased | 1.3 | 11% | 10% | 11% | 11% | 14% |
| As per sub-scenario 1.1 and environmental tree lot plantings | 1.4 | 7% | | 4% | 3% | -6% |
| Feed intake improved via better pasture management | 1.5 | 6% | 5% | 6% | 5% | 5% |
| **2.0 Beef genetics** | | | | | | |
| Reduce the % of GEI* converted to $CH_4$* which reduces $CH_4$ emissions | 2.1 | -3% | -5% | -3% | -7% | -4% |
| As per sub-scenario 2.1 and young/trade cattle sold earlier | 2.2 | -4% | -6% | -9% | -10% | -6% |
| As per sub-scenario 2.1 and total livestock numbers increased | 2.3 | 0% | 3% | -1% | -2% | 0% |
| **3.0 Early weaning** | | | | | | |
| Lambs weaned at 14 weeks and calves at 6 months | 3.1 | -1% | -1% | 0% | 0% | -1% |
| As per sub-scenario 3.1 and livestock enterprise changes | 3.2 | -2% | -7% | -6% | -3% | -3% |
| As per sub-scenario 3.1 and livestock enterprise changes | 3.3 | -3% | -10% | -14% | -7% | -4% |
| Combination of sub-scenarios 3.1 and 1.1 | 3.4 | 6% | 5% | 7% | 4% | 8% |
| Combination of sub-scenarios 3.1 and 1.5 | 3.5 | 5% | 5% | 6% | 4% | 5% |
| **4.0 Reproductive efficiency** | | | | | | |
| 110% lambing and increased sheep numbers | 4.1 | 5% | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 98% calving and increased cattle numbers | 4.2 | | 2% | 1% | | |
| 100% spring calving | 4.3 | | | | | 1% |
| **5.0 Matching pasture supply and demand for sheep enterprises** | | | | | | |
| Change lambing from May - July to August - October | 5.1 | | 0% | | | |
| As per sub-scenario 5.1 and early weaning for lambs | 5.2 | | 0% | | | |
| **6.0 Faster beef cattle turnoff** | | | | | | |
| Increased liveweight gain per day and shorter carrying period for stores | 6.1 | -2% | | -22% | -14% | |
| As per sub-scenario 6.1 and further increase to liveweight gain per day | 6.2 | -1% | | -21% | -13% | |
| **7.0 Grain finishing cattle** | | | | | | |
| Trade cattle in feedlot for 100 days | 7.1 | | | 21% | 36% | 4% |
| Trade cattle in feedlot for 120 days and increased liveweight gain per day | 7.2 | | | 24% | 36% | 5% |
| Feed intake as per sub-scenario 7.1 and feedlot period of 150 days | 7.3 | | | 24% | 40% | 5% |
| **8.0 Hypothetical methane inhibitor** | | | | | | |
| New technology for sheep that reduces $CH_4$ emissions | 8.1 | -13% | -1% | | | |
| New technology for cattle that reduces $CH_4$ emissions | 8.2 | -2% | -16% | -15% | -18% | -18% |
| Combination of sub-scenarios 8.1 and 8.2 | 8.3 | -15% | -17% | | | |
| Oils and Tannins for cattle reducing $CH_4$ emissions | 8.4 | -1% | -8% | -6% | -9% | -9% |
| **9.0 Improved fertiliser use** | | | | | | |
| Reduction in fertiliser applications to crops | 9.1 | 0% | | | | |
| Reduction in fertiliser applications to crops and crop yield penalty | 9.2 | 0% | | | | |
| Reduction in fertiliser applications to pastures | 9.3 | | 0% | | | |
| **10.0 Nitrogen fertiliser inhibitor** | | | | | | |
| The use of nitrogen inhibitors in conjunction with fertiliser applications | 10.1 | 0% | 0% | | | |
| **11.0 Enterprise change** | | | | | | |
| see Appendix A | 11.1 | -1% | -5% | 10% | 0% | |
| see Appendix A | 11.2 | -1% | -8% | 7% | 0% | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| see Appendix A | 11.3 | -2% | -15% | -1% | 0% | |
| see Appendix A | 11.4 | -3% | -21% | -8% | 0% | |
| see Appendix A | 11.5 | -4% | -24% | -11% | 0% | |
| 40% increase in cropping area and reduced sheep breeding numbers | 11.6 | -6% | | | | |
| No wethers are carried and trade hoggets are increased each month | 11.7 | -4% | | | | |
| **12.0 Tree lot** | | | | | | |
| The planting of environmental tree lots | 12.1 | -4% | | -6% | -4% | -20% |

*$CO_2$e = carbon dioxide equivalents *Sthn = southern, Nthn = northern *GEI = Gross Energy Intake *$CH_4$ = methane     Not applicable

**Table E2: Net Present Value ('000 dollars) for each scenario modelled.**

| Case study farms financial analysis | | Sthn Farm 1 | Sthn Farm 2 | Nthn Farm 1 | Nthn Farm 2 | Nthn Farm 3 | |
|---|---|---|---|---|---|---|---|
| Net Present Value assumed discount rate | | 8% | 8% | 8% | 8% | 8% | |
| Scenario (brief description of assumptions) | Sub-Scenario Number | Net Present Value ('000 dollars) | | | | | Project life (years) |
| **1.0 Improved pasture** | | | | | | | |
| Legume content and liveweight gain increased | 1.1 | $47 | $103 | $40 | $47 | -$74 | 4 |
| As per sub-scenario 1.1 and young/trade cattle sold earlier | 1.2 | $47 | $21 | -$109 | $47 | -$74 | 4 |
| As per sub-scenario 1.1 and total livestock numbers increased | 1.3 | $102 | $184 | $128 | $58 | -$45 | 4 |
| As per sub-scenario 1.1 and environmental tree lot plantings | 1.4 | | | | | | |
| Feed intake improved via better pasture management | 1.5 | $41 | $47 | $33 | $17 | $19 | 1 |
| **2.0 Beef genetics** | | | | | | | |
| Reduce the % of GEI converted to $CH_4$ which reduces $CH_4$ emissions | 2.1 | $0 | $0 | $0 | $0 | $0 | 5 |
| As per sub-scenario 2.1 and young/trade cattle sold earlier | 2.2 | -$29 | -$19 | -$6 | -$3 | -$8 | 5 |
| As per sub-scenario 2.1 and total livestock numbers increased | 2.3 | $9 | $161 | $92 | $70 | -$12 | 5 |
| **3.0 Early weaning** | | | | | | | |
| Lambs weaned at 14 weeks and calves at 6 months | 3.1 | $0 | $0 | $0 | $0 | $0 | 1 |
| As per sub-scenario 3.1 and livestock enterprise changes | 3.2 | $0 | -$80 | -$17 | $5 | $1 | 1 |
| As per sub-scenario 3.1 and livestock enterprise changes | 3.3 | -$1 | -$5 | $0 | -$9 | -$4 | 1 |
| Combination of sub-scenarios 3.1 and 1.1 | 3.4 | $47 | $103 | $40 | $47 | -$74 | 4 |
| Combination of sub-scenarios 3.1 and 1.5 | 3.5 | $41 | $47 | $33 | $17 | $19 | 1 |
| **4.0 Reproductive efficiency** | | | | | | | |
| 110% lambing and increased sheep numbers | 4.1 | $34 | | | | | 1 |
| 98% calving and increased cattle numbers | 4.2 | | $50 | $7 | | | 1 |
| 100% spring calving | 4.3 | | | | | $32 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **5.0 Matching pasture supply and demand for sheep enterprises** | | | | | | | |
| Change lambing from May - July to August - October | 5.1 | | $0 | | | | 1 |
| As per sub-scenario 5.1 and early weaning for lambs | 5.2 | | $0 | | | | 1 |
| **6.0 Faster beef cattle turnoff** | | | | | | | |
| Increased liveweight gain per day and shorter carrying period for stores | 6.1 | $10 | | $11 | $15 | | 1 |
| As per sub-scenario 6.1 and further increase to liveweight gain per day | 6.2 | $28 | | $55 | $31 | | 1 |
| **7.0 Grain finishing cattle** | | | | | | | |
| Trade cattle in feedlot for 100 days | 7.1 | | | $175 | $58 | $10 | 1 |
| Trade cattle in feedlot for 120 days and increased liveweight gain per day | 7.2 | | | $229 | $76 | $13 | 1 |
| Feed intake as per sub-scenario 7.1 and feedlot period of 150 days | 7.3 | | | $158 | $53 | $9 | 1 |
| **8.0 Hypothetical methane inhibitor** | | | | | | | |
| New technology for sheep that reduces $CH_4$ emissions | 8.1 | -$46 | -$5 | | | | 1 |
| New technology for cattle that reduces $CH_4$ emissions | 8.2 | -$2 | -$15 | -$8 | -$1 | -$9 | 1 |
| Combination of sub-scenarios 8.1 and 8.2 | 8.3 | -$48 | -$20 | | | | 1 |
| Oils and Tannins for cattle reducing $CH_4$ emissions | 8.4 | -$7 | -$72 | -$30 | -$6 | -$43 | 1 |
| **9.0 Improved fertiliser use** | | | | | | | |
| Reduction in fertiliser applications to crops | 9.1 | $4 | | | | | 1 |
| Reduction in fertiliser applications to crops and crop yield penalty | 9.2 | -$50 | | | | | 1 |
| Reduction in fertiliser applications to pastures | 9.3 | | | | | | |
| **10.0 Nitrogen fertiliser inhibitor** | | | | | | | |
| The use of nitrogen inhibitors in conjunction with fertiliser applications | 10.1 | -$7 | | | | | 1 |
| **11.0 Enterprise change** | | | | | | | |
| see Appendix A | 11.1 | -$3 | $24 | $87 | -$11 | | 1 |
| see Appendix A | 11.2 | -$5 | $58 | $54 | -$8 | | 1 |
| see Appendix A | 11.3 | -$17 | $77 | -$27 | $0 | | 1 |
| see Appendix A | 11.4 | -$19 | $140 | -$123 | $4 | | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| see Appendix A | 11.5 | -$23 | $241 | -$171 | $2 | | 1 |
| 40% increase in cropping area and reduced sheep breeding numbers | 11.6 | -$29 | | | | | 1 |
| No wethers are carried and trade hoggets are increased each month | 11.7 | $18 | | | | | 1 |
| **12.0 Tree lot** | | | | | | | |
| The planting of environmental tree lots | 12.1 | -$34 | | -$58 | -$22 | -$99 | 41 |

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# 1.0 Introduction

## 1.1 Background

Significant research has been undertaken to develop management systems that can be implemented by farm businesses in order to abate Greenhouse Gas (GHG) emissions. The financial implications of these abatement options have not however been fully investigated, due to the complexities associated with integrating individual activities within a multi-enterprise farm business and the extended timeframes and seasonal variability that characterise agricultural systems.

This research aims to assess the affect of GHG abatement strategies on whole farm GHG emissions and the financial viability of each strategy.

Agriculture is responsible for around 14.6% or 79.5 million tonnes of carbon dioxide equivalents ($CO_2$) of Australia's GHG emissions. Methane ($CH_4$) and nitrous oxide ($N_2O$) are the two major types of Greenhouse Gas (GHG) emitted from agricultural practices.

The production of $CH_4$ during enteric fermentation by ruminant livestock animals is the most significant contributor to the GHG emissions of the Australian agricultural sector. In 2010, $CH_4$ from enteric sources made up 67.8% of agricultural GHG emissions. $N_2O$ from agricultural soils contributed 16.7% of agricultural GHG emissions. Additional sources of GHG emissions include the burning of savannas (10.8%), manure management (4.2%), rice cultivation (<1%) and the burning of crop and pasture residues (<1%). Soil nutrient cycling processes associated with the application of nitrogen fertilisers and animal waste to soils, the planting of nitrogen fixing crops and pastures, and the decay of agricultural residue make only a minor contribution to the national GHG accounts.

The two categories of GHG emission abatement options available to farmers are mitigation and sequestration. Mitigation refers to actions that reduce the amount of emissions associated with a particular activity, whilst sequestration refers to actions that permanently remove GHG from the atmosphere over time through activities such as forestry development. Mitigation actions can be annual or one off activities, whereas sequestration activities are undertaken over a longer term.

In 2011, the Australian Government introduced the Carbon Farming Initiative (CFI). The CFI provides incentive to Australian farmers to initiate GHG abatement projects and generate revenue from the sale of Australian Carbon Credit Units (ACCUs) generated by these projects. Large businesses with a liability under the Clean Energy Futures (CEF) legislation are the principle purchasers of ACCUs. The CEF legislation was introduced to meet Australia's GHG emission abatement obligations under the Kyoto Protocol, which is an agreement established under the United Nations Framework Convention on Climate Change (UNFCCC), whereby signatory nations have committed to reduce national GHG emissions over the next decade.

Under the CFI, farmers are able to voluntarily undertake emission abatement projects utilising approved CFI methodologies. The CFI methodologies specify the particular management actions participating farmers are required to take, and the monitoring, reporting and auditing requirements associated with the specific methodology. If farm businesses adopt and successfully implement such projects and they are verified by an independent auditor, the farm business is allocated ACCUs equivalent to the tonnes of emission abatement achieved. These may then be sold to emitters which are required to account for the emissions produced by their activities, and to retire a volume of ACCUs each year equivalent to the tonnes of emissions they produce.

### 1.2 Project objective

The primary objective of this research was to carry out a detailed analysis of the abatement potential and costs associated with a range of GHG management scenarios for case study farm businesses involved in different enterprises and located in different geographic regions. The GHG emissions associated with the implementation of a number of different farm management scenarios were evaluated using the *FarmGAS* tool. Indicative *Marginal Abatement Cost Curves* (MACCs) were then developed for a number of different management scenarios and a sensitivity analysis was used to compare the scenario outcomes.

### 1.3 Overview of the FarmGAS tool and Marginal Abatement Cost Curves

FarmGAS is an online tool developed by the Australian Farm Institute (AFI) for estimating GHG emissions from agricultural enterprises. The calculations in FarmGAS are based on the internationally accepted GHG accounting methodologies that are used by the Department of Climate Change and Energy Efficiency (DCCEE) to estimate emissions from the agricultural sector at a national level. The details of the emission calculation methodology are provided on the following website: http://www.climatechange.gov.au/en/climatechange/emissions.aspx. The FarmGAS tool modifies this methodology to facilitate GHG calculations at a farm level. This tool is described in detail on the following website: http://www.farminstitute.org.au/calculators/farm-gas-calculator.

For GHG accounting purposes, all GHG emissions are calculated and reported as tonnes of carbon dioxide equivalents ($CO_2e$). Carbon dioxide equivalents are the standard unit of GHG emissions used to express the combined effect of combinations of different GHGs, each of which has a different warming effect in the atmosphere. For example, a tonne of $N_2O$ in the atmosphere has the same warming effect as 310 tonnes of $CO_2$, hence $N_2O$ is allocated a Global Warming Potential (GWP) for emission accounting purposes of 310.  Methane ($CH_4$) has a GWP of 21.

A key feature of the FarmGAS tool is that it can be used to undertake scenario analyses for multiple-enterprise farms. In this research the baseline GHG emissions of the case study farms were calculated and then compared with the GHG emissions calculated to be generated if the management scenario under consideration was implemented.

Marginal abatement cost curves were developed by McKinsey & Company (2007) to identify how much abatement an economy can afford and where policy should be directed to achieve the optimum emission reductions at least cost to an economy. The use of the MACC at the individual business level has the potential to assist farm business managers to identify which GHG abatement options have the greatest potential for their specific enterprise. The MACC financial modelling tool used in this research has been developed at the University of Southern Queensland (USQ) and tailored to suit the particular needs of the Australian livestock sector.

### 1.4 Report structure

The remainder of this report is structured as follows:

*Section 2* - details the GHG emissions modelling methodology adopted in this assessment

*Section 3.1 & 3.2* – provides an overview of the case study farms and summarises the GHG emissions modelling results, including an evaluation of the GHG emission abatement implications of each of the management scenarios evaluated

*Section 3.3 & 3.4* – details the methodology and results of the financial analysis and MACC analysis which was undertaken by the University of Southern Queensland

*Section 4* – summarises the most significant results arising from the GHG emissions and financial performance modelling analysis and discusses the implications of the results for sheep and beef cattle farmers.

# 2.0 Project methodology

## 2.1 Identification of case study farms

The research initially involved the identification of a number of case study farm businesses. The aim was to identify two farms in each of three different production regions, enabling an understanding to be obtained of both enterprise and regional factors that may affect GHG management options available to farm businesses. MLA (Meat and Livestock Australia) managers, public extension officers, research agronomists, natural resource management agencies and prominent farmer groups were consulted and seven participating businesses were initially identified in three enterprise categories:

- Two prime lamb, mixed grazing and cropping enterprises located in the eastern border region of NSW and Victoria;
- Three beef dominant enterprises located in the northern tablelands of NSW; and
- Two beef specialist businesses located in northern Queensland.

Project timing and business commitments resulted in the withdrawal of the two beef specialists in Queensland from the project. Following consultation with MLA, it was agreed that the project would proceed with the remaining five farm businesses.

Phone and/or email contact was made with each participating farmer to outline the research objectives and detail the level of commitment required.

## 2.2 Base farm GHG profile development

General farm information and production data was obtained for each participating farm. A follow up telephone meeting was held to clarify the data provided.

A visit to each participating farm by AFI and USQ staff was arranged and during the farm visits the production statistics were refined and each base farm profile was confirmed. A discussion was also held to identify potential GHG emissions abatement scenarios.

## 2.3 Identification of scenarios

The GHG emissions abatement scenarios and the sub-scenarios identified during the farm meetings were largely management related, with only a few technological scenarios identified (see *Table 2.1*). Research literature was consulted to determine how the abatement scenarios might be implemented on farm, what responses could be expected from the farming systems and the anticipated financial costs and benefits of each scenario.

**Table 2.1: Description of scenarios modelled.**

| Scenario number | Scenario assumptions | Southern Farm 1 | Southern Farm 2 | Northern Farm 1 | Northern Farm 2 | Northern Farm 3 |
|---|---|---|---|---|---|---|
| 1.1 | Pastures are improved with an increase in legume content (5% increase). The consequences are:<br>10% increase in Dry Matter Digestibility (DMD)<br>5% increase in Crude Protein (CP)<br>5% increase in liveweight gain (LWG) | X* | X | X | X | X |
| 1.2 | Pastures are improved with an increase in legume content (5% increase). The consequences are:<br>10% increase in DMD<br>5% increase in CP<br>5% increase in LWG<br>Trade cattle are turned off at nine months. | X | X | X | X | X |
| 1.3 | Pastures are improved with an increase in legume content (5% increase). The consequences are:<br>10% increase in DMD<br>5% increase in CP<br>5% increase in LWG<br>Cattle and sheep numbers are increased by 5% due to the improved pasture quality. | X | X | X | X | X |
| 1.4 | Pastures are improved with an increase in legume content (5% increase).The consequences are:<br>10% increase in DMD<br>5% increase in CP<br>5% increase in LWG<br>The stocking rate is increased by 5% and a portion of grazing land is converted to a tree lot. | X<br>(50ha) | N/a* | X<br>(86ha) | X<br>(15ha) | X<br>(164ha) |
| 1.5 | Quality of feed intake is improved via better pasture management with a 5% | X | X | X | X | X |

| | | | | | | |
|---|---|---|---|---|---|---|
| | increase in DMD and CP assumed. LWG increases by 5%. | | | | | |
| | | | | | | |
| 2.1 | Beef breeding for improved feed conversion efficiency. Percentage of Gross Energy Intake converted to $CH_4$ is reduced by 5%. | X | X | X | X | X |
| 2.2 | Beef breeding for improved feed conversion efficiency. Percentage of Gross Energy Intake converted to $CH_4$ is reduced by 5%.<br>Young/trade cattle sold at 9 months. | X | X | X | X | X |
| 2.3 | Beef breeding. To simulate improved feed conversion efficiency. Percentage of Gross Energy Intake yielded as $CH_4$ is reduced by 5%.<br>Livestock numbers are increased. | X | X | X | X | X |
| | | | | | | |
| 3.1 | Earlier weaning. | X<br>Lambs weaned at 14 weeks | X<br>Lambs weaned at 14 weeks.<br>Calves weaned at 6 months | X<br>Calves weaned at 6 months | X<br>Calves weaned at 6 months | X<br>Calves weaned at 6 months |
| 3.2 | Earlier weaning. As per 3.1 plus enterprise structure changes for managing younger weaners. | X<br>Wethers are reduced by 10% | X<br>Wethers and steers are sold | X<br>Trade cattle are sold one month earlier | X<br>Trade cattle are sold one month earlier | X<br>Young cattle are sold one month earlier |
| 3.3 | Earlier weaning. As per 3.1 plus enterprise structure changes for managing younger weaners. | X<br>Other ewes are sold | X<br>Steers are sold, dry cows are sold and half the older ewes are sold | X<br>Dry cows are moved to a second property | X<br>1-2 year old heifers reduced from 108 to 54 and sold | X<br>1 year old steers are sold |
| 3.4 | Earlier weaning. As per 3.1 plus pastures are improved with legumes (*c.f.* scenario 1.1) for managing all classes of livestock. | X | X | X | X | X |
| 3.5 | Earlier weaning. As per 3.1 plus improved pasture intake quality is assumed (*c.f.* Scenario 1.5) for managing all classes of livestock. | X | X | X | X | X |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.1 | Reproductive efficiency with 110 % lambing. Total sheep flock numbers increase. | X | N/a | N/a | N/a | N/a |
| 4.2 | Reproductive efficiency with 98% calving. Saleable progeny sold at 12 months. | N/a | X | X | N/a | N/a |
| 4.3 | 100% spring calving. | N/a | N/a | N/a | N/a | X |
| | | | | | | |
| 5.1 | Match lambing with pasture supply; changing from May – July lambing to August – October lambing. | N/a | X | N/a | N/a | N/a |
| 5.2 | Match lambing with pasture supply; changing from May – July lambing to August – October lambing. Implement an early weaning strategy (14 weeks). | N/a | X | N/a | N/a | N/a |
| | | | | | | |
| 6.1 | Faster beef turnoff: Trade cattle grow at 0.1kg/hd/d above usual LWG (based on DMD 70% and 10.5 MJ/kg DM). Number of days between buying and selling cattle is reduced by 30 days. | X | N/a | X | X | N/a |
| 6.2 | Faster beef turnoff: Trade cattle grow at 0.2kg/hd/d above usual LWG (based on DMD 70% and 10.5 MJ/kg DM and better farm management). Number of days between buying and selling cattle is reduced by 30 days. | X | N/a | X | X | N/a |
| | | | | | | |
| 7.1 | Grain finishing store cattle. 1-2 year old trade cattle (450kg) are in a feed lot for 100 days to reach 550kg. Daily feed intake is 10kg/ hd/ d. | N/a | N/a | X | X | X |
| 7.2 | Grain finishing store cattle – 1-2 year old trade cattle (450kg) are in a feed lot for 120 days to reach 600kg. Daily feed intake is 10.50kg/ hd/ d. | N/a | N/a | X | X | X |
| 7.3 | Grain finishing store cattle – 1-2 year old trade cattle (450kg) are in a feed lot for 150 days to reach 600kg. Daily feed intake is 10kg/ hd/ d. | N/a | N/a | X | X | X |
| | | | | | | |
| 8.1 | Implementation of a new technology for *Sheep* (bolus, vaccine, phage therapy) which reduces $CH_4$ emissions by 20%. | X | X | N/a | N/a | N/a |
| 8.2 | Implementation of a new technology for *Cattle* (bolus, vaccine, phage therapy) which reduces $CH_4$ emissions by 20%. | X | X | X | X | X |
| 8.3 | $CH_4$ reduction technology applied to sheep and cattle reducing $CH_4$ emissions | X | X | N/a | N/a | N/a |

| | | | | | | |
|---|---|---|---|---|---|---|
| | by 20%. | | | | | |
| 8.4 | Oils and Tannins are fed to beef cattle reducing $CH_4$ emissions by 10%. | X | X | X | X | X |
| | | | | | | |
| 9.1 | Fertiliser application reduces by 25% due to improved application efficiency in cropping (optimum threshold, in-crop applications etc). No yield penalty. | X | N/a | N/a | N/a | N/a |
| 9.2 | Fertiliser application reduces by 25% due to improved application efficiency in cropping (optimum threshold, in-crop applications etc). Yields decline by 10%. | X | N/a | N/a | N/a | N/a |
| 9.3 | Fertiliser application reduces by 25% due to improved application efficiency in pasture. | N/a | X | N/a | N/a | N/a |
| | | | | | | |
| 10.1 | Application of a nitrogen inhibitor to fertiliser and soil (FracGASF/volatilisation reduces by 50%). | X | X | N/a | N/a | N/a |
| | | | | | | |
| 11.1 | Enterprise changes.<br>(For livestock changes the carrying capacity/dse remains constant) | X<br>Cropping area increases by 5%.<br>Ewes and lambs reduce by 102 | X<br>80% beef cattle breeding: 20% sheep | X<br>20% beef cattle breeding: 80% beef cattle trading | X<br>20% beef cattle breeding: 80% beef cattle trading | N/a |
| 11.2 | Enterprise changes.<br>(For livestock changes the carrying capacity/dse remains constant) | X<br>Cropping area increases by 10%.<br>Ewes and lambs reduce by 204 | X<br>70% beef cattle breeding: 30% sheep | X<br>30% beef cattle breeding: 70% beef cattle trading | X<br>30% beef cattle breeding: 70% beef cattle trading | N/a |
| 11.3 | Enterprise changes.<br>(For livestock changes the carrying capacity/dse remains constant) | X<br>Cropping area increases by 15%.<br>Ewes and lambs reduce by 306 | X<br>50% beef cattle breeding: 50% sheep | X<br>50% beef cattle breeding: 50% beef cattle trading | X<br>50% beef cattle breeding: 50% beef cattle trading | N/a |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11.4 | Enterprise mix changes.<br>(For livestock changes the carrying capacity/dse remains constant) | X<br>Cropping area increases by 20%.<br>Ewes and lambs reduce by 408 | X<br>30% beef cattle breeding: 70% sheep | X<br>70% beef cattle breeding: 30% beef cattle trading | X<br>70% beef cattle breeding: 30% beef cattle trading | N/a |
| 11.5 | Enterprise mix changes.<br>(For livestock changes the carrying capacity/dse remains constant) | X<br>Cropping area increases by 25%.<br>Ewes and lambs reduce by 510 | X<br>20% beef cattle breeding: 80% sheep | X<br>80% beef cattle breeding: 20% beef cattle trading | X<br>80% beef cattle breeding: 20% beef cattle trading | N/a |
| 11.6 | Enterprise mix changes. | X<br>Cropping area increases by 40%.<br>Ewes and lambs reduce by 816 | N/a | N/a | N/a | N/a |
| 11.7 | Enterprise mix changes.<br>(For livestock changes the carrying capacity/dse remains constant) | X<br>Wethers are no longer carried. Trade hoggets increase by 2000 on existing monthly numbers. | N/a | N/a | N/a | N/a |
| | | | | | | |
| 12 | Replace up to 5% of total area with an environmental planting (treelot). | X<br>(50ha) | N/a | X<br>(15ha) | X<br>(17ha) | X<br>(165ha) |

*X signifies modelling (assumptions) completed for that case study farm and N/a indicates the scenario is not applicable.

## 2.4 Industry opinion on specific management strategies

Comment was sought from industry experts to assess the commercial relevance of the beef genetics, early weaning and methane inhibitor scenarios.

**Beef genetics**

The research modelled scenarios which involved using beef genetics to improve feed conversion efficiency by reducing the percentage of Gross Energy Intake converted to $CH_4$ by 5%. The project did not model any productivity gains in association with these genetic changes.

*Industry opinion (Associate Professor Richard Eckard, Director of the Primary Industries Climate Challenges Centre, University of Melbourne): Research into the genetics of methane production by ruminant animals in Australia is currently being undertaken. This research is focusing both on breeding animals that produce less methane and animals that have high feed conversion efficiency (lower residual feed intake). The heritability of low methane production by ruminant animals is quite low, but the current research indicates that a 15% reduction in methane production would be possible via the genetic improvement of a herd.*

On the basis of this feedback, the 5% reduction in methane emissions modelled in this research provides a conservative estimate of potential genetic improvements to beef cattle $CH_4$ emissions. The scenarios modelled in this project did not included productivity gain assumptions such as increased liveweight gains, which is consistent with current research results.

It was also highlighted that any more detailed modelling of the GHG and financial implications of implementing genetic changes as a GHG abatement strategy would need to factor in the incremental nature of genetic change in a herd, given the multiple competing breeding objectives of producers, and the generation intervals associated with beef cattle production.

**Early weaning**

The project modelled a variety of early weaning scenarios without any productivity gains.

*Industry opinion (John Wilkins, Senior Livestock Research Officer, Department of Primary Industries Agriculture NSW): Feedback indicated that currently early weaning is generally used as a measure to prevent a decline in herd performance, rather than as a herd improvement strategy. Early weaning is often used to prevent a decline in the reproductive performance of cattle operations in situations of poor nutrition (typically droughts). The aim of early weaning under these circumstances is to minimise any delays in the return to estrus of the cows and associated lower herd conception rates.*

It was also highlighted that the implementation of an early weaning strategy would result in an earlier return to estrus and a more concentrated calving period, which should be included in any detailed modelling of GHG emissions and financial performance associated with the implementation of early weaning as a GHG emissions abatement strategy.

**Methane inhibitor**

The research modelled scenarios involving the implementation of a hypothetical technology for sheep and cattle which reduces $CH_4$ emissions by 20%. The project did not model any potential productivity gains associated with the use of this technology.

*Industry opinion (Associate Professor Richard Eckard, Director of the Primary Industries Climate Challenges Centre, University of Melbourne): The use of methane inhibitors in the guts of ruminant animals is not currently receiving significant research attention in Australia, but a research program in this area is being led by Dr. Peter Jansen of AgResearch in New Zealand. AgResearch are currently aiming to achieve 20% reductions in methane output using inhibitors placed in the guts of ruminant animals. The production impacts of these substances are not yet clear but preliminary findings indicate that they were anticipated to be minimal. AgResearch expect that a methane inhibitor product would not be available for commercialisation until sometime between 2015 and 2018.*

On this basis, the assumptions used in the modelling undertaken for this scenario appear realistic.

### 2.5 Carbon policy impacts on the scenario analysis

The main objective for the CFI is to incentivize farm businesses to reduce GHG emissions. This means that, in order to be approved, CFI methodologies need to reduce overall GHG emissions for a farm activity. Methodologies that reduce GHG emissions per unit of output, but do not lower the GHG emissions for the specific farm activity, would not currently be approved as a CFI methodology. Therefore, in many cases, improvements in productivity which increase GHG emissions associated with specific farm activities will be penalised under the current carbon policy for agriculture in Australia.

Biological nitrogen fixation from plants such as legumes is an example of a carbon policy issue that impacts on the usefulness of some management strategies for livestock and cropping farm businesses. The National Greenhouse Gas Inventory (NGGI) methodology is underpinned by the 1996 IPCC guidelines under which biological nitrogen fixation are calculated as a direct source of GHG emissions. The IPCC guidelines for National Greenhouse Gas Inventories are due to change in 2015 when the 2006 IPCC guidelines will be adopted. Under the IPCC guidelines to be implemented in 2015, biological nitrogen fixation will be removed as a direct source of emissions.[1] This is an important change as pasture improvement is one of the most common and widely used methods used to improve farm productivity and profitability.

### 2.6 GHG emissions modelling

The base farm data obtained for each farm business was entered into the *FarmGAS* tool to calculate the baseline GHG emissions for each case study farm. The base farm inputs for each farm are summarised in *Table A1* and *Table A2* of *Appendix A*.

Each GHG emissions abatement scenario was then modelled separately for each farm using the *FarmGAS* tool. The abatement scenarios and input data for each farm are summarised in *Table A1* and *Table A2* of *Appendix A*.

[1] Biological nitrogen fixation will be removed as a direct source of $N_2O$ because of the lack of evidence of significant emissions arising from the fixation process itself (Rochette and Janzen, 2005). These authors concluded that the $N_2O$ emissions induced by the growth of legume crops/forages may be estimated solely as a function of the above-ground and below-ground nitrogen inputs from crop/forage residue (the nitrogen residue from forages is only accounted for during pasture renewal). Conversely, the release of N by mineralisation of soil organic matter as a result of change of land use or management is now included as an additional source. These are significant adjustments to the methodology previously described in the 1996 IPCC Guidelines.

The whole farm GHG emissions results for each management scenario were then compared to the base GHG emissions for each farm. This comparison was used to identify the farm management strategies with the potential to significantly reduce GHG emissions. For the purpose of this assessment a GHG emissions reduction of above 2% was used as the threshold for GHG emissions changes to be considered a significant GHG emissions abatement.

## 2.7 Financial analysis

For each scenario analysed, financial modelling was carried out which involved identifying all capital and operating costs associated with the implementation of the scenario on the farm. In cases where there was uncertainty, estimates from industry experts and relevant Government departments were used. The modelling involved projections over periods ranging from 1 to 41 years. The future capital costs and revenue were discounted at a rate of 8% annually in order to calculate the net present value (NPV) of future capital costs and revenue. This information was then used to generate the MACC for each scenario.

The financial analysis and MACC modelling methodology and results are outlined in *Section 3.3 and 3.4* of this report.

# 3.0 Case study results

## 3.1 Farm background

The five case study farm businesses included in this assessment were located in eastern Australia, with two properties located in the border region of NSW and Victoria and three farms located in the northern tablelands of NSW. All of these farm businesses were primarily undertaking either beef cattle or prime lamb production.

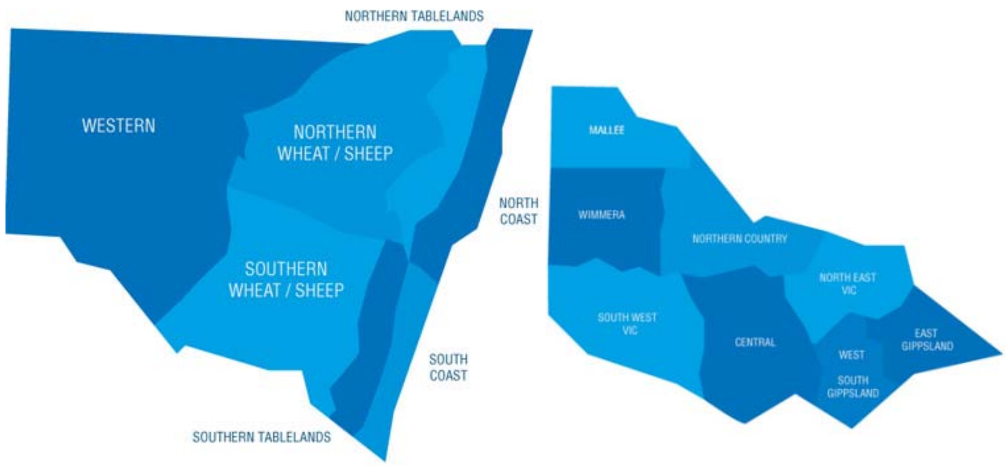


**Figure 3.1: Production zones for NSW and Victoria as per the National Greenhouse Gas Inventory methodology.***

* Maps not drawn to scale

### Southern Farm-1

Southern Farm-1 is located in the southern wheat sheep zone of New South Wales (see *Figure 3.1*). The property is 2,200 hectares (ha) in area, and the farm business involves an enterprise mix of merino sheep/ prime lambs, trade cattle and dryland winter cropping.

The main enterprise undertaken on the property is sheep production, with 7,000 breeding ewes lambing in spring with an average lambing percentage of over 92%. The farm operator normally buys 400 trade cattle in February of each year and sells these animals in November. The livestock carrying capacity of the property is estimated to be 11 dry sheep equivalents (dse) per ha.

The grazing pastures on the property are largely improved, with a relatively high legume content (30%). The pasture quality on the farm is superior to the district average, allowing the property to operate more productively than the benchmarks detailed in the National Greenhouse Gas Inventory (NGGI) methodology for this production zone (see *Appendix B*).

The dryland cropping program on this farm is small in scale relative to the sheep business with only 340 ha allocated to producing crops such as wheat and triticale annually. The grain yields achieved on the property average around 6 tonnes per ha. Nitrogen fertiliser is used as an input for crop production and is the largest source of GHG emissions arising from the cropping enterprise (see *Figure 3.2*).

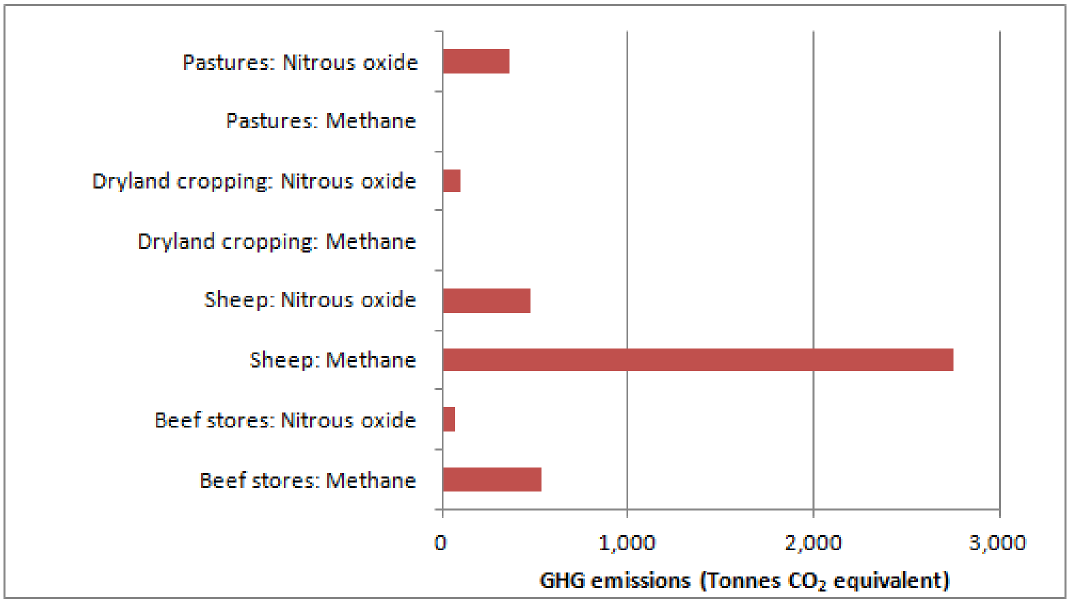


**Figure 3.2: Southern Farm-1 GHG emissions by enterprise.**

### Southern Farm-2

Southern Farm-2 is located in North-Eastern Victoria. The farm comprises 4,166 ha and the main enterprise is beef breeding with a carrying capacity of 7.9 dse per ha. The beef breeding enterprise includes 1,600 cows calving in spring with average calving percentages of 88%. The farm operator also buys and sells 400 trade cattle between June and December each year. A relatively smaller sheep enterprise of 600 ewes is also operated. The farm also has better quality pastures than most farms in the district.

The GHG emissions by enterprise are summarised in *Figure 3.3* below.

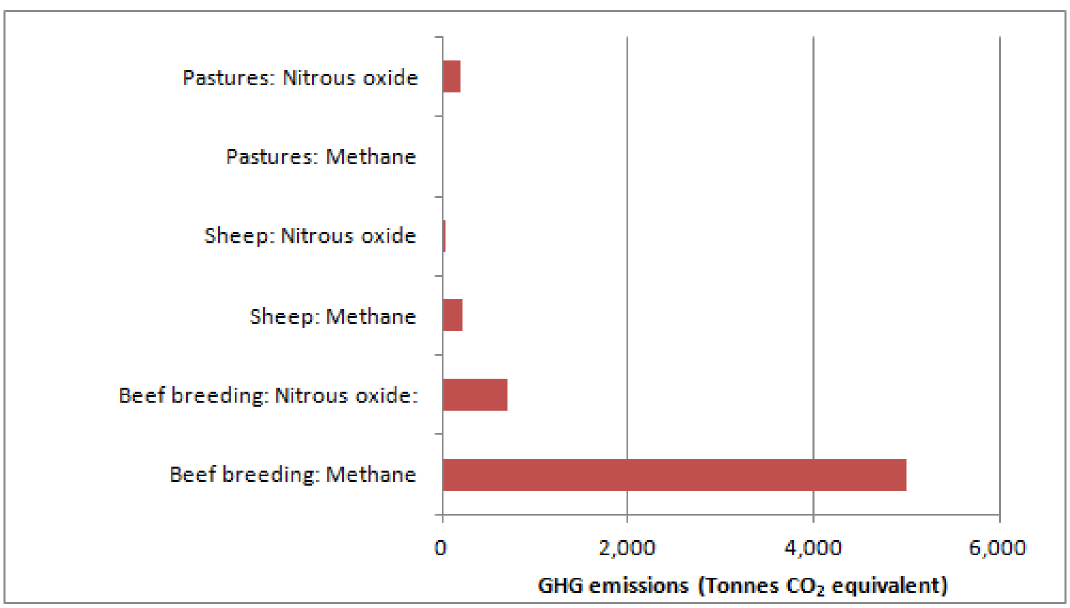


**Figure 3.3: Southern Farm-2 GHG emissions by enterprise.**

### Northern Farm-1

The farm is located on the northern tablelands of NSW. The farm comprises 1,722 ha of land and is split between beef breeding and trade cattle enterprises. The carrying capacity of the property is estimated at 10 dse per ha with grazing pastures that predominantly consist of rye grass, tall fescue and clover. The beef breeding herd includes 500 cows calving in spring with a calving percentage of 92%. The trade cattle herd fluctuates throughout the year with numbers varying from a peak of over 1800 head in January to around 500 head in June. The pastures on the farm are similar to the district average.

The GHG emissions by enterprise are summarised in *Figure 3.4* below.

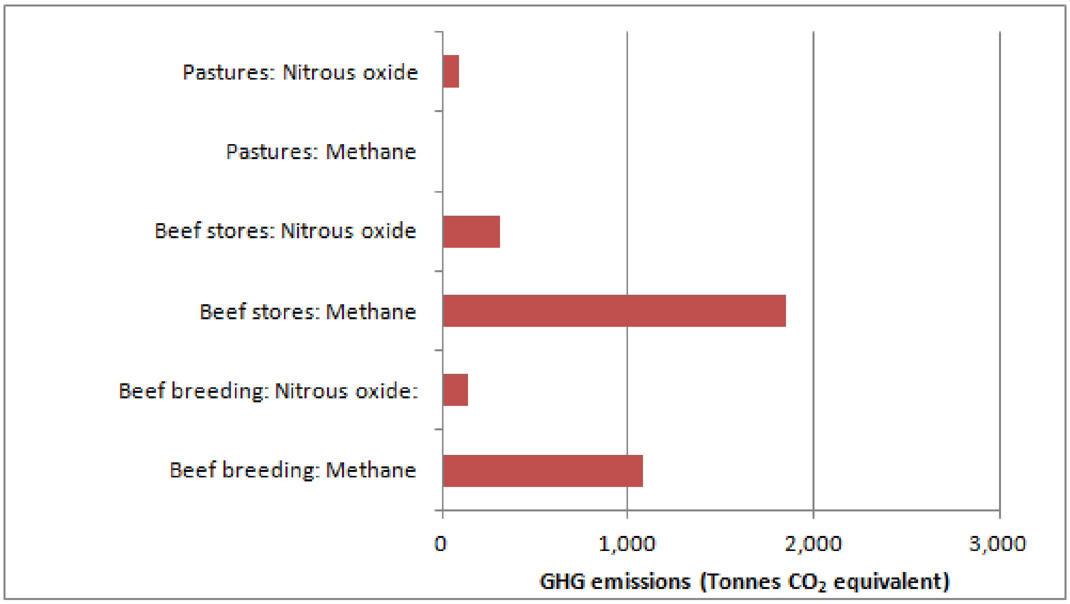


**Figure 3.4: Northern Farm-1 GHG emissions by enterprise.**

### Northern Farm-2

The farm is a much smaller farm than the other farms included in this research project, consisting of only 292 ha of land. The livestock carrying capacity of this property is, however, by far the highest at 18 dse per ha. This more intensive farm business operates beef breeding and trade cattle enterprises with 110 cows and 392 trade cattle consistently running on the pastures. The pasture on this property has a legume content of 15% which supports the relatively high carrying capacity. Although the farm has robust production characteristics, the farms GHG emissions are estimated to be below the district average (see *Appendix B*). The main factors leading to this difference are lower DMD and CP feed intake estimates from existing pastures.

The GHG emissions by enterprise are summarised in *Figure 3.5* below.

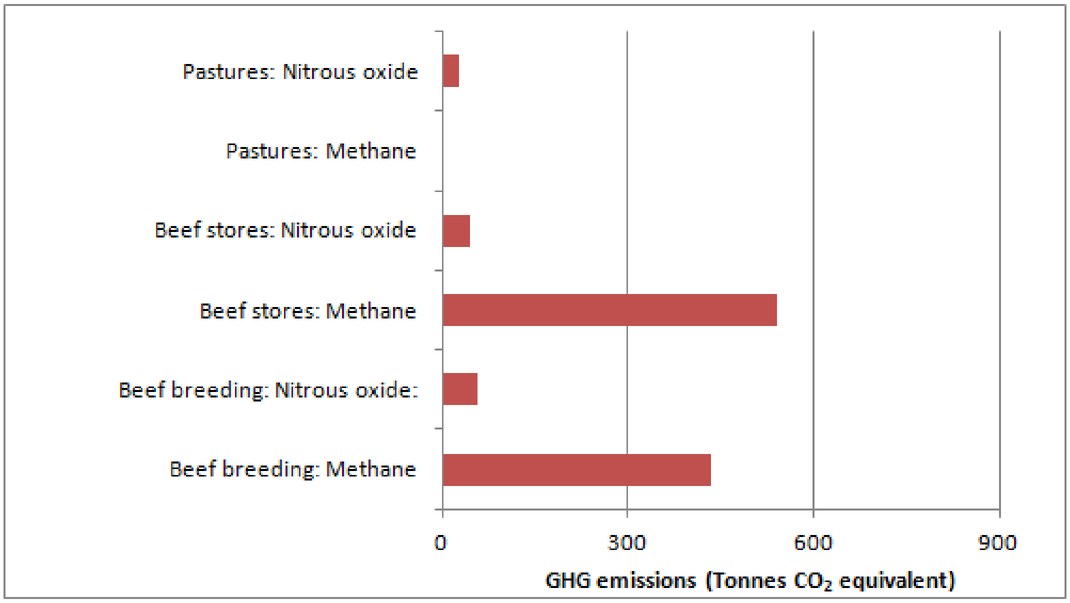


**Figure 3.5: Northern Farm-2 GHG emissions by enterprise.**

### Northern Farm-3

This farm is located in the northern tablelands of New South Wales and is a beef cattle breeding enterprise running over 600 cows on 3,278 ha. The livestock carrying capacity on the farm is estimated at 4 dse per ha which is the lowest among the farm businesses assessed in this research. The pastures on this property have only a relatively low legume content, and there is no fertiliser used. The pasture quality on this property is considered below the district average. The beef breeding herd has a split calving strategy with a small portion of the calves born in autumn rather than spring.

The GHG emissions by enterprise are summarised in *Figure 3.6* below.

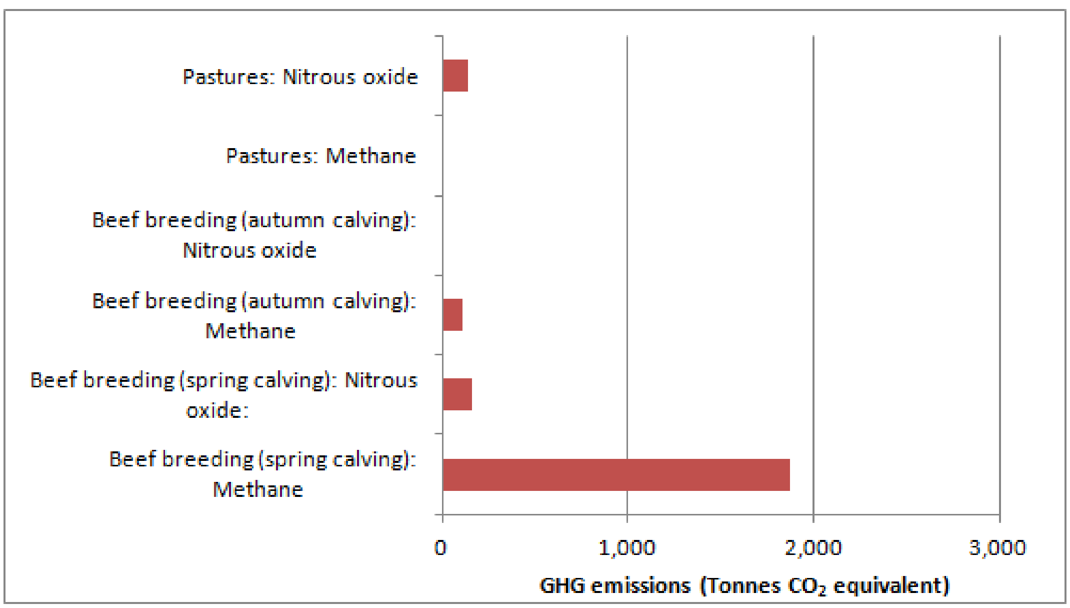


**Figure 3.6: Northern Farm-3 GHG emissions by enterprise.**

## 3.2 Case study GHG emission modelling results

**Improved pasture: Scenarios 1.1 – 1.5**

The improved pasture quality scenario involved increasing the legume content of pastures by 5% and employing better pasture management strategies. The assumed production outcomes of these actions were a 10% increase in Dry Matter Digestibility (DMD), 5% increase in Crude Protein (CP) and ultimately a 5% increase in Live Weight Gain (LWG). Five separate sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3*.

The estimated GHG emissions abatement for each of the case study farm businesses under these scenarios are summarised in *Figure 3.7* below. *Figure 3.7* illustrates that in the majority of circumstances, improving pasture quality results in a corresponding increase in GHG emissions. This increase can be attributed to an increase in the emission of $N_2O$ by the more legume dominant pastures and associated increases in CP content in feed and animal weight gains. The higher CP content in feed lead to increased nitrogen in the animals feed ration and increased $N_2O$ excretion to the environment.

Significant GHG emissions reductions were calculated for Northern Farm-3 under scenario 1.4, which included improvements in pasture quality and the planting of a 165 ha tree lot. This farm has low quality native pastures and the marginal GHG emission increase calculated for this farm under an improved pasture scenario were readily offset by the emissions abatement associated with a tree lot. It should also be noted that scenario 1.4 did not model any loss of production from the area set aside for the tree lot.

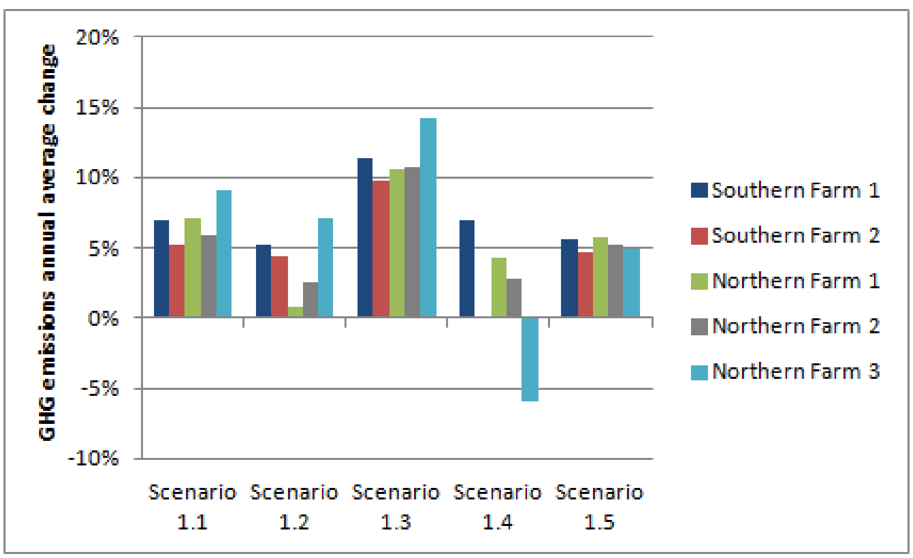


**Figure 3.7: Changes in GHG emissions on case study farms potentially arising from the adoption of improved pasture management strategies.**

**Improved beef genetics: Scenarios 2.1 – 2.3**

The improved beef genetics scenario involved increasing the feed conversion efficiency of the herd by 5% using a targeted breeding approach. The assumed production outcome of this strategy was a 5% reduction in the percentage of gross energy intake converted to $CH_4$. Three separate sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these scenarios are summarised in *Figure 3.8* below. In the majority of circumstances, improving beef genetics reduces GHG emissions. This result can be attributed to a decrease in the emission of $CH_4$ per unit of beef produced.

In Scenario 2.2, where the young beef cattle were sold earlier at nine months in conjunction with improving beef genetics, a more significant GHG abatement response was achieved.

Scenario 2.3 included an increase in livestock numbers, facilitated by the improved pasture use efficiency of the beef herd. There were a range of assumptions applied to each farm for this sub-scenario which included; Southern Farm-1 increased sheep flock by 5%, Southern Farm-2 increased cattle breeding herd by 10%, Northern Farm-1 increased beef stores by 5%, Northern Farm-3 increased cattle breeding herd by 5% and Northern Farm-3 increased cattle breeding herd by 5%. In the majority of farm operations studied the GHG abatement response was negated when additional livestock were added to the whole farm business.

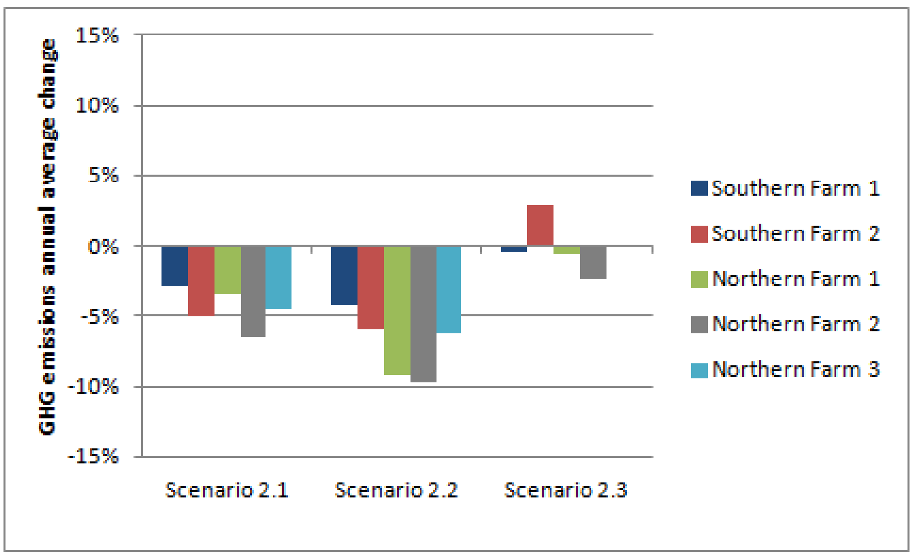


**Figure 3.8: Changes in GHG emissions on case study farms potentially arising from the adoption of improved beef cattle genetics.**

### Early weaning: Scenarios 3.1 – 3.5

The early weaning scenario involved the weaning of lambs at 14 weeks rather than 16 weeks and the weaning of calves at six months rather than nine months. Five separate sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these scenarios are summarised in *Figure 3.9* below. Early weaning in isolation had a negligible effect on estimated GHG emissions (Scenario 3.1).

Scenario 3.2 and 3.3 involved management strategies such as the sale of older stock to accommodate the management of the weaners, with reductions in the overall livestock numbers reducing overall GHG emissions for the farm business.

Scenario 3.4 and 3.5 included the pasture improvements that would be necessary to accommodate the management of the weaners without any reductions in stock numbers. In accordance with the results illustrated using management scenarios 1.1 and 1.5, improving pasture quality has a corresponding increase in estimated GHG emissions, due to an increase in the emissions of $N_2O$ from the more legume dominant pastures (Scenario 1.1) and associated increases in feed factors and animal weight gains with all classes of livestock retained (Scenario 1.5).

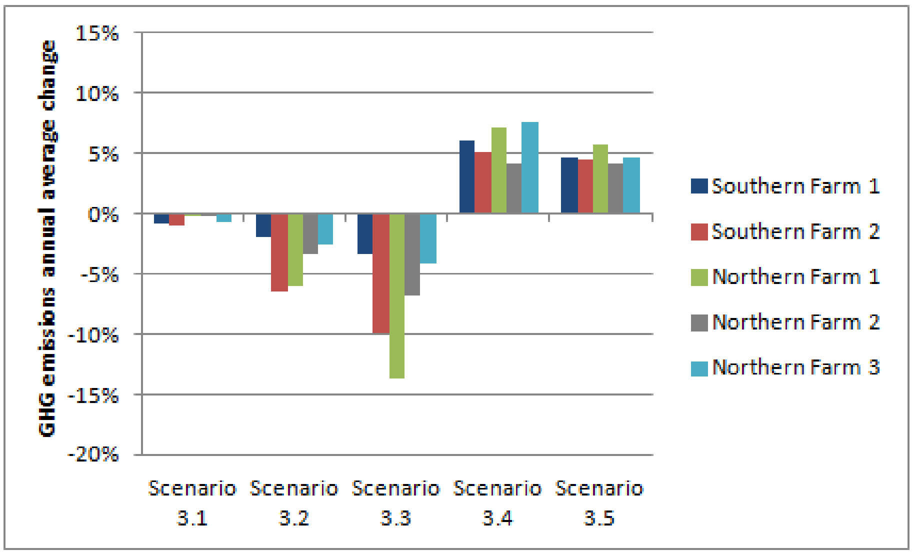


**Figure 3.9: Changes in GHG emissions on case study farms potentially arising from the adoption of early weaning management strategies.**

### Reproductive efficiency: Scenarios 4.1 – 4.3

The reproductive efficiency scenario involved improving the reproductive efficiency of the livestock breeding enterprise through the use of improved management. Three separate sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3.* The assumed production outcomes of these scenarios were a 110% lambing percentage (Scenario 4.1), 98% calving percentage (Scenario 4.2) and a shift to 100% spring calving (Scenario 4.3). Scenario 4.3 was only investigated at Northern Farm-3, as none of the other farms utilised split calving.

The estimated GHG emissions abatement for each of the case study farm businesses under this management scenario are summarised in *Figure 3.10* below. Improving the reproductive efficiency of livestock increases estimated GHG emissions. This increase is due to the presence of higher numbers of stock on each farm. This result highlights one of the major limitations of the NGGI accounting methodology when it is applied at an individual farm level. GHG emissions are estimated on a whole farm basis and do not take into account the GHG intensity of production systems, for example units of GHG per kilogram of beef produced.

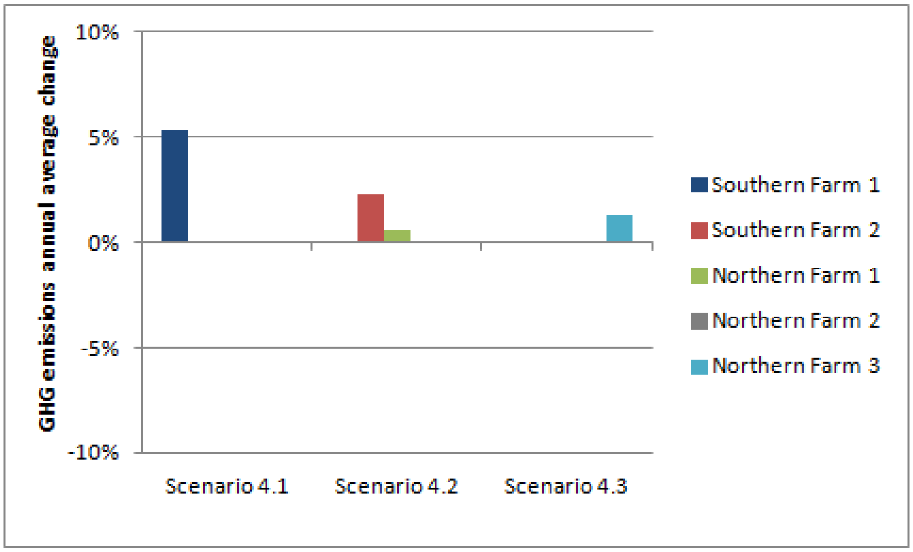


**Figure 3.10: Changes in GHG emissions on case study farms potentially arising from the adoption of improved reproductive efficiency.**

**Matching sheep enterprise feed demand with optimal pasture supply: Scenarios 5.1 – 5.2**

The matching sheep enterprise feed demand with optimal pasture supply scenario involved changing the lambing period from May – July to August – October. This change was only applicable to Southern Farm-2 as the other farms either did not run sheep or had already implemented this strategy. Two separate sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3.*

The estimated GHG emissions abatement under these management scenarios are summarised in *Figure 3.11* below. The emissions modelling result for scenario 5.1 illustrates that matching pasture supply with a sheep breeding enterprises feed demand slightly increases the estimated GHG emissions. To offset the slight increase in GHG emissions for the sheep breeding enterprise, early weaning could be implemented depending on pasture condition. In cases where optimal pasture supply supports an early weaning scenario a slight reduction in GHG emissions would be achieved (Scenario 5.2).

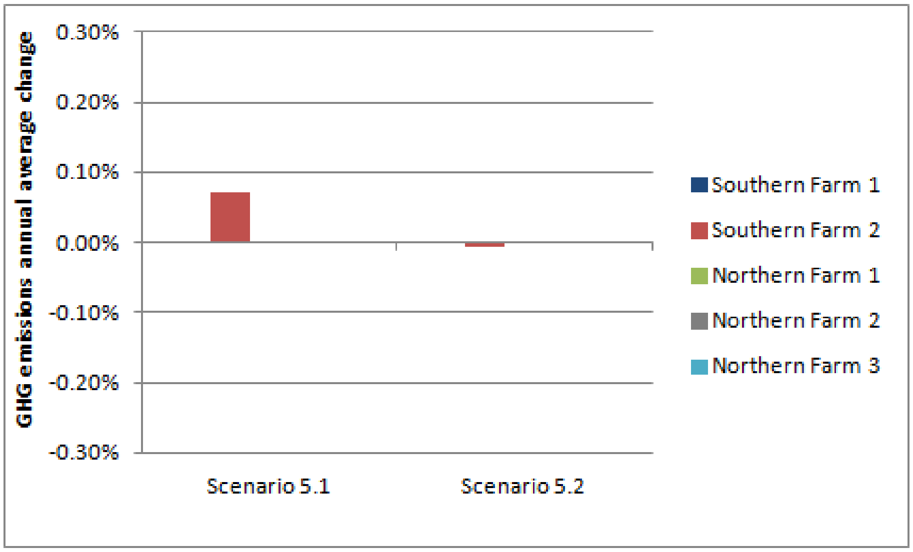


**Figure 3.11: Changes in GHG emissions on case study farms potentially arising from the adoption of matching a sheep breeding enterprises feed demand with optimal pasture supply.**

### Faster beef cattle turnoff: Scenarios 6.1 – 6.2

The faster beef cattle turnoff scenario involved increasing daily weight gains so that the number of days between buying and selling trade cattle is reduced. This scenario was only applicable to Southern Farm-1, Northern Farm-1 and Northern Farm-2, as the other farm businesses mainly involved beef cattle breeding.

The increased liveweight gains required to implement this scenario were assumed to be achieved through the use of improved management strategies. Two separate sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3.* The assumed production outcomes of this scenario were trade cattle increasing liveweight gains by 0.1 kg per day with time on farm being reduced by 30 days (Scenario 6.1) and trade cattle increasing liveweight gains by 0.2 kg per day with time on farm being reduced by 30 days (Scenario 6.2).

The estimated GHG emissions abatement for each of the case study farm businesses under these management scenarios are summarised in *Figure 3.12* below. Shortening the period over which trade cattle are run on the farm without sacrificing liveweight gain can provide significant GHG emissions abatement for farms with large trading herds. Only a marginal GHG emissions abatement was achieved at Southern Farm-1, due to the relatively small trading herd included in this operation.

The reduction in GHG emissions achieved using the faster beef cattle turnoff scenario can be attributed to reductions in livestock numbers on the farm over a full year. This result highlights that matching trade cattle numbers with periods of higher feed value is a potentially useful GHG emissions abatement strategy for beef cattle trading operations.

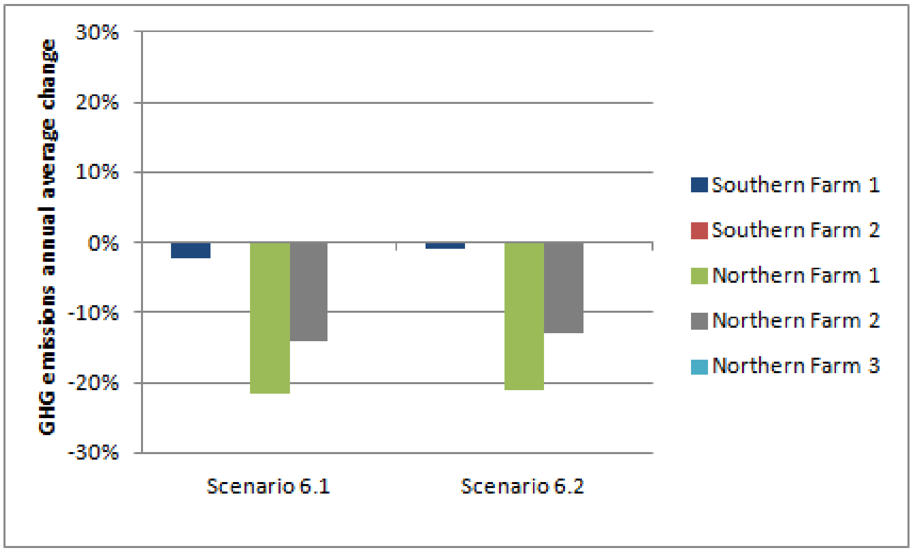


**Figure 3.12: Changes in GHG emissions on case study farms potentially arising from the adoption of faster beef cattle turnoff.**

### Grain finishing cattle: Scenarios 7.1 – 7.3

The grain feeding scenario involved finishing store cattle using purchased grain without making any changes to beef cattle numbers for the overall farm. This scenario was only applicable to the northern farms, due to a lack of necessary infrastructure on the southern farms and the farm operators indicating that grain finishing cattle was not suitable for their operation. Three separate weight gain and feeding length sub-scenarios of this management scenario were modelled, as detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these scenarios are summarised in *Figure 3.13* below. Grain finishing cattle to a heavier liveweight significantly increases estimated GHG emissions per animal. The most significant increases in GHG emissions following the introduction of a grain feeding scenario were evident for Northern Farm-2, where store cattle that switched from pasture to grain feeding represented the greatest proportion of the total beef cattle herd. The annual change estimated for GHG emissions for Northern Farm-3 was not as substantial as the other two farms as only the young steers (proportionately less animals) from the beef breeding enterprise were placed in a feedlot and grown to a heavier liveweight.

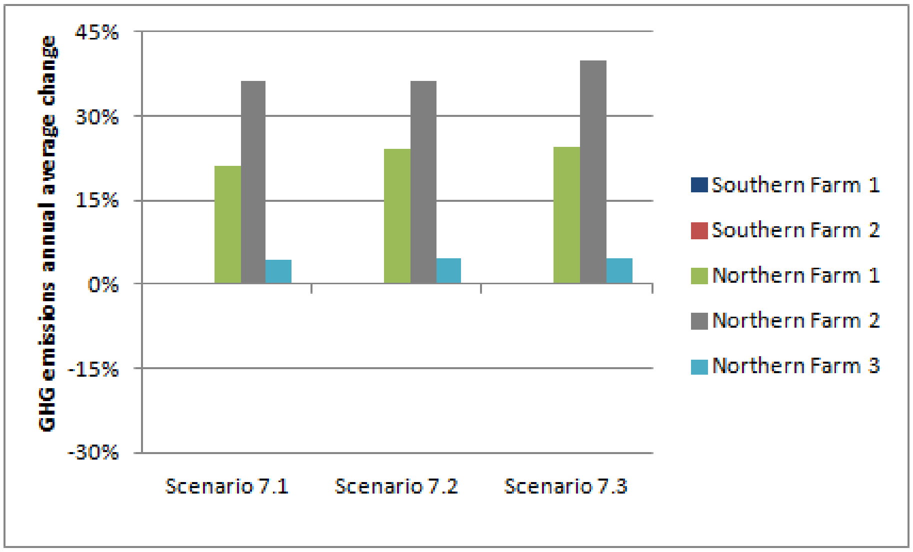


**Figure 3.13: Changes in GHG emissions on case study farms potentially arising from the adoption of grain finishing cattle.**

**Hypothetical methane inhibitor: Scenarios 8.1 – 8.4**

The hypothetical methane inhibitor scenarios involved the use of a methane inhibiting bolus, in sheep (Scenario 8.1), cattle (Scenario 8.2) and sheep and cattle (Scenario 8.3). The assumed methane emission reduction achieved via the use of this bolus was 20%. Scenario 8.4 modelled a methane emission reduction of 10% occurring as a result of feeding oil seeds and tannins to cattle. The model inputs applied under this management scenario are detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these management scenarios are summarised in *Figure 3.14* below. The use of a methane inhibitor has the potential to provide significant GHG emission abatement for farm businesses with large trading or breeding herds or flocks.

It is noted that while research into the use of methane inhibitors in ruminant animals is currently underway in New Zealand, commercialisation of a methane inhibiting product is not likely to occur for a number of years (see *Section 2.4*).

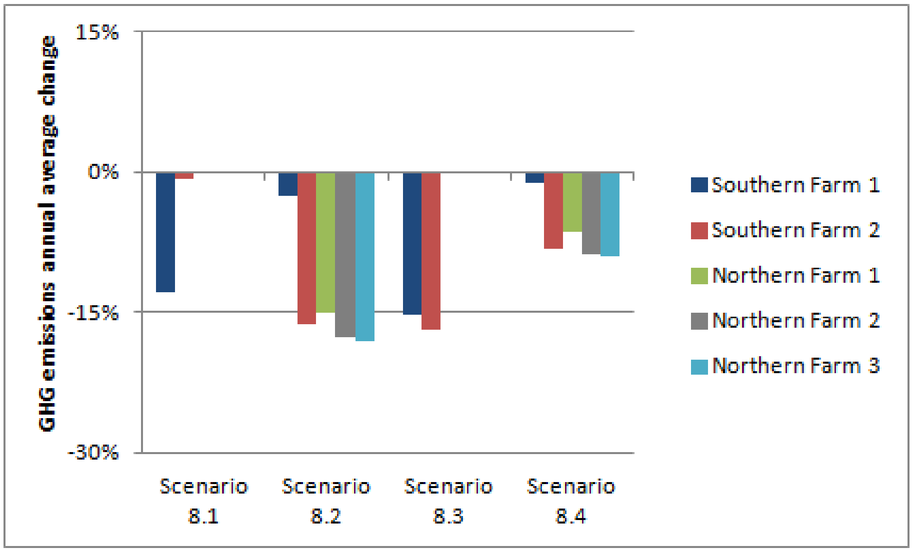


**Figure 3.14: Changes in GHG emissions on case study farms potentially arising from the application of methane inhibiting strategies.**

### Improved fertiliser use: Scenarios 9.1 – 9.3

The improved fertiliser use scenarios involved reducing total fertiliser application rates without sacrificing crop yields (Scenario 9.1), with sacrificing crop yields (Scenario 9.2) and without sacrificing pasture yields (Scenario 9.3), due to improvements in application efficiency. This strategy was only applicable to the two farms with substantial fertiliser application programs; Southern Farm-1 and Southern Farm-2. The model inputs applied under this management strategy are detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these scenarios are summarised in *Figure 3.15* below. Improvement in fertiliser application efficiency and associated reductions in fertiliser rates resulted in only a marginal reduction in GHG emissions.

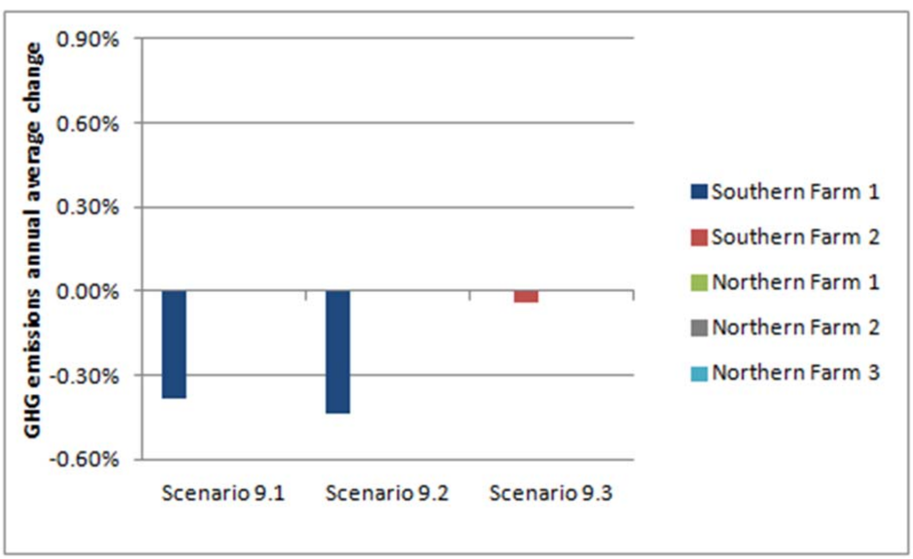

**Figure 3.15: Changes in GHG emissions on case study farms potentially arising from improved fertiliser management strategies.**

### Nitrogen inhibitor used with fertiliser practices: Scenario 10.1

There are two kinds of nitrogen inhibitors currently available for use in conjunction with fertiliser application. Urease inhibitors such as Agrotain reduce ammonia volatilisation by 50-90% but are very expensive. Nitrification inhibitor products such as DCD and DMPP prevent nitrate leaching and direct nitrous oxide loss by 25-50% and increase the cost of fertiliser products by 10-15%. The nitrogen inhibitor scenario modelled in this research assumed a 50% reduction in nitrogen loss following fertiliser application. This scenario was only applicable to the two farms with substantial fertiliser application programs; Southern Farm-1 and Southern Farm-2. The model inputs applied under this management scenario are detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these scenarios are summarised in *Figure 3.16* below. The use of a nitrogen loss inhibitor resulted in only a marginal reduction in GHG emissions.

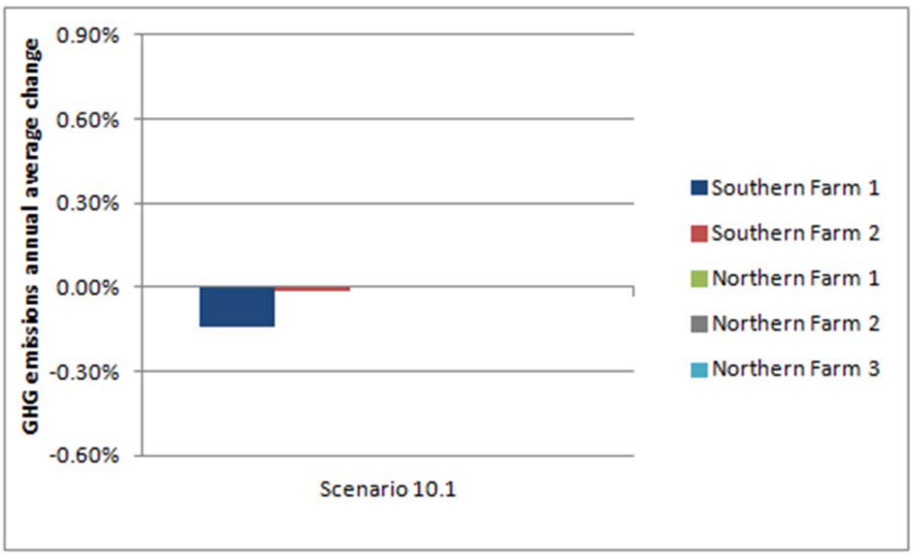


**Figure 3.16: Changes in GHG emissions on case study farms potentially arising from the application of nitrogen inhibiting fertiliser strategies.**

### Enterprise changes: Scenarios 11.1 – 11.7

The enterprise changes involved implementing different enterprise scenarios for each farm except Northern Farm-3. Northern Farm-3 was solely a beef cattle breeding business and for this reason no additional enterprises were simulated. For Southern Farm-1 the modelling assumed an increased cropping area facilitated by a corresponding decrease in sheep numbers. For Southern Farm-2 modelling assumed an increase in sheep breeding numbers, offset by a corresponding decrease in the beef cattle numbers. Modelling for both Northern Farm-1 and Northern Farm-2 involved an increase in the number of breeding cattle, offset by a decrease in the number of store cattle. The model inputs applied under these management scenarios are detailed in *Section 2.3.*

The estimated GHG emissions abatement for each of the case study farm businesses under these management scenarios are summarised in *Figure 3.17* below. Implementing changes in the enterprise mix of farm businesses has the potential to result in significant GHG emission abatement for some farm businesses.

Increasing the area of land allocated to cropping and reducing sheep numbers on Southern Farm-1 reduces GHG emissions for the overall farm business. The increased emissions of $N_2O$ from nitrogen fertiliser and plant decay arising from the increased cropping area are substantially less than the $CH_4$ emission reduction arising as a consequence of reduced sheep numbers.

Switching from a beef dominant farm business to a sheep dominant farm business, while retaining the same total number of stock equivalents (dse's), significantly reduces GHG emissions for Southern Farm-2. Scenario 11.5 indicates that the sheep enterprise emits 0.13 tonnes of $CO_2$e per dse compared to the beef cattle breeding enterprise at 0.19 tonnes of $CO_2$e per dse which suggests switching to a sheep dominant farm business has potential to provide significant GHG emission abatement for this farm. However, technical considerations must be made for the individual farms stocking rates for different animal types. These considerations could alter the results and likely show little GHG emissions difference when switching between animal types in practice.

The change of enterprise mix scenario for Northern Farm-1 and Northern Farm-2 assumed changing from a split beef cattle breeding and beef cattle trading enterprise to a dominant beef cattle breeding enterprise. This scenario resulted in only limited changes in overall farm GHG emissions for Northern Farm-2, as this farm has a higher level of livestock intensity per hectare and the change to a breeding cattle dominant enterprise mix has a relatively minor impact. For Northern Farm-1 however, the change to a breeding cattle dominant enterprise resulted in a significant GHG emissions reduction for the overall farm business. It should also be noted that beef cattle breeding enterprises are not as flexible as beef cattle trading enterprises as the breeding herd continuously carried on the farm constantly adds to the overall farms GHG emissions.

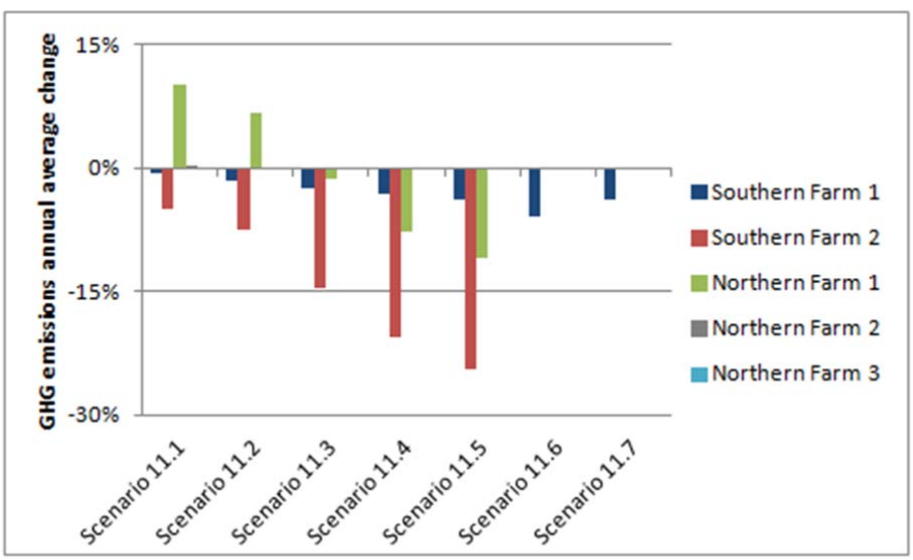


**Figure 3.17: Changes in GHG emissions on case study farms potentially arising from changes in the enterprise mix.**

**Tree lots: Scenario 12.1**

The tree lot scenarios involved replacing less than 5% of the total farm area with a tree plantation. It was assumed that this plantation would remain in place for a 100 year period. It was also assumed that no loss of farm productivity occurred from the area set aside for trees. The model inputs applied under these scenarios are detailed in *Section 2.3.* This scenario was not modelled for Southern Farm-2, because there was not sufficient suitable land available on this farm for planting trees.

The estimated GHG emissions abatement for each of the case study farm businesses under this scenario are summarised in *Figure 3.18* below. Environmental tree plantings have the potential to provide significant GHG emission abatement but larger planting areas may be required on many properties to produce a significant amount of abatement.

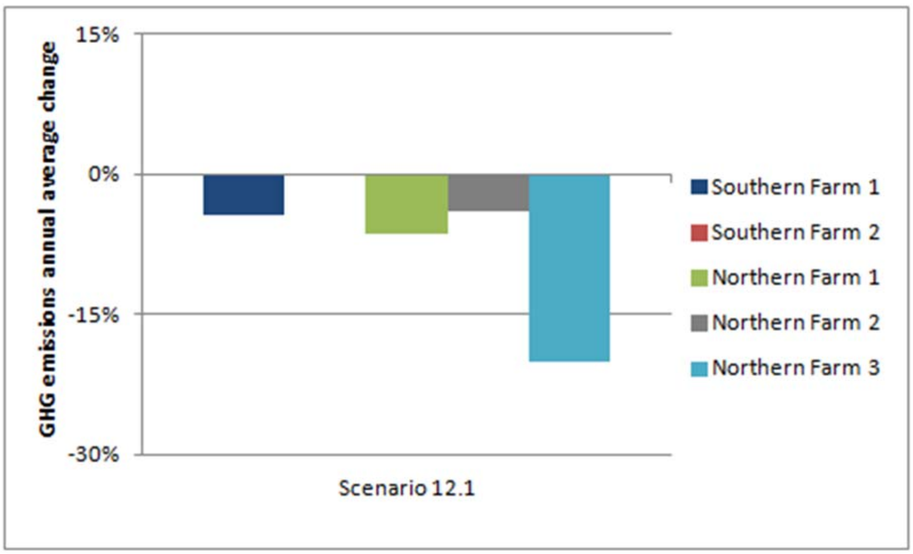


**Figure 3.18: Changes in GHG emissions on case study farms potentially arising from the planting of tree lots.**

## 3.3 Case study financial analysis

This section reports the results of financial analyses for the twelve GHG emissions abatement scenarios evaluated. Discounted cash flow techniques were applied to determine the financial results and the net present value (NPV) for each sub-scenario. NPVs represent the difference between the capital expenditure associated with a scenario and the present value of projected cash flows over the scenario's project life. Only those cash flows that were different to the business-as-usual case were included. To calculate NPVs, future changes in cash flows (from the business-as-usual base case) were discounted using an assumed discount rate of 8%. This rate is similar to that used in previous studies (Beadle et al, 2011; Crossman et al, 2011). Positive NPVs indicate profitable investment opportunities. This approach is different to the enterprise gross margin approach used in some prior research. It provides an estimate in current day terms of the value of future cash flows emanating from a specific investment or project. It enables robust comparisons to be made of the potential financial outcomes of investments or projects with different project lives and capital expenditure requirements.

Estimated changes in GHG emissions, annual changes in cash flows, and capital expenditure, NPV and assumed project life were analysed in each sub-scenario modelled for each of the five case study farms examined. For scenarios where no capital expenditure was required, the present value of changes in cash flows (PV) is shown instead of NPV. This is because there is no capital expenditure to be netted off against the present value of changes in cash flows. This information was then used to construct a marginal abatement cost curve for each case study farm.

Several assumptions were made for the financial analysis. A carbon price of $23 per tonne was assumed for all scenarios as this price was the same as the Australian carbon price at the time the research was conducted. Not all GHG emission abatement options evaluated are eligible for consideration and approval under the Carbon Farming Initiative (CFI). Indeed, the majority of emission abatement options considered do not currently have an available CFI methodology and for that reason it was decided not to include potential cash flows from ACCU's in the analysis of these sub-scenarios. The two scenarios where cash flows from ACCUs were considered are scenarios 1.4 and 12.1, which both include a treelot. Transaction costs for these scenarios were assumed to be $2,000 per ha on establishment of the tree lot and $1,000 each year for maintenance of the tree lot thereafter. These costs are similar to that used in previous studies (Whittle et al. 2013).

In the first phase of the project during interviews with farmers it became apparent that the quality and comprehensiveness of financial information available for the case study farms varied considerably, and thus would not allow for a meaningful comparison across cases. Therefore some standard costs assumptions have been made to facilitate comparisons between farms. A flexible budgeting approached was used with farm production multiplied by standardised regional financial price data such as historical cattle sale prices. Annual rather than monthly average prices were used to eliminate the impact of case specific decisions around the months of sales or purchases.

This approach improves comparability of each scenario between farms and regions as it focuses on the impacts of specific management activities rather than other factors such as timing of commodity sales that can impact on price and have the effect of skewing the financial results. However, the price assumptions are based on historical data comparable to regional market prices and any future change to these prices in real terms will have a significant bearing on the viability of the scenarios analysed.

Transactions costs associated with scenarios 1, 2, 3 and 11 were calculated by determining the marginal costs associated with sale of each animal including cartage, industry levies and national livestock identification system costs (NSW Department of Primary Industries, 2013, Meat and Livestock Australia, 2013). It was assumed all animals purchased were in excellent health and fit for purpose. Other assumptions that relate to specific scenarios are detailed below along with the discussion of the financial analysis for each of the twelve GHG emission abatement scenarios. Summaries of average financial outcomes for southern, northern and all farms are also provided.

**Scenario 1: Improved pastures**

Scenarios 1.1, 1.2, 1.3 and 1.4 all involved pasture improvement through increasing legume content by 5% leading to a subsequent 10% increase in Dry Matter Digestibility (DMD) and a 5% increase in Crude Protein (CP). This was assumed to result in a 5% increase in liveweight gain. Scenarios 1.3 and 1.4 also involved increasing the stocking rate by 5% to take advantage of the improved pasture quality. That is, for scenario 1.3, stock numbers were assumed to increase without any change in the area of the farm. Scenario 1.4 was essentially a combination of scenario 1.3 and scenario 12.1 which involved reducing the grazing area by 5% and then planting a tree lot on this area. Transaction costs associated with stock purchases were included.

NPVs were not calculated for scenario 1.4 since its two components (pasture and trees) have different project lives, and from a financial perspective it can best be considered as a combination of two potential investment projects rather than a single scenario. Further, annual cash flow changes are not shown for this scenario since they vary by year with the amount of $CO_2$e sequestered. Further details about the assumptions made for the treelot scenario can be found in the discussion for scenario 12.1.

Scenario 1.5 involved improvement in the quality of feed through a 5% increase in both DMD and CP through pasture management rather than an increase in legume content. A project life of four years was used to calculate NPVs for each sub-scenario except 1.5, where the analysis was over one year as pasture depreciation costs are not considered. Under this scenario, it was assumed that there were no capital or other additional costs associated with improved pasture management.

There was considerable variability in the estimated per hectare costs supplied by individual farmers to improve or maintain pasture under Scenario 1. To overcome this variation, pasture establishment cost estimates were obtained from seed suppliers with agronomic expertise in each region in order to develop a standard estimate of costs per hectare to improve and maintain pasture. For example, the northern cost estimate was $38 per hectare for legume establishment costs and $26 per hectare for tractor expenses. The total standard per hectare cost was then applied to the area under pasture on the relevant farms to calculate the overall cost to improve pasture.

As noted earlier in this report, pastures with a higher percentage of legumes produce more nitrous oxide ($N_2O$) from nitrogen fixation and pasture decay, increasing total GHG emissions from the pasture. Due to this effect, all farms had an increase in GHG emissions under scenarios 1.1, 1.2 and 1.3.

The majority of case study farms had positive NPVs under sub-scenarios 1.1 to 1.3, with the changed cash flows from increased productivity over the four year project life generally being more than sufficient to outweigh the capital costs associated with pasture improvement. Scenario 1.3, which involved an increase in stock numbers, showed the greatest productivity benefits as expected. Large capital expenditures relative to productivity benefits resulted in negative NPVs for Northern Farm-1 scenario 1.2 and Northern Farm-3 scenarios 1.1 to 1.3. The required capital investment varied across case study farms in accordance with the number of hectares under pasture and changes in stocking rates. Northern Farm-3 has 2,254 ha of pastures and was able to generate only relatively low cash flows from the relatively small herd size on this farm.

For scenario 1.4, capital costs included both pasture improvement and planting a treelot, and were substantially higher than for the other sub-scenarios. The cost of planting trees on the four farms ranged from $32,000 to $330,000. As noted above, calculation of NPVs is not appropriate for this combined scenario.

Scenario 1.5, pasture management, was assumed to have no capital cost and returns were calculated over a one year project life. Changed cash flows were therefore a suitable indicator of profitability for this sub-scenario, and these were positive for all case study farms. In almost all cases where the financial returns were positive there were significant increases in total GHG emissions due to the increase in $N_2O$ emissions. Intuitively there would be an expectation that some GHG emissions would be offset by the increase in pasture biomass leading to lower GHG emissions than estimated in scenario 1. This increase in GHG emissions was due to *FarmGAS* deriving its emission factors from the National Greenhouse Gas Inventory (NGGI) which calculates GHG emissions arising from nitrogen-fixing plants such as legumes.

As noted earlier in this report, latest research findings about GHG emissions from legume pastures indicates that $N_2O$ emissions associated with biological nitrogen fixation are much lower than originally considered, and are highly variable across farming systems. These research findings have lead to the IPCC deciding to remove this factor as a source of GHG emissions from the 2015 Inventory reporting guidelines.

**Table 3.1: Financial analysis for case study farms scenario 1 – improved pastures.**

| Farms | | Scenarios | | | | |
|---|---|---|---|---|---|---|
| | | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| **Sthn † Farm 1** | **Annual average change in $CO_2$e*** | 299 | 225 | 488 | 298 | 239 |
| | **Annual change in cash flow** | $43,824 | $43,824 | $60,522 | NA † | $43,824 |
| | **Capital Expenditure** | $98,001 | $98,001 | $98,001 | NA | 0 |
| | **NPV/PV** | $47,151 | $47,151 | $102,456 | NA | $40,578 |
| | **Project life (years)** | 4 | 4 | 4 | NA | 1 |
| **Sthn Farm 2** | **Annual average change in $CO_2$e*** | 323 | 272 | 602 | NA | 285 |
| | **Annual change in cash flow** | $50,264 | $25,584 | $74,772 | NA | $50,264 |
| | **Capital Expenditure** | $63,803 | $63,803 | $63,803 | NA | 0 |
| | **NPV/PV** | $102,678 | $20,934 | $183,852 | NA | $46,541 |
| | **Project life (years)** | 4 | 4 | 4 | NA | 1 |
| **Nthn † Farm 1** | **Annual average change in $CO_2$e*** | 246 | 297 | 368 | 265 | 199 |
| | **Annual change in cash flow** | $35,185 | -$9,820 | $61,838 | NA | $35,185 |
| | **Capital Expenditure** | $76,563 | $76,563 | $76,563 | $248,563 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **NPV/PV** | $39,975 | -$109,087 | $128,253 | NA | $32,579 |
| | **Project life** | 4 | 4 | 4 | NA | 1 |
| **Nthn Farm 2** | **Annual average change in $CO_2$e*** | 65 | 28 | 118 | 74 | 57 |
| | **Annual change in cash flow** | $18,536 | $18,536 | $21,711 | NA | $18,536 |
| | **Capital Expenditure** | $14,037 | $14,037 | $14,037 | $46,037 | 0 |
| | **NPV/PV** | $47,356 | $47,356 | $57,872 | NA | $17,163 |
| | **Project life (years)** | 4 | 4 | 4 | NA | 1 |
| **Nthn Farm 3** | **Annual average change in $CO_2$e*** | 190 | 150 | 297 | -124 | 102 |
| | **Annual change in cash flow** | $21,055 | $21,055 | $29,805 | NA | $21,055 |
| | **Capital Expenditure** | $143,811 | $143,811 | $143,811 | $471,811 | 0 |
| | **NPV/PV** | -$74,076 | -$74,076 | -$45,091 | NA | $19,495 |
| | **Project life (years)** | 4 | 4 | 4 | NA | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

*† Sthn = Southern, Nthn = Northern. NA= Not Applicable*

**Scenario 2: Beef genetics**

Scenario 2 involved using changed beef genetics to improve feed conversion and reduce methane emissions. Herd improvements are achieved through an increased focus on particular traits in selecting bulls to be purchased. For scenario 2.1 it was assumed that there was no increase in the cost of breeding stock selected on the basis of improved GHG efficiency. The premise is that farmers select improved genetics based on a specific budget and often through selective culling of existing stock. Consequently, the cost over time would replicate normal costs. That is, this option provided the potential to reduce GHG emissions and increase feed conversion efficiency at minimal or no cost. It was assumed to provide an environmental gain but not a financial gain.

Scenarios 2.2 and 2.3 differed from scenario 2.1 in that they assumed a 10% cost premium associated with purchasing genetically superior bulls with the particular target traits. Bull purchases were based on an assumed 20% turnover in bulls per year over a five year replacement program. Faster turnoff was assumed to be achieved through faster weight gain for the genetically superior cattle. In addition, scenario 2.3 considered the case where faster turnoff from improved beef genetics was used to generate productivity gains through replacing animals sooner and increasing stocking rates through the purchase of more cattle or by retaining the previous year's heifers. Earlier replacement was not assumed for scenario 2.2. Transaction costs related to cattle sales and/or purchases are included.

Since these scenarios were calculated over a five year project life but involved only a marginal upfront capital outlay, present values (PVs) were the most suitable measure of profitability. PVs for scenario 2.2 were negative as a result of the price premium paid for genetically superior bulls. However PVs for scenario 2.3 tended to be positive across the five case study farms indicating that this scenario was one that has both environmental and financial benefits. However the GHG emissions reduction on a whole of farm basis is substantially lower for scenario 2.3 due to animal replacement following faster turnoff. Indeed, a GHG emissions increase was found for Southern Farm-2 for this scenario as herd numbers on this farm were increased by up to 10% rather than the 5% increase simulated on the other farms.

Northern Farm-3 had a negative NPV for scenario 2.3 due to transaction costs being greater than the extra cash flows arising from productivity benefits. Estimated PVs for scenario 2 projects indicated that the cost of improved genetics was higher for the southern farms when compared to the northern farms involved in this research. This is possibly due to the larger average herd sizes for farms located in the NSW and Victoria border region leading to larger numbers of genetically superior animals needing to be purchased each year to achieve the 20% turnover rate.

**Table 3.2: Financial analysis for case study farms scenario 2 – beef genetics.**

| Farms | | Scenarios | | |
|---|---|---|---|---|
| | | 2.1 | 2.2 | 2.3 |
| Sthn Farm 1 | Annual average change in $CO_2e$* | -126 | -178 | -17 |
| | Annual change in cash flow | $0 | -$7,186 | $2,325 |
| | Capital Expenditure | $0 | $0 | $0 |
| | NPV/PV | $0 | -$28,692 | $9,284 |
| | Project life (years) | 5 | 5 | 5 |
| Sthn Farm 2 | Annual average change in $CO_2e$* | -310 | -368 | 180 |
| | Annual change in cash flow | $0 | -$,873 | $40,187 |
| | Capital Expenditure | $0 | $0 | $0 |
| | NPV/PV | $0 | -$19,456 | $160,453 |
| | Project life (years) | 5 | 5 | 5 |
| Nthn Farm 1 | Annual average change in $CO_2e$* | -121 | -319 | -20 |
| | Annual change in cash flow | $0 | -$1,624 | $23,043 |
| | Capital Expenditure | $0 | $0 | $0 |
| | NPV/PV | $0 | -$6,484 | $92,004 |
| | Project life (years) | 5 | 5 | 5 |
| Nthn Farm 2 | Annual average change in $CO_2e$* | -72 | -106 | -26 |
| | Annual change in cash flow | $0 | -$541 | $17,431 |
| | Capital Expenditure | $0 | $0 | $0 |
| | NPV/PV | $0 | -$2,660 | $69,597 |
| | Project life (years) | 5 | 5 | 5 |
| Nthn Farm 3 | Annual average change in $CO_2e$* | -93 | -130 | 3 |
| | Annual change in cash flow | $0 | -$1,949 | -$2,889 |

| | | | | |
|---|---|---|---|---|
| | **Capital Expenditure** | $0 | $0 | $0 |
| | **NPV** | $0 | -$7,782 | -$11,535 |
| | **Project life (years)** | 5 | 5 | 5 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

**Scenario 3: Early weaning**

Scenario 3.1 was based on early weaning with no other changes. There are no financial implications associated with this scenario. This option provided the potential to reduce GHG emissions at minimal or no cost. That is, it provided an environmental gain but not a financial gain. Scenarios 3.2 and 3.3 include structural changes in addition to earlier weaning. The particular structural changes involved differ across case study farms based on the current livestock enterprise structure. Transaction costs were included for these scenarios. Estimated GHG emissions reductions under scenario 3.3 are greater than those under scenario 3.2 in each case. However it is difficult to make a meaningful comparison of financial implications between case study farms and scenarios since the changes involved differ substantially. Scenario 3.2 for Northern Farm-2 and Northern Farm-3 showed some potential to make financial gains along with GHG emissions reductions. This scenario involved selling livestock in both cases, albeit different classes and at different times.

Scenario 3.4 involves early weaning and improved pastures with legumes (*c.f*. scenario 1.1) which allowed all classes of stock to be kept. The financial implications relate to the pasture changes and were the same as for scenario 1.1. That is, most farms had a positive NPV except Northern Farm-3 due to the large capital expenditure needed for this farm. Similarly, scenario 3.5 involved early weaning and improved pasture intake quality (*c.f.* scenario 1.5). The financial implications were identical to those for scenario 1.5 whereby all farms had positive changes in cash flows and present values. However GHG emissions increased for many of the case study farms for scenarios 3.4 and 3.5 due to the effects of increased nitrous oxide from pasture improvements (including changes such as increased legume content and crude protein levels) carried forward from scenario 1.1 and 1.5.

**Table 3.3: Financial analysis for case study farms scenario 3 – early weaning.**

| Farms | | Scenarios | | | | |
|---|---|---|---|---|---|---|
| | | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 |
| Sthn Farm 1 | Annual average change in $CO_2e$* | -40 | -82 | -142 | 259 | 199 |
| | Annual change in cash flow | $0 | -$406 | -$1,140 | $43,824 | $43,824 |
| | Capital Expenditure | $0 | $0 | $0 | $98,001 | $0 |
| | NPV/PV | $0 | -$376 | -$1,056 | $47,151 | $40,578 |
| | Project life (years) | 1 | 1 | 1 | 4 | 1 |
| Sthn Farm 2 | Annual average change in $CO_2e$* | -67 | -319 | -616 | 312 | 277 |
| | Annual change in cash flow | $0 | -$86,695 | -$5626 | $50,264 | $50,264 |
| | Capital Expenditure | $0 | $0 | $0 | $63,803 | $0 |
| | NPV/PV | $0 | -$80,274 | -$5209 | $102,678 | $46,541 |
| | Project life (years) | 1 | 1 | 1 | 4 | 1 |
| Nthn Farm 1 | Annual average change in $CO_2e$* | -5 | -212 | -477 | 252 | 201 |
| | Annual change in cash flow | $0 | -$18,302 | $0 | $35,185 | $35,185 |
| | Capital Expenditure | $0 | $0 | $0 | $76,563 | $0 |
| | NPV/PV | $0 | -$16,946 | $0 | $39,975 | $32,579 |
| | Project life (years) | 1 | 1 | 1 | 4 | 1 |
| Nthn Farm 2 | Annual average change in $CO_2e$* | -1 | -37 | -75 | 46 | 46 |
| | Annual change in cash flow | $0 | $4,890 | -$9,970 | $18,536 | $18,536 |
| | Capital Expenditure | $0 | $0 | $0 | $14,037 | $0 |
| | NPV/PV | $0 | $4,528 | -$9,231 | $47,356 | $17,163 |
| | Project life (years) | 1 | 1 | 1 | 4 | 1 |
| Nthn Farm 3 | Annual average change in $CO_2e$* | -15 | -54 | -88 | 158 | 98 |
| | Annual change in cash flow | $0 | $956 | -$3,782 | $21,055 | $21,055 |
| | Capital Expenditure | $0 | $0 | $0 | $143.811 | $0 |
| | NPV/PV | $0 | $885 | -$3,501 | -$74,076 | $19,495 |
| | Project life (years) | 1 | 1 | 1 | 4 | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

**Scenario 4: Reproductive efficiency**

Increasing reproductive efficiency increased total GHG emissions due to the resulting increased number of livestock. However it also showed the potential to reduce GHG emissions intensity and increase productivity. The positive changes in cash flows shown for four of the five case study farms indicated that this increased productivity has the potential to increase profitability. Since there is no capital expenditure associated with reproductive efficiency, annual changes in cash flows were used as an indicator of expected profitability for this scenario. The greatest change in cash flow increases were forecast for the southern case study farms, where Southern Farm-2 showed an increase of $54,493 for scenario 4.2 and Southern Farm-1 showed an increase of $37,097 for scenario 4.1. For the northern case study farms, Northern Farms-1 and Northern Farm-3 showed the potential to benefit from reproductive efficiency with projected increases in incremental cash flow of $6,824 and $34,263 respectively. Northern Farm-3 simulated all calving in spring at a rate above 98%.

In the event GHG emissions intensity rather than whole farm GHG emissions were considered, reproductive efficiency would likely be an attractive option.

**Table 3.4: Financial analysis for case study farms scenario 4 – reproductive efficiency.**

| Farms | | Scenarios | | |
|---|---|---|---|---|
| | | 4.1 | 4.2 | 4.3 |
| Sthn Farm 1 | Annual average change in $CO_2e$* | 229 | NA | NA |
| | Annual change in cash flow | $37,097 | NA | NA |
| | Capital Expenditure | $0 | NA | NA |
| | NPV | $34,349 | NA | NA |
| | Project life (years) | 1 | NA | NA |
| Sthn Farm 2 | Annual average change in $CO_2e$* | NA | 139 | NA |
| | Annual change in cash flow | NA | $54,493 | NA |
| | Capital Expenditure | NA | $0 | NA |
| | NPV/PV | NA | $50,457 | NA |
| | Project life (years) | NA | 1 | NA |
| Nthn Farm 1 | Annual average change in $CO_2e$* | NA | 22 | NA |
| | Annual change in cash flow | NA | $6,824 | NA |
| | Capital Expenditure | NA | $0 | NA |
| | NPV/PV | NA | $6,319 | NA |
| | Project life (years) | NA | 1 | NA |
| Nthn Farm 2 | Annual average change in $CO_2e$* | NA | NA | NA |
| | Annual change in cash flow | NA | NA | NA |
| | Capital Expenditure | NA | NA | NA |
| | NPV/PV | NA | NA | NA |
| | Project life (years) | NA | NA | NA |
| Nthn Farm 3 | Annual average change in $CO_2e$* | NA | NA | 28 |
| | Annual change in cash flow | NA | NA | $34,263 |
| | Capital Expenditure | NA | NA | $0 |
| | NPV/PV | NA | NA | $31,725 |
| | Project life (years) | NA | NA | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

**Scenario 5: Spring lambing**

Southern Farm-2 was the only case study farm that a spring lambing scenario was applicable to. There were no significant financial implications or GHG emissions reductions associated with this scenario.

**Table 3.5: Financial analysis for case study farms scenario 5 – spring lambing.**

| Farms | | Scenarios | |
|---|---|---|---|
| | | 5.1 | 5.2 |
| **Sthn Farm 2** | **Annual average change in $CO_2e$*** | 3 | -2 |
| | **Annual change in cash flow** | $0 | $0 |
| | **Capital Expenditure** | $0 | $0 |
| | **NPV/PV** | $0 | $0 |
| | **Project life (years)** | 1 | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

**Scenario 6: Faster trade cattle turnoff (pasture)**

Scenarios 6.1 and 6.2 involved faster turnoff through increased weight gains of 0.10 and 0.20 kg per head per day respectively. Under these scenarios, cattle were not replaced. These scenarios were applicable to Southern Farms-1, Northern Farm-1 and Northern Farm-2. Increased productivity facilitated earlier target sale weights and decreased GHG emissions for all of the farms evaluated. Increased weight gains are reflected in increased incremental cash flows across all applicable case study farms due to increased productivity. Northern Farm-1 was particularly well placed to profit from this scenario due to the relatively high number of steers held by this enterprise.

**Table 3.6: Financial analysis for case study farms scenario 6 – faster trade cattle turnoff.**

| Farms | | Scenarios | |
|---|---|---|---|
| | | 6.1 | 6.2 |
| **Sthn Farm 1** | **Annual average change in $CO_2e$*** | -93 | -41 |
| | **Annual change in cash flow** | $10,486 | $30,210 |
| | **Capital Expenditure** | $0 | $0 |
| | **NPV/PV** | $9,709 | $27,972 |
| | **Project life (years)** | 1 | 1 |
| **Sthn Farm 2** | **Annual average change in $CO_2e$*** | NA | NA |
| | **Annual change in cash flow** | NA | NA |
| | **Capital Expenditure** | NA | NA |
| | **NPV/PV** | NA | NA |
| | **Project life (years)** | NA | NA |
| **Nthn Farm 1** | **Annual average change in $CO_2e$*** | -757 | -730 |
| | **Annual change in cash flow** | $11,351 | $59,270 |
| | **Capital Expenditure** | $0 | $0 |
| | **NPV/PV** | $10,510 | $54,880 |
| | **Project life (years)** | 1 | 1 |
| **Nthn Farm 2** | **Annual average change in $CO_2e$*** | -155 | -144 |
| | **Annual change in cash flow** | $15,835 | $33,210 |
| | **Capital Expenditure** | $0 | $0 |
| | **NPV/PV** | $14,662 | $30,750 |
| | **Project life (years)** | 1 | 1 |
| **Nthn Farm 3** | **Annual average change in $CO_2e$*** | NA | NA |
| | **Annual change in cash flow** | NA | NA |
| | **Capital Expenditure** | NA | NA |
| | **NPV/PV** | NA | NA |
| | **Project life (years)** | NA | NA |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

**Scenario 7: Grain finishing store cattle**

Scenario 7 which involved store cattle being finished on grain was applicable only to the Northern case study farms. Northern Farm-3 simulated the grain finishing of a portion of young steers from the beef breeding cattle herd. The number of days on grain was 100, 120 and 150 for scenarios 7.1, 7.2 and 7.3 respectively. Scenario 7.1 and 7.3 assumed a daily feed intake of 10kg, while 7.2 assumed daily intakes of 10.5 kg. The four year moving average of NSW feed barley delivered on-farm was used as basis for cost estimates. This information was gathered from ABARE commodity reports from 2009 to 2013. An assumption was made that each case study farm had grain handling machinery on-site. If this was not the case, costs would be substantially higher.

Finishing cattle with grain increased both GHG emissions and costs. However the cost increase was offset by productivity gains and this was reflected in positive changes in cash flows. As for scenario 6, the high number of steers held by Northern Farm-1 lead to particularly high incremental cash flows for this enterprise. Replacement of stock has the potential to further increase productivity gains but was not considered under any of these scenarios.

**Table 3.7: Financial analysis for case study farms scenario 7 – grain finishing store cattle.**

| Farms | | Scenarios | | |
|---|---|---|---|---|
| | | 7.1 | 7.2 | 7.3 |
| **Nthn Farm 1** | **Annual average change in $CO_2e$*** | 734 | 839 | 854 |
| | **Annual change in cash flow** | $189,125 | $246,895 | $171,068 |
| | **Capital Expenditure** | $0 | $0 | $0 |
| | **NPV/PV** | $175,114 | $228,573 | $158,396 |
| | **Project life (years)** | 1 | 1 | 1 |
| **Nthn Farm 2** | **Annual average change in $CO_2e$*** | 398 | 398 | 435 |
| | **Annual change in cash flow** | $62,934 | $82,147 | $56,926 |
| | **Capital Expenditure** | $0 | $0 | $0 |
| | **NPV/PV** | $58,272 | $76,002 | $52,709 |
| | **Project life (years)** | 1 | 1 | 1 |
| **Nthn Farm 3** | **Annual average change in $CO_2e$*** | 93 | 99 | 99 |
| | **Annual change in cash flow** | $10,757 | $14,040 | $9,730 |
| | **Capital Expenditure** | $0 | $0 | $0 |
| | **NPV/PV** | $9,960 | $13,000 | $9,009 |
| | **Project life (years)** | 1 | 1 | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

**Scenario 8: New methane mitigation technology**

Scenario 8 considered the implementation of new technologies for sheep (8.1), cattle (8.2), sheep and cattle (8.3) and feeding oils and tannins (8.4). In scenarios 8.1 to 8.3 where a vaccine was used to reduce methane emissions by 20% the cost of this technology was unknown for cattle and sheep at the time the research was conducted. For cattle the cost per head to purchase and administer a technology such as this was assumed to be consistent with the price of the Queensland tick fever vaccine ($4.07 per head). Similarly sheep vaccine prices were derived from the South Australian OJD vaccine project ($2.50 per head). In this scenario it was also assumed that the feed conversion rates did not change from using the vaccine since research to date does not indicate an effect on productivity.

Under these assumptions, while new methane reducing technologies are expected to be effective in reducing GHG emissions, they were not cost-effective. The changes in cash flows for all options under scenario 8 were negative. In the event a CFI methodology was introduced to enable ACCUs to be earned from these mitigation technologies, scenario 8.2 (cattle vaccine) would become profitable for Southern Farm-2, Northern Farm-1 and Northern Farm-2 when a carbon price of $23 per tonne and transaction costs of $2000 were assumed. However this scenario remained unprofitable for all case study farms when a carbon price of $15 per tonne was assumed. Sensitivity analysis using reduced prices of vaccines showed that scenario 8.2 would be profitable with a carbon price of $15 per tonne for these case study farms when the price of vaccines is assumed to be $2.00 per animal. The ability to earn ACCUs at $23 per tonne did not generate sufficient revenue to cover the costs of the other new methane technologies examined for any of the case study farms (sheep vaccine, and feeding oils and tannins).

**Table 3.8: Financial analysis for case study farms scenario 8 – methane inhibitors.**

| Farms | | Scenarios | | | |
|---|---|---|---|---|---|
| | | 8.1 | 8.2 | 8.3 | 8.4 |
| Sthn Farm 1 | Annual average change in $CO_2$e* | -552 | -106 | -658 | -53 |
| | Annual change in cash flow | -$50,000 | -$1,620 | -$51,620 | -$7,837 |
| | Capital Expenditure | $0 | $0 | $0 | $0 |
| | NPV/PV | -$46,296 | -$1,500 | -$47,796 | -$7,256 |
| | Project life (years) | 1 | 1 | 1 | 1 |
| Sthn Farm 2 | Annual average change in $CO_2$e* | -45 | -999 | -1,044 | -500 |
| | Annual change in cash flow | -$5,270 | -$16,010 | -$21,280 | -$77,445 |
| | Capital Expenditure | $0 | $0 | $0 | $0 |
| | NPV/PV | -$4,880 | -$14,824 | -$19,703 | -$71,708 |
| | Project life (years) | 1 | 1 | 1 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **Nthn Farm 1** | **Annual average change in $CO_2e$*** | NA | -525 | NA | -223 |
| | **Annual change in cash flow** | NA | -$8,763 | NA | -$32,793 |
| | **Capital Expenditure** | NA | $0 | NA | $0 |
| | **NPV/PV** | NA | -$8,114 | NA | -$30,364 |
| | **Project life (years)** | NA | 1 | NA | 1 |
| **Nthn Farm 2** | **Annual average change in $CO_2e$*** | NA | -195 | NA | -98 |
| | **Annual change in cash flow** | NA | -$1,327 | NA | -$6,527 |
| | **Capital Expenditure** | NA | $0 | NA | $0 |
| | **NPV/PV** | NA | -$1,229 | NA | -$6,043 |
| | **Project life (years)** | NA | 1 | NA | 1 |
| **Nthn Farm 3** | **Annual average change in $CO_2e$*** | NA | -376 | NA | -181 |
| | **Annual change in cash flow** | NA | -$9,451 | NA | -$46,487 |
| | **Capital Expenditure** | NA | $0 | NA | $0 |
| | **NPV/PV** | NA | -$8,751 | NA | -$43,044 |
| | **Project life (years)** | NA | 1 | 1 | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

### Scenario 9: Fertiliser use

Reduced fertiliser use was not applicable for the majority of the case study farms, and results in relatively small GHG emissions reductions for those case study farms where it could be applicable. Further, it was difficult to estimate the amount of fertiliser or nitrogen inhibitors used for Southern Farm-2, and therefore the financial impacts for this case study farm were not calculated. There was an estimated total saving in the cost of fertiliser of $4,260 for the mixed cropping enterprise Southern Farm-1. However the estimated annual change in cash flow was -$54,360 when crop yield decreased 10% (scenario 9.2). However this assumption was only relevant in the absence of over fertilising. In the event over fertilising was occurring, the yield decrease may be considerably less or zero.

**Table 3.9: Financial analysis for case study farms scenario 9 – fertiliser efficiency.**

| Farms | | Scenarios | |
|---|---|---|---|
| | | 9.1 | 9.2 |
| **Sthn Farm 1** | **Annual average change in $CO_2e$*** | -16 | -19 |
| | **Annual change in cash flow** | $4,260 | -$54,360 |
| | **Capital Expenditure** | $0 | $0 |
| | **NPV** | $3,944 | -$50,333 |
| | **Project life (years)** | 1 | 1 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

### Scenario 10: Nitrogen inhibitor

The application of a nitrogen inhibitor was not relevant for the majority of case study farms, and results in minimal GHG emissions reductions when applied to pastures. It was difficult to determine with any confidence the amount of nitrogen inhibitor able to be used on Southern Farm-2, leaving Southern Farm-1 as the only farm able to be analysed for this scenario. For the mixed cropping enterprise Southern Farm-1, the use of the nitrogen inhibitor had a negative impact of $7,920 on incremental cash flow, with no offsetting increase in revenues. Prices were obtained from local suppliers to derive a standard per hectare price. In the event a CFI methodology was to become available for this type of GHG emission reduction, costs would be only partially recovered.

**Table 3.10: Financial analysis for case study farms scenario 10 – nitrogen inhibitor.**

| Farms | | Scenarios |
|---|---|---|
| | | 10.1 |
| **Sthn Farm 1** | **Annual average change in $CO_2e$*** | -15 |
| | **Annual change in cash flow** | -$7,920 |
| | **Capital Expenditure** | $0 |
| | **NPV/PV** | -$7,333 |
| | **Project life (years)** | 1 |

**Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

### Scenario 11: Enterprise mix

Scenario 11 involved changes to the enterprise mix. It differed between southern and northern farms since the southern farms were mixed enterprises while the northern farms were beef enterprises. For the northern farms, changes to the enterprise mix involved increasing numbers of breeding cattle relative to trade cattle. For the southern farms, changes to enterprise mix involved increasing crops relative to sheep, or sheep relative to beef. In addition, scenario 11.7 which involved removing the wether portion of the sheep flock and increasing the number of trade hoggets with no change to the cropping enterprise was considered for Southern Farm-1. Transaction costs associated with sales and/or purchases of animals were included in the analysis. However no capital expenditure was allowed for on the assumption that each farm had the equipment necessary for the changed enterprise mix. Debt levels were not included in the analysis but would also be a consideration for substantial changes to the enterprise mix.

An increase in incremental cash flow was estimated for Southern Farm-1 under scenario 11.7. The changes in cash flow increases for the other scenarios involving increased cropping and decreased sheep were generally not as profitable for Southern Farm-1. This was at least partly due to transaction costs associated with changes to the enterprise mix. Southern Farm-2 showed positive returns and a reduction in GHG emissions for all sub-scenarios and had the potential to increase incremental cash flows between $24,093 and $241,137 by switching a proportion of production from beef to sheep.

**Table 3.11: Financial analysis for case study farms scenario 11 – enterprise change.**

| Farms | | Scenarios | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 11.1 | 11.2 | 11.3 | 11.4 | 11.5 | 11.6 | 11.7 |
| Sthn Farm 1 | Annual average change in $CO_2$e* | -28 | -63 | -105 | -136 | -163 | -258 | -165 |
| | Annual change in cash flow | -$2,712 | -$5,807 | -$18,274 | -$20,030 | -$24,081 | -$31,835 | $19,669 |
| | Capital Expenditure | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | NPV/PV | -$2,511 | -$5,377 | -$16,920 | -$18,546 | -$22,997 | -$29,477 | $18,212 |
| | Project life (years) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sthn Farm 2 | Annual average change in $CO_2$e* | -306 | -465 | -897 | -1,272 | -1,510 | NA | NA |
| | Annual change in cash flow | $26,020 | $62,948 | $82,776 | $151,150 | $260,428 | NA | NA |
| | Capital Expenditure | $0 | $0 | $0 | $0 | $0 | NA | NA |
| | NPV/PV | $24,093 | $58,285 | $76,645 | $139,953 | $241,137 | NA | NA |
| | Project life (years) | 1 | 1 | 1 | 1 | 1 | NA | NA |
| Nthn Farm 1 | Annual average change in $CO_2$e* | 348 | 235 | -44 | -273 | -385 | NA | NA |
| | Annual change in cash flow | $93,930 | $58,242 | -$28,712 | -$132,664 | -$184,790 | NA | NA |
| | Capital Expenditure | $0 | $0 | $0 | $0 | $0 | NA | NA |
| | NPV/PV | $86,972 | $53,928 | -$26,585 | -$122,837 | -$171,101 | NA | NA |
| | Project life (years) | 1 | 1 | 1 | 1 | 1 | NA | NA |
| Nthn Farm 2 | Annual average change in $CO_2$e* | 0 | 0 | 0 | 0 | -1 | NA | NA |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Annual change in cash flow** | -$11,663 | -$8,554 | $399 | $4,584 | $1,651 | NA | NA |
| | **Capital Expenditure** | $0 | $0 | $0 | $0 | $0 | NA | NA |
| | **NPV/PV** | -$10,799 | -$7,920 | $369 | $4,244 | $1,529 | NA | NA |
| | **Project life (years)** | 1 | 1 | 1 | 1 | 1 | NA | NA |
| **Nthn Farm 3** | **Annual average change in $CO_2$e*** | NA | NA | NA | NA | NA | NA | NA |
| | **Annual change in cash flow** | NA | NA | NA | NA | NA | NA | NA |
| | **Capital Expenditure** | NA | NA | NA | NA | NA | NA | NA |
| | **NPV/PV** | NA | NA | NA | NA | NA | NA | NA |
| | **Project life (years)** | NA | NA | NA | NA | NA | NA | NA |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

Northern Farm-1 scenario outcomes showed positive cash flows, but with GHG emissions increases for scenarios 11.1 and 11.2 which had smaller changes to the proportion of breeding cattle. On the other hand, scenarios 11.3 to 11.5 provided GHG emissions reductions as the proportion of breeding cattle was increased; but at a cost, with negative NPVs for all of these scenarios. Scenario 11.3 was the least cost enterprise change that provides a GHG emissions reduction. Northern Farm-2 had the potential for small increases in annual changes in cash flows through increases to breeding cattle relative to trade cattle under scenarios 11.3, 11.4 and 11.5 where the percentage of breeding cattle was increased to 50, 70 and 80% respectively; however the associated GHG emissions reductions are minimal. Scenario 11 was not applicable to Northern Farm-3.

**Scenario 12: Treelot**

Scenario 12 involved replacing a small percentage, generally 5%, of farm area with a tree lot. Available information indicates that the cost per hectare to establish tree plantations is approximately $2,000. The annual value of ACCU's was calculated based on an assumed carbon price of $23 per tonne and annual estimates of $CO_2$e sequestration based on FullCAM modelling. Transaction costs of $2,000 per ha upon establishment and $1,000 each year thereafter were assumed (Whittle et al, 2013). NPVs were calculated for this scenario based on a 41 year project life (following Crossman et al, 2010, 2011). It was also assumed that the area set aside for trees would not reduce farm productivity and whole farm profit.

NPVs were negative for all case study farms, and ranged between -$21,699 and -$98,504. These returns became substantially worse if the carbon price was assumed to be less than $23 per tonne. However, the FullCAM estimates of sequestration used for this scenario are considered conservative and this induces a negative bias into the analysis. Less conservative estimates may produce positive NPVs for some cases.

The capital expenditure required to plant a treelot was considerable, ranging between $32,000 and $330,000 for the four case study farms suitable for a treelot. This considerable capital requirement made it difficult to achieve a positive financial return.

Sensitivity analysis was undertaken to determine the break-even price of planting a treelot for each case study farm. The break-even point ranged between $550 and $1395 per ha, with three of the four case study farms becoming profitable when the cost was below $1315 per hectare.

**Table 3.12: Financial analysis for case study farms scenario 12 – tree lot.**

| Farms | | Scenarios |
|---|---|---|
| | | 12 |
| Sthn Farm 1 | Annual average change in $CO_2$e* | -190 |
| | Annual change in cash flow | - |
| | Capital Expenditure | $102,000 |
| | NPV/PV | -$34,010 |
| | Project life (years) | 41 |
| Sthn Farm 2 | Annual average change in $CO_2$e* | NA |
| | Annual change in cash flow | NA |
| | Capital Expenditure | NA |
| | NPV/PV | NA |
| | Project life (years) | NA |
| Nthn Farm 1 | Annual average change in $CO_2$e* | -220 |
| | Annual change in cash flow | - |
| | Capital Expenditure | $174,000 |
| | NPV/PV | -$58,298 |
| | Project life (years) | 41 |
| Nthn Farm 2 | Annual average change in $CO_2$e* | -38 |
| | Annual changes in cash flow | - |
| | Capital Expenditure | $32,000 |
| | NPV/PV | -$21,699 |
| | Project life (years) | 41 |
| Nthn Farm 3 | Annual average change in $CO_2$e* | -420 |
| | Annual change in cash flow | - |
| | Capital Expenditure | $330,000 |
| | NPV/PV | -$98,504 |
| | Project life (years) | 41 |

** Positive figures indicate an increase in GHG emissions, while negative figures indicate a reduction in GHG emissions.*

### 3.4 Case study Marginal Abatement Cost Curves

A marginal abatement cost curve (MACC) was developed for each case study farm based on the financial analysis discussed in the previous section. Marginal abatement cost curves were developed by McKinsey & Company (2007) to identify how much abatement an economy can afford and where policy should be directed to achieve the emission reductions. However employment of the MACC at the individual business or asset class level is where this emissions abatement tool has the potential to provide the greatest benefits for industry. It allows businesses to consider the prioritisation of alternate GHG emissions reduction options based on their financial characteristics. The MACC financial modelling tool used in this research has been developed at the University of Southern Queensland and tailored to suit the particular needs of the Australian livestock sector.

Only those sub-scenarios indicating a GHG emissions reduction when compared to baseline farm GHG emissions were considered in deriving the MACCs. That is, scenarios 1, 4 and 7 are not included for any case study farm since they were found to increase GHG emissions; while the remaining sub-scenarios were considered only for case study farms with GHG emissions reductions. The number of possible options for each farm was limited to those that were applicable for that particular property. Only one sub-scenario for each management scenario was included in the analysis for each farm. For example, for case study farms such as Southern Farm-2 that showed positive NPVs and reduced GHG emissions for several potential enterprise changes (scenario 11), the most profitable option that decreased GHG emissions was chosen for inclusion in the MACC. For Southern Farm-2 this was scenario 11.5.

Each bar in the MACCs discussed in this report represents a sub-scenario that decreased GHG emissions. The width is the amount of $CO_2$e that could potentially be reduced per year by implementing this option. The height is the average cost of avoiding one tonne of $CO_2$e with this scenario, relative to the activities that would otherwise occur in the business-as-usual case. Thus each of the opportunities examined were compared on a like-for-like basis. Those scenarios that fall ‘below the carbon price line’ represent opportunities to both reduce GHG emissions and increase profitability; with the most profitable options per tonne of $CO_2$e abated being those at the left of the MACC. Scenarios that fall ‘above the carbon price line’ are projected to cost more to implement than the potential cost savings or revenues associated with the option. As detailed in *Section 3.2* above, much of the abatement achieved in total GHG emissions are driven by reductions in total herd numbers, so this needs to be considered when interpreting the results.

Potential revenues from ACCUs are only considered for those sub scenarios that reduce GHG emissions and for which a CFI methodology exists. For those options where there is potential to earn ACCUs (scenarios 1.4 and 12.1), when net costs per tonne of $CO_2$e are less than the price of carbon (assumed $23 per tonne in the MACCs), the option may become profitable. However transaction costs and uncertainty associated with the carbon price would need to be considered. In the event transaction costs are high and the price of carbon falls, these options would become less viable. On the other hand, when the price of carbon increases some additional options would fall below the carbon price line on the MACC indicating that they have the potential to increase farm profitability.

A few scenarios indicate the potential to both substantially reduce GHG emissions and increase farm profitability. These vary across cases and include enterprise mix changes for southern farms and faster beef turnoff for both southern and northern farms. Several other sub-scenarios are either very profitable or substantially reduce GHG emissions, but not both. The variation across farms is substantial and indicates that it is important to consider individual farm characteristics such as regional location, enterprise mix and management strategy when evaluating GHG emissions abatement options.

**Southern Farms**

For each farm, the bars on the MACCs which were below the carbon price zero line indicate potentially profitable options to reduce GHG emissions. Southern Farm-1 had several GHG emissions abatement options including changing the enterprise mix to increase the number of trade hoggets, faster beef turnoff, fertiliser reduction and improved beef genetics. The first bar on the left showed that scenario 11.7 which involved removing the wether portion of the sheep flock and increasing the number of trade hoggets, and to a lesser extent scenario 6.2 which involved faster cattle turnoff through increased weight gains of 0.20 kg/hd/d had the potential to both reduce GHG emissions and increase farm profitability. Scenario 11.7 had the potential to produce $111 per tonne for each of the estimated 165 tonnes of $CO_2$e able to be abated each year with an NPV of $18,212, while scenario 6.2 was $679 per tonne for 41 tonnes of $CO_2$e per annum with an NPV of $27,972. These two options showed the greatest potential in terms of GHG emissions abatement and increased farm profitability.

Scenarios 9.1 assumed fertiliser reductions without yield decreases and scenario 2.3 assumed productivity increases through improved beef genetics. Both these scenarios also showed the potential to provide small decreases in GHG emissions and were cost effective for Southern Farm-1. However when yield decreases were considered, fertiliser reduction was not financially viable.

Several scenarios provided the potential to reduce GHG emissions at zero or minimal cost per tonne of $CO_2$e per annum. These options included early weaning and planting a treelot. However it should be noted that the treelot option showed a negative NPV of $34,010; indicating that while the abatement cost per tonne per annum was small, the return on investment was less than the 8% assumed cost of capital.

The greatest potential GHG emissions abatement (up to 658 tonnes of $CO_2$e) was achieved through new methane mitigation technologies. However these options tend to be quite expensive and current technologies were not associated with productivity gains. As sensitivity analysis discussed earlier in this report demonstrates, should CFI methodologies become available for these options, they have the potential to both reduce GHG emissions and be profitable for the case study farms. The use of nitrogen inhibitors in conjunction with fertiliser applications was not financially viable given current pricing for inhibitors.

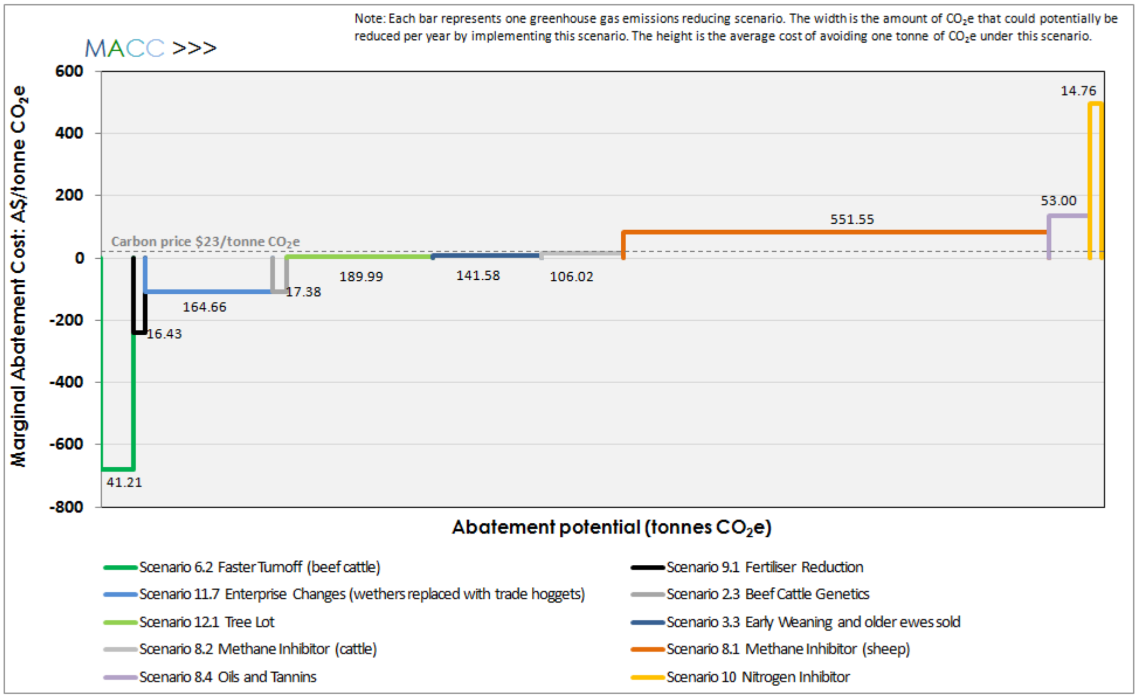


**Figure 3.19: Marginal Abatement Cost Curve for Southern Farm-1.**

The MACC for Southern Farm-2 indicated that it had the potential to both increase profitability and reduce GHG emissions through either pasture improvement or changes to its enterprise mix. Scenario 11.5 involved moving from predominantly beef to 80% sheep while maintaining total livestock carrying capacity. This scenario showed the potential to reduce GHG emissions by 1,511 tonnes of $CO_2$e per annum at a rate of $160 per tonne and an estimated NPV of $241,137.

Scenarios 2.1 (beef genetics) and scenario 3.3 (early weaning accompanied by structural changes to livestock management) showed the potential to reduce GHG emissions at little or no cost. As for Southern Farm-1, Scenarios 8.2 and 8.4 which involved new methane mitigation technologies showed the greatest potential to reduce GHG emissions on Southern Farm-2 but were not financially viable. However sensitivity analysis indicated that scenario 8.2 which involved a cattle vaccine would become profitable upon the introduction of a CFI methodology.

Overall, changes to enterprise mix showed the potential to reduce GHG emissions and substantially increase profitability for the two southern case study farms. Several other GHG emissions abatement options including pasture management, faster turnoff, beef genetics, early weaning and cattle vaccine (methane inhibitor) were also worth consideration.

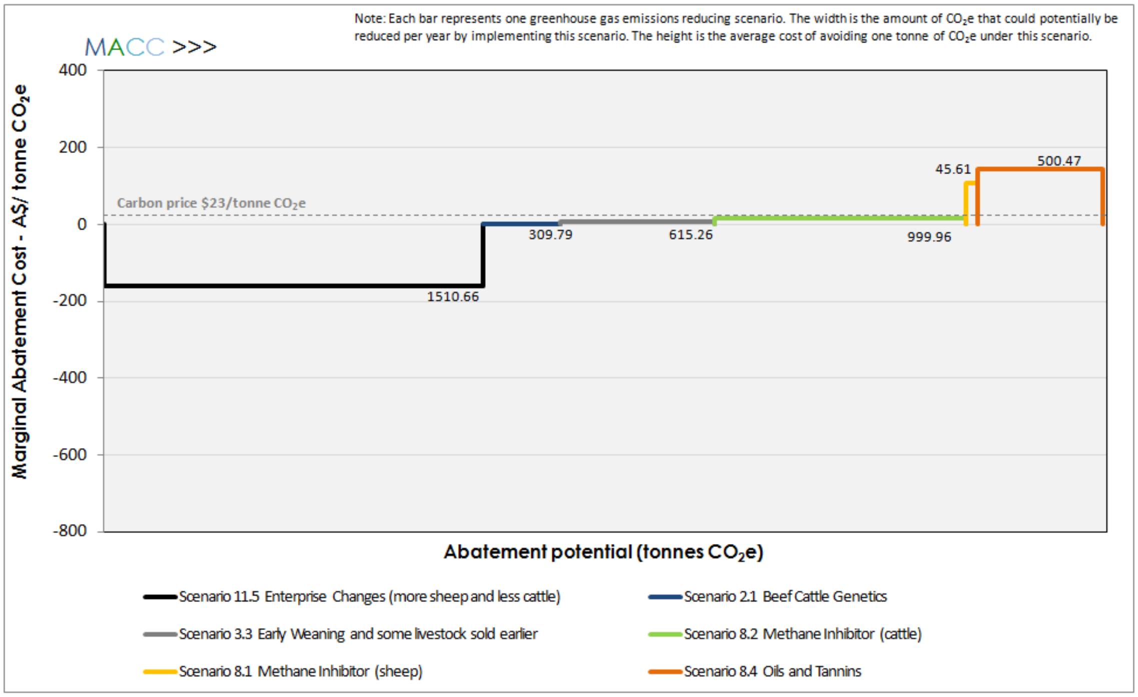


**Figure 3.20: Marginal Abatement Cost Curve for Southern Farm-2.**

### Northern Farms

For Northern Farm-1, faster cattle turnoff (scenario 6.2) and beef genetics with early replacement following faster turnoff (scenario 2.3) showed the potential to substantially reduce GHG emissions and also increase productivity and profitability. Scenario 6.2 showed the potential to reduce GHG emissions by 730 tonnes of $CO_2e$ per annum at a rate of $75 per tonne with an NPV of $54,879. Scenario 2.3 improved beef genetics was also profitable with an NPV of $92,004 at a rate of $948 per tonne per annum; however it only showed the potential to reduce whole farm GHG emissions by 19 tonnes of $CO_2e$.

Early weaning accompanied by structural changes or planting a treelot also showed the potential to reduce GHG emissions. However the caveat noted above about the low rate of return to treelots should be noted. As for the southern case study farms, new methane mitigation technologies showed the potential to substantially reduce GHG emissions but were not cost effective.

Enterprise mix changes were not a good option for Northern Farm-1. However results for Northern Farm-2 indicated profitability potential for enterprise mix changes that increased the breeding proportion of the herd and decreased trade cattle stores (scenario 11.5). However the GHG emissions reduction potential was minimal (1 tonne of $CO_2e$) due to small herd numbers. As for Northern Farm-1, beef genetics with a subsequent increase in cattle herd (scenario 2.3) was profitable at $541 per tonne, but with relatively low GHG emissions abatement (26 tonnes of $CO_2e$) when whole farm GHG emissions are considered. The estimated NPV for this option over a five year implementation timeframe was $69,596. On the other hand, scenario 6.2 faster beef cattle turnoff showed the potential to significantly reduce GHG emissions, with profitability per tonne of $CO_2e$ at $214 and an estimated NPV of $30,749. Early weaning showed that it may also be worth consideration, producing 37 tonnes of GHG emissions reductions at $123 per tonne of $CO_2e$ for an NPV of $4,528.

Similar comments to those made above regarding southern case study farms treelots and methane reduction technologies applied to Northern Farm-2.

For Northern Farm-3, scenario 3.2 early weaning was marginally profitable. It showed the potential to reduce GHG emissions by 54 tonnes of $CO_2$e at a rate of $16 per tonne for an estimated NPV of only $885. Significant GHG emissions abatement would be achieved through establishing a carbon sink treelot (average 420 tonnes of $CO_2$e per annum) or implementing new methane mitigation technologies (up to 376 tonnes of $CO_2$e). However for these options to become profitable, a CFI methodology for methane reduction technologies and a substantially higher price of carbon would be required.

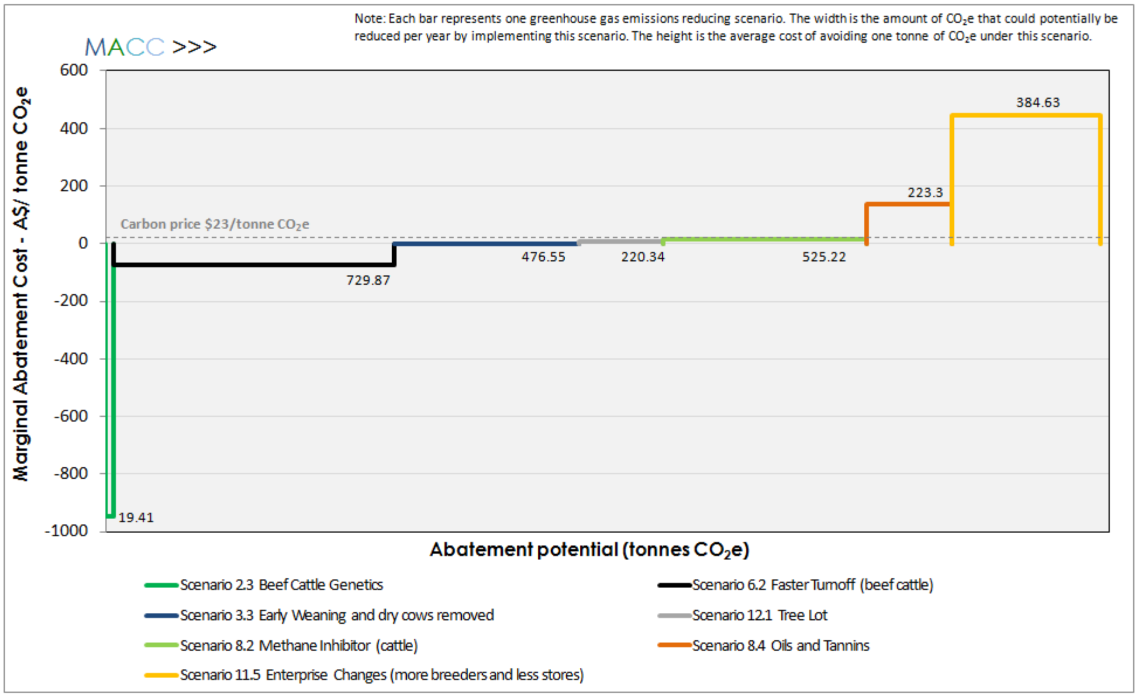


**Figure 3.21: Marginal Abatement Cost Curve for Northern Farm-1.**

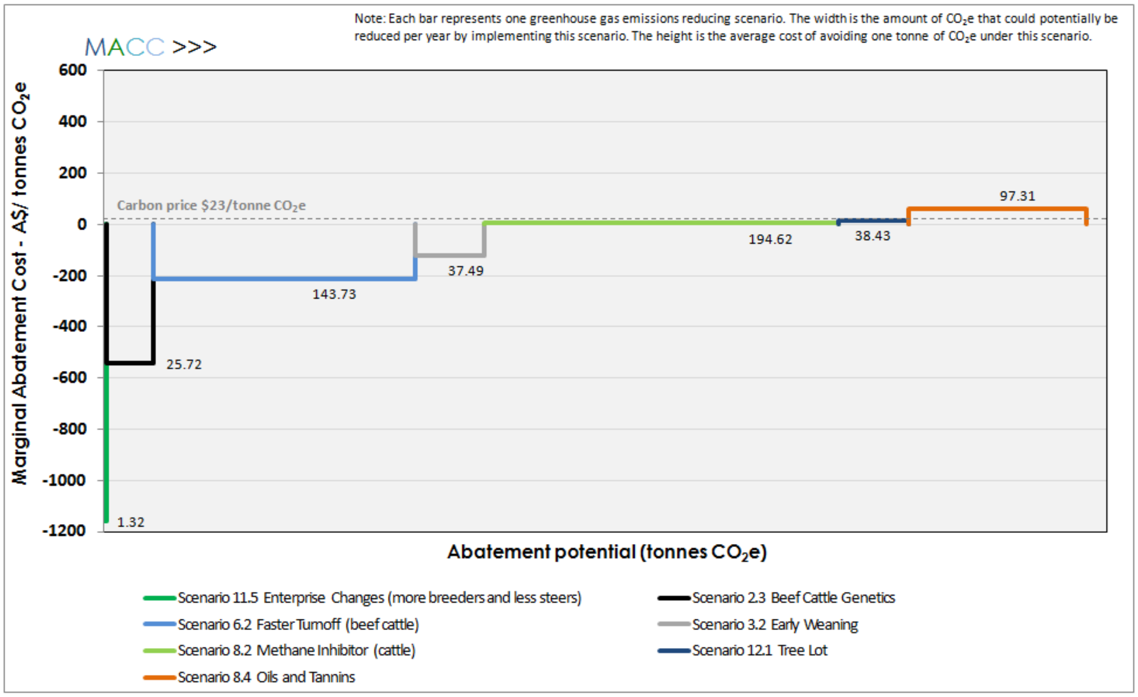


**Figure 3.22: Marginal Abatement Cost Curve for Northern Farm-2.**

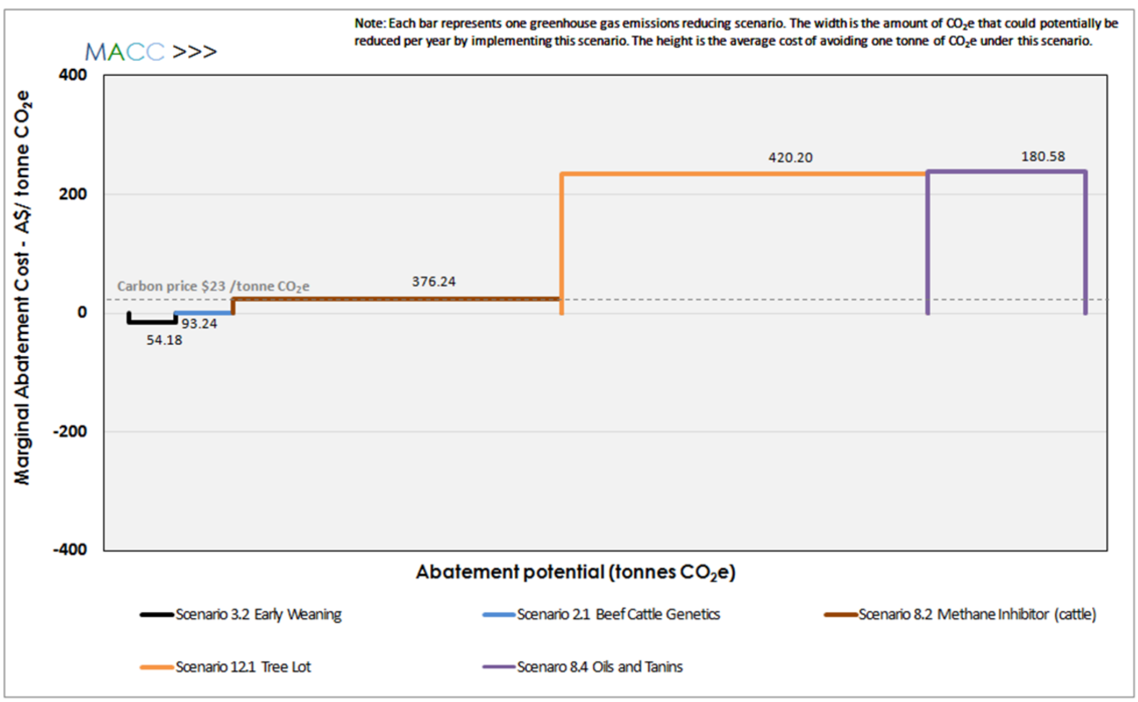


**Figure 3.23: Marginal Abatement Cost Curve for Northern Farm-3.**

Overall, potentially profitable options for the northern case study farms include faster beef cattle turnoff, enterprise changes, beef genetics and early weaning. However there were substantial differences between the case study farms in terms of both profitability and GHG emissions abatement.

## 4.0 Conclusions/ Implications

The results of this study suggest that there are some opportunities for Australian livestock producers to reduce GHG emissions and increase farm profitability. The results for the case study farms examined in this research indicate that the management scenarios that achieve both of these objectives vary across regions and between farms. These conclusions indicate that it is important to consider individual farm characteristics such as regional location, enterprise mix and existing management strategies, when evaluating GHG emissions abatement options.

The adoption of management scenarios that enhanced weight gain and resulted in more rapid beef cattle turnoff successfully reduced GHG emissions and increased farm profitability in a number of the case study farms examined. Changes to enterprise mix also showed the potential to be both profitable and reduce GHG emissions for some of the case study farms. Targeted improvements in beef genetics and earlier weaning demonstrated positive financial returns for a number of the case study farms but tended to achieve relatively lower GHG emission abatement. Conversely, new methane mitigation technologies showed the potential to significantly reduce GHG emissions for most of the enterprises but were not financially viable at the assumed prices for the technology.

Australia initially introduced a mandated price for carbon credits of $23 per tonne and this value was adopted in the financial analysis described in this report. It is widely anticipated however, that carbon credits in Australia will attract a significantly lower price following the deregulation of carbon pricing in 2015. In the event that the carbon price falls below $23 per tonne it will have a significant impact on the profitability of some of the management scenarios studied in this assessment. Alternatively in the event the carbon price increases above $23 per tonne then it will improve the viability of less profitable GHG emissions abatement options.

A number of the management scenarios assessed in this report demonstrated strong productivity and profitability gains but increased whole farm GHG emissions, as a result of higher livestock numbers. Pasture improvement scenarios also tended to increase GHG emissions, despite positive productivity outcomes. In the event GHG emissions intensity was evaluated rather than whole farm GHG emissions, a number of these additional management scenarios would provide both GHG emissions abatement and profitability benefits.

This report has identified six management scenarios that beef cattle and sheep farm businesses could potentially employ to reduce farm GHG emissions while maintaining profitability. These scenarios include faster beef cattle turnoff, changing the enterprise mix, improving beef cattle genetics, implementing early weaning, using methane inhibitors in the guts of ruminant animals and environmental plantings such as tree lots. To build upon the outcomes of this study, efforts could be focussed around incorporating these strategies into a systems approach to carbon farming. The potential exists to combine a number of these strategies within single operations to maximise the GHG emissions abatement potential. A challenge also remains to develop an approach to obtaining formal CFI approval for a carbon management system that is applicable to beef cattle and sheep farm businesses.

## 5.0 References

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# 6.0 Appendix

## 6.1 Appendix A: Base farm and scenario modelling inputs.

### Table A1: Modelling inputs for southern case study farms.

| # | Scenario | Southern Farm 1 | Southern Farm 2 |
|---|---|---|---|
| | Base Farm | **Steers – Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br><br>**Steers – Liveweight gain (kg /hd /d) -** Spring (0.67), Summer (0), Autumn (0.50), Winter (0.44)<br><br>**Sheep Liveweight (kg)**<br>*Breeding ewes* - Spring (54), Summer (49), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (0), Autumn (0), Winter (45)<br>*Other ewes* - Spring (52), Summer (48), Autumn (50), Winter (50)<br>*Lambs / Hogget* - Spring (22), Summer (24), Autumn (35), Winter (36)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (60), Summer (56), Autumn (56), Winter (56)<br><br>**Sheep – Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.02), Summer (-0.06), Autumn (0.03), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.5), Autumn (0), Winter (0.5)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.16), Summer (0.02), Autumn (0.12), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.04), Summer (-0.04), Autumn (0), Winter (0) | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.56), Summer (-0.56), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.56), Summer (-0.56), Autumn (0), Winter (0)<br>*Steers*- Spring (0.83), Summer (1.06), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.11), Summer (0.89), Autumn (0.44), Winter (0)<br>*Calves - steers*- Spring (1.11), Summer (0.89), Autumn (0.44), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep**<br>**Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (0), Summer (27), Autumn (50), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.03), Summer (-0.06), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.03), Summer (-0.06), Autumn (0.02), Winter (0) |

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|---|---|---|---|
| | | | *Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.14), Summer (0.07), Autumn (0.04), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0) |
| 1.1 | Pastures are improved with an increase in legumes content. The consequences are:<br>- 10% increase in Dry Matter Digestibility (DMD)<br>- 5% increase in liveweight gain (LWG)<br>- 5% Increase in crude protein (CP).<br><br>The potential increase in flock numbers is not including in this scenario. | **Steers – Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Steers – Liveweight gain** kg/hd/d - Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep Liveweight (kg) – as above**<br>**Sheep kg / hd / d**<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0) | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Steers*- Spring (0.88), Summer (1.11), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Calves - steers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep**<br>**Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (27), Summer (50), Autumn (0), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.15), Summer (0.07), Autumn (0.05), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0) |

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| 1.2 | Pastures are improved with an increase in legumes content<br><br>The consequences are:<br>- 10% increase in DMD<br>- 5% increase in liveweight gain<br>- increase in CP<br><br>The potential increase in flock numbers is not including in this scenario. Beef are turned off one month earlier (@9months). | **Steers**<br>**Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Liveweight gain** kg/hd/d - Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep**<br>**Liveweight (kg) – as above**<br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0) | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Steers*- Spring (0.88), Summer (1.11), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Calves - steers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep**<br>**Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (27), Summer (50), Autumn (0), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.15), Summer (0.07), Autumn (0.05), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Steers are sold in November** |

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| 1.3 | Pastures are improved with an increase in legumes content.<br>The consequences are:<br>- 10% increase in DMD<br>- 5% increase in liveweight gain<br>- increase in CP<br><br>Sold animals are replaced and beef and sheep numbers are increased by +5%. | **Liveweights**<br><br>**Steers – Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Steers – Liveweight gain** kg/hd/d - Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep Liveweight (kg) – as above**<br>**Sheep kg / hd / d**<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0)<br><br>**Extra Numbers**<br>**Steers – 20** extra head<br>**Sheep –**<br>*Breeding ewes* – 350 per month<br>*Maiden ewes* – 450 (Aug / Sept / Oct / Nov)<br>*Other ewes* – 0<br>*Lambs / Hogget* – 60 (Jan), 55 (Fe, Mar, Apr, May), 45 (Jun, Jul), 650 (Aug, Sept, Oct, Nov, Dec)<br>*Rams* - 0<br>*Wethers* -0 | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Steers*- Spring (0.88), Summer (1.11), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Calves - steers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep**<br>**Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (27), Summer (50), Autumn (0), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.15), Summer (0.07), Autumn (0.05), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Extra Numbers**<br>**Breeding cattle**<br>*Cows* **–** 80 extra head<br>*Heifers* – 25 extra |

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| | | | Heifer calves – 35 extra<br>Steer calves -35 extra<br>Bulls - 0<br><br>**Sheep –**<br>*Nil extra* |
| 1.4 | Pastures are improved with an increase in legumes content<br>The consequences are:<br>- 10% increase in DMD<br>- 5% increase in liveweight gain<br>- increase in CP<br><br>The number of sheep and cattle are increased by 5% and the grazing area reduced 5%. The remaining area is converted to a tree lot | **Steers**<br>**Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Liveweight gain (kg/hd/d)**- Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep**<br>**Liveweight (kg) – as above**<br>**Liveweight gain (kg/hd/d)**<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0)<br><br>**Treelot -** 104ha sequestering 108t C per yr or 395 t CO2e per year | N/a |
| 1.5 | Pasture quality of feed intake is improved through a 5% increase dry matter digestibility (DMD) and crude protein. 5% improvement in LWG | **Liveweights**<br><br>**Steers – Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Steers – Liveweight gain** kg/hd/d - Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep Liveweight (kg) – as above**<br>**Sheep kg / hd / d**<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0) |

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| | | Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0) | **Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Steers*- Spring (0.88), Summer (1.11), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Calves - steers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep**<br>**Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (27), Summer (50), Autumn (0), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.15), Summer (0.07), Autumn (0.05), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0) |
| | | | |
| 2.1 | Beef genetics breeding. To simulate improved feed conversion efficiency, Percentage of Gross Energy Intake yielded as methane - 5%<br>No other changes are made. | X | X |
| 2.2 | Beef genetics breeding. To simulate improved feed conversion efficiency, Percentage of Gross Energy Intake yielded as methane - | Steers are bought in Feb and sold in October | Steers are bought in Winter (late May / early June) and sold in late Oct / early June. |

| | | | |
|---|---|---|---|
| | 5%<br>Beef cattle are sold one month earlier | | |
| 2.3 | Beef genetics breeding. To simulate improved feed conversion efficiency, Percentage of Gross Energy Intake yielded as methane - 5% | **Sheep flock is increased by 5%. Total numbers per animal class**<br>*Breeding ewes – 7280*<br>*Maiden ewes* – 4950 (Aug / Sept / Oct / Nov)<br>*Other ewes* – 500<br>*Lambs / Hogget* – 6600 (Jan), 6050 (Feb, Mar, Apr), 5500 (May), 4950 (Jun, Jul), 7150 (Aug, Sept, Oct, Nov, Dec)<br>*Rams* - 120<br>*Wethers* - 1900 | **Beef herd is increased by 10%.**<br>*Cows* – 160 extra<br>*Heifers*- 50 extra<br>*Steers*- 0<br>*Calves –heifers* – 70 extra<br>*Calves – steers* - 70 extra<br>*Bulls >1yo*- 0<br>*Bulls <1yo*- 0 |
| | | | |
| 3.1 | Earlier weaning. No other changes. | Lambs weaned at 14 weeks | Lambs – 14 weeks<br>Calves – 6 months |
| 3.2 | Earlier weaning. As for 3.1 plus livestock structure changes to allow for weaner management | Wethers are reduced by 10%<br><br>*-190 wethers sold* | Wethers and steers are sold<br>- 360 lambs sold in Sept & 74 lambs sold in Oct<br>- Steers (400) are not purchased |
| 3.3 | Earlier weaning as for 3.1 plus livestock structure changes to allow for weaner management | Other ewes are sold<br><br>*- 500 other ewes sold* | - 250 older ewes are sold<br>- 300 sows are sold |
| 3.4 | Earlier weaning as for 3.1 plus pastures are improved with legumes (cf scenario 1) to allow all classes of stock to be kept. | **Steers**<br>**Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Liveweight gain (kg/hd/d**) - Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep**<br>**Liveweight (kg) – as above**<br>**Liveweight gain (kg/hd/d**)<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg/hd/d)**<br>*Cows* - Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Steers*- Spring (0.88), Summer (1.11), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0) |

| | | | |
|---|---|---|---|
| | | Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0) | *Calves - steers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep**<br>**Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (27), Summer (50), Autumn (0), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg/hd/d)**<br>*Breeding ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.15), Summer (0.07), Autumn (0.05), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0) |
| 3.5 | Earlier weaning as for 3.1 plus improved pasture intake quality is assumed (cf Scenario 1.5), allowing all classes of stock to be kept. | **Steers – Liveweight (kg) -** Spring (480), Summer (320), Autumn (380), Winter (420)<br>**Steers – Liveweight gain** kg/hd/d - Spring (0.7), Summer (0.00), Autumn (0.53), Winter (0.47)<br><br>**Sheep Liveweight (kg) – as above**<br>**Sheep kg / hd / d**<br>*Breeding ewes* - Spring (0.02), Summer (-0.05), Autumn (0.04), Winter (0)<br>*Maiden ewes* - Spring (0), Summer (-0.48), Autumn (0), Winter (0.53)<br>*Other ewes* - Spring (0.02), Summer (-0.04), Autumn (0.02), Winter (0)<br>*Lambs / Hogget* - Spring (-0.15), Summer (0.02), Autumn (0.13), Winter (0.01)<br>*Rams* - Spring (0.0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0.05), Summer (-0.04), Autumn (0), Winter (0) | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (600), Summer (550), Autumn (550), Winter (550)<br>*Heifers*- Spring (500), Summer (450), Autumn (450), Winter (450)<br>*Steers*- Spring (375), Summer (470), Autumn (0), Winter (300)<br>*Calves - heifers*- Spring (200), Summer (280), Autumn (320), Winter (100)<br>*Calves - steers*- Spring (210), Summer (290), Autumn (330), Winter (110)<br>*Bulls >1yo*- Spring (700), Summer (700), Autumn (700), Winter (700)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Heifers*- Spring (0.58), Summer (-0.53), Autumn (0), Winter (0)<br>*Steers*- Spring (0.88), Summer (1.11), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Calves - steers*- Spring (1.17), Summer (0.93), Autumn (0.47), Winter (0)<br>*Bulls >1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Sheep** |

| | | | |
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| | | | **Liveweight (kg)**<br>*Breeding ewes* - Spring (55), Summer (50), Autumn (52), Winter (52)<br>*Maiden ewes* - Spring (45), Summer (40), Autumn (42), Winter (42)<br>*Other ewes* - Spring (27), Summer (50), Autumn (0), Winter (0)<br>*Lambs / Hogget* - Spring (20), Summer (26), Autumn (30), Winter (7)<br>*Rams* - Spring (80), Summer (80), Autumn (80), Winter (80)<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Breeding ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Maiden ewes* - Spring (0.04), Summer (-0.05), Autumn (0.02), Winter (0)<br>*Other ewes* - Spring (0), Summer (0), Autumn (0.13), Winter (0)<br>*Lambs / Hogget* - Spring (0.15), Summer (0.07), Autumn (0.05), Winter (0)<br>*Rams* - Spring (0), Summer (0), Autumn (0), Winter (00<br>*Wethers* - Spring (0), Summer (0), Autumn (0), Winter (0) |
| | | | |
| 4.1 | Reproductive efficiencywith110 % lambing. Total herd numbers increase. | ***Total sheep numbers (total numbers per class)***<br>*Breeding ewes* – 7000<br>*Maiden ewes* – 5700 (Aug / Sept / Oct / Nov)<br>*Other ewes* – 500<br>*Lambs / Hogget* – 700 (Jan), 6500 (Feb, Mar, Apr),6000 (May), 5700 (Jun, Jul), 7700 (Aug, Sept, Oct, Nov, Dec)<br>*Rams* - 120<br>*Wethers* -1900 | N/a |
| 4.2 | Improved herd management with 98% calving. Additional calves are sold at 12 months. | N/a | ***Total cattle numbers***<br><br>*Cows* – 1600<br>*Heifers*- 500<br>*Steers*- 400 (June – Dec)<br>*Calves - heifers*- 784<br>*Calves - steers*- 784<br>*Bulls >1yo*- 45<br>*Bulls <1yo*-0 |
| 4.3 | 100% spring calving | N/a | N/a |
| | | | |
| 5.1 | Spring lambing - August lambing. No other change | N/a | Total numbers remain constant |

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| 5.2 | Spring lambing - August lambing and early weaning (14weeks). No other changes | N/a | Total numbers remain constant |
| | | | |
| 6.1 | Faster beef turnoff: Trade cattle grow at 0.1 kg/hd/d above base farm factors. Animals turned off at 30 days earlier than usual. | **Numbers**<br>400 (Mar – Nov)<br><br>**Liveweight gain**<br>0.1 kg/hd/d over base farm factors | N/a |
| 6.2 | Faster beef turnoff: Trade cattle grow at 0.2 kg/hd/d above base farm factors. Animals turned off at 30 days earlier than usual. | **Numbers**<br>400 (Mar – Nov)<br><br>**Liveweight gain**<br>0.2 kg/hd/d over base farm factors | N/a |
| | | | |
| 7.1 | Grain finishing store cattle – 1-2yo trade cattle (250kg) are in a feed lot from 12 months of age for 12 mths to reach 500kg. | N/a | N/a |
| 7.2 | Grain finishing store cattle – 1-2yo trade cattle (250kg) are in a feed lot from 12 months of age for 250day to reach 500kg. Growing at 1kg/dh/d. No replacement store cattle are bought. | N/a | N/a |
| 7.3 | Grain finishing store cattle – 1-2yo trade cattle (250kg) are in a feed lot from 12 months of age for 208day to reach 500kg. Growing at 1.2kg/dh/d. No replacement store cattle are bought. | N/a | N/a |
| | | | |
| 8.1 | Implementation of a new technology (*Sheep*) (bolus, vaccine, phage therapy). Methane emissions reduced | **Sheep (hd)**<br>Breeding ewes – 7000<br>Maiden ewes – 4500<br>Other ewes – 500 | **Sheep (hd)**<br>Breeding ewes – 600<br>Maiden ewes – 180<br>Other ewes – 500 |

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| | by 20% (theoretical assumption) | Lambs / Hoggets – 6000 (Jan), 5500 (Feb, Mar, Apr), 5000 (May), 4500 (Jun, Jul), 65000 (Aug, Sept, Oct, Nov, Dec) | Lambs / Hoggets – 288 (Jan, Feb, Mar), 180 (Apr), 720 (May, Jun, Jul, Aug, Sept, Oct), 288 (Nov, Dec) |
| 8.2 | Implementation of a new technology *(Cattle)* (bolus, vaccine, phage therapy). Methane emissions reduced by 20% (theoretical assumption). | **Steers** - 400 (Feb – Nov) | **Beef Cattle (hd)**<br>*Cows* – 1600<br>*Heifers*- 500<br>*Steers*- 400 (June – Dec)<br>*Calves - heifers*- 704<br>*Calves - steers*- 704<br>*Bulls >1yo*- 45<br>*Bulls <1yo*-0 |
| 8.3 | Methane reduction technology applied to sheep and cattle | **Sheep (hd)**<br>Breeding ewes – 7000<br>Maiden ewes – 4500<br>Other ewes – 500<br>Lambs / Hoggets – 6000 (Jan), 5500 (Feb, Mar, Apr), 5000 (May), 4500 (Jun, Jul), 65000 (Aug, Sept, Oct, Nov, Dec)<br><br>**Steers (hd)** - 400 (Feb – Nov) | **Sheep (hd)**<br>Breeding ewes – 600<br>Maiden ewes – 180<br>Other ewes – 500<br>Lambs / Hoggets – 288 (Jan, Feb, Mar), 180 (Apr), 720 (May, Jun, Jul, Aug, Sept, Oct), 288 (Nov, Dec)<br><br>**Beef Cattle (hd)**<br><br>*Cows* – 1600<br>*Heifers*- 500<br>*Steers*- 400 (June – Dec)<br>*Calves - heifers*- 704<br>*Calves - steers*- 704<br>*Bulls >1yo*- 45<br>*Bulls <1yo*-0 |
| 8.4 | Oils and Tannins e.g. oil seeds, or added tannins – 10% (limited research) | **Steers (hd)** - 400 (Feb – Nov) | **Beef Cattle (hd)**<br><br>*Cows* – 1600<br>*Heifers*- 500<br>*Steers*- 400 (June – Dec)<br>*Calves - heifers*- 704<br>*Calves - steers*- 704<br>*Bulls >1yo*- 45<br>*Bulls <1yo*-0 |
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| 9.1 | Fertiliser application reduction (-25%) due to improved application efficiency (optimum threshold, geo-application). No yield penalty. | Wheat – 228ha<br>Triticale – 112ha<br><br>Fertiliser - 75kg/ha | N/a |
| 9.2 | Reduced fertiliser application (-25 %). Yield decreased by 10 %. | Wheat – 228ha<br>Triticale – 112ha<br><br>Fertiliser - 75kg/ha | N/a |
| 9.3 | Reduced fertiliser application (-25 %) on pastures. | N/a | X |
| | | | |
| 10 | Application of a nitrogen inhibitor to crops, FrachGASF = - 50 % | Wheat – 228ha<br>Triticale – 112ha | Pasture area – 1000ha dryland pastures with legumes |
| | | | |
| 11.1 | Enterprises changes (total DSE remains constant) | Base farm: 340ha<br>+5% cropping (additional 17ha)<br><br>Lose 102 ewes per month and on average 83 lambs per month (Compare the base farm spreadsheet; Sheep tab) | Base Farm is 29,831 dse (cattle) and 2007 dse of sheep<br><br>**80% beef, 20% sheep**<br><br>Loss 4360.6 dse of cattle<br>Gain 4360 dse of sheep<br><br>In the modelling these are spread across the stock structures but if all were cows and ewes would be a loss of 363 cows and a gain of 2180 ewes. |
| 11.2 | Enterprises changes | Base farm: 340ha<br>+10% cropping (34ha)<br><br>Lose 204 ewes & on average 168 lambs per month | **70% beef, 30% sheep**<br><br>Loss 7545 dse of cattle<br>Gain 7544 dse of sheep<br><br>In the modelling these are spread across the stock structures but if all were cows and ewes would be a loss of 629 cows and a gain of 3,772 ewes. |

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| 11.3 | Enterprises changes | Base farm: 340ha<br>+15% cropping (51ha)<br><br>Lose 306 ewes & on average 302 lambs per month | **50% beef, 50% sheep**<br><br>Loss 13912 dse of cattle<br>Gain 13912 dse of sheep<br><br>In the modelling these are spread across the stock structures but if all were cows and ewes would be a loss of 1,159 cows and a gain of 6,956 ewes. |
| 11.4 | Enterprises changes | Base farm: 340ha<br><br>+20% cropping (68ha)<br><br>Lose 408 ewes & 380 lambs per month | **30% beef, 70% sheep**<br>Loss 20279.59 dse of cattle<br>Gain 20279 dse of sheep<br><br>In the modelling these are spread across the stock structures but if all were cows and ewes would be a loss of 1,690 cows and a gain of 10,140 ewes. |
| 11.5 | Enterprises changes | +25% cropping (85ha)<br><br>Lose 510 ewes & 470 lambs per month | **20% beef, 80% sheep**<br>Loss 23464 dse of cattle<br>Gain 23463 dse of sheep<br><br>In the modelling these are spread across the stock structures but if all were cows and ewes would be a loss of 1,955 cows and a gain of 11,732 ewes. |
| 11.6 | Enterprises changes | +40% cropping (136ha)<br><br>Lose 816 ewes & 717 lambs per month | N/a |
| 11.7 | Enterprise change | No wethers are run, increase trade hoggets by 2000 per month. | N/a |
| | | | |
| 12 | Replace 5% area with an environmental planting area (treelot). | Treelot - 30ha | N/a |

## Table A2: Modelling inputs for northern case study farms.

| # | Scenario | Northern Farm 1 | Northern Farm 2 | Northern Farm 3 |
|---|---|---|---|---|
| | Base Farm | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.56), Summer (0.56), Autumn (0.56), Winter (-0.56)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring 0), Summer (0.67), Autumn (0.67), Winter (0.67)<br>*Calves - steers*- Spring (0), Summer (0.67), Autumn (0.67), Winter (0.67)<br>*Bulls >1yo*- Spring (0), Summer (0.56), Autumn (0), Winter (-0.56)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)** | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.56), Summer (0.0), Autumn (0.0), Winter (-0.56)<br>*Heifers*- Spring (0.40), Summer (0.7), Autumn (0.3), Winter (0.2)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.5), Summer (0.9), Autumn (0.7), Winter (0.4)<br>*Calves - steers*- Spring (0.5), Summer (0.9), Autumn (0.7), Winter (0.4)<br>*Bulls >1yo*- Spring (0.2), Summer (0.4), Autumn (0.3), Winter (0.1)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360) | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.56), Summer (0.83), Autumn (-0.28), Winter (-1.11)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.14), Autumn (0.56), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.67), Autumn (0.33), Winter (0.22)<br>*Steers*- Spring (0), Summer (0.14), Autumn (0.56), Winter (0)<br>*Calves - heifers*- Spring (1.11), Summer (0.22), Autumn (0.0), Winter (0.53)<br>*Calves - steers*- Spring (1.11), Summer (0.28), Autumn (0.), Winter (0.56)<br>*Bulls >1yo*- Spring (-0.56), Summer (0), Autumn (1.11), Winter (-0.56)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260) |

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| | | *Steers*- Spring (1.67), Summer (0.28), Autumn (0.83), Winter (0) | **Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.1), Summer (0.4), Autumn (0.0), Winter (0.3)<br>*Steers*- Spring (1.1), Summer (0.4), Autumn (0.0), Winter (0.3) | *Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.56), Summer (0.83), Autumn (-0.28), Winter (-1.11)<br>*Calves - heifers*- Spring (0), Summer (0.53), Autumn (1.11), Winter (0.22)<br>*Calves - steers*- Spring (0), Summer (0.56), Autumn (1.11), Winter (-0.28) |
| 1.1 | Pastures are improved with an increase in legumes content. The consequences are:<br>- 10% increase in Dry Matter Digestibility (DMD)<br>- 5% increase in liveweight gain (LWG)<br>- 5% increase in crude protein (CP).<br><br>The potential increase in flock numbers is not including in this scenario. | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.58)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0) | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0) | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.15), Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.15), Autumn (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29) Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53) |

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| | | **Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), Autumn (0.88), Winter (0) | **Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)**<br>*Heifers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br>*Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4) | **Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (0.55), Autumn (1.17), Winter (0.23)<br>*Calves - steers*- Spring (0), Summer (0.58), Autumn (1.17), Winter (0.29) |
| 1.2 | Pastures are improved with an increase in legumes content<br><br>The consequences are:<br>- 10% increase in DMD<br>- 5% increase in liveweight gain<br>- increase in CP<br><br>The potential increase in flock numbers is not including in this scenario. Beef are turned off | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.58)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.15), Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.44) Autumn |

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| | one month earlier (@9months). | Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), Autumn (0.88), Winter (0)<br><br>440 steers sold in Feb<br>440 steers sold in Apr<br>422 steer sold in May | Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br>*Heifers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4) | (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29), Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (0.55), Autumn (1.17), Winter (0.23)<br>*Calves - steers*- Spring (0), Summer (0.58), Autumn (1.17), Winter (0.29)<br><br>240 steers sold in October |
| 1.3 | Pastures are improved with an increase in legumes content. The consequences are:<br>- 10% increase in DMD<br>- 5% increase in liveweight gain<br>- increase in CP | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), |

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| | Sold animals are replaced and beef numbers are increased by +5%. | (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.58)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br><br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), Autumn (0.88), Winter (0)<br><br>**Numbers**<br>**Extra Steers per month–**<br>91 (Jan & Feb)<br>69 (Mar & apr)<br>47 (May)<br>26 (Jun)<br>30 (Jul)<br>34 (Aug)<br>63 (Sept – Dec) | (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br>*Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br><br>**Numbers**<br>**Extra head per month–**<br>6 cows<br>2 heifers<br>6 calves<br>1bull | Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.15), Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.15), Autumn (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29), Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (0.55), Autumn (1.17), Winter (0.23)<br>*Calves - steers*- Spring (0), Summer (0.58), Autumn (1.17), Winter (0.29)<br><br>**Numbers**<br>**Extra head per month–**<br>9 cows (Autumn calving)<br>22 cows (spring calving)<br>11 heifers (1-2yo)<br>1 heifer (1yo)<br>2 Steer (1yo)<br>2 autumn calves |

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| | | | | 18 Spring calves |
| 1.4 | Pastures are improved with an increase in legumes content The consequences are:<br>- 10% increase in DMD<br>- 5% increase in liveweight gain<br>- increase in CP<br><br>The stocking rate is increased by 5% and the grazing area reduced 5%. The remaining area is converted to a tree lot | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.58)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)** | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.15), Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.15), Autumn (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29), Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275) |

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| | | Autumn (0.88), Winter (0)<br><br>**Numbers**<br>**Extra Steers per month–**<br>91 (Jan & Feb)<br>69 (Mar & apr)<br>47 (May)<br>26 (Jun)<br>30 (Jul)<br>34 (Aug)<br>63 (Sept – Dec)<br><br>**Treelot -** 40ha sequestering 28t C per yr or 102t CO2e per year | *Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br>*Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br><br>**Numbers**<br>**Extra head per month–**<br>6 cows<br>2 heifers<br>6 calves<br>1bull<br><br>**Treelot -** 17ha sequestering at 12t C per yr or 43t CO2e per year | **Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (0.55), Autumn (1.17), Winter (0.23)<br>*Calves - steers*- Spring (0), Summer (0.58), Autumn (1.17), Winter (0.29)<br><br>**Numbers**<br>**Extra head per month–**<br>9 cows (Autumn calving)<br>22 cows (spring calving)<br>11 heifers (1-2yo)<br>1 heifer (1yo)<br>2 Steer (1yo)<br>2 autumn calves<br>18 Spring calves<br><br>**Treelot -** 150ha sequestering 105t C per year or 384 CO2e/yr |
| 1.5 | Pasture quality of feed intake is improved through a 5% increase dry matter digestibility (DMD) and crude protein. 5% improvement in LWG | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.58)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.15), |

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| | | Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), Autumn (0.88), Winter (0) | (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.1), Summer (0.4), Autumn (0.0), Winter (0.3)<br>*Steers*- Spring (1.1), Summer (0.4), Autumn (0.0), Winter (0.3) | Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.15), Autumn (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29), Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (0.55), Autumn (1.17), Winter (0.23)<br>*Calves - steers*- Spring (0), Summer (0.58), Autumn (1.17), Winter (0.29) |
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| 2.1 | Beef genetics breeding. To simulate improved feed conversion efficiency, Percentage of Gross Energy Intake yielded as methane - 5%<br>No other changes are | X | X – No LW or LWG implications | X – No LW or LWG implications |

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| | made. | | | |
| 2.2 | Beef genetics breeding. To simulate improved feed conversion efficiency, Percentage of Gross Energy Intake yielded as methane - 5%<br>Beef cattle are sold one month earlier | 440 Steers sold in April | 54 Steers and 338 heifers sold in April<br><br>**Liveweight**<br>Steers & heifers – Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain**<br>Steers & heifers – Spring (1.1), Summer (0.3), Autumn (0), Winter (0.5) | 240 steers sold in October<br><br>**Liveweight**<br>Steers – Spring (275), Summer (300), Autumn (350), Winter (350)<br><br>**Liveweight gain**<br>Steers – Spring (0), Summer (0.42), Autumn (0.56), Winter (0) |
| 2.3 | Beef genetics breeding. To simulate improved feed conversion efficiency, Percentage of Gross Energy Intake yielded as methane - 5% | **Beef steers are increased by 5%.**<br>91 (Jan & Feb)<br>69 (Mar & apr)<br>47 (May)<br>26 (Jun)<br>30 (Jul)<br>34 (Aug)<br>63 (Sept – Dec) | **Beef breeding herd increases by 5%**<br>Extra head per month–<br>6 cows<br>2 heifers<br>6 calves<br>1bull | **Beef breeding herd increases by 5%**<br>14 cows (Autumn calving)<br>22 cows (spring calving)<br>6 heifers (1-2yo)<br>3 heifer (1yo)<br>3 Steer (1yo)<br>3 autumn calves<br>10 Spring calves<br><br>**No change in liveweight gain or liveweight** |
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| 3.1 | Earlier weaning. No other changes. | Calves weaned at 6months (start of march instead of May) | Calves weaned at 6months (end of Jan instead of May) | Autumn calves weaned in October rather than 120 in December and remainder in April.<br><br>Spring calves weaned in December rather than 137 in December and remainder in April |
| 3.2 | Earlier weaning as for | 422 steers sold in May | Trade stock sold in April instead of May 54 steers and 338 heifers | 240 Steers sold in October |

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| | 3.1 plus livestock structure changes to allow for weaner management | | **Liveweight**<br>Steers & heifers – Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain**<br>Steers & heifers – Spring (1.1), Summer (0.3), Autumn (0), Winter (0.5) | **Liveweight**<br>Steers – Spring (275), Summer (300), Autumn (350), Winter (350)<br><br>**Liveweight gain**<br>Steers – Spring (0), Summer (0.42), Autumn (0.56), Winter (0) |
| 3.3 | Earlier weaning as for 3.1 plus livestock structure changes to allow for weaner management | 500 dry cows placed on agistment March – Aug, 40 dry cows agistment Sept - Feb | 1-2yo heifers reduced from 108 to 54 and sold | All steers are sold (1yo)<br><br>30 Jan<br>29 Apr<br>40 September<br>240 November |
| 3.4 | Earlier weaning as for 3.1 plus pastures are improved with legumes (cf scenario 1) to allow all classes of stock to be kept. | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.58)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.15), Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.15), Autumn |

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| | | Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), Autumn (0.88), Winter (0) | Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)**<br>*Heifers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4)<br>*Steers*- Spring (1.2), Summer (0.5), Autumn (0.0), Winter (0.4) | (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29), Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (0.55), Autumn (1.17), Winter (0.23)<br>*Calves - steers*- Spring (0), Summer (0.58), Autumn (1.17), Winter (0.29) |
| 3.5 | Earlier weaning as for 3.1 plus improved pasture intake quality is assumed (cf Scenario 1.5), allowing all classes of stock to be kept. | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (600), Autumn (650), Winter (600)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (400), Summer (425), Autumn (450), Winter (350)<br>*Calves - heifers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Calves - steers*- Spring (100), Summer (160), Autumn (220), Winter (280)<br>*Bulls >1yo*- Spring (750), Summer (800), Autumn (800), Winter (750)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)** | **Beef Breeding**<br>**Liveweight (Kg)**<br>*Cows* - Spring (550), Summer (550), Autumn (550), Winter (500)<br>*Heifers*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Calves - steers*- Spring (75), Summer (160), Autumn (220), Winter (260)<br>*Bulls >1yo*- Spring (480), Summer (520), Autumn (550), Winter (560)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Liveweight gain (kg / hd / d)** | **Beef Breeding – Autumn calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Heifer 1-2yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Heifer 1yo*- Spring (300), Summer (360), Autumn (390), Winter (410)<br>*Steers – 1yo*- Spring (275), Summer (300), Autumn (350), Winter (350)<br>*Calves - heifers*- Spring (240), Summer (260), Autumn (45), Winter (140)<br>*Calves - steers*- Spring (250), Summer (275), Autumn (50), Winter (150)<br>*Bulls >1yo*- Spring (750), Summer (750), Autumn (850), Winter (800)<br><br>**Liveweight gain (kg / hd / d)** |

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| | | *Cows* - Spring (-0.53), Summer (0.58), Autumn (0.58), Winter (-0.53)<br>*Heifers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Calves - steers*- Spring (0), Summer (0.7), Autumn (0.7), Winter (0.7)<br>*Bulls >1yo*- Spring (0), Summer (0.58), Autumn (0), Winter (-0.53)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Steers*- Spring (400), Summer (425), Autumn (500), Winter (250)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.75), Summer (0.29), Autumn (0.88), Winter (0) | *Cows* - Spring (0.58), Summer (0.0), Autumn (0.0), Winter (-0.53)<br>*Heifers*- Spring (0.42), Summer (0.74), Autumn (0.32), Winter (0.21)<br>*Steers*- Spring (0), Summer (0), Autumn (0), Winter (0)<br>*Calves - heifers*- Spring (0.53), Summer (0.95), Autumn (0.74), Winter (0.42)<br>*Calves - steers*- Spring (0.53), Summer (0.95, Autumn (0.74), Winter (0.42)<br>*Bulls >1yo*- Spring (0.21), Summer (0.42), Autumn (0.32), Winter (0.11)<br>*Bulls <1yo*- Spring (0), Summer (0), Autumn (0), Winter (0)<br><br>**Beef Steers**<br>**Liveweight (Kg)**<br>*Heifers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br>*Steers*- Spring (460), Summer (500), Autumn (300), Winter (360)<br><br>**Liveweight gain (kg / hd / d)**<br>*Steers*- Spring (1.1), Summer (0.4), Autumn (0.0), Winter (0.3)<br>*Steers*- Spring (1.1), Summer (0.4), Autumn (0.0), Winter (0.3) | *Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Heifer 1-2yo*- Spring (0.0), Summer (0.29), Autumn (0.58), Winter (0.0)<br>*Heifer 1yo*- Spring (0), Summer (0.70), Autumn (0.35), Winter (0.23)<br>*Steers*- Spring (0), Summer (0.29), Autumn (0.58), Winter (0)<br>*Calves - heifers*- Spring (1.17), Summer (0.23), Autumn (0.0), Winter (0.55)<br>*Calves - steers*- Spring (1.17), Summer (0.29), Autumn (0.), Winter (0.58)<br>*Bulls >1yo*- Spring (-0.53), Summer (0), Autumn (1.17), Winter (-0.53)<br><br>**Beef Breeding – Spring calving mob**<br>**Liveweight (Kg)**<br>*Cows* - Spring (500), Summer (575), Autumn (550), Winter (450)<br>*Calves - heifers*- Spring (45), Summer (140), Autumn (240), Winter (260)<br>*Calves - steers*- Spring (50), Summer (150), Autumn (250), Winter (275)<br><br>**Liveweight gain (kg / hd / d)**<br>*Cows* - Spring (0.58), Summer (0.88), Autumn (-0.26), Winter (-1.06)<br>*Calves - heifers*- Spring (0), Summer (1.11), Autumn (1.17), Winter (0.12)<br>*Calves - steers*- Spring (0), Summer (1.17), Autumn (1.17), Winter (0.15) |
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| 4.1 | Reproductive efficiency- 110 % lambing Total herd numbers increase. | N/a | N/a | N/a |
| 4.2 | Improved herd management – 98% calving. Additional | 500 breeding cows, 490 lactating<br>extra 30 calves | N/a | N/a |

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| | calves are sold at 12 months. | | | |
| 4.3 | 100% spring calving | N/a | N/a | **All spring calving. Total numbers per class of animal per month.**<br><br>Cows – 800 (Jan – Feb), 595 (Mar), 565 (April – Aug), 800 (Sept – Dec)<br><br>Heifers (1-2yo) – 155 (Mar – May), 205 (Jun – Sept), 170 (Oct – Nov), 0 (Dec – Feb)<br><br>Heifers – 1yo – 60 (Jan –Dec)<br><br>Steers – 1yo – 30 (Jan), 29 (Feb – Apr), 40 (May – Sept), 240 (Oct – Nov)<br><br>Heifer calves (spring) - 328 (Jan / Feb), 298 (Mar / Apr), 175 (May – Aug). 328 (Sept – Dec)<br><br>Steer Calves 265 (Jan – May), 234 (June – Aug), 345 (Sept – Dec)<br><br>Bulls - 18 |
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| 5.1 | Spring lambing - August lambing. No other change | N/a | N/a | N/a |
| 5.2 | Spring lambing - August lambing and early weaning (14weeks). No other changes | N/a | N/a | N/a |
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| 6.1 | Faster beef turnoff: Trade cattle grow at 0.1 kg/hd/d above base farm factors. | **Numbers**<br>1600 (Sep), 1817 (Oct – Jan), 217 (Feb - Mar)<br><br>**Liveweight gain**<br>0.1 kg/hd/d over base farm LWG | **Numbers**<br>392 (Sep - Jul)<br><br>**Liveweight gain**<br>0.1 kg/hd/d over base farm LWG | N/a |

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| | Animals turned off at 30 days earlier than usual. | | | |
| 6.2 | Faster beef turnoff: Trade cattle grow at 0.2 kg/hd/d above base farm factors. Animals turned off at 30 days earlier than usual. | **Numbers**<br>1600 (Sep), 1817 (Oct – Jan), 217 (Feb - Mar)<br><br>**Liveweight gain**<br>0.2 kg/hd/d over base farm LWG | **Numbers**<br>392 (Sep - Jul)<br><br>**Liveweight gain**<br>0.2 kg/hd/d over base farm LWG | N/a |
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| 7.1 | Grain finishing store cattle with 1-2yo trade cattle placed in a feed lot for 100 days. No replacement store cattle are bought. | 1178 Steers (continuously)<br>100 days on grain<br>10kg daily feed intake/hd (2% of BW) | 392 head (continuously)<br>100 days on grain<br>10kg daily feed intake/hd (2% of BW) | 67 steers (continuously)<br>100 days on grain<br>10kg daily feed intake/hd (2% of BW) |
| 7.2 | Grain finishing store cattle with 1-2yo trade cattle placed in a feed lot for 120 days. No replacement store cattle are bought. | 1178 Steers<br>120 days on grain<br>10.5kg daily feed intake/hd | 392 steers<br>120 days on grain<br>10.5kg daily feed intake/hd | 67 steers<br>120 days on grain<br>10.5kg daily feed intake/hd |
| 7.3 | Grain finishing store cattle with 1-2yo trade cattle placed in a feed lot for 150 days. No | 1178 Steers (continuously)<br>150 days on grain<br>10kg daily feed intake/hd | 392 steers (continuously)<br>150 days on grain<br>10kg daily feed intake/hd | 67 steers (continuously)<br>150 days on grain<br>10kg daily feed intake/hd |

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| | replacement store cattle are bought. | | | |
| | | | | |
| 8.1 | Implementation of a new technology *(Sheep)* (bolus, vaccine, phage therapy). Methane emissions reduced by 20% (theoretical assumption) | N/a | N/a | N/a – No liveweight or liveweight gain implications |
| 8.2 | Implementation of a new technology *(Cattle)* (bolus, vaccine, phage therapy). Methane emissions reduced by 20% (theoretical assumption). | **Scenario applies to:**<br><br>**Beef Breeding**<br>Cows – 500<br>Heifer calves – 230<br>Steer Calves – 230<br>Bulls -15<br><br>**Beef stores**<br><br>Steers - 1178 (avg) | **Scenario applies to:**<br><br>**Beef Breeding**<br>Cows – 110<br>Heifers 1-2yo - 108<br>Heifer calves – 54<br>Steer Calves – 53<br>Bulls -1<br><br>**Beef stores**<br><br>Steers - 54<br>Heifers - 338 | **Scenario applies to :**<br><br>**Beef Breeding : number of animals per animal class per month**<br>Autumn Cows – 180 (Jan – Apr), 321 (May – Dec)<br><br>Spring Cows – 435 (Jan), 424 (Feb), 416 (Mar – Apr) 343 (May – June), 507(Jul- Dec)<br><br>Heifers 1-2yo – 214 (Jan – Apr), 164 (may – June), 0 (Jul – Sept), 177 (Oct – Nov), 0 Dec<br><br>Heifers 1yo – 12 (Jan – Apr), 67 May, 83 (Jun – dec)<br><br>Steers 1yo – 30 (Jan), 29 Feb – Apr), 40 (May – Sept), 240 Oct / Nov), 0 Dec<br><br>Autumn heifer calves – 12 (Jan – Apr), 67 May, 83 (June – Dec)<br><br>Autumn Steer Calves – 13 (Jan – Apr), 78 May, 92 (June – Dec) |

| | | | | |
|---|---|---|---|---|
| | | | | Spring heifer calves – 167 (Jan – Apr), 177( May – Sept), 247 (Oct – Dec)<br><br>Spring Steer Calves – 190 (Jan – Apr), 200 ( May – Sept), 247 (Oct – Dec)<br>Bulls -18 |
| 8.3 | Methane reduction technology applied to sheep and cattle | N/a | N/a | N/a |
| 8.4 | Oils and Tannins e.g. oil seeds, or added tannins – 10% (limited research) | **Scenario applies to:**<br><br>**Beef Breeding**<br>Cows – 500<br>Heifer calves – 230<br>Steer Calves – 230<br>Bulls -15<br><br>**Beef stores**<br><br>Steers - 1178 (avg) | **Scenario applies to:**<br><br>**Beef Breeding**<br>Cows – 110<br>Heifers 1-2yo - 108<br>Heifer calves – 54<br>Steer Calves – 53<br>Bulls -1<br><br>**Beef stores**<br><br>Steers - 54<br>Heifers - 338 | **Scenario applies to:**<br><br>**Beef Breeding; number of animals per animal class per month**<br><br>Autumn Cows – 180 (Jan – Apr), 321 (May – Dec)<br><br>Spring Cows – 435 (Jan), 424 (Feb), 416 (Mar – Apr) 343 (May – June), 507(Jul- Dec)<br><br>Heifers 1-2yo – 214 (Jan – Apr), 164 (may – June), 0 (Jul – Sept), 177 (Oct – Nov), 0 Dec<br><br>Heifers 1yo – 12 (Jan – Apr), 67 May, 83 (Jun – dec)<br><br>Steers 1yo – 30 (Jan), 29 Feb – Apr), 40 (May – Sept), 240 Oct / Nov), 0 Dec<br><br>Autumn heifer calves – 12 (Jan – Apr), 67 May, 83 (June – Dec)<br><br>Autumn Steer Calves – 13 (Jan – Apr), 78 May, 92 (June – Dec)<br><br>Spring heifer calves – 167 (Jan – Apr), 177( May – Sept), 247 (Oct – Dec)<br><br>Spring Steer Calves – 190 (Jan – Apr), 200 ( |

| | | | | |
|---|---|---|---|---|
| | | | | May – Sept), 247 (Oct – Dec)<br>Bulls -18 |
| | | | | |
| 9.1 | Fertiliser application reduction (-25%) due to improved application efficiency (optimum threshold, geo-application). No yield penalty. | N/a | N/a | N/a |
| 9.2 | Reduced fertiliser application (-25 %). Yield decreased by 10 %. | N/a | N/a | N/a |
| 9.3 | Reduced fertiliser application (-25 %) on pastures. | N/a | N/a | N/a |
| | | | | |
| 10 | Application of a nitrogen inhibitor to crops, FracGASF = -50 % | N/a | N/a | N/a |
| | | | | |
| 11.1 | Enterprises changes (total DSE remains constant) | Base Farm is 8020 dse (breeding cattle) and 9425.3 dse of trading cattle<br><br>**20% breeding, 80% stores**<br><br>Loss 4163 dse of breeding cattle (on | Base Farm is 2624 dse (breeding cattle) and 3136 dse of trading cattle (total = 5760 dse)<br><br>**20% breeding, 80% stores**<br><br>Loss 1472 dse of breeding cattle (on average | N/a |

| | | | | |
|---|---|---|---|---|
| | | average & compared to the base farm & Gain 4162.9 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a loss of 347 cows and a gain of 510 steers. | & compared to the base farm Gain 1472 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a loss of 123 cows and a gain of 184 steers. | |
| 11.2 | Enterprises changes | **30% breeding, 70% stores**<br><br>Loss 2464 dse of breeding cattle (on average)<br>Gain 2464 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a loss of 205 cows and a gain of 308 steers. | **30% breeding, 70% stores**<br><br>Loss 896 dse of breeding cattle (on average)<br>Gain 896 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a loss of 75 cows and a gain of 112 steers. | N/a |
| 11.3 | Enterprises changes | **50% breeding, 50% stores**<br><br>Gain 933 dse of breeding cattle (on average)<br>Loss 933 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a gain of 78 cows and a loss of 117 steers. | **50% breeding, 50% stores**<br><br>Gain 256 dse of breeding cattle (on average)<br>Loss 256 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a gain of 21 cows and a loss of 32 steers. | N/a |
| 11.4 | Enterprises changes | **70% breeding, 30% stores**<br><br>Gain 4329 dse of breeding cattle (on average)<br>Loss 4329 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a gain of 361 cows and a loss of 541 steers. | **70% breeding, 30% stores**<br><br>Gain 1408 dse of breeding cattle (on average)<br>Loss 1408 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a gain of 118 cows and a loss of 176 steers. | N/a |

| | | | | |
|---|---|---|---|---|
| 11.5 | Enterprises changes | **80% breeding, 20% stores**<br><br>Gain 6028 dse of breeding cattle (on average)<br>Loss 6028 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a gain of 502 cows and a loss of 753 steers. | **80% breeding, 20% stores**<br><br>Gain 1984 dse of breeding cattle (on average)<br>Loss 1984 dse of stores cattle<br><br>In the modelling these reductions are spread across the stock classes & months but if all were cows and steers there would be a gain of 165 cows and a loss of 248 steers. | N/a |
| | | | | |
| 12 | Replace 5% area with an environmental planting area (treelot). | Treelot - 86ha | Treelot - 15ha | Treelot - 164ha |

## 6.2 Appendix B: Emissions modelling results

### Table A3: Emission modelling results ($CO_2e$ tonnes) for case study farms.

| Southern Farm 1 | Default* | Revised** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Scenario: | Base | Base | District Average | Scenario 1.1 | Scenario 1.2 | Scenario 1.3 | Scenario 1.4 | Scenario 1.5 |
| Total Methane: | 2,995.70 | 3,288.08 | 3,093.04 | 3,470.63 | 3,407.19 | 3,629.77 | 3,629.77 | 3,470.63 |
| Total Nitrous Oxide: | 976.86 | 1,002.35 | 1,054.04 | 1,118.50 | 1,107.96 | 1,149.00 | 1,149.00 | 1,058.64 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | - 190.02 | |
| Total Emissions: | 3,972.56 | 4,290.43 | 4,147.08 | 4,589.14 | 4,515.15 | 4,778.77 | 4,588.75 | 4,529.28 |
| Total emissions/hectare: | 1.81 | 1.95 | 1.89 | 2.09 | 2.05 | 2.17 | 2.09 | 2.06 |
| Scenario emission abatement from base (Revised comparison) | | | -3% | 7% | 5% | 11% | 7% | 6% |
| BEEF-BREEDING | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total emissions/DSE: | | | | | | | | |
| BEEF-STORES | | | | | | | | |
| Total Methane: | 454.60 | 530.22 | 515.26 | 547.36 | 483.91 | 574.73 | 574.73 | 547.36 |
| Total Nitrous oxide: | 42.95 | 71.30 | 82.42 | 75.20 | 64.65 | 78.96 | 78.96 | 75.20 |
| TOTAL EMISSIONS: | 497.55 | 601.52 | 597.68 | 622.56 | 548.57 | 653.69 | 653.69 | 622.56 |
| Total emissions/DSE: | 0.19 | 0.23 | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| SHEEP | | | | | | | | |
| Total Methane: | 2,530.28 | 2,757.86 | 2,577.78 | 2,923.27 | 2,923.27 | 3,055.04 | 3,055.04 | 2,923.27 |
| Total Nitrous oxide: | 480.24 | 470.34 | 510.92 | 522.74 | 522.74 | 549.48 | 549.48 | 522.74 |
| TOTAL EMISSIONS: | 3,010.52 | 3,228.21 | 3,088.70 | 3,446.01 | 3,446.01 | 3,604.51 | 3,604.51 | 3,446.01 |
| Total emissions/DSE: | 0.14 | 0.15 | 0.14 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| FEEDLOT | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total Emissions/head: | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | |
| Total Methane: | 10.82 | - | - | - | - | | | |
| Total Nitrous oxide: | 94.51 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 |
| TOTAL EMISSIONS: | 105.33 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 |
| Total Emissions/hectare: | 0.31 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| PASTURES | | | | | | | | |
| Total Methane: | - | - | - | - | - | | | |
| Total Nitrous oxide: | 359.16 | 359.16 | 359.16 | 419.02 | 419.02 | 419.02 | 419.02 | 359.16 |
| TOTAL EMISSIONS: | 359.16 | 359.16 | 359.16 | 419.02 | 419.02 | 419.02 | 419.02 | 359.16 |
| Total Emissions/hectare: | 0.23 | 0.23 | 0.23 | 0.27 | 0.27 | 0.27 | 0.27 | 0.23 |

| Southern Farm 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 2.1 | Scenario 2.2 | Scenario 2.3 | Scenario 3.1 | Scenario 3.2 | Scenario 3.3 | Scenario 3.4 | Scenario 3.5 |
| Total Methane: | 3,199.29 | 3,148.84 | 3,287.82 | 3,256.35 | 3,219.93 | 3,168.89 | 3,438.90 | 3,438.90 |
| Total Nitrous Oxide: | 965.21 | 961.81 | 985.20 | 994.52 | 988.49 | 979.94 | 1,110.30 | 1,050.44 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | |
| Total Emissions: | 4,164.50 | 4110.65 | 4273.02 | 4250.87 | 4208.42 | 4,148.82 | 4,549.20 | 4,489.34 |
| Total emissions/hectare: | 1.89 | 1.87 | 1.94 | 1.93 | 1.91 | 1.89 | 2.07 | 2.04 |
| Scenario emission abatement from base (Revised comparison) | -3% | -4% | 0% | -1% | -2% | -3% | 6% | 5% |
| BEEF-BREEDING | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total emissions/DSE: | | | | | | | | |
| BEEF-STORES | | | | | | | | |
| Total Methane: | 441.43 | 390.97 | 390.97 | 530.22 | 530.22 | 530.22 | 547.36 | 547.36 |
| Total Nitrous oxide: | 34.16 | 30.77 | 30.77 | 71.30 | 71.30 | 71.30 | 75.20 | 75.20 |
| TOTAL EMISSIONS: | 475.59 | 421.74 | 421.74 | 601.52 | 601.52 | 601.52 | 622.56 | 622.56 |
| Total emissions/DSE: | 0.18 | 0.18 | 0.18 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| SHEEP | | | | | | | | |
| Total Methane: | 2,757.86 | 2,757.86 | 2,896.85 | 2,726.13 | 2,689.71 | 2,638.67 | 2,891.54 | 2,891.54 |
| Total Nitrous oxide: | 470.34 | 470.34 | 493.73 | 462.52 | 456.49 | 447.93 | 514.54 | 514.54 |
| TOTAL EMISSIONS: | 3,228.21 | 3,228.21 | 3,390.58 | 3,188.65 | 3,146.20 | 3,086.60 | 3,406.08 | 3,406.08 |
| Total emissions/DSE: | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.16 | 0.16 |
| FEEDLOT | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total Emissions/head: | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 |
| TOTAL EMISSIONS: | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 |
| Total Emissions/hectare: | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| PASTURES | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 419.02 | 359.16 |
| TOTAL EMISSIONS: | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 419.02 | 359.16 |
| Total Emissions/hectare: | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.27 | 0.23 |

| Southern Farm 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 4.1 | Scenario 6.1 | Scenario 6.2 | Scenario 8.1 | Scenario 8.2 | Scenario 8.3 | Scenario 8.4 | Scenario 9.1 | Scenario 9.2 |
| Total Methane: | 3,479.19 | 3,204.81 | 3,250.01 | 2,736.51 | 3,182.04 | 2,630.46 | 3,235.06 | 3,288.08 | 3,288.08 |
| Total Nitrous Oxide: | 1,040.43 | 992.15 | 999.18 | 1,002.35 | 1,002.35 | 1,002.35 | 1,002.35 | 985.89 | 983.61 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | |
| Total Emissions: | 4,519.62 | 4,196.96 | 4,249.19 | 3,738.85 | 4,184.38 | 3,632.81 | 4,237.41 | 4,273.96 | 4,271.69 |
| Total emissions/hectare: | 2.05 | 1.91 | 1.93 | 1.70 | 1.90 | 1.65 | 1.93 | 1.94 | 1.94 |
| Scenario emission abatement from base (Revised comparison) | 5% | -2% | -1% | -13% | -2% | -15% | -1% | 0% | 0% |
| BEEF-BREEDING | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | |
| BEEF-STORES | | | | | | | | | |
| Total Methane: | 530.22 | 446.95 | 492.15 | 530.22 | 424.17 | 424.17 | 477.19 | 530.22 | 530.22 |
| Total Nitrous oxide: | 71.30 | 61.10 | 68.13 | 71.30 | 71.30 | 71.30 | 71.30 | 71.30 | 71.30 |
| TOTAL EMISSIONS: | 601.52 | 508.05 | 560.28 | 601.52 | 495.47 | 495.47 | 548.49 | 601.52 | 601.52 |
| Total emissions/DSE: | 0.23 | 0.21 | 0.23 | 0.23 | 0.19 | 0.19 | 0.21 | 0.23 | 0.23 |
| SHEEP | | | | | | | | | |
| Total Methane: | 2,948.97 | 2,757.86 | 2,757.86 | 2,206.29 | 2,757.86 | 2,206.29 | 2,757.86 | 2,757.86 | 2,757.86 |
| Total Nitrous oxide: | 508.43 | 470.34 | 470.34 | 470.34 | 470.34 | 470.34 | 470.34 | 470.34 | 470.34 |
| TOTAL EMISSIONS: | 3,457.40 | 3,228.21 | 3,228.21 | 2,676.63 | 3,228.21 | 2,676.63 | 3,228.21 | 3,228.21 | 3,228.21 |
| Total emissions/DSE: | 0.15 | 0.15 | 0.15 | 0.12 | 0.15 | 0.12 | 0.15 | 0.15 | 0.15 |
| FEEDLOT | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 85.08 | 82.80 |
| TOTAL EMISSIONS: | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 101.54 | 85.08 | 82.80 |
| Total Emissions/hectare: | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.25 | 0.24 |
| PASTURES | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 |
| TOTAL EMISSIONS: | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 | 359.16 |
| Total Emissions/hectare: | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |

| Southern Farm 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 10.1 | Scenario 11.1 | Scenario 11.2 | Scenario 11.3 | Scenario 11.4 | Scenario 11.5 | Scenario 11.6 | Scenario 11.7 | Scenario 12.1 |
| Total Methane: | 3,288.08 | 3,256.98 | 3,225.75 | 3,186.36 | 3,155.10 | 3,123.70 | 3,030.35 | 3,148.74 | 3,288.08 |
| Total Nitrous Oxide: | 996.29 | 1,005.48 | 1,001.26 | 999.13 | 998.94 | 1,003.26 | 1,001.69 | 977.00 | 1,002.35 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | - 190.02 |
| Total Emissions: | 4,284.37 | 4,262.46 | 4,227.01 | 4,185.49 | 4,154.04 | 4,126.96 | 4,032.04 | 4,125.74 | 4,100.41 |
| Total emissions/hectare: | 1.95 | 1.94 | 1.92 | 1.90 | 1.89 | 1.88 | 1.83 | 1.88 | 1.86 |
| Scenario emission abatement from base (Revised comparison) | 0% | -1% | -1% | -2% | -3% | -4% | -6% | -4% | -4% |
| BEEF-BREEDING | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | |
| BEEF-STORES | | | | | | | | | |
| Total Methane: | 530.22 | 530.22 | 530.22 | 530.22 | | 530.22 | 530.22 | 530.22 | 530.22 |
| Total Nitrous oxide: | 71.30 | 71.30 | 71.30 | 71.30 | | 71.30 | 71.30 | 71.30 | 71.30 |
| TOTAL EMISSIONS: | 601.52 | 601.52 | 601.52 | 601.52 | | 601.52 | 601.52 | 601.52 | 601.52 |
| Total emissions/DSE: | 0.23 | 0.23 | 0.23 | 0.23 | | 0.23 | 0.23 | 0.23 | 0.23 |
| SHEEP | | | | | | | | | |
| Total Methane: | 2,757.86 | 2,726.76 | 2,695.53 | 2,656.15 | | 2,593.48 | 2,500.13 | 2,618.53 | 2,757.86 |
| Total Nitrous oxide: | 470.34 | 464.75 | 459.10 | 451.90 | | 445.87 | 429.07 | 444.99 | 470.34 |
| TOTAL EMISSIONS: | 3,228.21 | 3,191.51 | 3,154.63 | 3,108.04 | | 3,039.35 | 2,929.20 | 3,063.52 | 3,228.21 |
| Total emissions/DSE: | 0.15 | 0.15 | 0.15 | 0.15 | | 0.15 | 0.15 | 0.15 | 0.15 |
| FEEDLOT | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | 95.48 | 110.27 | 111.70 | 116.77 | | 126.93 | 142.16 | 101.54 | 101.54 |
| TOTAL EMISSIONS: | 95.48 | 110.27 | 111.70 | 116.77 | | 126.93 | 142.16 | 101.54 | 101.54 |
| Total Emissions/hectare: | 0.28 | 0.31 | 0.30 | 0.30 | | 0.30 | 0.30 | 0.30 | 0.30 |
| PASTURES | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | 359.16 | 359.16 | 359.16 | 359.16 | | 359.16 | 359.16 | 359.16 | 359.16 |
| TOTAL EMISSIONS: | 359.16 | 359.16 | 359.16 | 359.16 | | 359.16 | 359.16 | 359.16 | 359.16 |
| Total Emissions/hectare: | 0.23 | 0.23 | 0.23 | 0.23 | | 0.23 | 0.23 | 0.23 | 0.23 |

| Southern Farm 2 | Default* | Revised** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Base | Base | District Average | Scenario 1.1 | Scenario 1.2 | Scenario 1.3 | Scenario 1.5 | Scenario 2.1 | Scenario 2.2 | Scenario 2.3 |
| Total Methane: | 5,291.97 | 5,217.88 | 4,975.37 | 5,387.73 | 5,324.43 | 5,628.18 | 5,387.73 | 4,909.08 | 4,854.85 | 5,334.45 |
| Total Nitrous Oxide: | 1,373.55 | 946.52 | 864.62 | 1,100.80 | 1,112.78 | 1,138.87 | 1,061.83 | 946.52 | 943.06 | 1,010.00 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | | |
| Total Emissions: | 6,665.52 | 6,164.40 | 5,840.00 | 6,488.53 | 6,437.20 | 6,767.05 | 6,449.56 | 5,855.61 | 5,797.91 | 6,344.45 |
| Total emissions/hectare: | 1.60 | 1.48 | 1.40 | 1.56 | 1.55 | 1.62 | 1.55 | 1.41 | 1.39 | 1.52 |
| Scenario emission change from base (Revised comparison) | | | -5% | 5% | 4% | 10% | 5% | -5% | -6% | 3% |
| BEEF-BREEDING | | | | | | | | | | |
| Total Methane: | 5,088.85 | 4,994.81 | 4,785.17 | 5,149.93 | 5,090.88 | 5,385.56 | 5,149.93 | 4,686.01 | 4,631.78 | 5,111.38 |
| Total Nitrous oxide: | 1,123.57 | 706.07 | 631.02 | 808.54 | 820.92 | 845.31 | 808.54 | 706.07 | 702.61 | 769.55 |
| TOTAL EMISSIONS: | 6,212.43 | 5,700.89 | 5,416.19 | 5,958.47 | 5,911.79 | 6,230.87 | 5,958.47 | 5,392.09 | 5,334.39 | 5,880.93 |
| Total emissions/DSE: | 0.21 | 0.19 | 0.18 | 0.20 | 0.20 | 0.20 | 0.20 | 0.18 | 0.18 | 0.18 |
| BEEF-STORES | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | |
| SHEEP | | | | | | | | | | |
| Total Methane: | 203.12 | 223.07 | 190.21 | 237.80 | 233.55 | 242.63 | 237.80 | 223.07 | 223.07 | 223.07 |
| Total Nitrous oxide: | 38.13 | 35.24 | 28.39 | 48.08 | 47.68 | 49.37 | 48.08 | 35.24 | 35.24 | 35.24 |
| TOTAL EMISSIONS: | 241.25 | 258.31 | 218.60 | 285.88 | 281.23 | 292.00 | 285.88 | 258.31 | 258.31 | 258.31 |
| Total emissions/DSE: | 0.12 | 0.13 | 0.11 | 0.14 | 0.14 | 0.14 | 0.14 | 0.13 | 0.13 | 0.13 |
| FEEDLOT | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | |
| PASTURES | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | 211.85 | 205.21 | 205.21 | 244.18 | 244.18 | 244.18 | 205.21 | 205.21 | 205.21 | 205.21 |
| TOTAL EMISSIONS: | 211.85 | 205.21 | 205.21 | 244.18 | 244.18 | 244.18 | 205.21 | 205.21 | 205.21 | 205.21 |
| Total Emissions/hectare: | 0.21 | 0.21 | 0.21 | 0.24 | 0.24 | 0.24 | 0.21 | 0.21 | 0.21 | 0.21 |

| Southern Farm 2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 3.1 | Scenario 3.2 | Scenario 3.3 | Scenario 3.4 | Scenario 3.5 | Scenario 4.2 | Scenario 5.1 | Scenario 5.2 | Scenario 8.1 | Scenario 8.2 |
| Total Methane: | 5,155.57 | 4,871.31 | 4,677.59 | 5,377.51 | 5,381.76 | 5,340.37 | 5,222.01 | 5,217.60 | 5,173.27 | 4,218.92 |
| Total Nitrous Oxide: | 942.91 | 889.66 | 872.54 | 1,099.70 | 1,060.05 | 963.74 | 946.85 | 946.32 | 946.52 | 946.52 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | | |
| Total Emissions: | 6,098.48 | 5,760.97 | 5,550.13 | 6,477.21 | 6,441.81 | 6,304.11 | 6,168.87 | 6,163.92 | 6,119.79 | 5,165.44 |
| Total emissions/hectare: | 1.46 | 1.38 | 1.33 | 1.55 | 1.55 | 1.51 | 1.48 | 1.48 | 1.47 | 1.24 |
| Scenario emission change from base (Revised comparison) | -1% | -7% | -10% | 5% | 5% | 2% | 0.07% | -0.008% | -1% | -16% |
| BEEF-BREEDING | | | | | | | | | | |
| Total Methane: | 4,938.47 | 4,660.19 | 4,477.64 | 5,149.93 | 5,149.93 | 5,117.30 | 4,994.81 | 4,994.81 | 4,994.81 | 3,995.85 |
| Total Nitrous oxide: | 702.61 | 650.89 | 634.69 | 808.54 | 808.54 | 723.29 | 706.07 | 706.07 | 706.07 | 706.07 |
| TOTAL EMISSIONS: | 5,641.08 | 5,311.07 | 5,112.33 | 5,958.47 | 5,958.47 | 5,840.59 | 5,700.89 | 5,700.89 | 5,700.89 | 4,701.92 |
| Total emissions/DSE: | 0.19 | 0.19 | 0.19 | 0.20 | 0.20 | 0.19 | 0.19 | 0.19 | 0.19 | 0.16 |
| BEEF-STORES | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | |
| SHEEP | | | | | | | | | | |
| Total Methane: | 217.10 | 211.12 | 199.95 | 227.58 | 231.83 | 223.07 | 227.20 | 222.78 | 178.45 | 223.07 |
| Total Nitrous oxide: | 35.09 | 33.56 | 32.64 | 46.98 | 46.30 | 35.24 | 35.57 | 35.04 | 35.24 | 35.24 |
| TOTAL EMISSIONS: | 252.19 | 244.68 | 232.60 | 274.56 | 278.13 | 258.31 | 262.77 | 257.82 | 213.69 | 258.31 |
| Total emissions/DSE: | 0.13 | 0.12 | 0.13 | 0.14 | 0.14 | 0.13 | 0.13 | 0.13 | 0.11 | 0.13 |
| FEEDLOT | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | |
| PASTURES | | | | | | | | | | |
| Total Methane: | | | | | | | | | | |
| Total Nitrous oxide: | 205.21 | 205.21 | 205.21 | 244.18 | 205.21 | 205.21 | 205.21 | 205.21 | 205.21 | 205.21 |
| TOTAL EMISSIONS: | 205.21 | 205.21 | 205.21 | 244.18 | 205.21 | 205.21 | 205.21 | 205.21 | 205.21 | 205.21 |
| Total Emissions/hectare: | 0.21 | 0.21 | 0.21 | 0.24 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |

| Southern Farm 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 8.3 | Scenario 8.4 | Scenario 9.3 | Scenario 10.1 | Scenario 11.1 | Scenario 11.2 | Scenario 11.3 | Scenario 11.4 | Scenario 11.5 |
| Total Methane: | 4,174.30 | 4,718.40 | 5,217.88 | 5,217.88 | 4,944.66 | 4,798.68 | 4,410.15 | 4,070.60 | 3,857.50 |
| Total Nitrous Oxide: | 946.52 | 946.52 | 943.96 | 945.49 | 915.12 | 901.68 | 857.99 | 822.78 | 797.24 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | |
| Total Emissions: | 5,120.83 | 5,664.92 | 6,161.84 | 6,163.37 | 5,859.77 | 5,700.36 | 5,268.14 | 4,893.38 | 4,654.75 |
| Total emissions/hectare: | 1.23 | 1.36 | 1.48 | 1.48 | 1.41 | 1.37 | 1.26 | 1.17 | 1.12 |
| Scenario emission change from base (Revised comparison) | -17% | -8% | 0% | 0% | -5% | -8% | -15% | -21% | -24% |
| BEEF-BREEDING | | | | | | | | | |
| Total Methane: | 3,995.85 | 4,495.33 | 4,994.81 | 4,994.81 | 4,292.73 | 3,770.07 | 2,663.19 | 1,609.80 | 1,057.47 |
| Total Nitrous oxide: | 706.07 | 706.07 | 706.07 | 706.07 | 608.42 | 534.13 | 376.72 | 228.86 | 149.54 |
| TOTAL EMISSIONS: | 4,701.92 | 5,201.41 | 5,700.89 | 5,700.89 | 4,901.15 | 4,304.19 | 3,039.91 | 1,838.65 | 1,207.00 |
| Total emissions/DSE: | 0.16 | 0.17 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| BEEF-STORES | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | |
| SHEEP | | | | | | | | | |
| Total Methane: | 178.45 | 223.07 | 223.07 | 223.07 | 651.93 | 1,028.61 | 1,746.95 | 2,460.80 | 2,800.04 |
| Total Nitrous oxide: | 35.24 | 35.24 | 35.24 | 35.24 | 101.49 | 162.35 | 276.07 | 388.71 | 442.50 |
| TOTAL EMISSIONS: | 213.69 | 258.31 | 258.31 | 258.31 | 753.42 | 1,190.96 | 2,023.02 | 2,849.52 | 3,242.53 |
| Total emissions/DSE: | 0.11 | 0.13 | 0.13 | 0.13 | 0.12 | 0.13 | 0.13 | 0.13 | 0.13 |
| FEEDLOT | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | |
| PASTURES | | | | | | | | | |
| Total Methane: | | | | | | | | | |
| Total Nitrous oxide: | 205.21 | 205.21 | 202.64 | 204.17 | 205.21 | 205.21 | 205.21 | 205.21 | 205.21 |
| TOTAL EMISSIONS: | 205.21 | 205.21 | 202.64 | 204.17 | 205.21 | 205.21 | 205.21 | 205.21 | 205.21 |
| Total Emissions/hectare: | 0.21 | 0.21 | 0.20 | 0.20 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |

| Northern Farm 1 | Default* | Revised** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Base | Base | District Average | Scenario 1.1 | Scenario 1.2 | Scenario 1.3 | Scenario 1.4 | Scenario 1.5 | Scenario 2.1 | Scenario 2.2 | Scenario 2.3 |
| Total Methane: | 2,730.10 | 2,939.28 | 3,043.66 | 3,137.81 | 2,947.91 | 3,244.03 | 3,244.03 | 3,137.81 | 2,818.46 | 2,647.43 | 2,904.27 |
| Total Nitrous Oxide: | 383.58 | 547.53 | 516.43 | 595.07 | 568.24 | 610.66 | 610.66 | 548.31 | 547.53 | 520.85 | 563.14 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | - 220.35 | | | | |
| Total Emissions: | 3,113.68 | 3,486.82 | 3,560.09 | 3,732.88 | 3,516.15 | 3,854.70 | 3,634.35 | 3,686.11 | 3,365.99 | 3,168.29 | 3,467.40 |
| Total emissions/hectare: | 1.81 | 2.02 | 2.07 | 2.17 | 2.04 | 2.24 | 2.11 | 2.14 | 1.95 | 1.84 | 2.01 |
| Scenario emission change from base (Revised comparison) | | | 2% | 7% | 1% | 11% | 4% | 6% | -3% | -9% | -1% |
| BEEF-BREEDING | | | | | | | | | | | |
| Total Methane: | 1,080.02 | 1,085.08 | 1,221.18 | 1,133.76 | 1,133.76 | 1,133.76 | 1,133.76 | 1,133.76 | 1,106.87 | 1,106.87 | 1,106.87 |
| Total Nitrous oxide: | 110.15 | 142.77 | 173.70 | 142.80 | 142.80 | 142.80 | 142.80 | 142.80 | 142.77 | 142.77 | 142.77 |
| TOTAL EMISSIONS: | 1,190.17 | 1,227.85 | 1,394.87 | 1,276.57 | 1,276.57 | 1,276.57 | 1,276.57 | 1,276.57 | 1,249.63 | 1,249.63 | 1,249.63 |
| Total emissions/DSE: | 0.16 | 0.16 | 0.18 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| BEEF-STORES | | | | | | | | | | | |
| Total Methane: | 1,650.08 | 1,854.20 | 1,822.48 | 2,004.04 | 1,814.15 | 2,110.27 | 2,110.27 | 2,004.04 | 1,711.60 | 1,540.57 | 1,797.40 |
| Total Nitrous oxide: | 179.89 | 311.23 | 249.21 | 311.97 | 285.14 | 327.56 | 327.56 | 311.97 | 311.23 | 284.55 | 326.84 |
| TOTAL EMISSIONS: | 1,829.98 | 2,165.43 | 2,071.69 | 2,316.01 | 2,099.29 | 2,437.83 | 2,437.83 | 2,316.01 | 2,022.83 | 1,825.12 | 2,124.24 |
| Total emissions/DSE: | 0.19 | 0.23 | 0.22 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.21 | 0.21 | 0.21 |
| SHEEP | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | | |
| FEEDLOT | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | | |
| PASTURES | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | 93.53 | 93.53 | 93.53 | 140.30 | 140.30 | 140.30 | 140.30 | 93.53 | 93.53 | 93.53 | 93.53 |
| TOTAL EMISSIONS: | 93.53 | 93.53 | 93.53 | 140.30 | 140.30 | 140.30 | 140.30 | 93.53 | 93.53 | 93.53 | 93.53 |
| Total Emissions/hectare: | 0.08 | 0.08 | 0.08 | 0.12 | 0.12 | 0.12 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 |

| Northern Farm 1 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 3.1 | Scenario 3.2 | Scenario 3.3 | Scenario 3.4 | Scenario 3.5 | Scenario 4.2 | Scenario 6.1 | Scenario 6.2 | Scenario 7.1 | Scenario 7.2 | Scenario 7.3 |
| Total Methane: | 2,934.52 | 2,753.88 | 2,517.91 | 3,143.29 | 3,139.75 | 2,958.49 | 2,274.57 | 2,297.85 | 2,955.22 | 3,018.73 | 3,018.73 |
| Total Nitrous Oxide: | 547.26 | 520.85 | 492.36 | 595.03 | 548.53 | 549.91 | 455.18 | 459.10 | 1,265.88 | 1,307.52 | 1,321.70 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | | | |
| Total Emissions: | 3,481.78 | 3,274.73 | 3,010.26 | 3,738.31 | 3,688.28 | 3,508.40 | 2,729.75 | 2,756.94 | 4,221.10 | 4,326.25 | 4,340.43 |
| Total emissions/hectare: | 2.07 | 1.90 | 1.75 | 2.17 | 2.14 | 2.04 | 1.59 | 1.60 | 2.45 | 2.51 | 2.52 |
| Scenario emission change from base (Revised comparison) | 0% | -6% | -14% | 7% | 6% | 1% | -22% | -21% | 21% | 24% | 24% |
| BEEF-BREEDING | | | | | | | | | | | |
| Total Methane: | 1,080.32 | 1,085.08 | 663.70 | 1,133.76 | 1,135.71 | 1,104.29 | 1,085.08 | 1,085.08 | 1,113.98 | 1,113.98 | 1,113.98 |
| Total Nitrous oxide: | 142.49 | 142.77 | 87.59 | 142.80 | 143.03 | 145.14 | 142.77 | 142.77 | 146.52 | 146.52 | 146.52 |
| TOTAL EMISSIONS: | 1,222.81 | 1,227.85 | 751.30 | 1,276.57 | 1,278.74 | 1,249.43 | 1,227.85 | 1,227.85 | 1,260.51 | 1,260.51 | 1,260.51 |
| Total emissions/DSE: | 0.16 | 0.16 | 0.17 | 0.17 | 0.17 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| BEEF-STORES | | | | | | | | | | | |
| Total Methane: | 1,854.20 | 1,668.79 | 1,854.20 | 2,009.52 | 2,004.04 | 1,854.20 | 1,189.49 | 1,212.76 | | | |
| Total Nitrous oxide: | 311.23 | 284.55 | 311.23 | 311.92 | 311.97 | 311.23 | 218.88 | 222.80 | | | |
| TOTAL EMISSIONS: | 2,165.43 | 1,953.35 | 2,165.43 | 2,321.45 | 2,316.01 | 2,165.43 | 1,408.37 | 1,435.56 | | | |
| Total emissions/DSE: | 0.23 | 0.23 | 0.23 | 0.25 | 0.25 | 0.23 | 0.23 | 0.23 | | | |
| SHEEP | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | | |
| FEEDLOT | | | | | | | | | | | |
| Total Methane: | | | | | | | | | 1,841.24 | 1,904.75 | 1,904.75 |
| Total Nitrous oxide: | | | | | | | | | 1,025.82 | 1,067.46 | 1,081.64 |
| TOTAL EMISSIONS: | | | | | | | | | 2,867.06 | 2,972.21 | 2,986.39 |
| Total Emissions/head: | | | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | | |
| PASTURES | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | 93.53 | 93.53 | 93.53 | 140.30 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 |
| TOTAL EMISSIONS: | 93.53 | 93.53 | 93.53 | 140.30 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 |
| Total Emissions/hectare: | 0.08 | 0.08 | 0.08 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |

| Northern Farm 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 8.2 | Scenario 8.4 | Scenario 11.1 | Scenario 11.2 | Scenario 11.3 | Scenario 11.4 | Scenario 11.5 | Scenario 12.1 |
| Total Methane: | 2,415.31 | 2,717.22 | 3,234.47 | 3,143.43 | 2,914.99 | 2,730.14 | 2,640.86 | 2,939.28 |
| Total Nitrous Oxide: | 546.28 | 546.28 | 599.87 | 578.32 | 527.32 | 483.45 | 461.33 | 547.53 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | - | 220.35 |
| Total Emissions: | 2,961.59 | 3,263.51 | 3,834.34 | 3,721.75 | 3,442.31 | 3,213.58 | 3,102.19 | 3,266.47 |
| Total emissions/hectare: | 1.72 | 1.90 | 2.23 | 2.16 | 2.00 | 1.87 | 1.80 | 1.90 |
| Scenario emission change from base (Revised comparison) | -15% | -6% | 10% | 7% | -1% | -8% | -11% | -6% |
| BEEF-BREEDING | | | | | | | | |
| Total Methane: | 868.07 | 976.57 | 490.69 | 734.01 | 1,210.52 | 1,701.58 | 1,951.44 | 1,085.08 |
| Total Nitrous oxide: | 142.77 | 142.77 | 64.39 | 96.58 | 159.28 | 223.90 | 256.75 | 142.77 |
| TOTAL EMISSIONS: | 1,010.83 | 1,119.34 | 555.09 | 830.60 | 1,369.81 | 1,925.48 | 2,208.19 | 1,227.85 |
| Total emissions/DSE: | 0.13 | 0.15 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| BEEF-STORES | | | | | | | | |
| Total Methane: | 1,547.25 | 1,740.65 | 2,743.77 | 2,409.42 | 1,704.47 | 1,028.55 | 689.42 | 1,854.20 |
| Total Nitrous oxide: | 309.98 | 309.98 | 441.95 | 388.21 | 274.51 | 166.02 | 111.05 | 311.23 |
| TOTAL EMISSIONS: | 1,857.23 | 2,050.64 | 3,185.72 | 2,797.63 | 1,978.98 | 1,194.57 | 800.46 | 2,165.43 |
| Total emissions/DSE: | 0.20 | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| SHEEP | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total emissions/DSE: | | | | | | | | |
| FEEDLOT | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total Emissions/head: | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | |
| PASTURES | | | | | | | | |
| Total Methane: | | | | | | | | |
| Total Nitrous oxide: | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 |
| TOTAL EMISSIONS: | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 | 93.53 |
| Total Emissions/hectare: | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |

| Northern Farm 2 | Default* | Revised** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Base | Base | District Average | Scenario 1.1 | Scenario 1.2 | Scenario 1.3 | Scenario 1.4 | Scenario 1.5 | Scenario 2.1 | Scenario 2.2 | Scenario 2.3 |
| Total Methane: | 897.85 | 973.12 | 1,003.51 | 1,024.86 | 990.21 | 1,072.27 | 1,072.27 | 1,024.86 | 900.95 | 869.78 | 942.58 |
| Total Nitrous Oxide: | 116.27 | 126.37 | 169.25 | 140.02 | 136.77 | 145.06 | 145.06 | 131.44 | 126.37 | 123.27 | 131.20 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | - 43.56 | | | | |
| Total Emissions: | 1,014.12 | 1,099.49 | 1,172.76 | 1,164.88 | 1,126.98 | 1,217.33 | 1,130.21 | 1,156.30 | 1,027.31 | 993.05 | 1,073.78 |
| Total emissions/hectare: | 3.47 | 3.77 | 4.02 | 3.99 | 3.86 | 4.17 | 3.87 | 3.96 | 3.52 | 3.40 | 3.68 |
| Scenario emission change from base (Revised comparison) | | | 7% | 6% | 3% | 11% | 3% | 5% | -7% | -10% | -2% |
| BEEF-BREEDING | | | | | | | | | | | |
| Total Methane: | 397.94 | 433.27 | 433.00 | 451.99 | 451.99 | 473.10 | 473.10 | 451.99 | 388.51 | 388.51 | 406.61 |
| Total Nitrous oxide: | 39.69 | 55.68 | 62.12 | 57.88 | 57.88 | 60.73 | 60.73 | 57.88 | 55.68 | 55.68 | 58.45 |
| TOTAL EMISSIONS: | 437.63 | 488.95 | 495.12 | 509.87 | 509.87 | 533.82 | 533.82 | 509.87 | 444.19 | 444.19 | 465.06 |
| Total emissions/DSE: | 0.17 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.17 | 0.17 | 0.17 |
| BEEF-STORES | | | | | | | | | | | |
| Total Methane: | 499.91 | 539.85 | 570.51 | 572.87 | 538.22 | 599.17 | 599.17 | 572.87 | 512.44 | 481.27 | 535.96 |
| Total Nitrous oxide: | 50.86 | 44.97 | 81.41 | 47.84 | 44.60 | 50.04 | 50.04 | 47.84 | 44.97 | 41.87 | 47.03 |
| TOTAL EMISSIONS: | 550.77 | 584.82 | 651.92 | 620.71 | 582.82 | 649.22 | 649.22 | 620.71 | 557.40 | 523.15 | 582.99 |
| Total emissions/DSE: | 0.18 | 0.19 | 0.21 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.18 | 0.18 | 0.18 |
| SHEEP | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | | |
| FEEDLOT | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | | |
| PASTURES | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | 25.72 | 25.72 | 25.72 | 34.29 | 34.29 | 34.29 | 34.29 | 25.72 | 25.72 | 25.72 | 25.72 |
| TOTAL EMISSIONS: | 25.72 | 25.72 | 25.72 | 34.29 | 34.29 | 34.29 | 34.29 | 25.72 | 25.72 | 25.72 | 25.72 |
| Total Emissions/hectare: | 0.12 | 0.12 | 0.12 | 0.16 | 0.16 | 0.16 | 0.16 | 0.12 | 0.12 | 0.12 | 0.12 |

| Northern Farm 2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 3.1 | Scenario 3.2 | Scenario 3.3 | Scenario 3.4 | Scenario 3.5 | Scenario 6.1 | Scenario 6.2 | Scenario 7.1 | Scenario 7.2 | Scenario 7.3 | Scenario 8.2 |
| Total Methane: | 971.83 | 938.84 | 903.90 | 1,023.56 | 1,015.21 | 834.63 | 845.03 | 1,061.68 | 1,063.79 | 1,082.81 | 778.50 |
| Total Nitrous Oxide: | 126.30 | 123.20 | 120.62 | 139.94 | 130.58 | 110.32 | 110.72 | 436.16 | 433.64 | 454.73 | 126.37 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | | | |
| Total Emissions: | 1,098.13 | 1,062.04 | 1,024.51 | 1,163.50 | 1,145.79 | 944.95 | 955.76 | 1,497.84 | 1,497.43 | 1,537.55 | 904.87 |
| Total emissions/hectare: | 3.76 | 3.64 | 3.51 | 3.98 | 3.92 | 3.24 | 3.27 | 5.13 | 5.13 | 5.27 | 3.10 |
| Scenario emission change from base (Revised comparison) | 0% | -3% | -7% | 6% | 4% | -14% | -13% | 36% | 36% | 40% | -18% |
| BEEF-BREEDING | | | | | | | | | | | |
| Total Methane: | 431.98 | 431.98 | 364.05 | 450.70 | 451.26 | 433.27 | 433.27 | 448.98 | 448.98 | 448.98 | 346.62 |
| Total Nitrous oxide: | 55.61 | 55.61 | 49.93 | 57.80 | 57.51 | 55.68 | 55.68 | 69.08 | 69.08 | 69.08 | 55.68 |
| TOTAL EMISSIONS: | 487.59 | 487.59 | 413.98 | 508.49 | 508.77 | 488.95 | 488.95 | 518.05 | 518.05 | 518.05 | 402.30 |
| Total emissions/DSE: | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.15 |
| BEEF-STORES | | | | | | | | | | | |
| Total Methane: | 539.85 | 506.86 | 539.85 | 572.87 | 563.95 | 401.35 | 411.76 | | | | 431.88 |
| Total Nitrous oxide: | 44.97 | 41.87 | 44.97 | 47.84 | 47.34 | 28.92 | 29.33 | | | | 44.97 |
| TOTAL EMISSIONS: | 584.82 | 548.73 | 584.82 | 620.71 | 611.30 | 430.28 | 441.08 | | | | 476.85 |
| Total emissions/DSE: | 0.19 | 0.19 | 0.19 | 0.20 | 0.19 | 0.15 | 0.15 | | | | 0.15 |
| SHEEP | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | | |
| FEEDLOT | | | | | | | | | | | |
| Total Methane: | | | | | | | | 612.70 | 614.82 | 633.84 | |
| Total Nitrous oxide: | | | | | | | | 341.36 | 338.84 | 359.93 | |
| TOTAL EMISSIONS: | | | | | | | | 954.06 | 953.66 | 993.77 | |
| Total Emissions/head: | | | | | | | | 2.43 | 2.43 | 2.54 | |
| DRYLAND CROPPING | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | | |
| PASTURES | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | 25.72 | 25.72 | 25.72 | 34.29 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 |
| TOTAL EMISSIONS: | 25.72 | 25.72 | 25.72 | 34.29 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 |
| Total Emissions/hectare: | 0.12 | 0.12 | 0.12 | 0.16 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |

| Northern Farm 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 8.4 | Scenario 11.1 | Scenario 11.2 | Scenario 11.3 | Scenario 11.4 | Scenario 11.5 | Scenario 12.1 |
| Total Methane: | 875.81 | 983.46 | 979.01 | 971.13 | 963.39 | 958.27 | 973.12 |
| Total Nitrous Oxide: | 126.37 | 116.35 | 120.24 | 128.15 | 136.05 | 139.91 | 126.37 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | - 43.56 |
| Total Emissions: | 1,002.18 | 1,099.81 | 1,099.25 | 1,099.28 | 1,099.45 | 1,098.18 | 1,055.93 |
| Total emissions/hectare: | 3.43 | 3.77 | 3.76 | 3.76 | 3.77 | 3.76 | 3.62 |
| Scenario emission change from base (Revised comparison) | -9% | 0% | 0% | 0% | 0% | 0% | -4% |
| BEEF-BREEDING | | | | | | | |
| Total Methane: | 389.95 | 190.21 | 284.92 | 475.35 | 665.93 | 759.96 | 433.27 |
| Total Nitrous oxide: | 55.68 | 24.55 | 36.71 | 61.14 | 85.56 | 97.67 | 55.68 |
| TOTAL EMISSIONS: | 445.63 | 214.76 | 321.62 | 536.48 | 751.48 | 857.62 | 488.95 |
| Total emissions/DSE: | 0.17 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| BEEF-STORES | | | | | | | |
| Total Methane: | 485.87 | 793.25 | 694.09 | 495.78 | 297.47 | 198.31 | 539.85 |
| Total Nitrous oxide: | 44.97 | 66.07 | 57.81 | 41.30 | 24.78 | 16.52 | 44.97 |
| TOTAL EMISSIONS: | 530.83 | 859.32 | 751.91 | 537.08 | 322.25 | 214.83 | 584.82 |
| Total emissions/DSE: | 0.17 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| SHEEP | | | | | | | |
| Total Methane: | | | | | | | |
| Total Nitrous oxide: | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | |
| Total emissions/DSE: | | | | | | | |
| FEEDLOT | | | | | | | |
| Total Methane: | | | | | | | |
| Total Nitrous oxide: | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | |
| Total Emissions/head: | | | | | | | |
| DRYLAND CROPPING | | | | | | | |
| Total Methane: | | | | | | | |
| Total Nitrous oxide: | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | |
| Total Emissions/hectare: | | | | | | | |
| PASTURES | | | | | | | |
| Total Methane: | | | | | | | |
| Total Nitrous oxide: | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 |
| TOTAL EMISSIONS: | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 | 25.72 |
| Total Emissions/hectare: | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |

| Northern Farm 3 | Default* | Revised** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Base | Base | District Average | Scenario 1.1 | Scenario 1.2 | Scenario 1.3 | Scenario 1.4 | Scenario 1.5 | Scenario 2.1 | Scenario 2.2 | Scenario 2.3 |
| Total Methane: | 1,908.64 | 1,881.16 | 1,995.05 | 1,974.54 | 1,936.59 | 2,072.49 | 2,072.49 | 1,974.54 | 1,787.93 | 1,753.72 | 1,875.96 |
| Total Nitrous Oxide: | 236.98 | 211.96 | 338.30 | 308.69 | 306.05 | 317.22 | 317.22 | 220.85 | 211.96 | 209.45 | 220.03 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | - 420.20 | | | | |
| Total Emissions: | 2,145.62 | 2,093.12 | 2,333.35 | 2,283.23 | 2,242.64 | 2,389.71 | 1,969.51 | 2,195.39 | 1,999.89 | 1,963.17 | 2,095.99 |
| Total emissions/hectare: | 0.65 | 0.64 | 0.71 | 0.70 | 0.68 | 0.73 | 0.60 | 0.67 | 0.61 | 0.60 | 0.64 |
| Scenario emission change from base (Revised comparison) | | | 11% | 9% | 7% | 14% | -6% | 5% | -4% | -6% | 0% |
| BEEF-BREEDING (spring calving) | | | | | | | | | | | |
| Total Methane: | 1,814.69 | 1,778.74 | 1,884.00 | 1,867.16 | 1,829.21 | 1,957.42 | 1,957.42 | 1,867.16 | 1,690.85 | 1,656.64 | 1,773.75 |
| Total Nitrous oxide: | 174.94 | 151.06 | 268.85 | 159.55 | 156.91 | 167.46 | 167.46 | 159.55 | 151.06 | 148.56 | 158.69 |
| TOTAL EMISSIONS: | 1,989.63 | 1,929.80 | 2,152.85 | 2,026.71 | 1,986.13 | 2,124.88 | 2,124.88 | 2,026.71 | 1,841.91 | 1,805.20 | 1,932.44 |
| Total emissions/DSE: | 0.16 | 0.15 | 0.17 | 0.16 | 0.16 | 0.16 | 0.16 | 0.1616 | 0.15 | 0.15 | 0.15 |
| BEEF-BREEDING (autumn calving) | | | | | | | | | | | |
| Total Methane: | 93.95 | 102.42 | 111.05 | 107.38 | 107.38 | 115.08 | 115.08 | 107.38 | 97.07 | 97.07 | 102.21 |
| Total Nitrous oxide: | 9.34 | 8.19 | 16.75 | 8.59 | 8.59 | 9.21 | 9.21 | 8.59 | 8.19 | 8.19 | 8.63 |
| TOTAL EMISSIONS: | 103.28 | 110.62 | 127.80 | 115.97 | 115.97 | 124.29 | 124.29 | 115.97 | 105.27 | 105.27 | 110.85 |
| Total emissions/DSE: | 0.21 | 0.23 | 0.26 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.21 | 0.21 | 0.21 |
| SHEEP | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | | |
| FEEDLOT | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/head: | | | | | | | | | | | |
| DRYLAND CROPPING | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | | |
| PASTURES | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | |
| Total Nitrous oxide: | 52.70 | 52.70 | 52.70 | 140.55 | 140.55 | 140.55 | 140.55 | 52.70 | 52.70 | 52.70 | 52.70 |
| TOTAL EMISSIONS: | 52.70 | 52.70 | 52.70 | 140.55 | 140.55 | 140.55 | 140.55 | 52.70 | 52.70 | 52.70 | 52.70 |
| Total Emissions/hectare: | 0.02 | 0.02 | 0.02 | 0.06 | 0.06 | 0.06 | 0.06 | 0.02 | 0.02 | 0.02 | 0.02 |

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| Northern Farm 3 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario: | Scenario 3.1 | Scenario 3.2 | Scenario 3.3 | Scenario 3.4 | Scenario 3.5 | Scenario 4.3 | Scenario 7.1 | Scenario 7.2 | Scenario 7.3 | Scenario 8.2 | Scenario 8.4 | Scenario 12.1 |
| Total Methane: | 1,863.68 | 1,827.47 | 1,795.89 | 1,941.74 | 1,967.86 | 1,905.82 | 1,920.34 | 1,923.96 | 1,923.96 | 1,504.93 | 1,693.05 | 1,881.16 |
| Total Nitrous Oxide: | 213.97 | 211.47 | 209.06 | 309.56 | 223.18 | 215.26 | 265.40 | 267.77 | 268.58 | 211.96 | 211.96 | 211.96 |
| ADJUSTMENT: TREES - Carbon sequestration | | | | | | | | | | | | - 420.20 |
| Total Emissions: | 2,077.65 | 2,038.94 | 2,004.95 | 2,251.30 | 2,191.03 | 2,121.07 | 2,185.75 | 2,191.73 | 2,192.53 | 1,716.89 | 1,905.01 | 1,672.92 |
| Total emissions/hectare: | 0.63 | 0.62 | 0.61 | 0.69 | 0.67 | 0.65 | 0.67 | 0.67 | 0.67 | 0.52 | 0.58 | 0.51 |
| Scenario emission change from base (Revised comparison) | -1% | -3% | -4% | 8% | 5% | 1% | 4% | 5% | 5% | -18% | -9% | -20% |
| BEEF-BREEDING (spring calving) | | - 54.18 | | | | | | | | | | |
| Total Methane: | 1,761.25 | 1,725.05 | 1,693.47 | 1,839.31 | 1,860.48 | 1,905.82 | 1,713.20 | 1,713.20 | 1,713.20 | 1,422.99 | 1,600.86 | 1,778.74 |
| Total Nitrous oxide: | 153.07 | 150.57 | 148.16 | 160.82 | 161.88 | 162.55 | 146.16 | 146.16 | 146.16 | 151.06 | 151.06 | 151.06 |
| TOTAL EMISSIONS: | 1,914.33 | 1,875.62 | 1,841.63 | 2,000.14 | 2,022.36 | 2,068.37 | 1,859.36 | 1,859.36 | 1,859.36 | 1,574.05 | 1,751.93 | 1,929.80 |
| Total emissions/DSE: | 0.15 | 0.15 | 0.15 | 0.16 | 0.16 | 0.16 | 0.15 | 0.15 | 0.15 | 0.13 | 0.14 | 0.15 |
| BEEF-BREEDING (autumn calving) | | | | | | | | | | | | |
| Total Methane: | 102.42 | 102.42 | 102.42 | 102.42 | 107.38 | - | 102.42 | 102.42 | 102.42 | 81.94 | 92.18 | 102.42 |
| Total Nitrous oxide: | 8.19 | 8.19 | 8.19 | 8.19 | 8.59 | - | 8.19 | 8.19 | 8.19 | 8.19 | 8.19 | 8.19 |
| TOTAL EMISSIONS: | 110.62 | 110.62 | 110.62 | 110.62 | 115.97 | - | 110.62 | 110.62 | 110.62 | 90.13 | 100.37 | 110.62 |
| Total emissions/DSE: | 0.23 | 0.23 | 0.23 | 0.23 | 0.24 | - | 0.23 | 0.23 | 0.23 | 0.18 | 0.20 | 0.23 |
| SHEEP | | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | | |
| Total emissions/DSE: | | | | | | | | | | | | |
| FEEDLOT | | | | | | | | | | | | |
| Total Methane: | | | | | | | 104.72 | 108.33 | 108.33 | | | |
| Total Nitrous oxide: | | | | | | | 58.34 | 60.71 | 61.52 | | | |
| TOTAL EMISSIONS: | | | | | | | 163.07 | 169.05 | 169.85 | | | |
| Total Emissions/head: | | | | | | | 2.43 | 2.52 | 2.54 | | | |
| DRYLAND CROPPING | | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | | |
| Total Nitrous oxide: | | | | | | | | | | | | |
| TOTAL EMISSIONS: | | | | | | | | | | | | |
| Total Emissions/hectare: | | | | | | | | | | | | |
| PASTURES | | | | | | | | | | | | |
| Total Methane: | | | | | | | | | | | | |
| Total Nitrous oxide: | 52.70 | 52.70 | 52.70 | 140.55 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 |
| TOTAL EMISSIONS: | 52.70 | 52.70 | 52.70 | 140.55 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 | 52.70 |
| Total Emissions/hectare: | 0.02 | 0.02 | 0.02 | 0.06 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |

*Default: was calculated by using the farm relevant National Greenhouse Gas Inventory methodology in the FarmGAS tool.

† Revised: was calculated by inputting the User defined farm information in the FarmGAS tool.