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Analysis of the carbon footprint of Rural Funds Management's livestock production

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Abstract

Rural Funds Management (RFM) is working towards carbon neutrality in its livestock operations. This project determines a greenhouse gas (GHG) emissions baseline for RFM's livestock operations and provides the industry with a carbon footprint case study for a large-scale Queensland beef producer and a NSW cattle and sheep producer. Therefore, this project demonstrates the process required for other producers to follow on the path towards carbon reduction and neutrality.

This report provides a summary of RFM's calculated emissions outputs using the IPCC methodology and provides an analysis on these outputs. The emissions outputs from RFM's properties were compared with other published studies and provide a benchmark for other producers.

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1 Project Description and Background

Rural Funds Management (RFM) is an agricultural fund manager who manages assets and enterprises across a range of agricultural sectors. Livestock (especially beef cattle) form a major part of RFM's operations. RFM's livestock operations are made up of two major components: breeding and backgrounding cattle in northern and central Queensland (managed by Cattle JV, a wholly-owned subsidiary of RFM) and a smaller-scale sheep and cattle operation in the Riverina region of NSW.

Existing research (Browne et al. 2011; Smetana et al. 2015; Gerssen-Gondelach et al. 2017) has demonstrated that meat from ruminant animals has a higher carbon footprint than other types of farm produce, including meat alternatives. MLA reported that in 2016 the red meat industry emitted approximately 10% of Australia's total greenhouse gas (GHG) emissions. This has influenced some consumers to hold a negative view of the red meat industry and red meat consumption. In order to address these concerns the red meat industry has set a target of becoming carbon neutral by 2030.

A number of farms have demonstrated that substantial reductions in GHG emissions can be achieved (Doran-Browne *et al.* 2018) and that carbon neutrality is possible (Doran-Browne *et al.* 2016). RFM is also working towards this goal of carbon neutrality. This project determines a GHG emissions baseline for RFM's Queensland and New South Wales properties. This project also provides the industry with a carbon footprint case study for a large-scale beef producer and a cattle and sheep producer, thus demonstrating the process required for other producers to follow on the path towards carbon reduction and neutrality. Therefore, this project provides a learning experience for other enterprises, both large and small. This case study covers specific parts of the supply chain that haven't been as rigorously investigated in other areas.

2 Project objectives

- Calculation of RFM's total livestock emissions, emissions intensity and other relevant metrics;
- Establish baseline measures for each farm type;
- Comparison of results with similar farm enterprises in scientific literature; and
- Report presenting results and an explanation of the methods used to calculate emissions and an interpretation of the results, including comparisons with other published works. The report will be endorsed by the University of Melbourne.

3 Methodology

3.1 Method - Calculations of greenhouse gas (GHG) emissions

This project calculated the carbon footprint for the following RFM properties and time periods:

- Queensland:
    - Beef farm 1, 2018-19, 2019-20 (partial);
    - Feedlot, 2019-20 (partial);
    - Beef farm 2, 2016-17, 2017-18, 2018-19; and
    - Beef farm 3, 2016-17, 2017-18, 2018-19, 2019-20 (partial).
- New South Wales:
    - NSW Beef farm, 2016-17, 2017-18, 2018-19, 2019-20 (partial); and
    - NSW Sheep farm, 2016-17, 2017-18, 2018-19, 2019-20 (partial).

The GHG emitted for each RFM property was calculated using the IPCC methodology, as described in the Australian National Inventory (Australian Government 2017). The most current Global Warming Potential (GWP) values were used from the National Inventory for methane and nitrous oxide at 25 and 298, respectively (Australian Government 2017). The accounting methods used were also consistent with the Minimum Standards for Carbon Accounting and Carbon Footprints for Sheep and Beef Farms (Wiedemann 2020).

The method was extracted into spreadsheets and restricted to a farm boundary, with spreadsheets calculating baseline methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). The sources of on-farm GHG emissions calculated were enteric CH4 from livestock, waste management and burning of crop stubble, N_2O from fertiliser, waste management, soil cultivation, dung and urinary depositions, crop residues and indirect sources of N_2O that included N losses from leaching, runoff and ammonia volatilisation. The production of CO_2 emissions was also accounted for from the use of diesel, petrol and electricity. Appendix A lists the sources of activity data used for Scope 1,2 and 3 emissions.

Pre-farm emissions were calculated for additional livestock that were purchased on the beef farms and that were outside of the usual self-replacing herd system. Pre-farm emissions were also included from the production of supplementary feeds and the production of fertilisers.

Protein mass allocation (Wiedemann *et al*. 2015) was applied on sheep farms to allocate a portion of the emissions to sheep meat. Consistent with standards for Life Cycle Assessment (ISO 2006), the remaining emissions were attributed to wool production and therefore excluded from the study. Sequestration from vegetation and soil changes was excluded from the current study but may be included in the future, along with other GHG mitigation and offset activities.

3.2 Total emissions, emissions intensity and avoided emissions

While total farm emissions (t CO_2e) is an important measure of farm emissions, emissions intensity (t CO_2e/t product) is a common metric used to present emissions from farming enterprises. Emissions intensity is a measure of farm efficiency because it compares the GHG emissions generated to make a certain amount of farm produce. Therefore, while the total level of emissions may increase with higher levels of production, emissions intensity can go down, especially on a well-managed farm, and significant levels of emissions can be avoided. Avoided emissions are emissions that would have been produced if the emissions intensity had continued at a higher level.

4 Results and Discussion

4.1 Greenhouse gas emission (GHG) outputs across all properties

Total emissions from all farms were similar between 2016-17 to 2018-19 (Fig. 1). However, the total amount of livestock sold over this period increased, resulting in a decrease in emissions intensity (Fig. 2). Emissions intensity was combined for Queensland properties due to the transfer of cattle between each property. In Queensland and New South Wales, emissions intensity dropped by 43% and 17%, respectively from 2016-17 to 2018-19. The overall pattern of declining emissions intensity is ideal as it reflects improved efficiencies on the farm through reduced emissions, increased production or both.

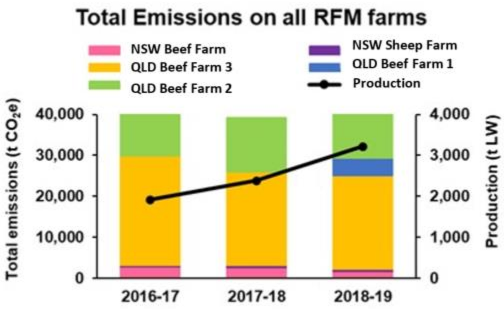


Fig. 1. Comparison of beef yields and total beef farm across all properties

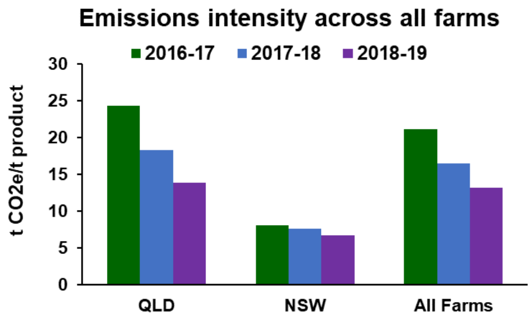


Fig. 2. Total Emissions intensity on the QLD, farms, NSW farms and all farms

Although total emission rose slightly between 2016-17 and 2018-19, emissions intensity declined and this resulted in 10,994 t CO_2e of avoided emissions by 2018-19 (Table 1). This figure shows the additional GHG emissions that would have been produced if emissions intensity had stayed at 2016-17 levels. A reduction of this magnitude in emissions is the equivalent of running about 2,800 average Australian cars for a year.

The net farm emissions from each farm, along with a breakdown by GHG (carbon dioxide, methane, nitrous oxide) are shown in the tables below for Queensland (Table 2) and New South Wales properties (Table 3).

Table 1: Total emission, emissions intensity, avoided emissions and reduced emissions for New South Wales, Queensland and all properties. The green cells show where emissions have decreased or been avoided. The last column showing All RFM properties is calculated from total emission figures and total production across all properties.

	Queensland properties			New South Wales properties			All RFM properties		
Type of greenhouse gas emissions	**2016-17**	**2017-18**	**2018-19**	**2016-17**	**2017-18**	**2018-19**	**2016-17**	**2017-18**	**2018-19**
Total farm emissions, incl pre-farm (t CO_2e)*	32,276	36,064	40,313	3,130	3,065	2,134	40,406	39,129	42,447
Emissions Intensity (t CO_2e/t LW meat)*	24.4	18.3	13.9	5.1	5.3	8.4	21.1	16.5	13.2
Total avoided emissions since 2016-17, calculated from Emissions Intensity (t CO_2e)		-12,061	-30,369		13	168		-10,994	-10,549
Total reduced emissions since 2016-17 (t CO_2e)		-1,213	3,036		-2	-33		-1,278	2,041

CO_2e, carbon dioxide equivalents;

Table 2: Total emission, emissions intensity, avoided emissions and reduced emissions for the feedlot and RFM's Queensland properties

Queensland properties	**QLD feedlot**	**QLD Farm 1**		**QLD Farm 2**			**QLD Farm 3**			
Type of greenhouse gas emissions	**2019-20**	**2018-19**	**2019-20**	**2016-17**	**2017-18**	**2018-19**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
CO_2 (t CO_2e)	20	274	291	217	163	758	365	349	415	416
CH_4 (t CO_2e)	710	2,279	1,228	9,426	11,417	11,200	18,239	20,729	20,984	20,182
N_2O (t CO_2e)	250	80	42	641	894	905	737	826	829	635
Total farm emissions, incl pre-farm (t CO_2e)*	1,208	4,240	1718	10,464	13,228	13,114	26,813	22,836	22,959	21,778
Emissions Intensity (t CO_2e/t LW beef)*		8.1	5.4	10.7	7.2	7.2	48.8	160.0	40.6	61.0

***** emissions intensity is calculated from both QLD Beef farm 2 and QLD feedlot figures

CH_4, methane; CO_2, carbon dioxide; CO_2e, carbon dioxide equivalents; N_2O, nitrous oxide

Table 3: Total emission, emissions intensity, avoided emissions and reduced emissions for RFM's New South Wales properties

New South Wales properties	**NSW - Sheep GHGE**				**NSW - Beef GHGE**			
Type of greenhouse gas emissions	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
CO_2 (t CO_2e)	7	7	9	3	10	13	14	4
CH_4 (t CO_2e)	426	421	327	43	2,164	2,005	1,331	570
N_2O (t CO_2e)	28	28	23	1	143	132	88	28
Total farm emissions, incl pre-farm	464	462	430	47	2,666	2,603	1,704	602
Emissions Intensity (t CO_2e/t LW beef)	5.1	5.3	8.4	0.5	9.0	8.3	6.4	1.5

CH_4, methane; CO_2, carbon dioxide; CO_2e, carbon dioxide equivalents; N_2O, nitrous oxide

Total emissions for 2019-20 were reported separately since the data are incomplete. These outputs are provided to give an indication of current estimates in the year to date (Fig. 3).

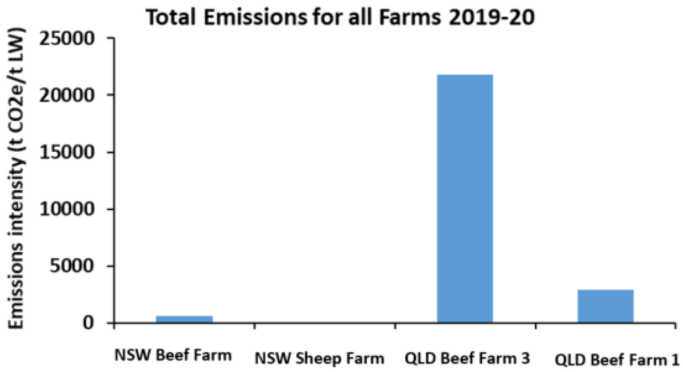


Fig. 3. Total Emissions to date on farms for the current 2019-20 year

4.2 Queensland beef operations

Throughout this report, a system boundary was drawn around the Queensland properties rather than analysing the properties individually. This was to avoid double-counting of pre-farm emissions or the production of stock, since stock were both transferred between the properties, as well as sold from each property. The Gulf property in particular transferred (as opposed to sold) a high percentage of stock, at 20%-85% for finishing elsewhere. Therefore, the emissions intensity at the Gulf property appeared high, but if transferred stock were included emissions intensity would be around 15-25 t CO_2e/t LW beef. In 2017-18 emissions intensity at the Gulf property was especially high (Table 1) due to 85% of stock that left the property being transferred to Rewan.

The Queensland beef operations had a declining trend for emissions intensity (Fig. 4). Since the bulk of stock are located on the Queensland beef farms this drove the reduction in total emissions intensity (see column "All RFM properties", Table 1, and Fig. 2). Further analysis is required to investigate the definitive causes of this reduction in emissions intensity. However, as total emissions were similar across the study period but liveweight production rose (Fig. 5) there is evidence that this reduction in emissions intensity was due to production efficiencies achieved on farm such as improving feed quality and animal management to achieved increased weight gains.

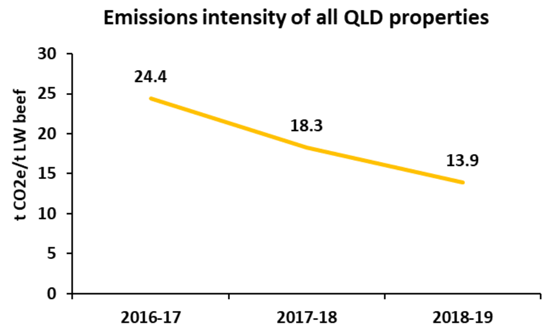


Fig. 4. Emissions intensity of QLD properties

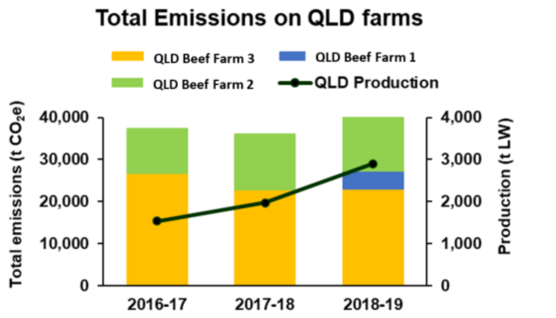


Fig. 5. Total Emissions and beef production on the QLD properties

4.3 New South Wales sheep and beef properties

Stock were sold off the NSW sheep and beef properties in 2018-19 and 2019-20 due to drought. Restocking has not yet occurred. These activities would have influenced emissions intensity over this time. The NSW beef operation showed a consistent decline in emissions intensity over the thee full years (Fig. 6 and 7).

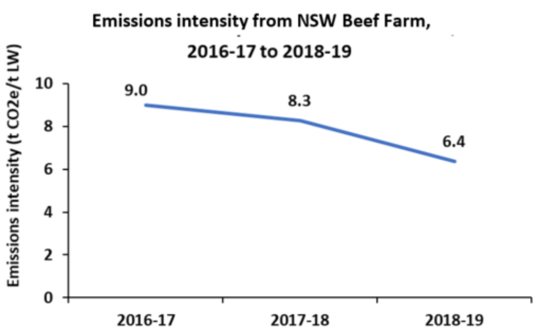


Fig. 6. Emissions intensity on the NSW

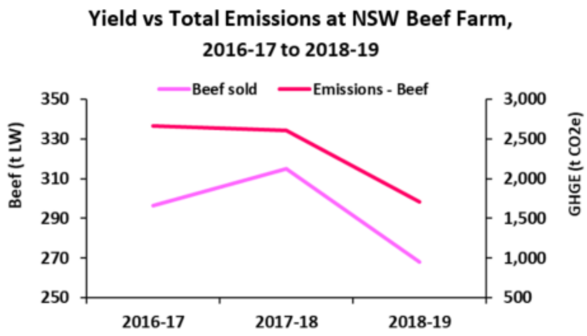


Fig. 7. Comparison of beef yields and total beef farm emissions at the NSW property

The sheep operation in NSW showed an increase in emissions intensity from 2016-17 to 2018-19 (Fig. 8 and 9).

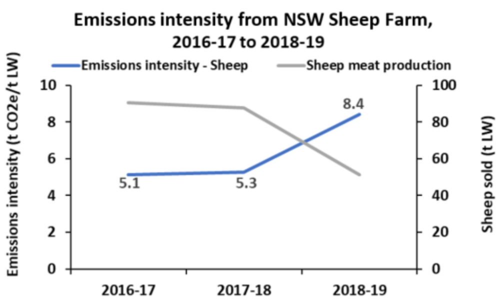


Fig. 8. Emissions intensity and production on the NSW sheep property

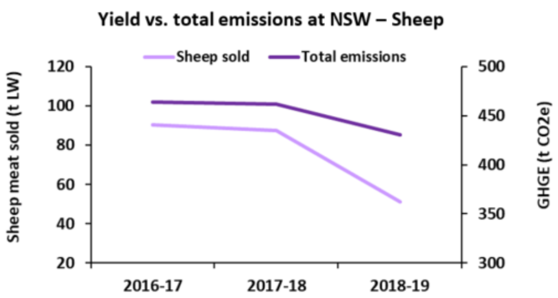
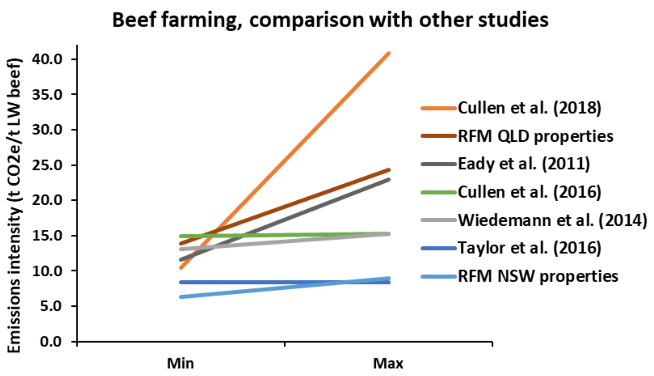


Fig. 9. Comparison of sheep yields and total emissions at the NSW operation

4.4 Comparison with other studies

The emissions intensity of RFM's Queensland beef farms was towards the upper end of what you would expect to see for rangeland beef farms (Fig. 10 and 11) but the NSW beef farm had a lower emissions intensity than other rangeland farms.



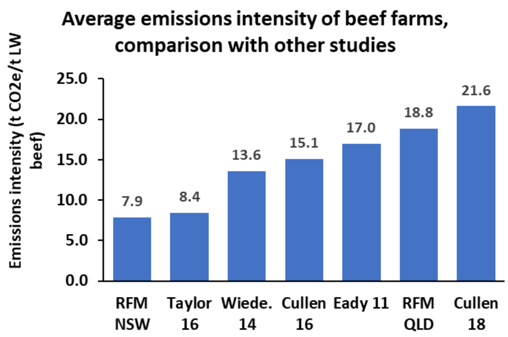
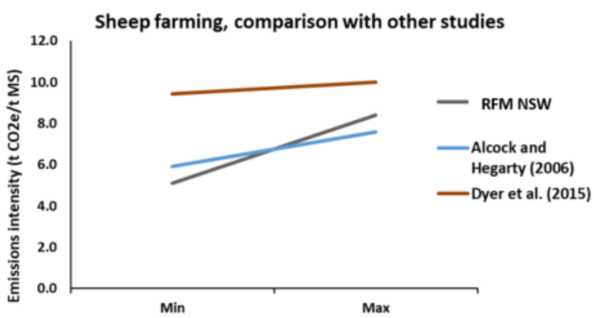


Fig. 10. Comparison of a range of emissions intensity from rangeland beef studies (Eady *et al.* 2011; Wiedemann *et al.* 2014; Cullen *et al.* 2016; Taylor *et al.* 2016; Cullen *et al.* 2018)

Fig. 11. Comparison of the average emissions intensity from rangeland studies (Eady *et al.* 2011; Wiedemann *et al.* 2014; Cullen *et al.* 2016; Taylor *et al.* 2016; Cullen *et al.* 2018)

Similarly, Fig. 12 and 13 compare the NSW sheep farm with other studies. Limited studies exist for the emissions output of Australian sheep farms in rangeland areas, so a comparison was made with a farm in southern New South Wales (Alcock and Hegarty 2006) and with rangeland sheep systems in Canada (Dyer *et al.* 2015). The NSW farm compared well with these studies.



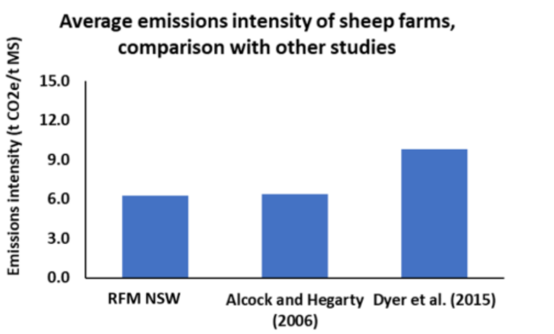


Fig. 12. Comparison of emissions intensity from sheep studies (Alcock and Hegarty 2006; Dyer et al. 2015)

Fig. 13. Comparison of the average emissions intensity from other studies (Alcock and Hegarty 2006; Dyer et al. 2015)

5 Conclusions/recommendations

This report provides baseline figures for RFM's Queensland Beef properties and New South Wales properties beef and sheep properties. The results show the improvements that have been made in emissions intensity over the past few years. Emissions intensity can provide an indication of the efficiency of a farm system.

The decrease in emissions intensity on the Queensland properties were especially promising since total emissions were similar across all years, but beef production increased nonetheless. While the NSW beef properties also improved emissions intensity over three years, they were destocked due to drought and it would be beneficial to examine trends over a longer period in the future to negate the effect of seasonal conditions and to ensure these gains continue with restocking.

On all properties, further improvements could be made through ongoing programs to increase forage quality and improve animal management. This could occur in conjunction with an analysis on carbon sequestration in trees and soils to improve RFM's environmental profile.

6 Key messages

- This project provides baseline emissions for a case study that consists of multiple rangeland beef and sheep properties in Queensland and New South Wales;
- Other Australian producers can use the emission outputs to benchmark their own emissions estimates against; and
- Increasing awareness of the carbon account of farms and awareness of emissions reduction assists the industry towards its 2030 carbon neutral target.

7 References

Alcock D, Hegarty RS (2006) Effects of pasture improvement on productivity, gross margin and methane emissions of a grazing sheep enterprise. *International Congress Series* **1293**, 103–106.

Australian Government (2017) National Inventory Report 2015 Volume 1. Commonwealth of Australia, Canberra Australia.

Browne NA, Eckard RJ, Behrendt R, Kingwell RS (2011) A comparative analysis of on-farm greenhouse gas emissions from agricultural enterprises in south eastern Australia. *Animal Feed Science and Technology* **166–67**, 641–652. doi:10.1016/j.anifeedsci.2011.04.045.

Clean Energy Regulator (2018) Greenhouse gases and energy. Accessed 1st May 2020. http://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme/Greenhouse-gases-and-energy.

Cullen BR, Eckard RJ, Timms M, Phelps DG (2016) The effect of earlier mating and improving fertility on greenhouse gas emissions intensity of beef production in northern Australian herds. *Rangeland Journal* **38**, 283–290. doi:10.1071/RJ15063.

Cullen BR, Macleod ND, Scanlan JC, Doran-Browne N (2018) Influence of climate variability and stocking strategies on greenhouse gas emissions (GHGE), production and profit of a northern Queensland beef cattle herd. *Animal Production Science* **58**, 990–997. doi:10.1071/AN15608.

Doran-Browne N, Wooton M, Taylor C, Eckard R (2018) Offsets required to reduce the carbon balance of sheep and beef farms through carbon sequestration in trees and soils. *Animal Production Science* **58**, 1648–1655. doi:http://dx.doi.org/10.1071/AN16438 Offsets.

Doran-Browne N, Ive J, Graham J, Eckard R (2016) Carbon neutral wool farming in south eastern Australia. *Animal Production Science* **56**, 417–422. doi:10.1071/AN15541.

Dyers JA, Verge XPC, Desjardins RL, Worth DE (2015) An assessment of greenhouse gas emissions from co-grazing sheep and beef in Western Canadian Rangeland. In 'Agriculture Management for Climate Change' (Eds MP McHenry, SN Kulshreshtha, S Lac)(Nova Publishers: New York, USA)

Eady S, Viner J, McDonnell J (2011) On-farm greenhouse gas emissions and water use- Queensland beef case studies. **51**, 667–681.

Gerssen-Gondelach SJ, Lauwerijssen RBG, Havlík P, Herrero M, Valin H, Faaij APC, Wicke B (2017) Intensification pathways for beef and dairy cattle production systems: Impacts on GHG emissions, land occupation and land use change. *Agriculture, Ecosystems and Environment* **240**, 135–147. doi:10.1016/j.agee.2017.02.012.

ISO (2006) ISO 14044:2006 Environmental management – Life cycle assessment – Requirments and guidelines. International Standard Organisation. Accessed 1st May 2020. <https://www.iso.org/obp/ui/#iso:std:iso:14044:ed-1:v1:en>

Smetana S, Mathys A, Knoch A, Heinz V (2015) Meat alternatives: life cycle assessment of most known meat substitutes. *International Journal of Life Cycle Assessment* **20**, 1254–1267. doi:10.1007/s11367-015-0931-6.

Taylor CA, Harrison MT, Telfer M, Eckard R (2016) Modelled greenhouse gas emissions from beef cattle grazing irrigated leucaena in northern Australia. *Animal Production Science* **56**, 594–604.

Wiedemann SG (2020) Minimum Standards for Carbon Accounting and Carbon Footprints for sheep and beef farms (Draft, version 2.0). Integrity Ag & Environment, Highfields Australia.

Wiedemann SG, Henry BK, McGahan EJ, Grant T, Murphy CM, Niethe G (2015) Resource use and greenhouse gas intensity of Australian beef production: 1981–2010. *Agricultural Systems* **133**, 109–118. doi:http://dx.doi.org/10.1016/j.agsy.2014.11.002.

Wiedemann SG, Ledgard SF, Henry BK, Yan M-J, Mao N, Russell SJ (2015) Application of life cycle assessment to sheep production systems: investigating co-production of wool and meat using case studies from major global producers. *International Journal of Life Cycle Assessment* **20**, 463–476. doi:10.1007/s11367-015-0849-z.

8 Appendix A: Sources of activity data

This analysis included Scope 1, 2 and 3 emissions as defined below by the Clean Energy Regulator (2018):

- Scope 1 – emissions from the direct result of activities
- Scope 2 – indirect emissions from the consumption of energy
- Scope 3 – indirect emissions other than Scope 2 emissions.

All emissions below are Scope 1, except where otherwise specified.

Livestock source of activity data

RFM activity data was used for:

- Livestock numbers throughout the year
- Livestock weight
- Livestock growth rates
- Pregnancy/lactation status
- Feed intake at the QLD feedlot

RFM's Feed Tests and published literature (scientific or industry reports) was used for:

- Crude Protein for pasture and supplementary feed, nitrogen content of feed (feedlot only)
- Dry matter digestibility of pasture and supplementary feed

Published literature (scientific or industry reports) was used for:

- Specific feed characteristics of feed used in feedlot (e.g. cellulose, hemicellulose, soluble residue)

The following activity data were excluded because the activities were not carried out at RFM:

- Residue mass to calculate burning of crops

Fertiliser and crop source for activity data

RFM activity data was used for:

- Area of land used for pasture and crop growth
- N content of fertiliser applied to crops or pasture
- Urea N applied to crops and pasture
- Limestone applied to soils

Energy and fuel source for activity data

RFM activity data was used for:

- On-farm diesel and petrol use
- Scope 2: Use and source of electricity
- Scope 3: The production of off-farm inputs (fertiliser, replacement livestock, fodder, grain, supplements)