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Beef Industry trends analysis - 2020

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Abstract

The Australian beef industries' sustainability framework reports key environmental metrics for the industry as a whole. As part of tracking performance towards the aspirational goal of establishing a carbon neutral beef industry, the framework tracks the carbon footprint of the slaughter herd.

This metric requires a robust analysis of the environmental impacts of the whole beef industry. To achieve this, the author previously developed a herd inventory and life cycle assessment model, and results were released for the 35 years leading up to 2015. To investigate recent performance and to report against industry goals, the present study updated the results for the five years to 2020 for the production of slaughter cattle. In addition to assessing changes in the industry over this time, results from the whole time series were revised to reflect methodological improvements in impact assessment and herd inventory development. The two major changes in the current analysis period were the update of emissions to apply AR5 GWP_{100} factors of 28 for methane and 265 for nitrous oxide, resulting in an increase in reportable impacts across the time series, and the revised methane prediction formula for feedlot cattle, which was revised to align with the IPCC (2019) method. This resulted in reduced methane emission predictions from the feedlot herd, supported by recent Australian research.

Total beef production from the Australian beef herd (excl. live export and dairy herd) has increased over the past 40 years to a peak of 67% in 2015, declining to a 58% increase in 2020, while estimated beef cows joined to produce slaughter calves decreased 12% over the same period, indicating a substantial improvement in herd productivity; more beef turnoff from fewer breeder cows and a smaller livestock inventory. In the most recent five-year period, carcase weights increased by 9%, further driving an increase in beef production per cow joined. Growth rates in young cattle were estimated to have increased by 3% in the past five years, principally in response to higher proportions of cattle fed in feedlots. The analysis revealed a 2.2% decline in GHG emission intensity (excl. LU and dLUC) in the most recent period and a 22% decline in emissions intensity over the whole analysis period, from 16.7 kg CO_2-e kg LW^{-1} in the five years to 1985, to 13.1 kg CO_2-e kg LW^{-1} in the five years to 2020 (all values updated to AR5 GWP_{100} values). This was principally in response to reductions in enteric methane. Total freshwater consumption was found to decline 18% in the most recent five-year period and was 400 L kg LW^{-1}. This was 73% lower than the five years to 1985.

Executive Summary

Introduction

Beef production in Australia is largely characterised by extensive, low-intensity northern production and higher-intensity southern pasture systems producing feeder steers for grain finishing and a proportion of cattle for processing. The Australian beef herd has changed significantly since the 1970s, largely due to disease eradication, the increased proportion of environmentally adapted *bos indicus* breeds, genetic selection for meat quality, improved transportation, integration of large northern cattle operations, continued expansion of lot feeding, the opening of large export markets and land development. These changes have resulted in a consistent trend towards increased slaughter weights over the past 40 years (ABS 2018). Meat quality assurance programs such as Meat Standards Australia (Polkinghorne *et al.* 2008; MSA 2011) have also promoted the production of younger slaughter cattle in order to receive market premiums.

Previous research by Wiedemann et al. (2015, 2019) showed that increased livestock productivity in the Australian herd led to reduced environmental impacts. Using life cycle assessment (LCA), these authors identified a 20% reduction in greenhouse gas emissions and a 68% reduction in freshwater consumption over 35 years (Wiedemann *et al.* 2019). In contrast, fossil energy use was found to increase as the industry relied more on intensive production systems. In order to observe changes in environmental performance and to report against the metrics and goals of the Australian Beef Sustainability Framework, the present study updated the results for the five years to 2020. In addition to assessing changes in the industry over this time, results from the whole time series were revised to reflect methodological changes and improvements with respect to the assessment of methane and to apply updated GWP_{100} factors.

Methods

The study investigated GHG emissions and applied the Intergovernmental Panel on Climate Change (IPCC) AR5 global warming potentials of 28 for CH_4 and 265 for N_2O (IPCC 2015) as applied in the Australian National Inventory Report (Commonwealth of Australia 2023). These were applied across the whole trend series in the present year. GHG emissions arising from land use (LU) and direct land use change (dLUC) were not reported in the current year as these are reported separately as part of the net emissions of the industry.

Freshwater consumption was also assessed using methods previously developed by the authors (Wiedemann *et al.* 2015). Modelling was conducted using SimaPro (Pré-Consultants, 2022).

The study examined the primary production system (i.e., cradle to farm gate) using a reference flow of one kilogram of live weight (LW) on-farm immediately prior to processing. The system included the national beef herd that produces cattle processed in Australia and specifically excluded the dairy herd and beef derived from dairy production and the live export herd, including beef from this herd (Figure 1).

The herd was modelled at 5-year intervals, with each period reflecting average production over those five years. The Australian beef herd was modelled using a revised inventory developed using three primary datasets: Feedlot livestock numbers (ALFA/MLA 2022) number, weight and sex of beef cattle processed (ABS 2020) and herd productivity indicators from the annual ABARES survey (ABARES 2018). The slaughter data were adjusted by removing the contribution of cull dairy cows and progeny to meat production, using dairy herd data from ABARES (2018).

Herd numbers were determined from slaughter data, estimated age and herd productivity indicators (branding/weaning rate and mortality rate). This enabled the estimation of the number of joined cows. Replacement heifers were assumed to be held in the herd to replace cows sold for slaughter (estimated to be 13%) and annual mortality. Bull inclusion rates were estimated to be 4% of the cow herd.

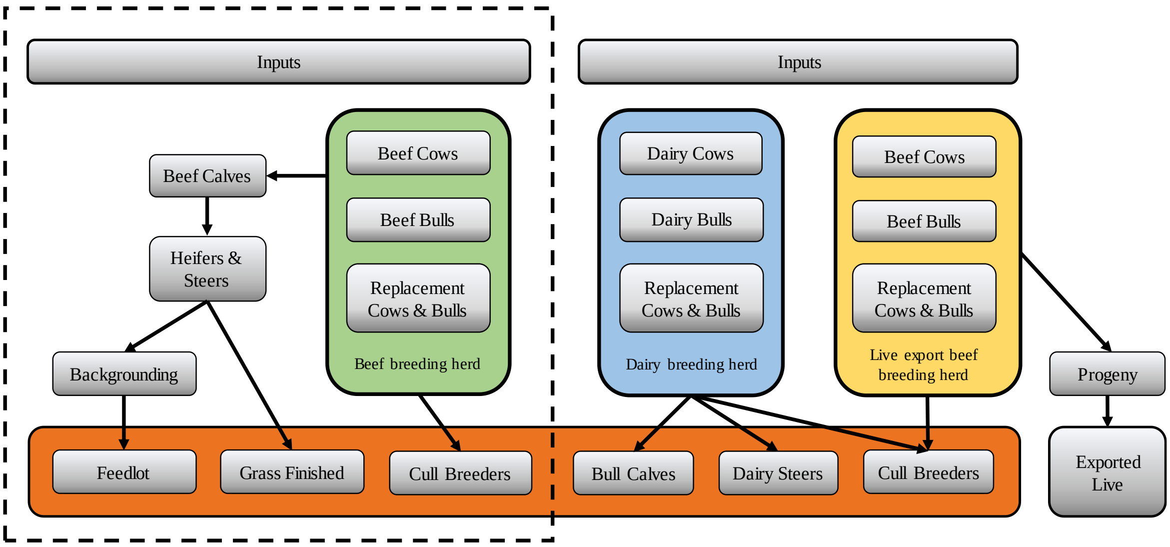


Figure 1. System boundary diagram showing coverage of the cradle-to-farm gate primary production system producing beef cattle processed in Australia

(dashed line) and excluded production systems – live export cattle, and beef from dairy herds.

Purchased inputs on grazing farms, including livestock feed, services, fuel and fertilisers, were determined from ABARES (2018) using the methods of Wiedemann et al. (2015). The inventory values used for energy and services used for the feedlot were from Davis et al. (2009), as applied in Wiedemann et al. (2017).

Background data for upstream processes such as generation and supply of energy and purchased products such as fertiliser were sourced from the Australian LCI database (Life Cycle Strategies 2015). Feed grain inputs were modelled using inventory data from Wiedemann et al. (2017) and the Australian National Life Cycle Inventory Database (AusLCI) (ALCAS 2017).

Fresh water consumption is inclusive of cropping irrigation, pasture irrigation, livestock drinking water, and the associated supply losses, which were modelled using water use data from ABS for irrigation water use and drinking water use was predicted from the livestock inventory using the prediction equation derived from CSIRO (2007) by Ridoutt et al. (2012). Drinking water requirements for feedlot cattle were determined from feed intake and ambient temperature using Winchester and Morris (1956). Drinking water supply loss rates were determined for different sources, and evaporation losses from farm dams were estimated using methods outlined in Wiedemann et al. (2016)..

Livestock GHG emissions were determined using methods reported in the Australian National Inventory Report (Commonwealth of Australia 2023), with the exception of emissions from farm dams, which require further review to verify emission rates in states and regions where dams are rarely used, and where the current method would grossly over-estimate emissions. A further exception was made with enteric methane from feedlot cattle. Multiple research studies (meta-analysis currently in preparation for publication) demonstrate that the mean methane emissions from Australian feedlot cattle are much lower than predicted using the current Australian NGGI method. Measured values (manuscript in preparation) have been found to be similar to the IPCC factors for feedlots and are, therefore, internationally consistent (IPCC 2019). This method is now under review with the Australian NGGI. Considering this, the model was updated to reflect the more recent research, applying methane factors of 13.6 g CH_4 kg DMI^{-1} for long-fed cattle and 10 g CH_4 kg DMI^{-1} for all other classes.

With respect to handling co-products, this was avoided by separating sub-systems at the farm level to divide impacts associated with beef from other agricultural products (i.e., sheep and cereals), The functional unit of the study did not differentiate between beef from different animal classes, and no allocation was performed. Manure nutrients from the grazing herd were assumed to return directly to the pasture and were considered a biological feedback loop without the need for allocation. Manure nutrients from feedlot manure were treated as residuals, following guidance from LEAP (FAO 2016).

Results and Discussion

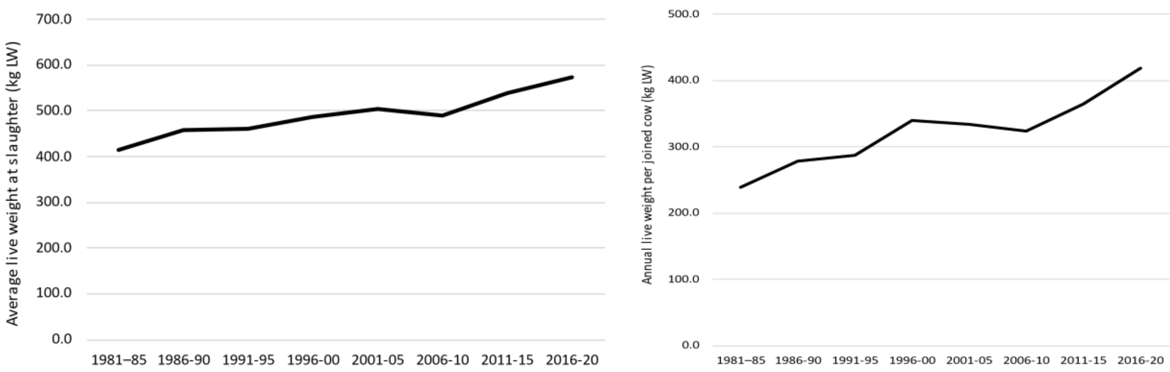
Herd Productivity

Total beef production from the Australian beef herd (excl. live export and dairy) increased over the 40-year analysis period by 67% to 2015. Production was lower in the most recent period at 2.24M tonnes because of the impact of drought conditions, which was 58% above the five years to 1985. The estimated number of beef cows joined to produce slaughter calves decreased by 12% over the same period. This was achieved via an improvement in the weaning rate to 79.3% in the current analysis period, which had increased from 77.6% in the five years to 2015.

Carcase weights increased by 43%, and beef production per cow joined increased substantially over the past 40 years (see Figure 2) while cow numbers declined. This showed a substantial improvement in herd productivity; with more beef turnoff from fewer breeder cows and a smaller livestock inventory. In the most recent five-year period, carcase weights increased by 9%, further driving an increase in beef production per cow joined. Growth rates in young cattle were estimated to have increased by 3% in the past five years, principally in response to higher proportions of cattle fed in feedlots. Young cattle finished on grain increased from 43% in the five years to 2015 to 52% in the five years to 2020, with some individual years being higher still. This was a long-term trend, but the rate of increase accelerated in response to drought conditions in eastern Australia during 2018 and 2019 when very large numbers of cattle were finished in feedlots. While numbers moderated in 2020 and 2021, they remained at very high levels.

In contrast to the trend to date, the age of slaughter steers increased very slightly in the present five-year period. This was partly in response to cattle being held longer to reach heavier market weights and higher returns and partly in response to slower growth rates in drought years when cattle were held longer to reach market weights.

The ongoing trend towards increased carcase weight and ongoing productivity increases in the most recent analysis period were remarkable, considering two years were considered record droughts in many eastern Australian cattle production regions. This can be attributed to the different practices used in the industry in the most recent drought, when many livestock were fed to support cattle production, and many cattle were finished through feedlots. This increased beef turnoff and had further environmental benefits through reducing grazing pressure in the low rainfall years.



A) B)

Figure 2. Changes in A) average live weight at slaughter and B) liveweight produced per joined female over the period 1985 to 2020

Product carbon footprint

In response to herd productivity improvements, the analysis revealed a 2.2% decline in GHG carbon footprint (excl. LU and dLUC) in the most recent period and a 22% decline from 16.7 kg CO_2-e kg LW^{-1} in the five years to 1985 to 13.1 kg CO_2-e kg LW^{-1} in the five years to 2020 (Figure 3). The reduction in emissions was primarily associated with decreased enteric methane emissions, which declined in absolute terms from 15.2 kg CO_2-e kg LW^{-1} to 10.6 kg CO_2-e kg LW^{-1}. The proportion of methane in the emission profile declined from 91% of total impacts in 1985 to 81% in 2020, partly in response to better efficiency in reducing methane and partly because the intensity of production increased, resulting in larger contributions from carbon dioxide associated with energy use.

The trend towards lower carbon footprints was supported by updated enteric methane prediction methods for feedlot cattle, which resulted in emissions being 50% lower while cattle were being grain finished for domestic, short-fed export, and mid-fed classes, compared to grass finishing. This demonstrated the role of grain finishing as a mitigation strategy for the herd, despite the higher inputs required for grain production, grain milling and transport, which were all included in the analysis.

Emission intensity results for the historic trend period (1985-2015) were re-analysed, resulting in slightly higher reported impacts than previously estimated by Wiedemann et al. (2019), because of an update in the GWP_{100} factors applied. Some other changes, such as the revision in feedlot enteric methane prediction, moderated this increase.

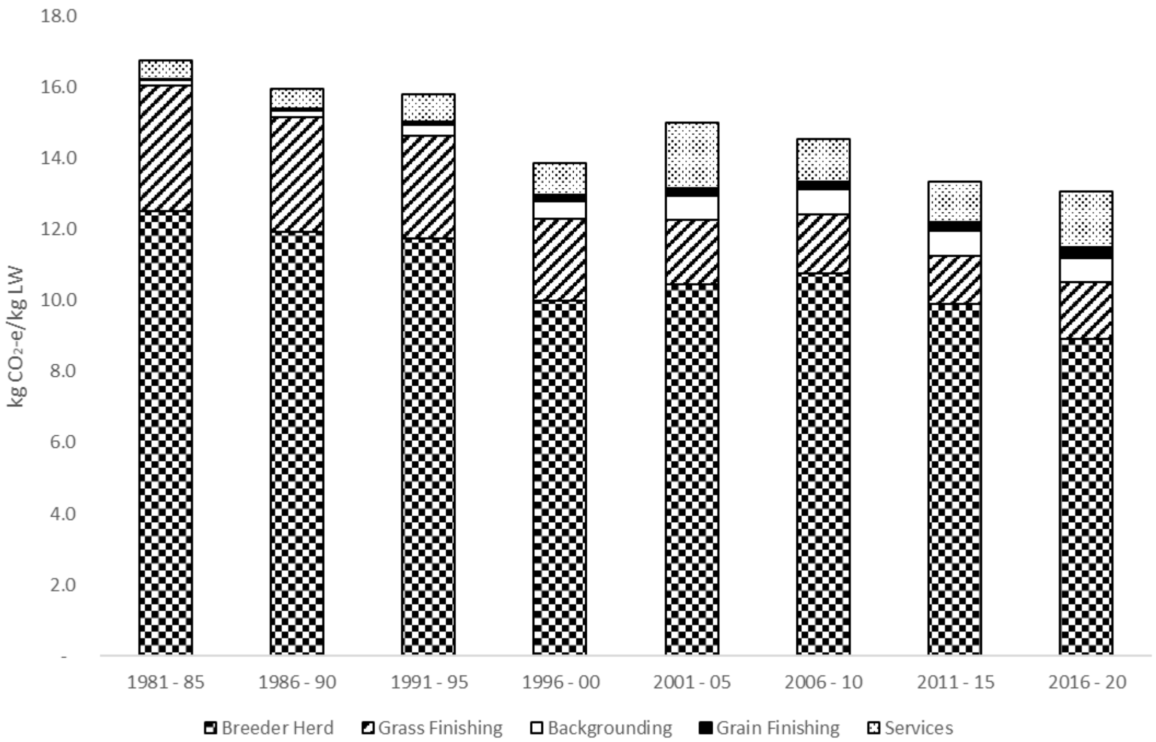
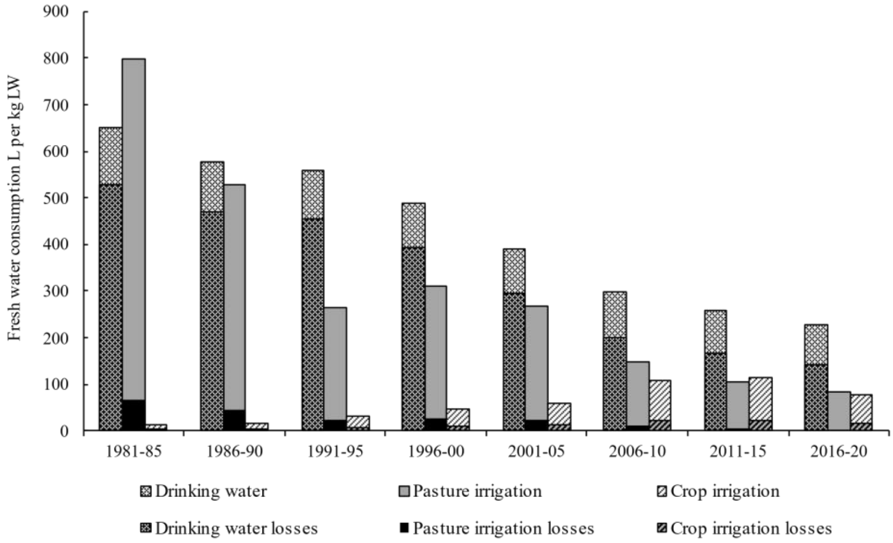


Figure 3. Changes in carbon footprint (excl. LU and dLUC) from the production of 1 kg of liveweight beef ready for slaughter over the period 1985 to 2020

Water Footprint

Total freshwater consumption was found to decline 18% in the most recent five-year period and was 73% lower in the five years to 2020 than in the five years to 1985. Over the 40 years, the dominant trends were the decline in losses associated with drinking water supply and the substantial decline in pasture irrigation, which was partly countered by an increase in irrigation requirements for feedlot ration production (see Figure 4). In the most recent period, declines were observed in irrigation water for pasture production, and drinking water, the latter of which declined in response to improved herd efficiency. Losses associated with irrigation water supply were also found to decline compared to the previous analysis period.



A)

Figure 4. Changes in freshwater consumption from the production of 1 kg liveweight beef over the period 1985 to 2020

Limitations

This study was developed using available datasets and analysis methods, and a series of limitations were observed. A full dataset of slaughter cattle, including sex and dentition, is urgently needed to accurately determine livestock weight and age by different cattle classes. This has a large bearing on herd productivity and the estimation of GHG emissions and drinking water. Further investigation of herd inventories and performance is required to confirm these estimates or to develop a more robust and nationally agreed herd inventory and model. The model depended on performance data from the ABARES survey for key factors such as the weaning rate of the herd. This is the only consistent value collected across the whole nation, and differences between this sample result and the true performance would not be observed in this analysis.

Conclusions

Beef herd productivity has increased substantially over the past 40 years. In the five years to 2020, total beef production declined, but per herd productivity factors, including growth and weaning rates, increased slightly, despite many eastern Australian cattle production regions experiencing record drought during 2018 and 2019. This was partly achieved through much higher proportions of cattle being finished on grain during this period and partly because cattle on grazing farms were supplementary fed to maintain productivity at higher levels than in previous drought periods. Notably, successful drought management in the most recent period resulted in ongoing productivity improvements through intensification to support animal performance. This maintained a slight improvement in carbon footprint compared to the previous period (based on the recalculated value with updated GWP_{100}). The reduction in carbon footprint was supported by revisions to the enteric methane calculation method for feedlot cattle, which resulted in lower emissions while cattle were finished on grain. Water use was found to continue to decrease substantially, largely because of continued declines in irrigation water use for pastures used in beef production.

Substantial improvements in productivity via intensification and better management have led to slightly lower environmental impacts and water use, with ongoing improvements observed in the five years to 2020, despite record drought conditions for two of these years, demonstrating that ongoing practice changes implemented by industry are reducing environmental impacts.

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Supplementary Material - Beef Industry trends analysis - 2020

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Table 1. Water consumption values used to produce Figure 5.

Year	Unit	Total	Drinking water	Drinking water losses	Total drinking water	Pasture irrigation	Pasture irrigation losses	Total pasture irrigation	Crop irrigation	Crop irrigation losses	Total crop irrigation	Other
1981-85	Litres	1,465	119.96	529.69	649.65	730.62	67.77	798.39	10.71	2.74	13.45	3.21
1986-90	Litres	1,128	105.61	471.55	577.15	484.01	44.89	528.90	13.77	3.53	17.30	4.16
1991-95	Litres	861	104.94	454.09	559.04	242.02	22.45	264.47	24.57	6.29	30.86	6.78
1996-00	Litres	858	94.68	394.13	488.81	284.24	26.36	310.60	38.01	9.73	47.74	10.52
2001-05	Litres	728	94.29	294.88	389.17	244.24	22.65	266.89	47.60	12.19	59.79	12.18
2006-10	Litres	567	99.95	198.61	298.56	138.87	10.06	148.93	86.29	22.09	108.39	11.20
2011-15	Litres	486	91.60	166.59	258.19	101.58	4.53	106.12	90.25	23.11	113.36	8.33
2016-20	Litres	400	85.44	142.99	228.43	78.70	3.52	82.22	60.74	15.62	76.36	12.00

Table 2. Greenhouse gas values used to produce Figure 6.

Year	Unit	Total	Breeder Herd	Grass Finishing	Backgrounding	Grain Finishing	Services
1981-85	kg CO2-e/kg LW	16.7	12.5	3.5	0.2	0.0	0.5
1986-90	kg CO2-e/kg LW	16.0	11.9	3.2	0.2	0.1	0.6
1991-95	kg CO2-e/kg LW	15.8	11.7	2.9	0.3	0.1	0.8
1996-00	kg CO2-e/kg LW	13.9	10.0	2.3	0.5	0.2	0.9
2001-05	kg CO2-e/kg LW	15.0	10.5	1.8	0.7	0.2	1.8
2006-10	kg CO2-e/kg LW	14.5	10.8	1.7	0.7	0.2	1.2
2011-15	kg CO2-e/kg LW	13.4	9.9	1.4	0.7	0.2	1.1
2016-20	kg CO2-e/kg LW	13.1	8.9	1.6	0.7	0.3	1.6