

Implications of changing birth and slaughter dates of finishing sheep and beef cattle on greenhouse gas emissions

David R. STEVENS^{1*}, Mike D. ROLLO², Ronaldo E. VIBART³, Jane CHRYSTAL⁴,
Brian SPEIRS⁵, Rob DAVISON⁵, Andrew BURTT⁵.

¹AgResearch, Invermay Research Centre, Private Bag 50034 Mosgiel, New Zealand

²AgResearch, Ruakura Research Centre, Private Bag 3123 Hamilton, New Zealand

³AgResearch, Grasslands Research Centre, Private Bag 11008, Palmerston North, New Zealand

⁴Beef + Lamb New Zealand, PO Box 5501, Dunedin, New Zealand

⁵Beef + Lamb New Zealand, PO Box 121, Wellington, New Zealand

*Corresponding author: David.stevens@agresearch.co.nz

Abstract

Significant variables in the calculation of greenhouse gas (GHG) emissions are estimates of birth date and slaughter date, as these alter the amount of time on-farm and hence feed used for animals destined for slaughter. Analysis of Beef + Lamb New Zealand Economic Service farm survey data calculated average birth and slaughter dates for both finishing sheep and beef cattle at a regional scale, from 1990-2019. Data were then used to calculate the potential GHG emissions related to lambs and slaughter cattle, and changes over time, and were compared to current national inventory calculations. There was no significant change in sheep mating date over the 30-year period, with a median lambing date of 10 September. Beef cattle mating date became later over the 30-year period. These resulted in calving dates of 20 September for the 1990-2000 period, and 25 September for the 2010-2019 period. The proportions of lambs slaughtered by February (early) or October (late), categories used by the National Inventory, have shifted from 84 and 16% respectively in 1990 to 78 and 22% recently. The ages at slaughter of 1–2-year-old heifers and steers were approximately 24 and 35 days younger in 2019 than in 1993 (528 vs 552 days of age at slaughter for heifers and 520 vs 555 days of age at slaughter for steers). The changing proportion of lambs slaughtered early and late had a small effect on total emissions. Later birth dates and earlier slaughter dates have reduced the individual emissions from 1–2-year-old cattle, but individual emissions from older cattle and bulls have changed little over the 27-year period examined.

Keywords: Lambs, Heifers, Steers, Commercial farms, New Zealand Agricultural GHG Inventory Model (AIM).

Introduction

Sheep and beef cattle are one of New Zealand's largest sources of agricultural GHG emissions (Ministry for the Environment 2021). To calculate their contribution to methane and nitrous oxide production, the New Zealand Agricultural GHG Inventory Model (AIM) calculates emissions separately based on 7 sheep and 11 beef cattle livestock classes, based on gender, age and whether they are used for breeding or finishing (MPI 2021).

On commercial farms, birth and slaughter timing varies across years, regions and farm enterprise types, and are affected by prices for livestock and feed availability. It is imperative that the current and historical data used in the AIM methodology are reviewed to ensure that the model accurately reflects past, current and future sheep and beef cattle populations, and hence emissions. These assumptions were last reviewed by Thomson et al. (2010). With more data now available, it is important that all available data is reviewed again, considering any changes from 1990 to present.

The purpose of this project was to review and revise current methods and assumptions in AIM for birth and slaughter dates for individual classes of sheep and beef cattle grown for finishing. This process considered changes that have occurred from 1990 to present, provided enough data were available.

Findings may be used by Ministry of Primary Industries (MPI) to ensure a) a more robust sheep and beef cattle population methodology, and b) a more accurate representation of animal energy requirements of growing animals, and thus feed intake, in the model. Feed intake is a critical variable for estimating agricultural methane and nitrous oxide emissions.

Materials and Methods

We investigated whether an update to the AIM is required. Specifically, the need for changes in the sheep

and beef birth and slaughter dates currently used in the AIM, based on industry datasets. First, we clarified the current assumptions for birth and slaughter dates for each age class, summarised relevant available industry data, and compared GHG emissions estimates between the current assumptions in the AIM and new data regarding sheep and beef cattle birth and slaughter dates.

The New Zealand Agricultural Inventory Model (AIM)

Briefly, calculations in AIM are undertaken on a monthly timestep based on energy requirements per head of livestock, and upscaled with monthly population estimates to provide total national emission estimates (Clark 2008; MPI 2021). AIM currently uses publicly available livestock population data from MPI and provided by Statistics New Zealand (StatsNZ) via Infoshare (<https://infoshare.stats.govt.nz/>). This methodology provides a summary of the parts of AIM which are relevant to this research.

Sheep birth and slaughter dates

The average carcass weights for non-breeding sheep classes can be accessed (using InfoShare) under Industry Sectors – Livestock Slaughtering – Total NZ kill by animal type. Data on the total number (of lambs for example) and total weight can be downloaded. The average weight for lamb slaughter can be calculated by dividing the total weight by the total number of lambs and is an input (activity data) to AIM.

For the lamb category, the current methodology assumes a national average median lambing date of 11 September (MPI 2021). For the months of October to February and for May to August, the population of lambs is reduced according to the following formula:

$$\begin{aligned} & \text{Population of lambs in month } m \\ &= \text{Population of lambs in } (m - 1) \\ & \times \left(1 - \frac{0.045 \times \text{number of days in } (m - 1)}{\text{number of days in year}} \right) \end{aligned}$$

where $m - 1$ is the previous month and 0.045 is the annual lamb death rate (expressed as a proportion) assumed by AIM (MPI 2021).

In March, the population of lambs is assumed to be equal to the preceding July sum of the four growing, non-breeding sheep categories (breeding ewe hoggets, dry ewe hoggets, ram hoggets and wether hoggets), with an adjustment for deaths that occurred between July and March. Every March, 84% of lambs in AIM are sold to slaughter, with the remainder (accounting for deaths) maturing into the hogget category. Therefore, the population of lambs in April is calculated according to the following formula:

$$\text{Population of lambs in April} = \text{Population of lambs in March} \times (1 - 0.84)$$

where 0.84 is the proportion of lambs sold to slaughter in March (MPI 2021).

The following recommendation was from the 2011 Agricultural Inventory Advisory Panel report (Pickering 2011), referring to a panel paper titled “Review of population models within the national methane inventory” (Thomson et al. 2010).

“One slaughter date for lambs in February – change to two slaughter dates with 84 percent of lambs slaughtered 28 February and the remainder 31 August using the average carcass weight for each month as input values.” Thomson et al. (2010) provide details on the basis for the change to two lamb slaughter dates cited above, including justification for the value of 84%.

Beef cattle birth and slaughter dates

The average carcass weights for non-breeding beef classes can be accessed (using InfoShare) under Industry Sectors / Livestock Slaughtering / Total NZ kill by animal type (annual – June). Data on the total graded number (of heifers for example) and total graded weight can be downloaded. The average weight for slaughter cattle can be calculated for 1- to 2- and 2- to 3-year-old heifers, steers and bulls, and is an input (activity data) to AIM.

For the beef category, the current methodology assumes a national average median calf birth date of 20 September (MPI 2021). As the animals age, the proportion of heifers retained as replacements is assumed to be 17% of the population of mature breeding cows. Slaughter heifers are removed from the population in September, while slaughter steers are removed in February (MPI 2021).

Beef cattle classed as growing (either for slaughter or as breeding replacements) have a liveweight which increases linearly from their assigned birth date to the date at which the model deems that they have reached maturity or are slaughtered. Calves are presumed to be weaned at 150 days-of-age (5 months) and be on milk only until then (MPI 2021).

To calculate liveweight, information on mature and slaughter weights are required, along with information or assumptions on the animal birth weight. Results are reported for a Southern Hemisphere growing season, from July to June. Calculations are always made on the physiological year of the animal (i.e., from birth). The physiological year is then mapped to the July-June reporting year. So, the September rising-2-year-old population will have just received the rising-1-year-old population that have turned 12 months of age. As a result of this movement to a new class on birth date, any July rising-2-year-old beef animals are nearly two years

old. These results (reported for the July to June growing year) are then mapped to a calendar year (January to December) for final reporting in the agricultural sector of the national GHG inventory.

Data source

Data were provided by Beef + Lamb New Zealand (B+LNZ, pronounced Beef and Lamb New Zealand). The Economic Service of B+LNZ has been providing reliable, independent information and analysis of the sheep and beef sector since 1950. The Sheep and Beef Farm Survey is a sample survey of 5.6% of the commercial sheep and beef farm population in which the sample is randomly selected from the business frame used in the country's census of agricultural producers to reflect New Zealand's livestock base. A random proportional sample is selected from the distribution of sheep and beef stock units on farms that operate commercially. The commercial farm definition includes farm size (750 or more sheep and beef stock units), 70% or more of farm revenue must be derived from sheep and beef with an exception for mixed cropping farms, which are mainly in Canterbury that farm livestock within crop rotations, at least 80% of the stock units must be sheep and/or beef cattle stock units, and the farm must be run as a commercial sheep and beef farm. This has resulted in an estimated total commercial sheep and beef farm number of 9,165 (compared with 19,600 in 1990-91).

Over 2,000 annual data points are captured to describe each sheep and beef farm business. Information collected by the survey that may be relevant to the birth and slaughter date information required here include information from a diary of all livestock transactions, including date, livestock class/category and carcass or liveweight.

Two datasets were provided that include data from the whole survey: a) "Summary of Sales Transactions: 1990-2019 Survey", and b) "Breeding information: 1990-2019 Survey", a period of 30 years. The first dataset contains 'transaction' data; every transaction is in a row comprising farm class (1 - 8), region (1 - 11) (Table 1), livestock class, weighted date (from 01 Jul 1990 to 30 Jun 2020), average carcass weight per head, average liveweight per head and number of head. The second dataset contains 'breeding' data. In a similar structure, every row has a farm class (1 - 8), region (1 - 11), and mating date, dam to sire, and birth rate percent (per dam mated), for both sheep and cattle.

From the transaction dataset, the first step was to separate sheep from beef classes, followed by a separation of 'intermixed' sales (i.e., prime vs store sales, determined by examining the weight numerical value; prime sales have a carcass weight whereas store sales have a liveweight numerical value). We extracted

information on sheep and cattle birth dates, slaughter dates and carcass weights. A simple comparison of relative intake, using equations published in the Feeding Standards for Australian Ruminants (Corbett et al. 1990) upon which the AIM methodology is based, was made to identify the potential for differences between data of actual slaughter dates (1990-2020) extracted from B+LNZ dataset and the existing assumptions in AIM.

Table 1 Beef + Lamb New Zealand (B+LNZ) regions.

1.	Northland
2.	Waikato – Bay of Plenty
3.	Gisborne
4.	Hawkes Bay
5.	Wairarapa
6.	Taranaki – Manawatu
7.	Nelson – West Coast
8.	Marlborough
9.	Canterbury
10.	Otago
11.	Southland

Analysis

Lamb and calf birth dates

An examination of sheep and beef cattle mating dates was made to determine whether any changes over time had occurred in average birth date of lambs and calves. Start of mating was used as a reference point to determine change over time. Birth date was then calculated to investigate the impacts of potential birth date changes on rate of liveweight gain to slaughter, and hence total feed intake.

The methodology documented by Thomson et al. (2010) was used to determine mean birth dates as follows. Gestation lengths were added to mating dates; 152 days was added to sheep mating date to attain potential start of lambing, and 282 days added to beef cattle mating dates to attain potential start of calving. A median lambing date of 17 days after potential start of lambing was chosen. For cattle, birth date was calculated using a 21-day cycle, assuming equal number of cows cycling each day, with a 70% conception success in each cycle, for three mating cycles.

Data were summarised as the average for each year of the dataset (1990-2019) and for each geographic region (from Northland to Southland; Table 1). The national averages were weighted to reflect the relative population of sheep and cattle in each region.

Slaughter dates

Slaughter dates of both lambs and finishing cattle were calculated from the dataset for both region and year. To estimate age at slaughter, these dates were then adjusted for birth date. As beef animals may be slaughtered over two to three years, estimates of slaughter date may be up displaced by 365 days. Therefore, expert advice was sought to ensure that relevant ages were determined. Proportions of lambs slaughtered before 01 March was determined with remaining lambs being assigned to the 31 August slaughter date.

Results and Discussion

Sheep and cattle mating and birth dates

Analysis of the national data indicated that there were no significant changes in sheep mating date between the previous 20y time frame and this analysis over the 30-year time frame (Figure 1). When translated into median lambing date, this equates to 10 September. This is similar to the currently used date in the inventory (11 September).

Regionally, there was a significant trend towards later mating dates moving from north to south (Figure 2; 1 = Northland, 11 = Southland). Mating dates were weighted by sheep populations in each region (Figure 2). This weighting for sheep population (ewes to ram), shifted the median lambing date from 10 September to 13 September. Again, this trend would have relatively little impact on current inventory outcomes. Although the trend would have little impact on current inventory outcomes, a change would improve accuracy by updating these dates.

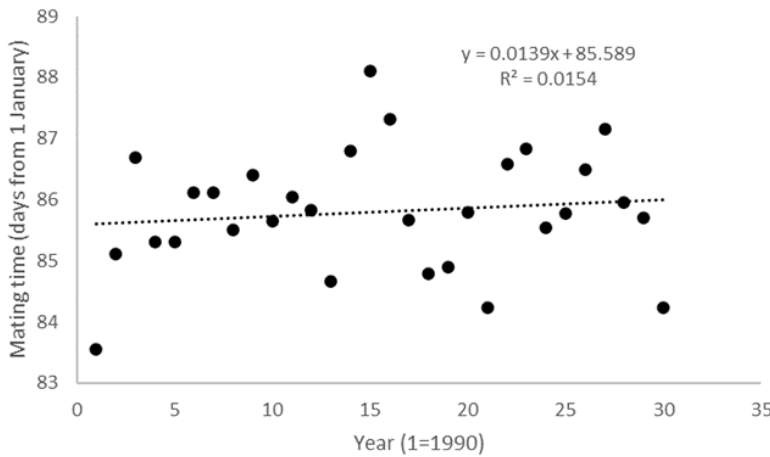


Figure 1

Mean breeding ewe mating dates (days after 01 January) over the period 1990 – 2019. The range of days after 01 January in the y-axis represent the following dates: 83 = 24-March, 89 = 31-March.

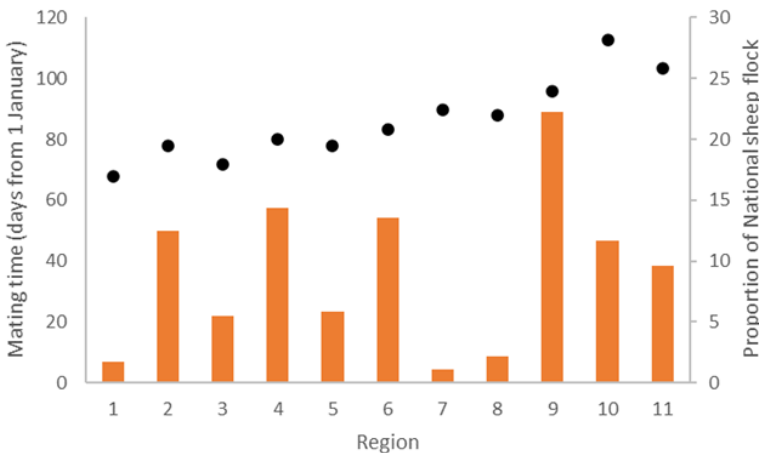


Figure 2

Regional differences in mean mating dates (dots) and proportions of the national sheep flock (columns) in each region (1 = Northland, 11 = Southland). The range of days after 01 January in the y-axis represent the following dates: 0 = 01-January, 120 = 30-April.

The national mean mating date of beef moved later over the 30-year time frame (Figure 3). This is described in equation 1 ($r^2 = 0.94$). The shape of the curve represents a stable mating date from 1990 until 2000, then a steady trend towards a later mating date until approximately 2010 and a more stable mating date between 2011 and 2019. These mating dates translate into calving dates of 10 September for 1990-2000, and 25 September for 2010-2019. The inventory date of 20 September was calculated by Thomson et al. (2010) based on mating data from 2006/2007. The mean birth date weighted for population distribution across all years is 17 September and is consistent with the data presented here.

$$f = y_0 + \frac{a}{(1 + \exp(-\frac{x-x_0}{b}))^c}$$

where f = mean mating date (days after 01 January), $a = 14.0517$; $b = 3.5273$, $c = 4.7491$, and $x_0 = 10.6242$. All slaughter bulls, steers and heifers are assigned the

same birth date. Most slaughter bulls are sourced from the dairy industry, which has an inventory birth date of 01 August. Dairy calves are weaned to grass at two months of age (MPI 2021) entering the inventory in month three, while animals assumed to be in the beef supply chain are weaned to grass at five months of age (MPI 2021), entering the inventory in month six. Therefore, dairy bulls enter the inventory with a gap in record (difference between dairy cattle weaning date and beef cattle weaning date) of 140 days. This creates a potentially significant gap in emissions resulting in an artificially lower GHG output than equivalent beef-bred animals.

Regional differences in beef cattle mating dates occur, most significantly between Northland and Otago/Southland, while mating dates in other regions were similar (Figure 4). Trends towards later mating dates were evident in most regional datasets, although the extent of the shift varied slightly between regions.

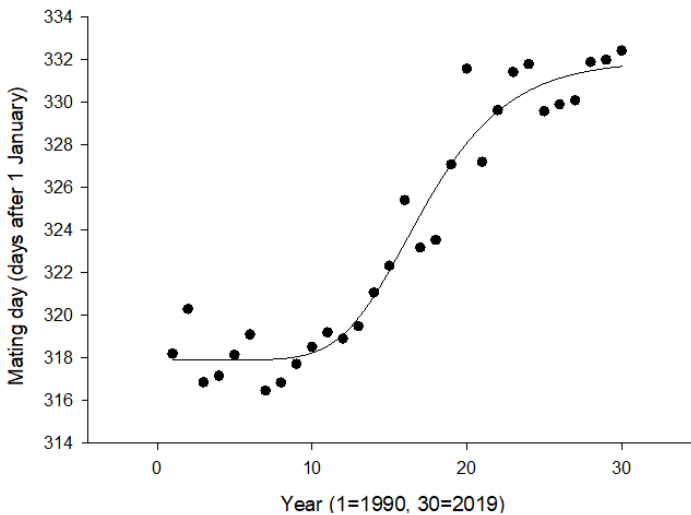


Figure 3

Mean breeding beef cow mating dates (days after 01 January) over the period 1990 – 2019. The range of days after 01 January in the y-axis represent the following dates: 314 = 10-November, 334 = 30-November.

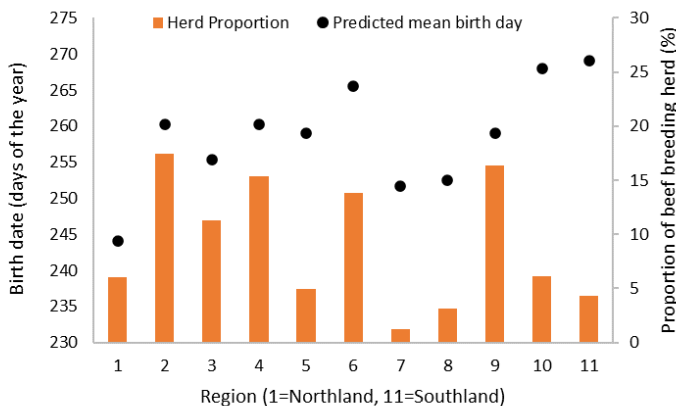


Figure 4

Regional differences in mean breeding beef cow birth date (1 = Northland, 11 = Southland). The range of days of the year in the y-axis represent the following dates: 230 = 19-August, 275 = 2-October.

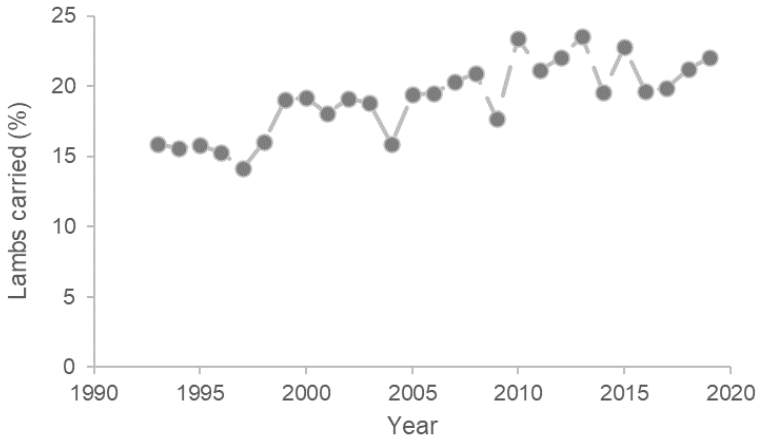


Figure 5 Proportion of lambs carried beyond the first lamb slaughter date (as currently described in the AIM methodology) over the period 1993 – 2019.

Slaughter dates

Lambs

Since the introduction of split slaughter dates for lambs to the AIM (see above Thomson et al. 2010), the percentage of lambs killed at the first slaughter date has remained fixed at 84%, and this value has been used for estimating GHG emissions since. All lambs are slaughtered, and the class is self-contained and assumes no lactation or gestation involved when calculating their metabolisable energy (ME) requirements.

An examination of lamb slaughter dates (available from the data) revealed a clear trend for the proportion of lambs carried through to the second slaughter date (from the first lamb slaughter date), ranging from 14% (1997) to 24% (2013) (Figure 5). The trend to an increasing proportion of lambs being held to a second slaughter date appears to have stabilised in the period 2010-2019 averaging approximately 22%. While the data only goes back to 1993, there is a clear case for using 84% (the current default in AIM) back to 1990, though a revised value of 22% should be considered from 2010 onwards.

Finishing cattle slaughter dates

Slaughter dates and age at slaughter for all classes of finishing beef cattle across the recorded period (1993-2019) demonstrate little variation in average slaughter date within livestock classes, with consistently low coefficient of variation (Table 2). The current dates and age at slaughter when sales animals are removed from the inventory (sold to slaughter) (Table 2) indicate a significant difference between Inventory dates and the Beef + Lamb New Zealand data. Average cattle age at slaughter was calculated to be 20, 72 and 135 days later than the currently used ages in the national inventory for heifers, steers, and bulls respectively.

Slaughter dates were translated into age at slaughter for beef bulls (Figure 6), heifers (Figure 7) and steers (Figure 8) to test the change in age at slaughter over time. The age of bulls at slaughter (Figure 6) was relatively stable through time, except for 2018 and 2019. This aligns with widespread drought conditions during these years. The average days to slaughter for 2-3-year-old cattle remains unchanged over the 27-year period (Figures 7 and 8).

Table 2 Beef cattle slaughter dates and predicted age at slaughter at slaughter from Beef + Lamb New Zealand (B+LNZ) Economic Service data from 1993 to 2019 compared with the current national Inventory data (AIM). CV; Coefficient of variation. YO: year-old.

	Average Slaughter date		Age at slaughter (d)		CV%
	Inventory	B+LNZ	Inventory	B+LNZ	
Bulls	1-Oct	3-Feb	730	865	2.6
1-2YO Heifers	1-Oct	19-Mar		544	4.0
2-3YO Heifers	1-Oct	6-Jan		837	3.4
Heifers (average)	1-Oct		730	750	
1-2YO Steers	1-Feb	21-Mar		546	4.5
2-3YO Steers	1-Feb	14-Jan		845	2.5
Steers (Average)	1-Feb		730	802	

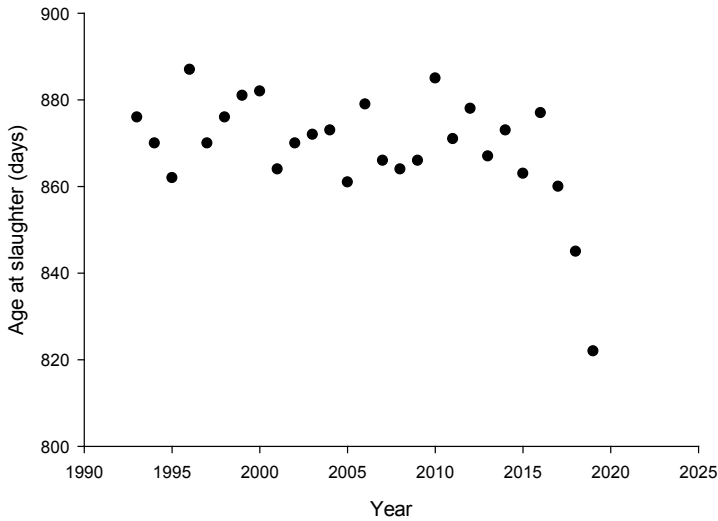


Figure 6

Age of bulls at slaughter from the Beef +Lamb New Zealand Economic Service dataset from 1993 to 2019.

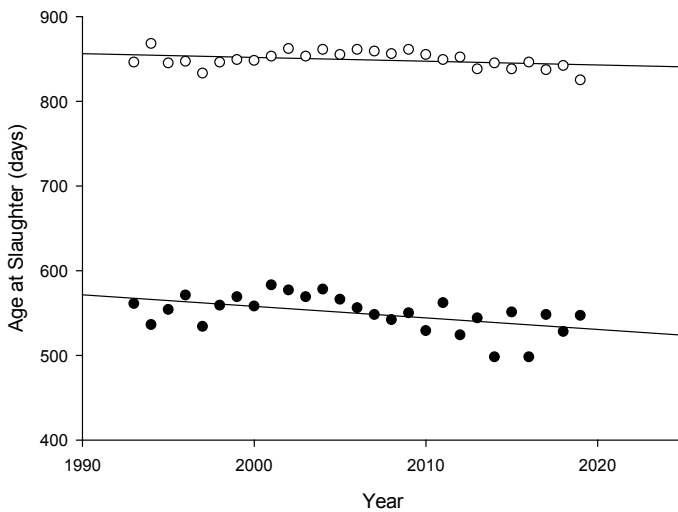


Figure 7

Age of heifers at slaughter (closed symbols = 1-2-year-old heifers, open symbols = 2-3-year-old heifers) from the Beef + Lamb New Zealand Economic Service dataset from 1993 to 2019.

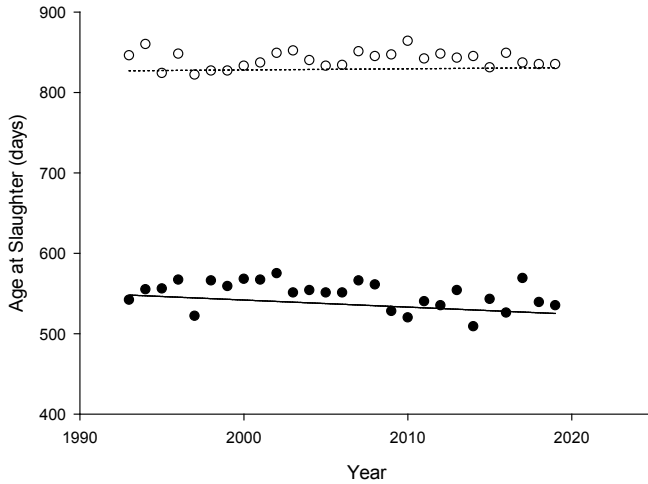


Figure 8
Age of steers at slaughter (closed symbols = 1-2-year-old steers, open symbols = 2-3-year-old steers) from the Beef + Lamb New Zealand Economic Service dataset from 1993 to 2019.

The age at slaughter of both 1-2-year-old heifers (Figure 7) and steers (Figure 8) has declined slightly over the past 27 years. The decline in age at slaughter is approximately 0.9 and 1.3 days per year of record ($P < 0.05$) for heifers and steers respectively, over the 27 years. This equates to 1-2-year-old heifers being slaughtered approximately 24 days younger in 2019 than in 1993 (528 vs 552 age at slaughter respectively). Steers of 1-2-years-of-age were slaughtered approximately 35 days earlier in 2019 than in 1993 (520 vs 555 age at slaughter respectively). These changes may reflect genetic gain in the beef herd. There has been significant genetic improvement in yearling live weight over the

past 30 years (Rovere et al. 2022), and this may have translated into earlier slaughter of younger animals. These age at slaughter calculations are supported by the growth rates (Table 4) which aligns with industry best practice and expert knowledge (Bob Thomson personal communication).

Regional differences in slaughter dates for cattle from the B+LNZ Economic Service data (1993-2019) generally represent earlier slaughter dates in northern regions than southern regions (Table 3). Average age at slaughter (Figure 10) again varies between regions and is indicative of differences in feed quality, feed supply and variations in birth date.

Table 3 Beef cattle slaughter dates from regions across New Zealand (from the Beef + Lamb New Zealand Economic Service data 1993-2019). YO: year-old. CV; Coefficient of variation. LSD; Least significant difference.

Region	Slaughter day of year					
	Bulls	Cows	1-2 YO Heifers	2-3 YO Heifers	1-2 YO Steers	2-3 YO Steers
Northland	4-Jan	6-Feb	18-Feb	23-Nov	21-Feb	26-Dec
Waikato/Bay of Plenty	25-Jan	16-Feb	10-Mar	11-Dec	10-Mar	13-Jan
Gisborne	8-Feb	20-Feb	14-Apr	11-Jan	21-Apr	15-Jan
Hawkes Bay	3-Feb	27-Feb	6-Apr	24-Jan	28-Mar	18-Jan
Wairarapa	25-Jan	3-Mar	6-Apr	31-Dec	14-Mar	5-Jan
Taranaki/Manawatu	11-Feb	6-Mar	22-Mar	14-Jan	31-Mar	5-Feb
Nelson/West Coast	28-Jan	2-Mar	28-Mar	9-Feb	14-Mar	25-Jan
Marlborough	19-Jan	22-Feb	21-Feb	19-Dec	26-Feb	25-Dec
Canterbury	30-Jan	7-Mar	3-Mar	26-Dec	10-Mar	26-Dec
Otago	19-Feb	11-Mar	20-Mar	8-Feb	24-Mar	29-Jan
Southland	14-Mar	28-Mar	3-Apr	11-Feb	10-Apr	7-Feb
LSD (days)	13.5	11.7	23.3	16.1	26.3	12.2
CV%	3.4	2.8	5.3	4.3	5.9	3.2

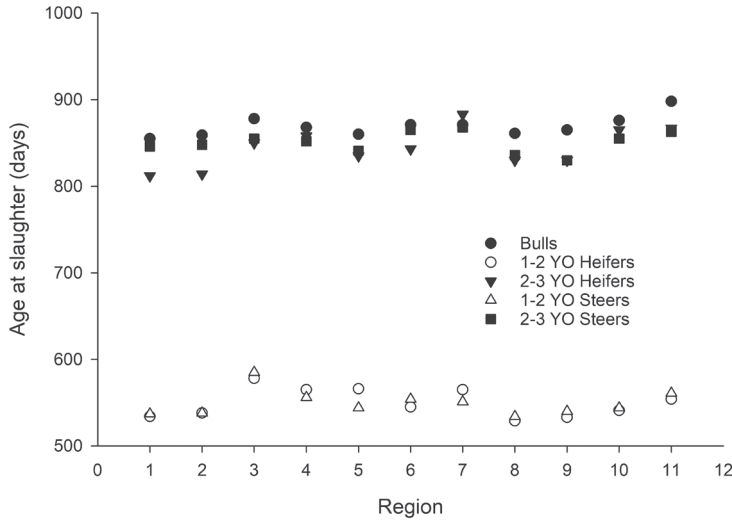


Figure 10

Regional differences in bulls, heifers and steers age at slaughter (in days).

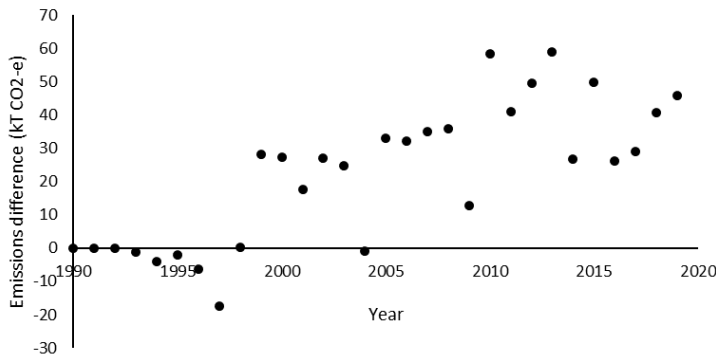


Figure 11

The difference in sheep emissions (kT CO₂-e) between the current default of 84% in February and 16% in August and using the Beef + Lamb New Zealand dataset to determine age at slaughter which demonstrated a trend of decreasing percentage slaughtered at first slaughter date; (Figure 5).

Greenhouse gas implications

Varying birth and slaughter dates may result in changes in GHG emissions if finishing faster is more efficient with lower total feed consumed.

Impact on sheep GHG production

The lack of any trends in birth date indicated that, nationally, this variable has remained constant since 1990, resulting in no change required to Inventory GHG predictions. The proportion of lambs being carried through winter for slaughter has increased from 16 to 22%, resulting in a greater feed intake for 6% of the slaughter population of lambs. This has a material increase of approximately 45 kT CO₂-equivalents (Figure 11), though this translates into 0.48% of total emissions from sheep.

Impact on beef GHG production

Significant differences between the birth dates (Figure 3) and the potential slaughter dates (Table 2) were uncovered using the Beef + Lamb New Zealand data sets. These differences were then translated into potential differences in GHG emissions (Table 4). Age at slaughter were calculated either from 20 September for the Inventory or from 25 September, as per the birth date section conclusions.

Creating separate categories for 1-2-year-old cattle increased the level of precision of Inventory calculations by capturing the efficiency of faster growing cattle. To create relativities to the inventory, relative proportions of young and older cattle were calculated. Weighed age at slaughter were greater in all categories when comparing the B+LNZ data set to the inventory standards (Table 4).

Heifer carcass weights (when weighted for population), and bull carcass weights were higher, while steer carcass weights were lower (Table 4). Inventory carcass weights (2015-2019) were calculated from total carcass weight recorded divided by the number of animals slaughtered for each category.

Methane emissions (Table 4) suggest that the current inventory calculations may underrepresent the methane emissions from beef cattle. Bull beef were the furthest group from current calculations with inventory numbers representing only 75% of the emissions calculated from the B+LNZ dataset. This was due both to higher growth rates of bulls as well as later slaughter dates, combining to produce heavier carcasses (Table 4) than estimated by AIM.

The current B+LNZ database also suggested that the proportions of heifers, steers and bulls contributing to the national slaughter pool were different from the Inventory calculations, based on Statistics NZ data. This generates a significant difference in the total calculation of GHG. If current proportions are replaced by the B+LNZ proportions, the GHG emissions of beef cattle grown for slaughter rise by 2.6%. If B+LNZ data are used in conjunction with the current inventory proportions, then the GHG emissions of beef cattle grown for slaughter rises by 16.4%. Using only the

B+LNZ data, including revised birth dates, slaughter age and proportions of livestock class contributing to slaughter population, then the relative increase in calculated GHG for beef cattle grown for slaughter is 24.7%.

Conclusions and implications

A review recent trends in birth and slaughter dates for lambs and cattle grown for slaughter suggests that some modifications of the national inventory for GHG accounting may be required. Lamb birth date appears to be stable over the past 30 years. However, calf birth date in beef cattle herds appears to have shifted from 10 September to 25 September with most of this shift occurring between 2000 and 2010. Lamb sales date have also shifted later with the proportion of the lambs sold for slaughter in the winter and spring increasing from 16 to 22%. This translates into an increase in total GHG emissions of 0.48% for sheep. Average cattle age at slaughter was calculated to be 20, 72 and 135 days later than the currently used ages in the national inventory for heifers, steers, and bulls respectively. These differences in birth date and slaughter date translates into a potential increase in GHG emissions from beef cattle grown for slaughter of approximately 25%.

Table 4 Comparison of Inventory (AIM) and Beef + Lamb New Zealand (B+LNZ) carcass weight, growth rates, relative GHG emissions and contributions to the national slaughter populations using data for the 2015-2019 period. YO: year-old.

	Carcass weight (kg)		Growth rates (kg/d)		GHG emissions ¹		Slaughter Population (%)	
	Inventory	B+LNZ ¹	Inventory	B+LNZ	Inventory	B+LNZ	Inventory	B+LNZ
Bulls	301.5	356	0.75	0.77	113	154	31	49
1-2YO Heifers		231		0.77		71		31
2-3YO Heifers		256		0.56		110		69
Heifers (average)	236.5	249	0.58	0.62	90	98	32	19
1-2YO Steers		261		0.87		78		16
2-3YO Steers		305		0.66		129		84
Steers (Average)	306.5	299	0.77	0.69	115	122	37	32

1 GHG emissions are expressed as kg CO₂-equivalents over the lifetime of the animal.

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