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- Structure and Efficiency of the Scottish Beef Herd
- Cattle Tracing System Insights

Structure and Efficiency of the Scottish Beef Herd - Cattle Tracing System Insights

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Key points

- CTS data represent a rich source of information from which insights can be gained into key performance indicators of Scottish beef producers. The results presented here are sufficient to indicate key metrics for policy to focus on and are consistent with the direction of travel recommended by both the Suckler Beef Climate Group and the Farming for 1.5 Degrees
- The analysis reveals considerable variation across farms, implying industry-wide scope for improvement to deliver both production and emission benefits.
- The analysis also reveals the complexity and diversity of the Scottish beef sector both in terms of herd structure and in on-farm/croft performance. The dynamic nature of the sector alongside the stratified nature of the industry plus the mix dairy and suckler reared cattle being part of the beef supply chain adds complexity to any analytical framework.
- Production is unevenly distributed, with only 15% of suckler herds having 100 cows or more but collectively accounting for 50% of the national herd, compared to 39% of the businesses having fewer than 20 cows that only accounted for 6% of the national herd. Similarly, 53% of all prime cattle are finished by only 250 of the largest farms (with 82% accounted for by 20% of the producers supplying abattoirs with prime cattle.
- Within this, extended upland systems (selling calves mostly at 11-12 months) accounted for 36% of the suckler calves registered in 2017 whilst extensive upland systems accounted for 12% of the calves. Rearer-finishers were responsible for 24% of suckler calf registrations with 15% from lowland suckler producers in 2017.
- Calving dates amongst the suckler beef (but not the dairy) herd are concentrated in Spring, meaning that maintaining a smooth throughput for Scottish abattoirs requires variation in finishing times and/or slaughter weights, which may constrain scope for adjusting these to reduce emissions.
- There is a wide range in suckler cow fertility, or technical performance, between producers that give rise to opportunities to make efficiency gains and produce the same output from fewer cows.
- Average suckler calf registration rates varied between 80% and 82% and are affected by extreme weather years, such as the 2018 Beast from the East. There was significant variance in calf registration rates. For example, 25% of suckler herds with 20+ cows managed calf registration rates of over 91% in 2019 whilst 25% performed worse 77 calves per 100 cows. This implies considerable scope for reducing the overhead burden of emissions (and maintenance costs) of breeding animals not contributing to actual beef production.
- Median calving intervals for non-dairy herds and production systems are around 12 months. However, variation either side of this implies scope for improvement in many cases.
- Beef herds have a pronounced bi-modal distribution for the age at first calving, with peaks around 24 and 38 months (dairy has a single peak at around 24 months). However, there is considerable variation around these modes, implying scope for lowering of typical ages at first

calving, as another way to lower the overhead burden of time spent by breeding animals not in calf.

- On-farm suckler calf-mortality rates average 6% for animals up to the age of 36 months (with 12% in the dairy sector), representing a significant loss of marketable product. The majority of calf mortality are in the first few months of life, but also in older calves during winter housing periods. There was considerable variation between farms, suggesting scope for improvement through adoption of best practice.

- On farm mortality rates amongst breeding cattle were consistently around 5% and were affected by poor weather years (2013 and 2018). Breeding herd mortality therefore represents an opportunity for further efficiency gains, and to minimise cull-cow wastage.

- Beef finishing is highly concentrated and is becoming increasingly concentrated. Whilst finished cattle throughput remained pretty stable between 2013 and 2019 there was a 23% increase in the amount of prime cattle supplied by finishers that hove more than 500 finished cattle a year.

- The median slaughter age of prime cattle has only decreased marginally over the period 2011 to 2017, from just over 23 months to just over 22 months Median slaughter ages have decreased in recent years from just over 23 months to just over 22 months. However, there is considerable variation around this average, implying managerial (but not necessarily market) scope for adjustment.

- Concentration in the both the suckler herd and finishing sector mean that any future policy interventions that require targeting of high volumes of cattle (such as incentives to improve calving rates or reduced slaughter age) can be targeted at a relatively small population of businesses to impact on the majority of the cattle.

- Whilst smaller producers may be less important in terms of greenhouse gas emissions and food production it is likely that these cattle play important roles in extensive grazing systems that may provide a range of biodiversity benefits.

Contents

List of Tables

List of Figures

Introduction and Methods

1. The Cattle TRACING System (CTS)[1] run by the British Cattle Movement Service (BCMS)[2] holds data on the births, movements between businesses (i.e. farms, marts and abattoirs) and deaths of all cattle within Great Britain. Although collected primarily for livestock traceability purposes, CTS data are also a source of rich information on how the national herd is structured and performs.

2. Data extracted from CTS by the Animal and Plant Health Agency (APHA)[3] for Scottish cattle were made available to SRUC via EPIC[4] (Scotland's Centre of Expertise on animal disease outbreaks: Epidemiology, Population health and Infectious disease Control). The evolution of this unique methodological approach is embedded within the Rural Industries work package (WP2.4) of the 2016-2021 Scottish Government Strategic Research Programme[5], and this work extends this ongoing analysis. This analytical framework of the population of Scottish cattle systems can provide greater insights than data derived from relatively small sample sizes, or national datasets that do not account for the dynamic nature of the industry.

3. Throughout the report insights provided are based on individual CTS animal data and are either shown as (a) a single cohort of calves (i.e. born in 2013 and followed through their lives) or (b) at a business level between years. Both cohorts and calendar year have their own merits particularly due to the dynamic nature of the sector, and the different movements that occur between farms/crofts, between farms/crofts and markets, and between farms/crofts and abattoirs. It is sometimes easier to follow a cohort of calves through time to explain age at slaughter, age at first calving etc., but this approach is less intuitive from a business/policy perspective that deals in annual cycles or snapshots in time. To illustrate how the 'cohort' method can be beneficial, and to highlight the system (and hence data) complexity Figure 1 illustrates how many moves and what type of move occurred for all calves born in 2013 destined for slaughter before the age of 36 months. Here the pink band represents movements to slaughter within each move number, whilst the moves to market are represented by purple and the moves to farms/crofts represented by green. This illustrates the complexity of inter-business moves (either directly or through markets) that need tracing at an individual animal level in order to create cow/calf metrics that then need aggregated to business level metrics.

4. TS animal level data were aggregated through RESAS holding to business look-up tables to analyse the structure and performance of herds at both a business and national level over time. For example, in terms of breed, age and 'role' (bull, cow, replacement heifer, steer etc.) plus calving rates, on-farm mortality rates and slaughter age. Analysis was conducted using R programming language[6], at different levels of aggregation: animal, breed, farm holding, farm business, farming system and Scotland. Analysis at the farm business level required use of look-up tables matching Business Reference Numbers (BRNs) used for administration of policy schemes with County/Parish/Holding (CPH) numbers used to identify physically separate farm holdings on the ground used by CTS (and indeed the June Agricultural Census). Analysis at the farming system level

[1] https://www.gov.uk/cattle-tracing-online
[2] https://www.gov.uk/government/organisations/british-cattle-movement-service
[3] https://www.gov.uk/government/organisations/animal-and-plant-health-agency
[4] https://www.epicscotland.org/about-epic/
[5] https://sefari.scot/about-us/strategic-research-programme
[6] https://www.r-project.org/about.html

required classification of individual businesses on the age at which the majority of their cattle move. An illustration of the analytical stages and some of the metrics assessed is provided in Figure 2.

Figure 1 Number of prime cattle by movement number and type pre-slaughter for 2103 cohort of calves

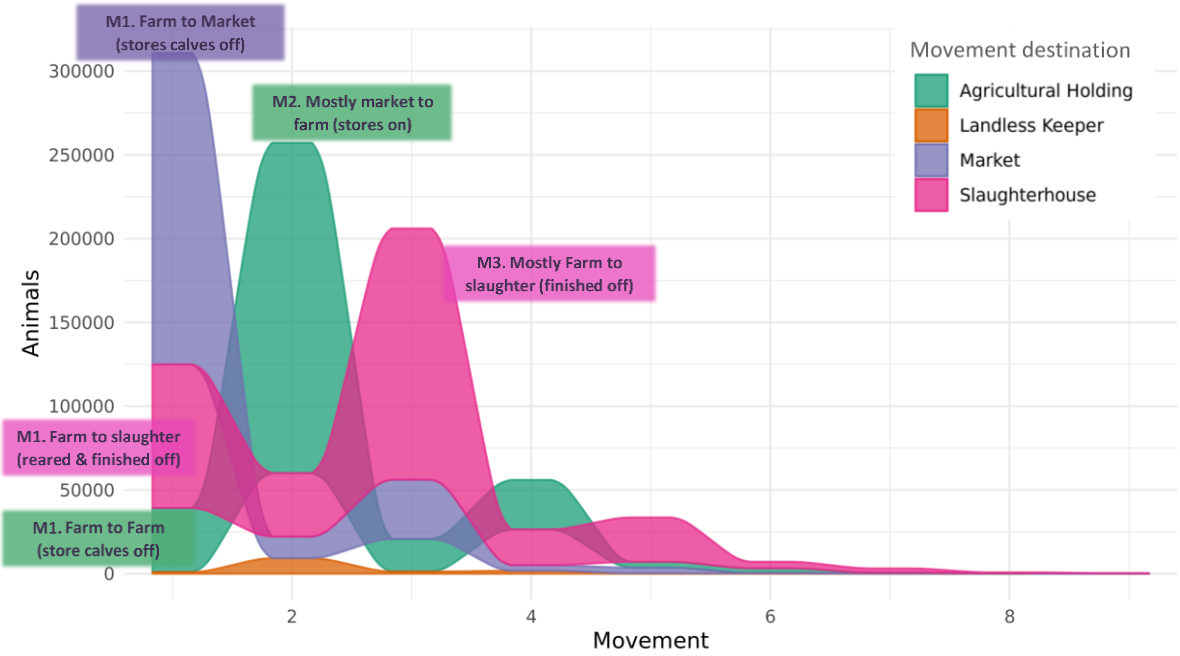
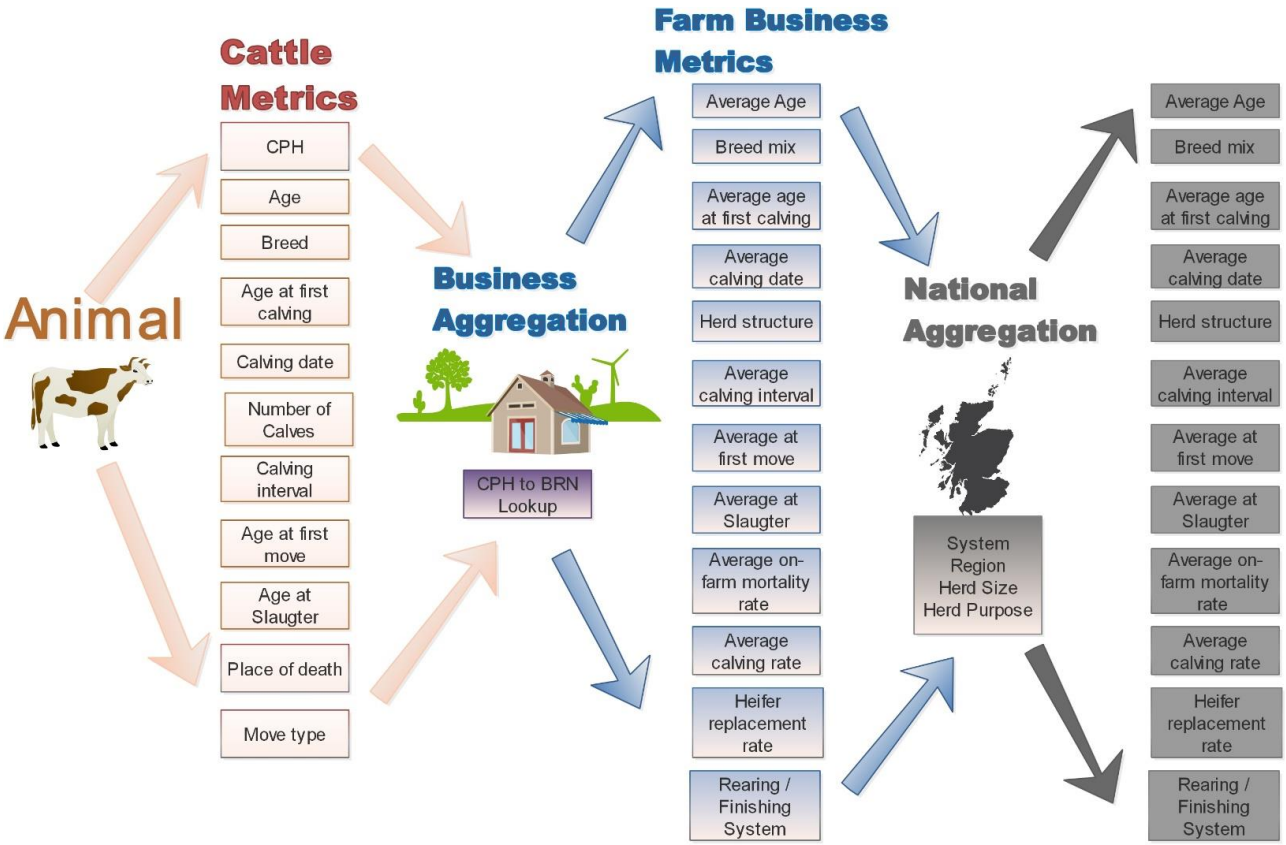


Figure 2 Illustration of animal to business to national level metrics from CTS



5. Within the CTS database holdings are assigned a 'dairy' marker if dairy breeds dominate the herd on an agricultural holding. Whilst there are errors in this approach to demarcate commercial dairy herds (i.e. a holding with 2 cows from dairy breeds and a suckler cow would be classed as 'dairy') it provides useful insights from the perspective of any support scheme targeted using beef genetics. This marker has been used to split the national herd at a business level into dairy and suckler herds – acknowledging there are some suckler cows on dairy holdings and vice versa.

6. Results are subject to several caveats, including some occasional evident errors in the data (particularly more historic data), minor inconsistencies between numbers revealed by different formulations of the same data query, and the skewed distribution of herd size limiting the reliability of simple mean (average) and percentage calculations as reliable indicators of 'typical' conditions in some cases. In addition, the biological time lag between cattle being born and entering the breeding herd or the food chain unavoidably means that a complete picture is not available for the most recent two to three years and the dynamic churn of BRNs means that look-up tables between BRNs and CPHs are not always completely accurate.[7] As such, some caution is advisable to avoid over-interpretation of results.

7. Further analysis is required, ideally including some ground-truthing, with further quality assurance (QA) assessments of the R-coding extraction and aggregation process. The sheer volume of data (tens of millions of rows), complexity of assessing a dynamic industry (which farm does a moved cow get allocated to) and the number of metrics assessed means that there has been limited time to do full QA on the summary data in the reporting timeframe. Nevertheless, the summary results presented within this report are sufficient here to illustrate the relevance of CTS metrics to better understanding of the Scottish beef sector's performance.

8. The methodological approach demonstrates the added value that can be derived from administrative datasets through looking at the data through a new lens. The approach enables farm-level technical efficiency metrics to be assessed that have the potential to be used: (a) to help administer and monitor any future support scheme based on cattle efficiency metrics; (b) to improve the methods used in the smart inventory; (c) to help benchmarking at a farm level. As the approach is novel and in a state of evolution it could benefit significantly from some ground-truthing with farms to assess the quality of the baseline data and the analytical metrics extracted at a business level.

9. At a national level the metrics used to assess herd performance provide a baseline for current 'baseline' Scottish suckler herd performance. Whilst these can provide insights nationally they mask significant variance between individual herds, herd size groupings and production systems. Therefore throughout this report headline summary data are provided alongside subsequent presentation of the variance that exists between (a) individual herd performance; (b) production system, and; (c) herd sizes.

[7] The analysis used June Agricultural Census CPH-BRN snapshots rather than dynamic changes that any scheme relying on this data would require.

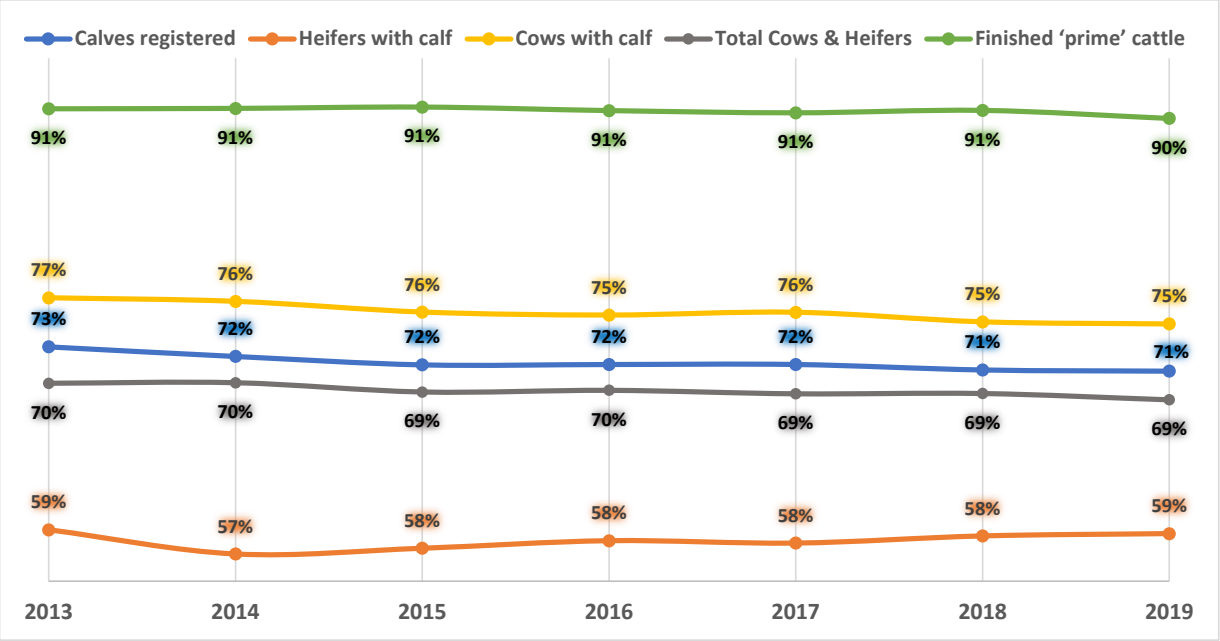
National herd structure

10. The structure of Scotland's cattle systems is complex, with both dairy and suckler cow herds feeding into specialist finishers who in turn largely manage the supply of finished 'prime' cattle to Scotland's abattoirs. Within the suckler herd (cattle specifically bred for beef production) a stratified system operates for a large number of rearers – whereby they sell calves they have reared to weaning (8-9 months) or at about 1 year old to specialist finishing units who will manage the calves until they are ready for slaughter. In between specialist rearers and specialist finishers are a group of farms that both rear and finish cattle spread across the country. In recent years dairy herds (encouraged by their supply chain) are increasingly utilising male born calves (formerly they were often considered a waste product and killed at birth) – increasingly using artificial insemination and sexed semen to increase the quantity and quality of beef coming from the dairy sector.

11. In addition to cattle system complexity there is very large variation in herd sizes run on individual farms/crofts – ranging from single animals into thousands of animals on a single business. For many businesses cattle are one of a mix of farm/croft activities with sheep, cropping, pigs, poultry and horticulture enterprises regularly run alongside cattle enterprises – although there are many businesses where cattle are the main focus of their business activities. For example, in 2019 the CTS analysis suggests there were 8,491 businesses with 656,239 beef and dairy breeding cows and heifers – with an additional 1,100 businesses that had no breeding cows or heifers that carried 131,698 'prime' cattle (under 36 months) that were sent to slaughter.

Suckler herd trends

Figure 3 Estimated proportion of the Scottish cattle from the suckler herd- cows with calf, heifers with calf, registered calves, breeding herd and finished prime cattle - 2013-2019



12. Figure 3 shows that there has recently been relative stability in the make-up of the national herd in terms of suckler: dairy mix, as would perhaps be expected given the long-term nature of beef production cycles. The proportion of total suckler cows and heifers in the total cow and heifer population has remained relatively static about 70% (falling to 69% from 2017). The proportion of

total cows with calves registered that were from the suckler herd fell from 77% in 2013 to 75% in 2019 likely reflecting increased use calves from the dairy herd (dairy-beef), and changes in practices in how male calves from the dairy herd are used. Similarly, the proportion of Scottish calves registered to the suckler herd fell from 73% in 2013 to 71% in 2019. The proportion of total heifers from the suckler herd was, again, relatively static at 59%, and this lower proportion illustrates higher replacement rates and shorter breeding lives of cows in the dairy herd. Finally, the proportion of national calves finished and sent to slaughter from the suckler herds remained relatively stable at 91%, falling to 90% in 2019 – meaning about 9-10% of prime cattle sent to slaughter came from dairy businesses (NB. the data extraction process simply allocates as finished 'prime' if cattle moved to slaughter was under 36 months old and was slaughtered within 7 days from leaving a business – meaning failed heifers could be allocated as 'prime' within this method).

13. Table 1 provides more detail of the absolute numbers of cattle, with an estimated 451,975 suckler cows and heifers in 2019, with a heifer replacement rate of 18.6% (herd replacement every 5.4 years) compared to 32.4% in the dairy herd (herd replacement every 3.1 years). As the population of heifers put to the bull is unknown a proxy for calving rate (acknowledging it does not account for pre-registration neonatal mortality) is the calf registration rate amongst breeding cows (total cows) – this fluctuated between 80% and 82% for the suckler herd but has increased from 64.4% in 2013 to 68.4% in 2019 amongst dairy herds (with lower dairy calf registration rates per calendar year also reflecting longer lactation cycles). Suckler heifer replacement rates increased from 16.5% to 18.6% over the period suggesting some changes in suckler cow replacement policy across the national herd.

Table 1 Summary of number of breeding cows, heifers, calves and finished 'prime' cattle by CTS allocated system, 2013-2019

SUCKLERS	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Calves born	393,404	393,044	398,133	396,946	395,648	382,998	382,175
Heifers with calf	67,153	67,662	71,418	70,511	72,303	70,604	70,878
Cows	405,778	398,777	396,376	397,961	395,530	388,805	381,097
Cows with calf	326,251	325,382	326,715	326,435	323,345	312,394	311,297
Total Cows & Heifers	**472,931**	**466,439**	**467,794**	**468,472**	**467,833**	**459,409**	**451,975**
Heifer replacement rate	16.5%	17.0%	18.0%	17.7%	18.3%	18.2%	18.6%
Breeding Cows calf registration rate	80.4%	81.6%	82.4%	82.0%	81.7%	80.3%	81.7%
Finished 'prime' cattle	331,387	341,678	329,764	336,433	327,001	322,913	324,979
DAIRY	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Calves born	146,072	151,396	158,292	157,614	157,085	155,194	155,564
Heifers with calf	46,805	50,891	52,760	50,870	52,554	50,177	50,004
Cows with calf	154,510	147,281	152,781	153,744	154,357	152,804	154,260
Cows with calf	99,267	100,505	105,532	106,744	104,531	105,017	105,560
Total Cows & Heifers	**201,315**	**198,172**	**205,541**	**204,614**	**206,911**	**202,981**	**204,264**
Heifer replacement rate	30.3%	34.6%	34.5%	33.1%	34.0%	32.8%	32.4%
Breeding Cows calf registration rate	64.2%	68.2%	69.1%	69.4%	67.7%	68.7%	68.4%
Finished 'prime' cattle	32,229	33,105	31,556	33,278	33,020	31,885	34,522

Herd sizes

14. Table 2 highlights the number of businesses and average herd sizes of businesses carrying suckler cows (top left-hand panel), suckler heifers (top right-hand panel), suckler calves (bottom left-hand panel) and finished prime cattle (bottom right-hand panel).

- From 2013 to 2019 there were 13% fewer businesses with suckler herds (7,273 in 2019), and the number of cows fell by 4.4% over the same period with mean heard size of 52 cows in 2019. Average suckler herd sizes were skewed by the larger herds – the median was only 30

cows with 25% of businesses (lower quartile) having less than 10 cows, and 25% (upper quartile) had 70 or more cows in 2019.

- The number of businesses with suckler heifers with calf fell by 8.3% over the same period (to 5,841) whilst the total number of heifers with calf increased by 5.5% to 701,878 in 2019. The mean number of suckler heifers remained relatively stable at 11 or 12 cows.
- The mean number of suckler born calves increased from 47 to 51 over the timeframe (with median rising to 30 and upper quartile to 70). During the same period the number of calves registered fell by 3% and there were 10% fewer businesses registering calves in 2019 than 2013.
- For those selling finished 'prime' cattle to abattoirs the average herd size increased from 66 to 79 although this was very heavily skewed by the largest businesses – with the upper quartile lower than the mean. The lower quartile indicates that 25% of the businesses sending calves under 36 months to slaughter only dispatched 1 or 2 calves in 2019. Overall, the number of businesses sending 'prime' animals to slaughter fell by 17.4% whilst the number of cattle put to abattoirs only fell by 1.9%.

Table 2: Businesses with breeding cows, number of breeding cows and average breeding cows, 2013-2017

	Total Cows						Heifers					
	BRNs	Total Cows	Mean	Lower Quartile	Median	Upper Quartile	BRNs	Total Heifers	Mean	Lower Quartile	Median	Upper Quartile
2013	8,362	405,778	49	7	27	66	6,368	67,153	11	2	6	13
2014	7,966	398,777	50	9	29	67	6,274	67,662	11	2	6	13
2015	7,909	396,376	50	8	29	67	6,275	71,418	11	2	6	13
2016	7,738	397,961	51	9	29	69	6,219	70,511	11	2	6	13
2017	7,589	395,530	52	9	30	70	6,097	72,303	12	2	6	14
2018	7,387	388,805	53	9	30	70	5,953	70,604	12	2	6	14
2019	7,273	381,097	52	9	30	70	5,841	70,878	12	2	6	14
	Registered Calves						**Finished Cattle**					
	BRNs	Calves Registered	Mean	Lower Quartile	Median	Upper Quartile	BRNs	Finished Cattle	Mean	Lower Quartile	Median	Upper Quartile
2013	8,362	393,404	47	7	26	63	4,985	331,387	66	2	13	60
2014	8,214	393,044	48	7	26	65	4,695	341,678	73	2	14	67
2015	8,149	398,133	49	7	26	65	4,463	329,764	74	2	15	66
2016	7,982	396,946	50	7	27	67	4,450	336,433	76	2	14	67
2017	7,801	395,648	51	8	28	67	4,323	327,001	76	2	12	65
2018	7,625	382,998	50	8	27	67	4,236	322,913	76	2	11	63
2019	7,481	382,175	51	8	28	68	4,116	324,979	79	2	13	64

15. To ensure there is full appreciation of the diversity of scale within the sector Table 3 provides detailed breakdown of the proportion of businesses within each suckler herd size category in 2019 alongside the number and proportion of businesses and animals carried within each size grouping. Understanding this diversity in scale is essential for any policy targeting – be that on greenhouse gas emissions, food production, biodiversity or socio/economic objectives.

    - 25.3% of the 7,273 farms and crofts with suckler cows only accounted for 2.1% (8,129) of the national suckler herd (excluding heifers).
    - Overall, 39.4% of the businesses had suckler herds of less than 20 cows that only accounted for 5.9% of the national herd – illustrating the small scale nature of beef production for a large proportion of those with suckler cows. Whilst these producers may be less important in terms of GHG emissions and food production it is likely that these cows play important roles in extensive grazing systems that may provide biodiversity benefits.

- In contrast, in 2019 there were 20 business (0.3%) with 500 or more suckler cows that accounted for 4.2% of the national herd – with 129 businesses (1.8%) having herds over 250 cows accounting for 13.7% of the national herd.
- Further, the 1,070 (14.7%) suckler producers with 100 or more cows accounted for 50% of the national herd.

Table 3: Proportion of businesses and cattle number, suckler cows, suckler calves, suckler heifers and finished cattle by different suckler herd sizes, 2019.

Suckler Herd Size	Suckler Cows				Suckler Calves			
	Businesses		Cows (head)		Businesses		Calves (registered)	
Zero	-	-	-	-	208	2.8%	864	0.2%
1-9	1,843	25.3%	8,129	2.1%	1,843	24.6%	9,410	2.5%
10-19	1,027	14.1%	14,464	3.8%	1,027	13.7%	14,532	3.8%
20-49	1,799	24.7%	59,373	15.6%	1,799	24.0%	59,061	15.5%
50-99	1,534	21.1%	108,652	28.5%	1,534	20.5%	107,951	28.2%
100-249	941	12.9%	138,402	36.3%	941	12.6%	137,492	36.0%
250-499	109	1.5%	36,242	9.5%	109	1.5%	36,401	9.5%
500+	20	0.3%	15,835	4.2%	20	0.3%	16,464	4.3%
Scotland	**7,273**		**381,097**		**7,481**		**382,175**	
Suckler Herd Size	**Suckler Heifers**				**Finished Cattle**			
	Businesses		**Heifers (head)**		**Businesses**		**Cattle (head)**	
Zero	208	3.6%	864	1.2%	1,089	26.5%	140,781	43.3%
1-9	874	15.0%	2,656	3.7%	306	7.4%	18,168	5.6%
10-19	719	12.3%	2,642	3.7%	262	6.4%	8,372	2.6%
20-49	1,526	26.1%	10,324	14.6%	690	16.8%	23,386	7.2%
50-99	1,456	24.9%	17,672	24.9%	908	22.1%	41,840	12.9%
100-249	929	15.9%	24,839	35.0%	748	18.2%	60,061	18.5%
250-499	109	1.9%	7,556	10.7%	94	2.3%	18,645	5.7%
500+	20	0.3%	4,325	6.1%	19	0.5%	13,726	4.2%
Scotland	**5,841**		**70,878**		**4,116**		**324,979**	

16. If a large proportion of cattle, rather than producers, are to be targeted through any future Scottish Government schemes then 78.5% of the national herd can be reached through 35.8% (2,604) of producers. Predictably, a similar pattern is observed for calves registered to suckler herds in 2019.

17. Table 3 also highlights that:

- There were 208 producers (smaller on average) that had no suckler cows but had calves registered to heifers in 2019 – perhaps some producers new to suckler beef that had bought in calf heifers to start a small herd.
- Compared to the proportion of suckler cows in each of the size categories, the smaller suckler herds had a smaller proportion of the national heifer herd in 2019, reflecting that in small herd sizes there is less of a need to replace breeding cows every year.
- In contrast to the suckler cow, calf and heifer distribution the beef finishing herd has an entirely different distribution across businesses.
- In fact, 43.3% of the abattoir throughput in 2019 came from farms and crofts that did not have any breeding cows (1,089 businesses) and 50% came from businesses without suckler cows – a group containing some very large specialist finishers.
- The businesses with larger suckler herds tended to have relatively smaller proportions of finished cattle (than suckler cows and calves) meaning that there are many specialist rearers that do not finish cattle, or only finish a proportion of the cattle that they raise.

18. Figure 4 illustrates how the number and proportion of businesses with different suckler herd sizes, and the suckler cows they carried, changed between 2013 and 2019. Despite the overall decline in the number of businesses carrying suckler cows (top graph) the relative proportions in each size grouping remained relatively stable – with a slightly lower proportion of businesses in the 1-9 cow size group. A similar pattern is observed for the distribution of Scotland's suckler cow herd (bottom graph) – with a marginal increase in the proportion of cows (1% increase) in herd sizes over 100 cows

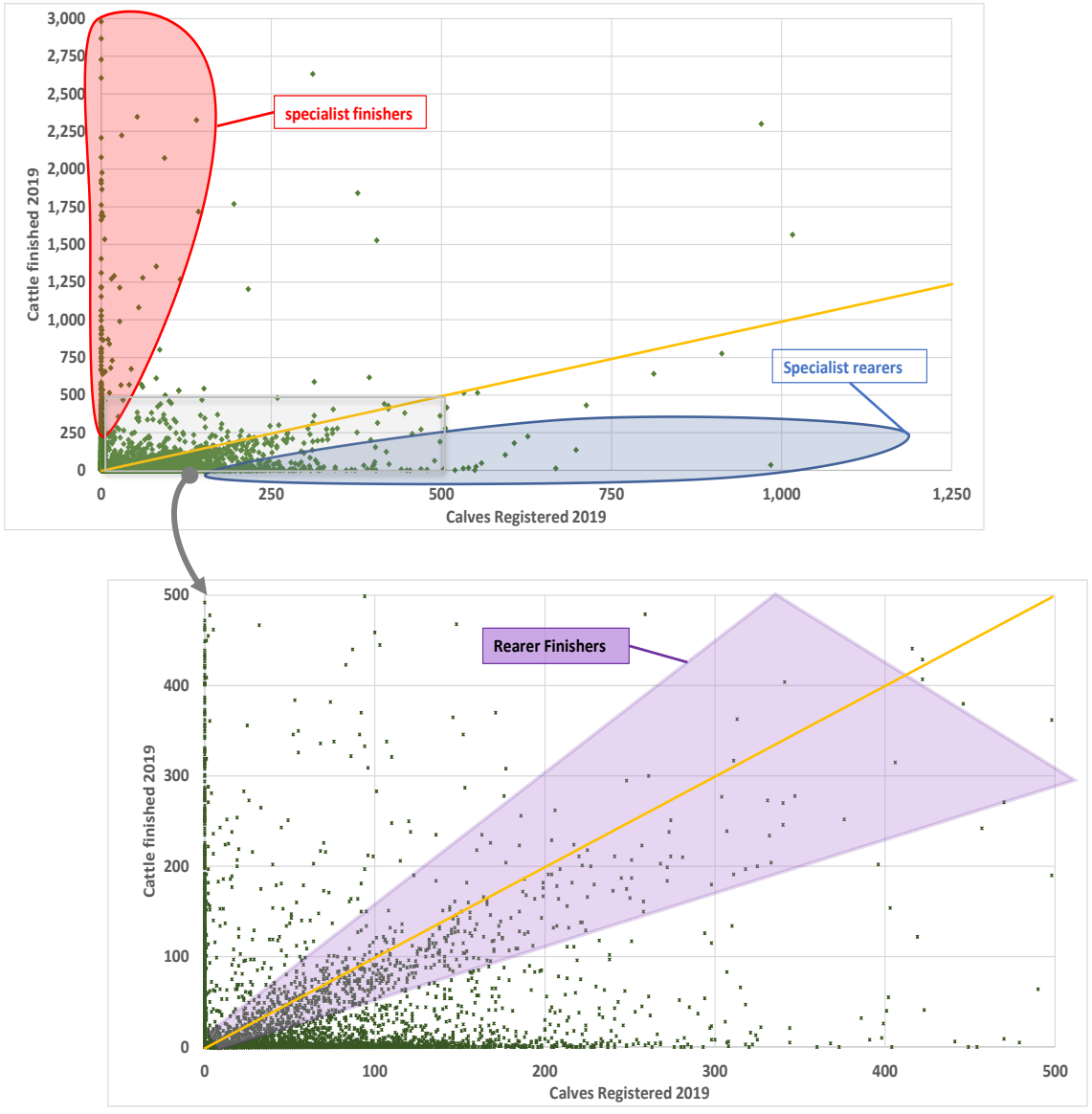
Figure 4: The number of businesses and suckler cows (numbers and %) by herd size; 2013-2019.

19. The distribution of the suckler herd is uneven - a small number of businesses account for a high proportion of cows. Similarly, the distribution of finished cattle prior to slaughter reveals significant concentrations of cattle on specialist, large, farms. These concentrations mean that important considerations will need to be given to how best to target any future beef schemes to achieve national objectives.

20. Whilst scale of production provides some distinction between different parts of the beef supply chain, it is possible to provide insights to different types of production system using CTS. When the number of calves registered by a business is mapped against the number of cattle finished in a given year it allows specialisms to be identified. Figure 5 shows the plot of finished cattle (*y-axis)* against the number of calves born and registered (*x-axis*) for 2019. The top graph provides oversight for the entire industry (capped at 3,000 finished cattle and 1,250 registered calves) whilst the bottom graph zooms in to the bottom left quadrant (limited to 500 finished cattle and 500 registered calves) to

provide more detailed insight. Within the graphs any business that falls above the yellow line finished more cattle than they registered in 2019 and if they fall below the line they registered more calves than finished. Using this plot it is relatively easy to identify specialist suckler calf producers/rearers (blue oval), coalescing around the *x-axis* with very few finished cattle compared to the number of calves born and registered. It is also possible to identify the specialist finishers (red encasement), coalescing around the *y-axis,* with very few calves born and registered cattle compared to their throughput of finished cattle. The businesses that fall near the centre (yellow) line it are rearing and finishing similar numbers of calves – illustrated by the purple cone in the lower plot.

Figure 5 Calves registered plotted against finished calves in 2019 demonstrating specialist rearers, specialist finishers and rearer-finishers



21. This therefore illustrates that if we are to truly understand the Scottish beef supply chain we need to distinguish between different production systems and specialisations as well as scales. The next section provides new insights into production systems and scales before assessing technical performance across scale and system

Beef production systems

22. Using CTS data at a business level it has been possible to allocate crofts and farms to beef rearing and finishing systems by predominant outcomes for the calves registered / bought into a business that were destined for slaughter before 36 months of age from in a specific calendar year cohort. The systems were derived in order to provide a better disaggregation of the beef sector beyond the traditional 'farm types' allocated using Standard Outputs (SO) from the June Agricultural Census. The cattle system categories were evolved from the classifications used by Quality Meat Scotland (QMS) in their annual Cattle & Sheep Enterprise Profitability in Scotland publication with dairy farms added.

23. The classification system used was first outlined in Thomson et al (2020)[8] that focused on classification based on all calves (dairy and suckler) by predominant use of the calves registered in 2013 destined for slaughter by 36 months of age (i.e. dairy farms selling store calves or finishing cattle were allocated to a 'beef' system initially, with businesses unallocated but tagged as 'dairy' in CTS - based on breed dominance – then deemed dairy). In this report any business marked as dairy in CTS was classified as 'dairy' irrespective of the outcome of their registered calves destined for slaughter (sold as young calves or store cattle or sold directly to abattoirs as finished cattle). Thereafter the businesses were allocated to beef systems based on the predominant age of sale of store animals for rearers or whether finishers predominately finished cattle under or over the median slaughter age (699 days in 2013) of Scottish born cattle, slaughtered in Scotland at less than 36 months. Due to the dynamic nature of the sector and the long-term nature of rearing and finishing cattle (up to 36 months) this is a complex allocation and is based on 'throughput' of calves from a specific year (i.e. those that were born in a specific year plus calves from that cohort bought into a businesses for finishing).

24. The differentiated cattle system categories are described as:

- **Dairy**: the business (or holding within a business) are identified as a 'dairy' in the CTS data based on predominance of dairy breeds.
  - From an analytical perspective all cattle on these dairy businesses are classed as "dairy" despite some suckler calves being reared.
- **Extensive upland suckler producers**: calves mostly moved off the business within 9-10 months from registration.
  - From an analytical perspective this included all LFA businesses where the majority of calves born were moved to another business (not for slaughter) within 10 months of registration.
- **Extended upland suckler producers**: calves mostly moved off the business within 11-12 months of registration.
  - From an analytical perspective this included all LFA businesses where the majority of calves born were moved to another business (not for slaughter) between 10-12 months of registration.

[8] Steven Thomson, Mike Spencer & Aaron Reeves (2020) Scottish Beef Finishing – Evidence from 2013 born animals. Cattle Network Briefing Note 1. Available at: https://www.ruralbrexit.scot/future-policy/scottish-beef-finishing-cattle-network-briefing-note-1/

- **Lowland suckler producers**: calves are moved to another business after 12 months from registration.
  - From an analytical perspective this included all non-LFA businesses where the majority of calves born were moved to another business (not for slaughter) between 8 and 16 months from registration.
- **Rearer-finishers**: registered calves are mostly born, reared and finished within single businesses.
  - From an analytical perspective if a business brought in more calves from other businesses to finish than they reared themselves they would not be classed as a rearer-finisher. Equally if the business finished fewer cattle than sold as 'stores' they would not be classed as a rearer-finisher.
- **Early finishers**: the predominant system is cattle brought onto farm for finishing and the majority of the cattle are finished (and slaughtered within 6 days of leaving business) less than 699 days from registration.[9]
  - This includes calves born on dairy farms that are brought to finish.
- **Late finishers**: the predominant system is cattle brought onto farm for finishing and the majority of the cattle are finished (and slaughtered within 6 days of leaving business) more than 699 days after registration.
  - This includes calves born on dairy farms that are brought to finish.

25. Table 3 summarises the estimated structure of the national cattle herd by allocated production system based on how the calves were utilised (sold as 'stores', or brought in to finish) alongside herds classified as 'dairy' within CTS. As the final destination of calves born in 2018 and 2019 were not fully known from the CTS data held by EPIC at the time of analysis many in the finishing categories were 'unclassified' for 2018 and 2019 (and are therefore excluded from this summary).
    - The data reveals that in any given year the largest proportion of Scotland's suckler producers were categorised as Extended Upland Suckler producers (43.5% in 2017) selling calves at 10-12 months, and they accounted for a similar proportion of the suckler cow herd (45.5% in 2017).
    - Extensive Upland Suckler producers, selling calves at less than 10 months, accounted for the second largest proportion of producers (20.6% in 2017) but they only accounted for 12.5% of the national suckler cow herd in 2017 – with many very small producers (including crofters) falling into this category.
    - In 2017 Lowland Suckler producers accounted for 11.3% of Scotland's suckler producers and 12.1% of the suckler cow herd.
    - The 9.3% of producers that were classified as rearer-finishers in 2017 were larger on average – carrying 16.6% of the suckler cows.
    - It is worth noting that 'unclassified' categories account for cases where competing systems have similar weighting meaning system allocation is not intuitive. The specialist finishers with suckler cows only account for a very small proportion of the suckler cow herd.

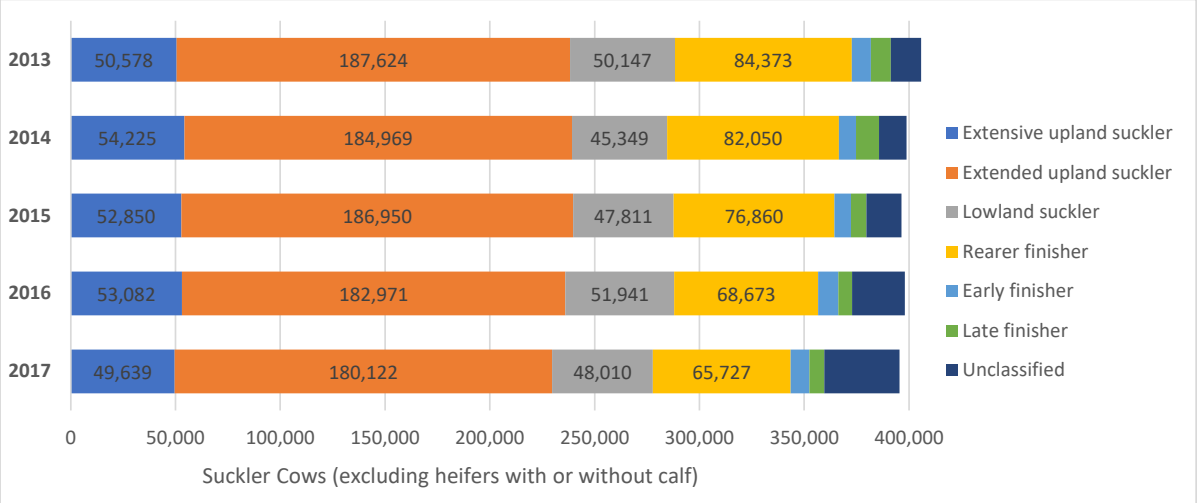
[9] Median age of slaughter in 2013

Table 4: Number and proportion of businesses and breeding cows by system (% exclude 'dairy') 2013-2017

	Businesses (% exclude dairy)									
	2013		2014		2015		2016		2017	
Extensive upland suckler	1,700	20.3%	1,667	20.9%	1,654	20.9%	1,659	21.4%	1,565	20.6%
Extended upland suckler	3,825	45.7%	3,739	46.9%	3,747	47.4%	3,500	45.2%	3,302	43.5%
Lowland suckler	1,072	12.8%	896	11.2%	905	11.4%	900	11.6%	857	11.3%
Rearer finisher	1,017	12.2%	967	12.1%	884	11.2%	785	10.1%	702	9.3%
Early finisher	159	1.9%	145	1.8%	140	1.8%	123	1.6%	127	1.7%
Late finisher	207	2.5%	171	2.1%	152	1.9%	152	2.0%	144	1.9%
Unclassified	382	4.6%	381	4.8%	427	5.4%	619	8.0%	892	11.8%
Dairy	1,128		1,087		1,085		1,067		1,045	
	Cows (% exclude dairy)									
	2013		2014		2015		2016		2017	
Extensive upland suckler	50,578	12.5%	54,225	13.6%	52,850	13.3%	53,082	13.3%	49,639	12.5%
Extended upland suckler	187,624	46.2%	184,969	46.4%	186,950	47.2%	182,971	46.0%	180,122	45.5%
Lowland suckler	50,147	12.4%	45,349	11.4%	47,811	12.1%	51,941	13.1%	48,010	12.1%
Rearer finisher	84,373	20.8%	82,050	20.6%	76,860	19.4%	68,673	17.3%	65,727	16.6%
Early finisher	9,132	2.3%	8,152	2.0%	7,837	2.0%	9,599	2.4%	8,996	2.3%
Late finisher	9,510	2.3%	10,930	2.7%	7,430	1.9%	6,598	1.7%	7,134	1.8%
Unclassified	14,414	3.6%	13,102	3.3%	16,638	4.2%	25,097	6.3%	35,902	9.1%
Dairy	154,510		147,281		152,781		153,744		154,357	

26. Figure 6 reaffirms that the largest proportion of the national suckler herd are on extended rearing farms, where the most calves are sold between 10 and 12 months. The decline in the size of the number of cows on rearer-finisher farms over the 2013 -2017 is apparent – and ties in with the 2014 CAP reforms and the move to regionalised Basic Payment Scheme and Greening between 2015 and 2019 (Thomson and Moxey; 2020[10] confirm that rearer-finishers indeed were hardest hit in terms of declines in their CAP payments per unit of suckler beef output of all sectors).

Figure 6: Distribution of suckler cows by production system



27. Table 5 provides a summary of which production system Scottish calves registered with CTS were born to and which systems cattle were finished on prior to abattoir move. The distribution of calves follows a similar pattern to the cow population, but it is worth noting that the figures here include all calves born – including to heifers.

[10] Thomson and Moxey (2020) Structure and Support of the Scottish Beef Sector 2019 – impact of CAP 2015 reforms

- Extended upland systems accounted for 35.6% of the suckler calves registered in 2017 whilst extensive upland systems accounted for 12.3% of the calves. Rearer-finishers were responsible for 24.4% of calf registrations in 2017 and lowland suckler producers 14.9%.

28. Reflecting the stratified beef supply-chain, the distribution of finished cattle differs markedly from the suckler herd (see Table 5) – with specialist finishers accounting for a significant proportion of the finished 'prime' cattle before they were transferred to the abattoir for slaughter.

- In 2017 the extended suckler producers only accounted for 4.7% of the finished cattle sent for slaughter and the extensive upland producers only 0.8%. Lowland suckler producers accounted for 3.7% of finished cattle.
- Dairy farms also rear and finish calves that go into the beef supply chain and dairy businesses accounted for 9.1% of the finished cattle in 2017 (with other dairy born calves finished by other businesses).
- Rearer-finishers were the source of 15.8% of finished cattle in 2017 (with some of the calves born in these systems finished elsewhere).
- The specialist finishers dominate abattoir throughput – and they accounted for over 60% of the finished cattle in Scotland in 2017. Late finishers (those who finish more cattle over than the median slaughter age than under it) accounted for 31.6^ of the finished cattle in 2017 and early finishers (those with more cattle under the median slaughter age than over it) accounted for 29.2% of abattoir throughput.

Table 5 Calves registered and finished cattle by system 2013-2017

	Registered Calves (% excludes dairy)									
	2013		2014		2015		2016		2017	
Extensive upland suckler	47,971	12.2%	49,691	12.6%	50,163	12.6%	51,313	12.9%	48,575	12.3%
Extended upland suckler	180,890	36.8%	182,957	37.0%	186,964	36.9%	183,490	36.5%	179,524	35.6%
Lowland suckler	48,255	15.5%	44,995	14.4%	48,473	15.2%	49,938	15.6%	48,270	14.9%
Rearer finisher	83,791	31.7%	82,837	30.8%	78,956	28.9%	70,033	25.8%	68,033	24.4%
Early finisher	8,780	4.8%	8,138	4.3%	8,359	4.3%	10,093	4.9%	9,368	4.4%
Late finisher	9,148	4.7%	11,310	5.6%	7,571	3.7%	6,734	3.2%	7,114	3.2%
Unclassified	14,569	7.4%	13,116	6.5%	17,647	8.3%	25,345	11.5%	34,764	15.3%
Dairy	146,072		151,396		158,292		157,614		157,085	
	Finished Cattle (% includes dairy-beef)									
	2013		2014		2015		2016		2017	
Extensive upland suckler	2,363	0.6%	4,072	1.1%	2,243	0.6%	2,418	0.7%	2,721	0.8%
Extended upland suckler	21,443	5.9%	19,876	5.3%	17,706	4.9%	18,326	4.9%	17,193	4.7%
Lowland suckler	11,541	3.2%	11,422	3.0%	13,669	3.8%	15,042	4.0%	13,387	3.7%
Rearer finisher	68,832	18.8%	70,108	18.6%	64,959	17.9%	59,456	16.0%	57,337	15.8%
Early finisher	92,459	25.3%	94,676	25.1%	97,372	26.8%	112,043	30.1%	105,638	29.2%
Late finisher	122,768	33.6%	127,890	33.9%	118,427	32.6%	113,811	30.6%	114,324	31.6%
Unclassified	11,981	3.3%	13,634	3.6%	15,388	4.2%	15,337	4.1%	16,401	4.5%
Dairy	32,229	8.8%	33,105	8.8%	31,556	8.7%	33,278	9.0%	33,020	9.1%

29. Table 5 reaffirms the distinction between producers and finishers and their specific roles in Scotland's beef supply chain. When the distribution of cattle across producers of different scale is brought into consideration it adds even further complexity to the analysis. Table 6 shows the proportion of businesses in each of the production systems by suckler cow herd size. As the table demonstrates very small herds (less than 10 cows) dominate the extensive upland systems – reflecting the many small herds running on crofts – with 58.% of Extensive upland producers having less than 20 suckler cows (compared with 33% of extended upland producers, 33.9% of lowland producers and only 13.6% of rearer-finishers.

Table 6: Distribution of producers by size band and production system 2017

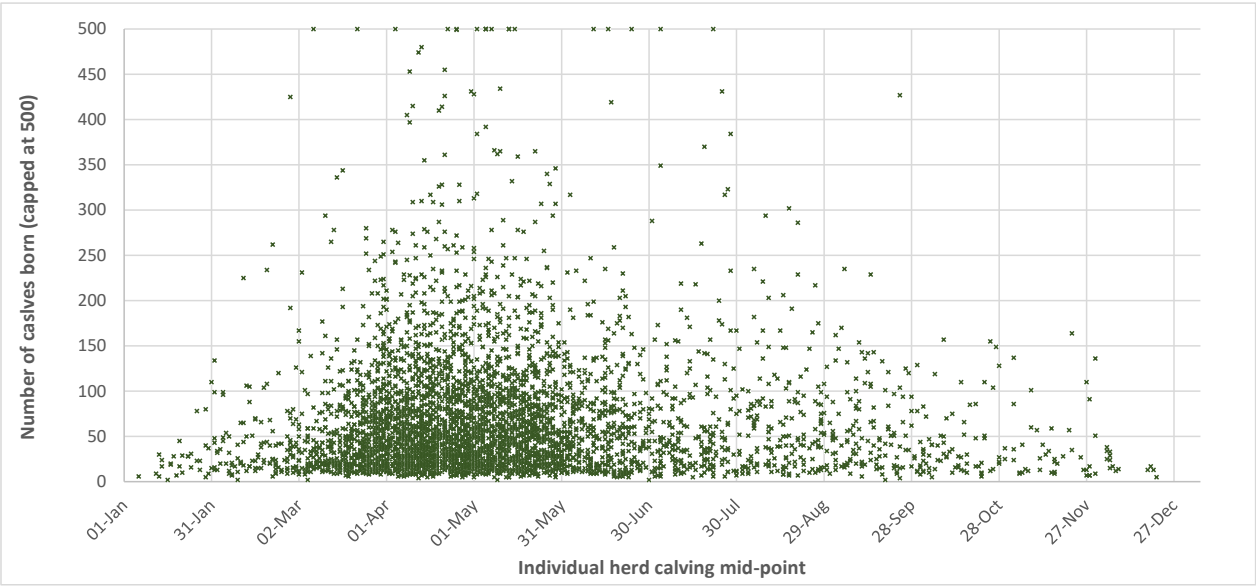
Suckler Cows	Extensive upland suckler	Extended upland suckler	Lowland suckler	Rearer-finisher
n=1-9	39.0%	18.8%	19.5%	7.5%
n=10-19	19.5%	14.0%	14.4%	6.1%
n=20-49	22.9%	26.3%	28.8%	18.5%
n=50-99	11.9%	25.4%	21.5%	32.6%
n=100-249	5.9%	14.0%	13.7%	31.3%
n=250+	0.7%	1.4%	2.2%	3.8%
Businesses	**1,565**	**3,302**	**857**	**702**

Calving season

30. In Scotland, suckler beef production is dominated by spring calving. Spring calving allows farmers and crofters to benefit from the flush of milk when cows are turned out to spring grass at an age when young calves can benefit the most. Further spring-born calves can be weaned in late autumn meaning it is it is comparatively cheaper to feed housed cows over the winter than if it is suckling an autumn born calf.

31. Calving within herds can take place over prolonged periods, particularly if there is more than one targeted calving block (e.g. spring and autumn) within a businesses. In order to illustrate where the bulk of calves are born within individual herds the median calving date (when the 50th percentile calf was born) provides insights into herd calving 'mid-points'. Figure 7 shows the mid calving point of individual suckler cow herds 2017 alongside the number of calves registered on the *y-axis* (noting this excludes herds of less than 20 cows and specialist finishers). It demonstrates the large grouping of calving mid-points that fall in the spring – although a small proportion of herds are focused on late summer and autumn calving.

Figure 7: Date of calving mid-point for suckler herds (excluding specialist finishers) with 20+ cows in 2017[11]

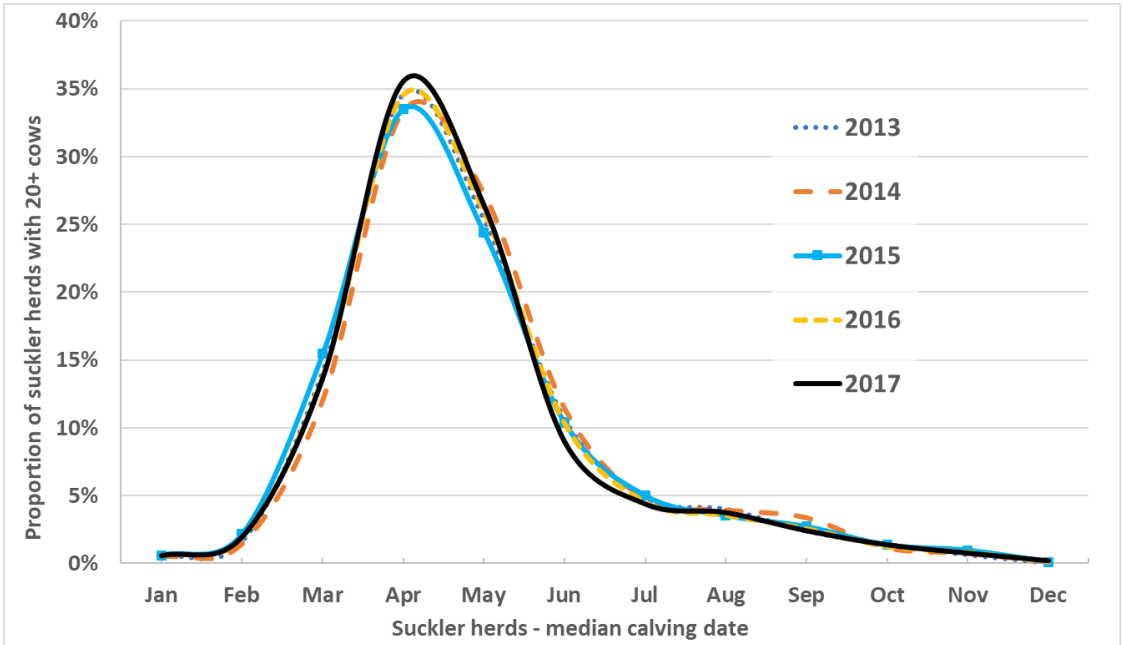


[11] Businesses with over 500 calves born are capped at 500 and appear in the graph as 500 calves

32. Whilst spring calving has not always been as prevalent as it is today, there was little change in the mid-point of calving (when 50% of calving is completed within a herd) when averaged across Scotland between 2013 and 2019. Figure 8 demonstrates the limited change that occurred in the mid-point of calving on farms and crofts between 2013 and 2017[12].

- Over the 2013 -2017 period 34% of the businesses had their mid-calving point falling in April, with 26% in May and 14% in March. The data table attached to Figure 8 illustrates that in 2017 across the 3,822 herds with more than 20 suckler cows the mid-point was 30th April, with 25% of Scottish suckler herds having calving mid-points before 10th April and 25% had mid calving points falling after 27th May. These dates and the overall distribution appear to vary little between years.

Figure 8 Distribution of herd calving mid-points of suckler herds with 20+cows (excluding specialist finishers) 2013 to 2017



	2013	2014	2015	2016	2017
Businesses	4,154	4,054	3,981	3,923	3,822
25th percentile calving mid-point	10-Apr	12-Apr	08-Apr	10-Apr	10-Apr
Median of calving mid-point	01-May	04-May	30-Apr	01-May	30-Apr
75th percentile calving mid-point	31-May	03-Jun	30-May	30-May	27-May

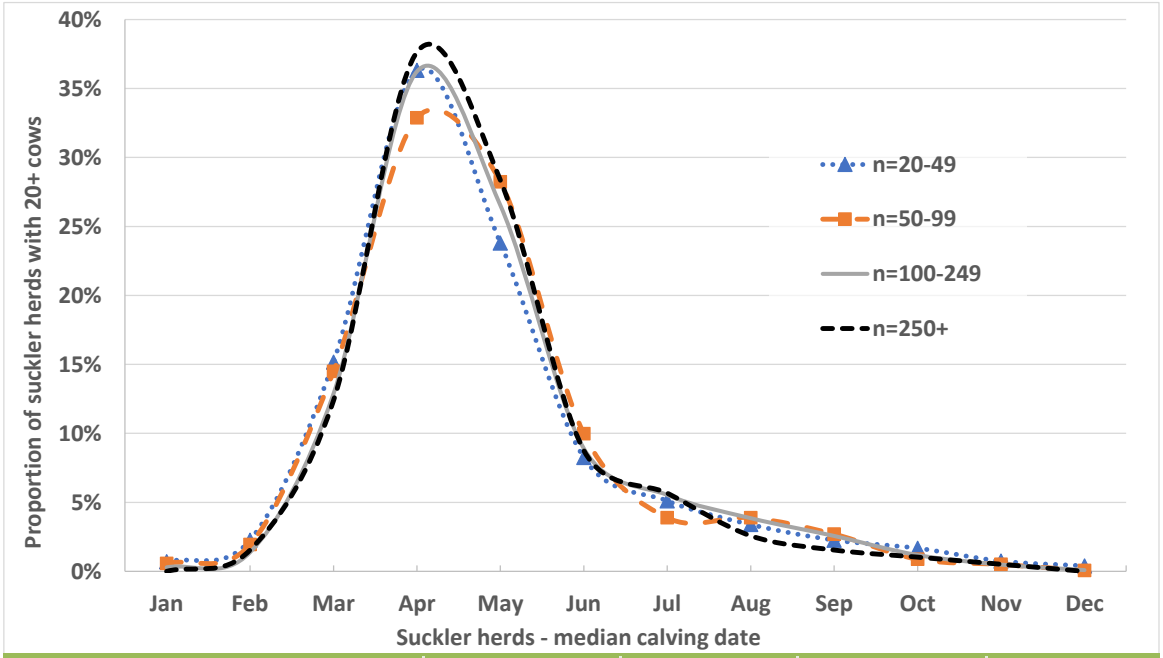
33. In order to assess if smaller herds and larger herds differ in terms of their main calving periods the distribution of calving midpoints for herds of different sizes in 2017 is presented in Figure 9.

- There appears to be limited differences in the distribution of calving mid-points between herd size groupings. The 146 businesses with 250+ cows in 2017 had slightly tighter mid-calving points.

[12] This does not include 2018 and 2019 as the production system allocation was used to filter out specialist finishers

- The table shows that when averaged across all herds within a size grouping (expressed as median) the mid points of the different herd sizes all fell within a week (the end of April / beginning of May).
- The mid-point of suckler calving fell earlier than 6-13 April (depending on herd size) for a quarter of producers (25th percentile) and for another quarter their calving mid-point fell after 22-28 May (indicating more of a tendency for summer / autumn calving).
- In 2017 78% of businesses had their 50th percentile calf born in March, April or May (compared to 75% for other size groups). Overall only 8% of herds had calving mid-points from August to December.[13]

Figure 9: Distribution of herd calving mid-points by herd size grouping for businesses with 20+ suckler cows (excluding specialist finishers) 2017



	20-49 cows	50-99 cows	100-249 cows	250+ cows
Businesses	1,798	1,496	942	146
25th percentile calving mid-point	06-Apr	08-Apr	11-Apr	13-Apr
Median of calving mid-point	27-Apr	03-May	01-May	30-Apr
75th percentile calving mid-point	27-May	28-May	27-May	22-May

34. Whilst there was little difference in the distribution of calving mid-points between years and size categories, Figure 10 reveals that there was a difference in the calving mid points by dominant system in 2017. Firstly, dairy were added here for contrast as many herds have prolonged calving periods to ensure year round milk production – and the mid-point of dairy calf registration therefore takes place for the majority of dairy businesses in the summer months.

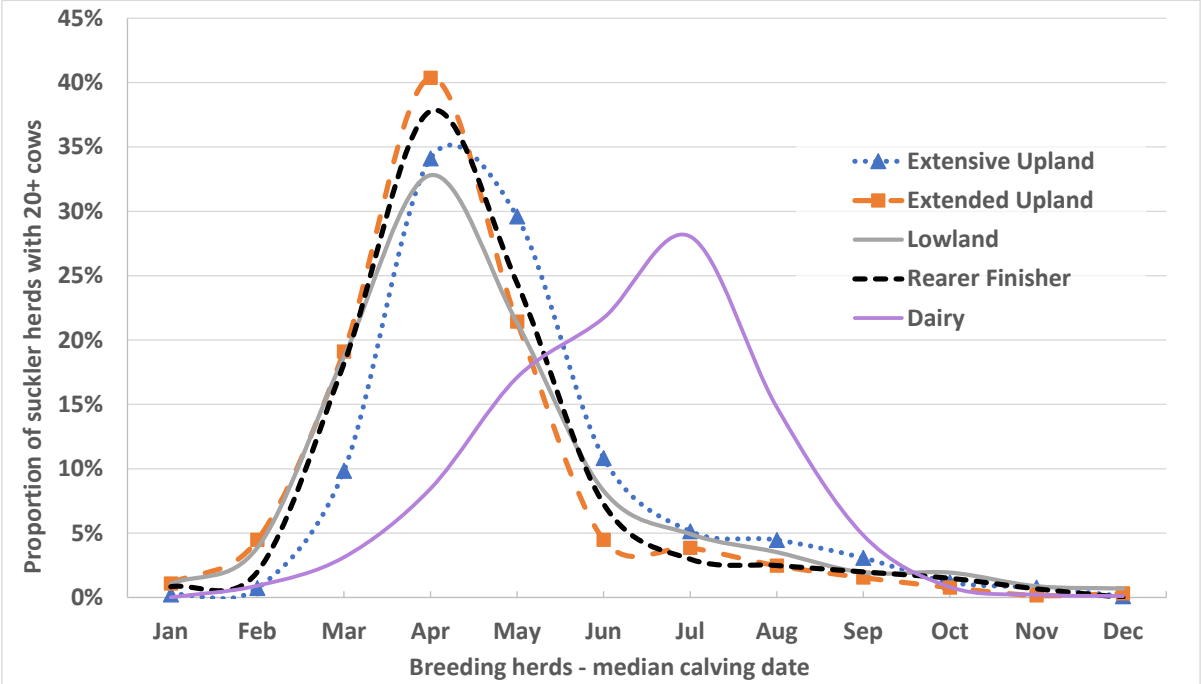
35. Figure 10 illustrates that whilst extended upland, rearer-finishers and lowland systems have similar distributions and were dominated by spring calving the lowland producers (in 2017) had relatively fewer businesses with calving midpoints falling in the spring – with relatively more businesses (21%)

[13] It is worth noting that for this analysis it takes the mid-point within a calendar year – meaning any businesses having a calving period running between calendar years have some embedded errors.

with mid-point calving falling between October and June compared to extended rearing (13%) and rearer-finishers (16%).In addition, the extensive upland producers have, what appears to be a lagged curve – that is that calving mid-point distributions follow a similar pattern to other suckler systems but 2-3 weeks later. This is likely due in part to geography and biophysical constraints on grass growth meaning calving occurs marginally later for those selling calves at weaning. Only 10% of the extended upland producers had March mid points compared to about 19% in the other systems and 25% had mid points falling between June and October.

36. The data table associated with Figure 10 illustrates the lag in the median and upper and lower quartiles of 2-3 weeks for the 1,977 extensive upland producers. This is a reminder that some farmers and crofters face biophysical and grass growth constraints that can restrict when their main calving period occurs in the spring.

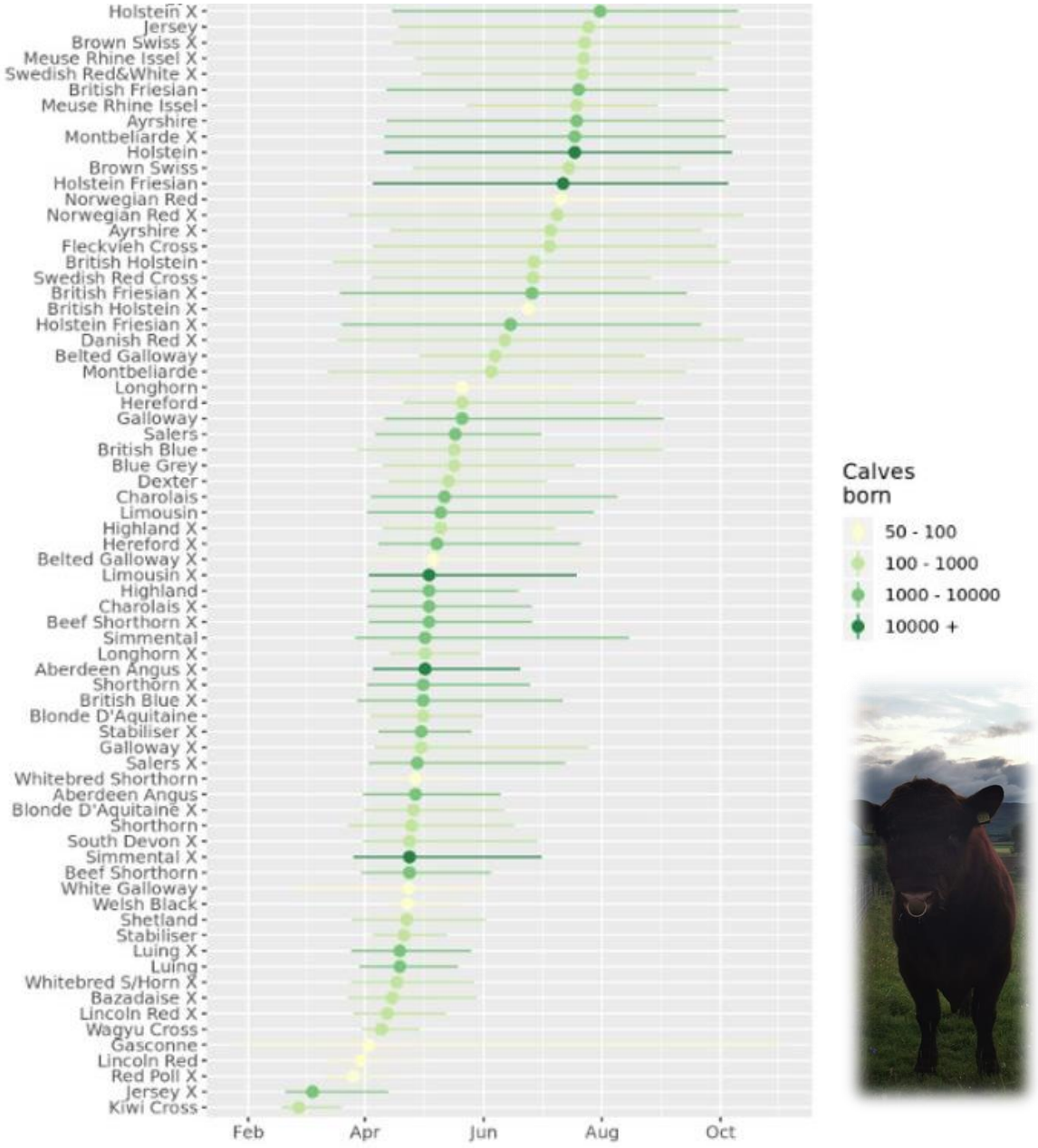
Figure 10: Distribution of herd calving mid-points by system for businesses with 20+ suckler cows (excluding specialist finishers) 2017



	Extended upland suckler	Extensive upland suckler	Lowland suckler	Rearer finisher	Dairy
Businesses	1,977	551	499	558	911
25th percentile calving mid-point	15-Apr	02-Apr	02-Apr	05-Apr	24-May
Median of calving mid-point	06-May	18-Apr	24-Apr	24-Apr	30-Jun
75th percentile calving mid-point	03-Jun	12-May	23-May	19-May	26-Jul

37. Further illustrating that systems and geographies lead to differences in peak calving periods Figure 11 shows the differences between cattle breeds. Here the dairy breeds tend to be at the top of the figure, with mid calving points occurring in the summer months. The mid calving point of the main beef breeds (the dark green dots and lines represent the most popular calf breeds) generally are in a relatively tight spring calving window – but it is evident to see more native hill breeds such as the Galloway, Belted Galloway and Blue Greys having mid-calving points in late May / early June – that coincide with hill pasture availability.

Figure 11: Average date of calving by breed (median and interquartile range)

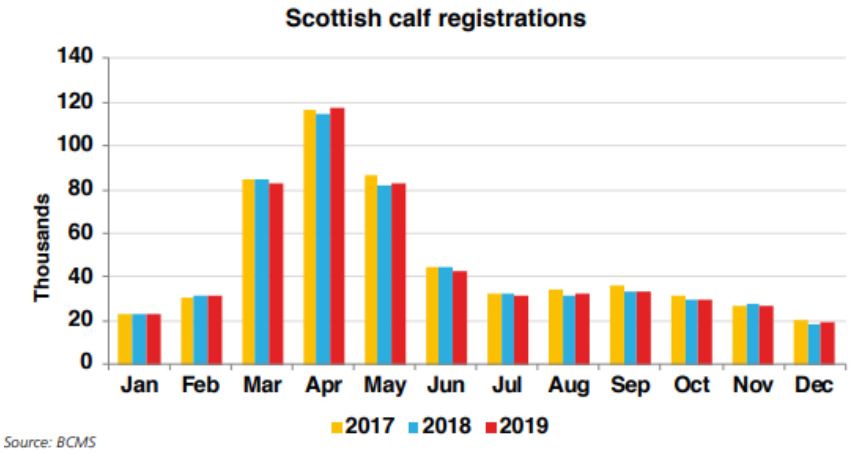


38. Despite the beef system being dominated by spring calving, in order to manage overhead costs and production efficiencies whilst meeting market demand, Scottish abattoirs operate a more-or-less constant throughout of prime cattle throughout the year, as shown in the right hand chart in Figure 12. Achieving a smooth supply of prime cattle from concentrated calving dates (the top chart in Figure 12) means that different animals are reared and finished at different rates and/or slaughtered at different weights/ages. This calving Imbalance with demand profile for finished cattle therefore has implications for the extent to which diets and slaughter ages can be manipulated to reduce carbon emissions without disrupting market relationships.

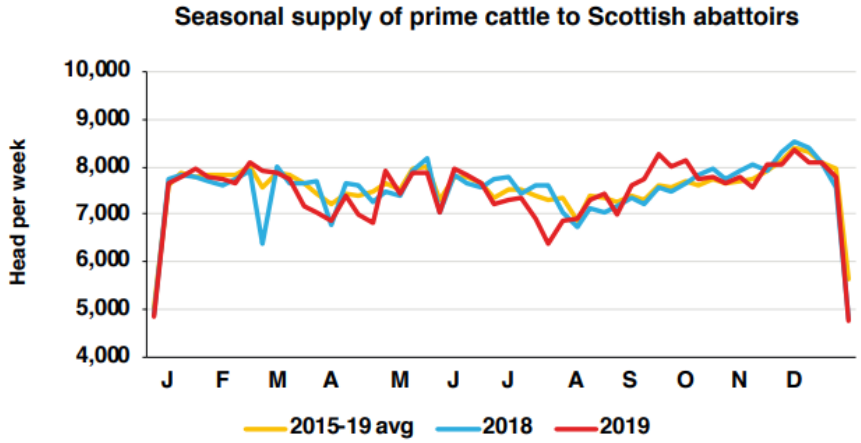
39. Specialist finishers play a vital role in the beef supply chain, and any efforts to reduce the age at slaughter, or reduce carcase weights in order to minimise emissions will need a coordinated approach across all parts of the supply chain – from suckler calf producers, dairy calf producers, finishers and abattoirs and could likely benefit from improved demand-side signals and rewards for

lower emissions beef to go alongside any policy mechanisms impacting the supply-side. Breed differences and spring calving imbalance means that these factors must be considered in any attempts to impose reductions or thresholds on finishing age.

Figure 12: Monthly Scottish beef calf registrations and weekly Scottish abattoir throughput



Source: BCMS



Source: Scottish Government; QMS calculations

Photo: Jos Poelmans from Pixabay

Suckler Cow Fertility

40. Suckler herd fertility is directly linked to profitability, technical efficiency and, importantly, greenhouse gas emissions –i.e. 'empty cows' both cost money and contribute to emissions. Riddell et al (2017) *A Guide to Improving Suckler Herd Fertility*[14] provide suckler fertility targets that 'top' performing herds should aim to achieve:

- Calvings per cow and heifer put to the bull – 95%
- Barren cows – no more than 5%
- Cows calving in first three weeks – 65%
- Cows calving in six weeks – 90%
- Bulling periods – nine weeks for cows and six weeks for heifers
- Calf mortality birth to weaning – less than 3%
- Calves reared – 94% (calves reared to cows and heifers bulled)
- Replacement rate – less than 15%[15]

41. Whilst achieving these targets undoubtedly improves the financial performance of suckler rearing, both intuitively and scientifically achieving these targets can also help reduce GHG emissions from any given herd. This section of the report examines various of these metrics to assess how Scotland's suckler herds are performing and illustrate the large amount of variance that exists from these targets.

Calving rates

42. In the vast majority of suckler herds the principal reason for having cows is to produce calves that are either destined for prime beef supply or future breeding animals (bulls and cows). Regardless if a producer is a pedigree cattle producer selling bulls and breeding cows, or a suckler rearer producing calves for slaughter one of the most fundamental measures of technical performance is the calving rate – that is the proportion of calves born per breeding cow in a year.

43. Cows that do not produce a calf represent an overhead burden of emissions (and of maintenance costs) incurred without any accompanying beef produced. Higher calving rates dilute this overhead, reducing the emissions-intensity of beef and lowering the total emissions arising from production of a given volume of carcase meat.

44. As CTS only records the number of calves registered to a business we have used the calf registration rate as a proxy for calving rate. It is acknowledged that as producers have 28 days from a calf's birth in which to register it, there are instances where neonatal mortality (death under 28 days) would mean that a calf is never registered despite being born alive. As some neo-natal mortality is therefore absorbed into the effective calf registration rate the true calving rates may be marginally higher than reported here – but equally on farm mortality figures would be correspondingly lower. Low calving rates and on farm mortality both represent technical inefficiencies - and therefore wasted GHG emissions.

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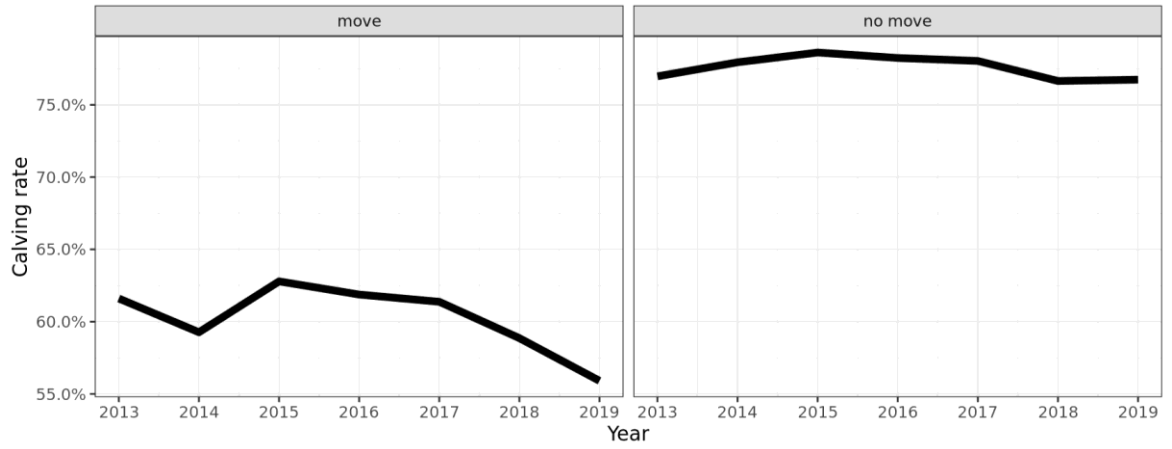
[14] Iain Riddell, George Caldow, Basil Lowman, Ian Pritchard, Colin Morgan (2017) A Guide to Improving Suckler Herd Fertility. A booklet for QMS.
https://www.qmscotland.co.uk/sites/default/files/qm2879_suckler_herd_a5_brochure_issuu_517.pdf

[15] Image by Steven Thomson

45. There are analytical complications of allocating successful or unsuccessful calving to a specific herd if a cow moves between businesses during a specific year. For example, Figure 13 reveals that there is a 20-25% difference in the calving rate of cows that are transferred to another business in any specific year. These moving cows are a small proportion of the national herd, and can be excluded from the analysis – but that leads to inaccuracies of both the national and herd level figures. It is considered more prudent to have some small errors at herd level than omit a proportion of lower performing cows from the analysis.

Figure 13: Calf registration rate differences between cows that move between businesses in a given year and those that do not.



46. The National Animal Disease Information Service (NADIS)[16] suggest "if the calf crop % is < 90% figures must be analysed to see where in the production cycle the losses are occurring – i.e. is it poor cow fertility or subsequent calf losses that are the problem. Without farmer and vet analysing these figures together it is hard to target advice and efforts to maximise profits. It may be much easier to improve output by reducing areas of calf losses (e.g. dystocia and neonatal disease) than trying to push herd pregnancy rates up by a few %."

47. This reiterates the challenge of reliance on a single metric from national databases – and therefore helps to stress that figures must be considered holistically – i.e. how many calves per cow survived to breeding or slaughter is the best metric to use but is more complex to measure. A further analytical complexity arises from the need to exclude calved heifers from the analysis since from an analytical perspective they calf at 100% as there is no measurement of how many heifers are put to the bull of have unsuccessful births.[17]

48. Figure 14 provides a scatter plot of the calf registration rate from cows (excluding heifers[18]) against suckler herd size (x-axis) in 2019. This reiterates the wide variability in performance within the

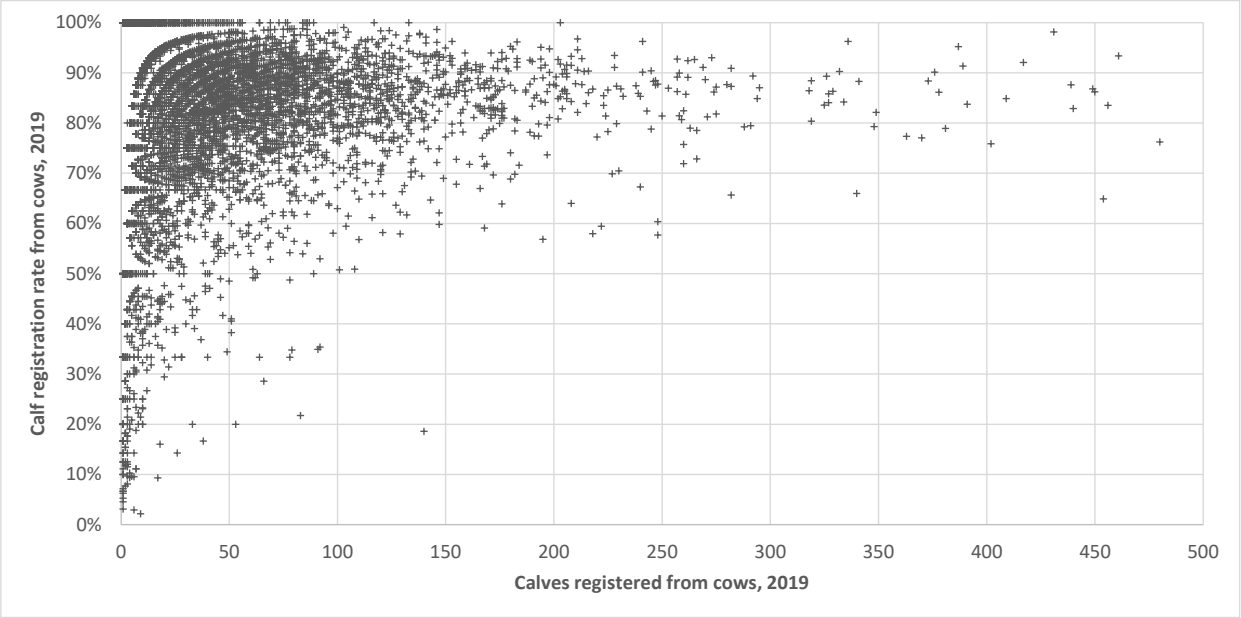
[16] https://www.nadis.org.uk/disease-a-z/cattle/beef-herd-fertility/beef-herd-fertility-1/

[17] This reiterates the challenges when interrogating CTS data to calculate farm, system and national level performance metrics. Cows born to heifers must be calculated and removed from total calves that can be used with total female cattle that had previously had a calf to calculate calving rates – if heifers and all calves are added in it generally increases calving rates by 2%-4% depending on the system.

[18] Heifers were excluded since the number of heifers put to the bull, had failed calving, or neonatal mortality that resulted in no calf registration are unknown. As such heifer calf registration can only ever be 100% as that is the first point from an analytical perspective that it is known the animal is earmarked for breeding. In addition, it excludes heifer pregnancies that were unplanned.

sector, at all scales. Cause of variable performance is unknown from this data – but there may be farms that specialise in trading cull cows, or farms and crofts with extensive herds on hill land kept principally for agri-environmental purposes. In addition, it is worth highlighting that with small herds only a couple of barren cows can lead to very low calving rates. It is important to note that this analysis does not exclude cows that were moved off the farm/croft within the year (i.e. those that may have been sold to others 'in calf' or as cull cows).

Figure 14: Suckler calf registration rate by number of suckler calves registered per business 2019



49. Whilst NADIS suggest that action should take place to identify where there are suckler cow fertility issues if calving rates fall below 90% the CTS data suggests that in reality the national calving rate from cows is considerably lower (see Table 7), averaging 81.5% over the 2013 to 2019 period (fluctuating between 80% and 82%).

50. Table 7[19] reveals the effective calving rate of suckler cows (cows on a farm that have previously had a calf registered to it) by production system between 2013 and 2019. There are evident performance differences between both production systems, and years. The differences between years appear to be linked to weather, with 2012 having an extremely poor summer in many locations (that left producers with poor quality or insufficient quantity of winter fodder) that was followed by extremely wet autumn and harsh winter / spring that left many farms and crofts without enough spring feed in 2013 - this appears to have impacted on some calving rates (and calf mortality rates). The second major weather event that occurred during the analytical time period was the 2018 hard winter / spring period – the so called 'Beast from the East' Both these events impacted on different geographies in different ways – but their impact on calving rates is apparent.

    - The more extensive systems, selling calves at weaning have the lowest calf registration rate (average of 78.4% over the 6 year period) and were notably affected by the 2018 'Beast from the East' – falling 7% in that year.

[19] Note this is calculated from the number of calves registered to cows within a system in a given calendar year and is not a summary of individual herd calving rates that is explored later.

- Extended upland producers averaged 82.7% over the 6 year period. These producers were 2% below their norm in 2013, suggesting some weather related impacts affecting calving rates.
- Lowland suckler producers averaged 79.1% calf registration rate over the period and appear to also have been adversely affected in 2013 (but also had a 3.5% fall in calving rate between 2015 and 2016.
- The rearer-finisher system performed best with an average of 84.2% calving rate over the period.
- For comparison, the calf registration rate from CTS dairy businesses is also included. Whilst the calving rate appears to have improved from 2013 the average was 68% over the 7 years and 2013 appears to have been an outlier – likely affected by neo-natal calf losses during spring 2013 pre-calf registration.

Table 7: Calf registration rate to suckler cows by production system (excluding heifers) 2013-2019

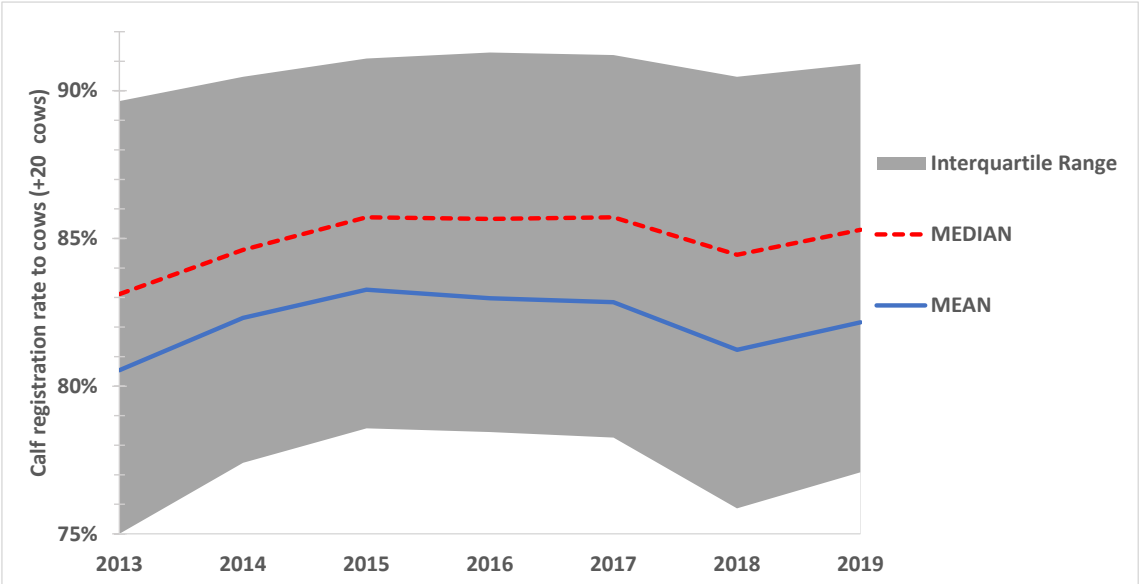
Year	Extensive upland suckler	Extended upland suckler	Lowland suckler	Rearer-finisher	Scotland Sucklers	*Dairy*
2013	79.2%	81.1%	77.8%	81.4%	**80.4%**	*64.2%*
2014	76.9%	83.1%	79.8%	83.4%	**81.6%**	*68.2%*
2015	78.8%	83.2%	80.3%	84.4%	**82.4%**	*69.1%*
2016	81.3%	83.5%	76.8%	84.2%	**82.0%**	*69.4%*
2017	80.8%	82.9%	80.0%	84.9%	**81.7%**	*67.7%*
2018	73.6%	82.1%	79.7%	86.9%*	**80.3%**	*68.7%*
2019					**81.7%**	*68.4%*

** High % unclassified in 2018 due to final calf destination query*

51. Figure 15 provides a summary of the calf registration rates of individual herds (businesses) with 20+ suckler cows. The median sits abovet the mean indicating that some low herd calving rates are influenceing the mean (this may be, for example, from businesses specialising in the cull-cow trade).

- The median was 83.1% in 2013 (poor weather year) rising to 85.3% in 2019 (with the 'Beast from the East' casuing the median to fall by over 1% in 2018) menaing half the businesses performed better and half performed worse than these figures.
- The mean (artithmetical average) is clearly influenced by poorly performing herds and generally sits about 3% below the median.
- The interquartile range illustrates the calving rate of 50% of the businesses with 25% of herds performing better than the upper quartile (90.9% in 2019) and 25% perform worse than the lower quartile 77.1% in 2019.
- This illustrates that at least 25% of producerswith 20+ suckler cows are achieving calving rates of more than 90% each year (with the exception of 2013).

Figure 15: Summary of suckler calf registration rates to cows in suckler herds of 20+ cows, 2013-2019



	2013	2014	2015	2016	2017	2018	2019
BRNs	4,847	4,753	4,681	4,642	4,551	4,472	4,403
Upper Quartile	89.7%	90.5%	91.1%	91.3%	91.2%	90.5%	90.9%
Median	83.1%	84.6%	85.7%	85.7%	85.7%	84.4%	85.3%
Mean	80.5%	82.3%	83.3%	83.0%	82.8%	81.2%	82.2%
Lower Quartile	75.0%	77.4%	78.6%	78.4%	78.3%	75.9%	77.1%
Standard Deviation	13.4%	12.6%	12.3%	13.1%	13.3%	14.2%	13.8%
Standard Error of Mean	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
95 Confidence Interval	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%

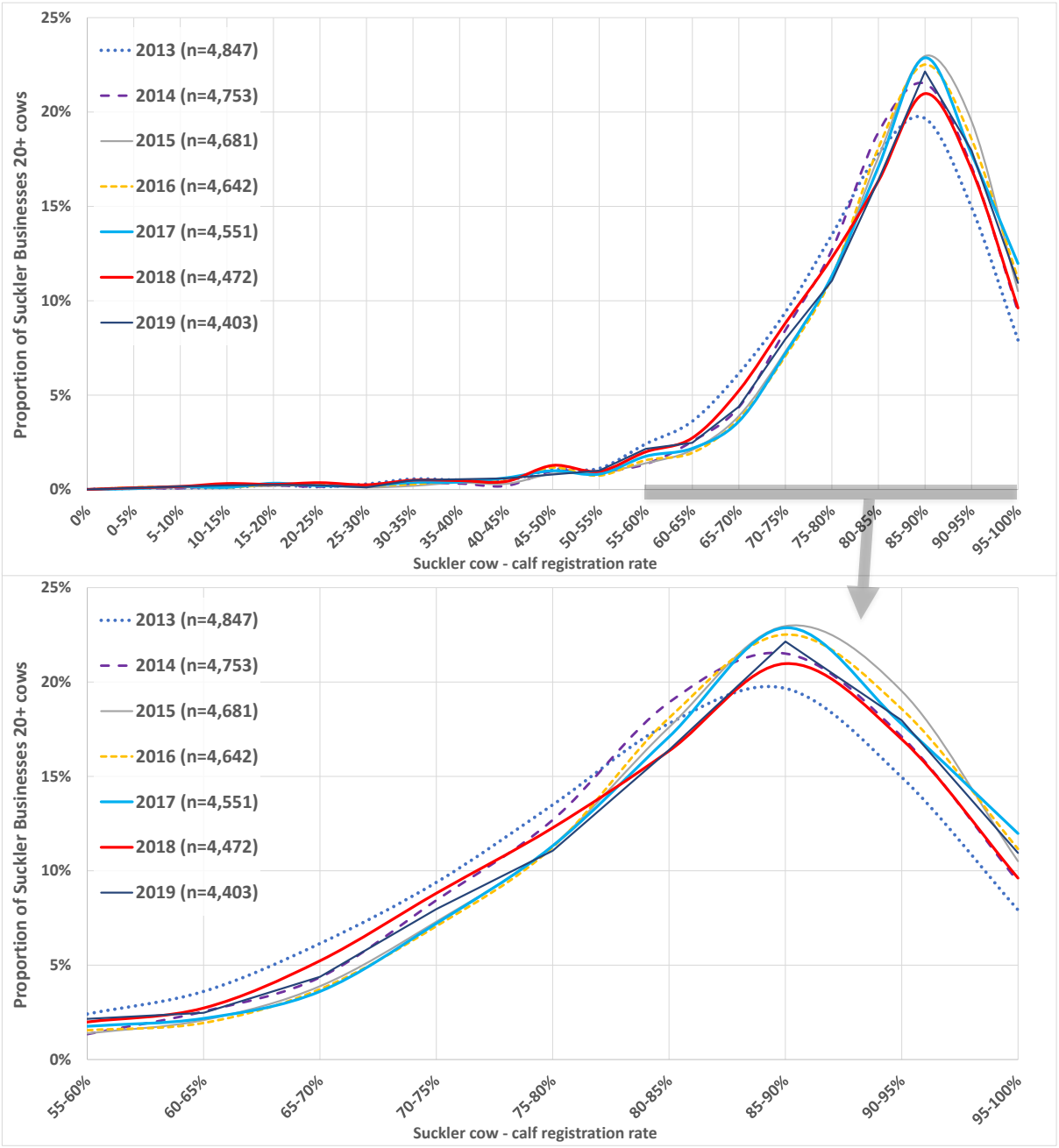
- As discussed above, there is considerable variance in herd performance, with the mean calving rate being impacted on by low performing herds.

52. Figure 16 illustrates the distribution of calf registration rates for individual businesses over the 2013 to 2019 period (the top graph shows the full distribution and the lower graph focuses on the 55-100% calf registration rate distribution to provide greater clarity).

- There is a long tail of poor performance in every year, but only about 3% of businesses had calf registration rates of less than 50% in any given year.
- Whilst the curve is not normally distributed there is a peak in the distribution at 85-90% calf registration rate each year (20-23% of businesses).
- 8-11% of business have calf registration rates of over 95% over the period and a further 15-20% have rates of 90-95%. These illustrate a high level of performance is already being achieved (and meeting NADIS recommendations) by 25-30% of businesses in any given year.
- The distribution curves help to illustrate how weather can impact on calf registration rates – with noticeably fewer businesses in the higher performance bands in both 2013 and 2018. [20]

[20] Picture: SRUC

Figure 16: Distribution of calf registration rates to cows in suckler herds of 20+ cows by year, 2013-2019

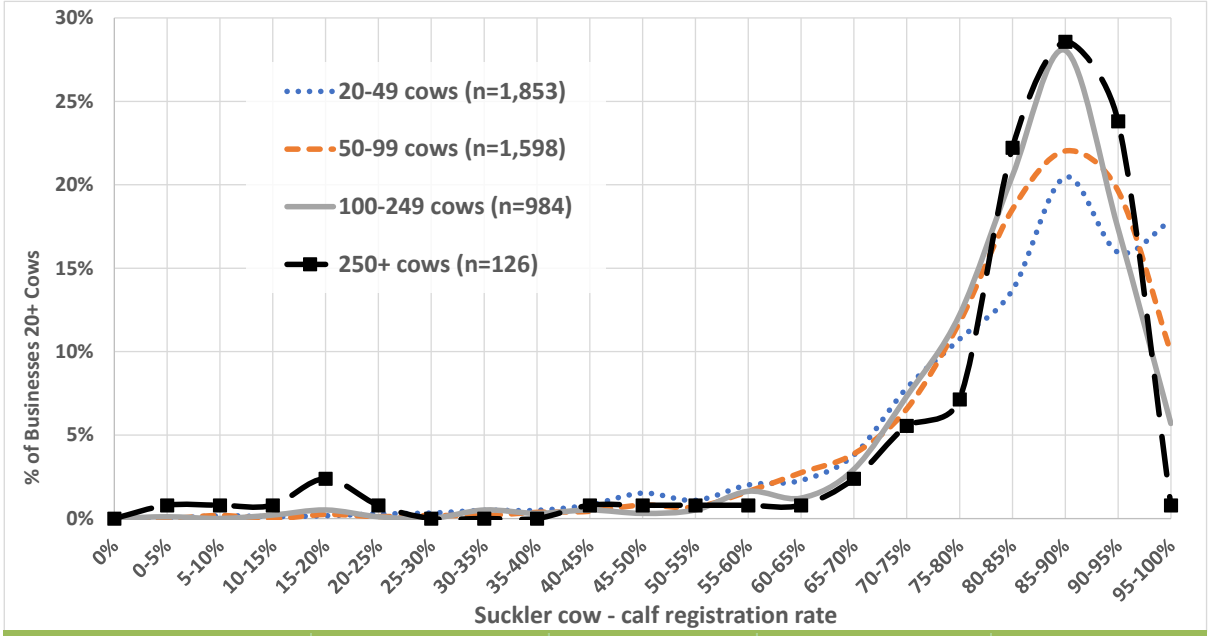


53. Figure 17 shows the calf registration rate for suckler herds with 20+ cows by the herd size groupings in 2017.

- Achieving very high calf registration rates becomes increasingly difficult in larger herds and the data reveals that only 1 business of 250+ cows achieved that in 2017, compared to 18% in the 20-49 cows grouping and 10% in the 50-99 cows group.
- 29% of the 250+ cow grouping achieved calf registration rates of 85-50% with a further 24% 24% achieving 90-95%. For the 100-249 cow grouping the corresponding figures were 28% and 17% of producers.
- Despite similar medians (within 1%) the upper quartile of the smaller herds perform marginally better than in larger herds, whilst the lower quartile in the smaller herds

performed worse (with 25% of businesses lower than 77.3% calf registration rate – compared to lower quartile rate of 80% in the 250+ herds).

Figure 17: Distribution of calf registration rates to cows in suckler herds of 20+ cows by suckler cow size, 2017



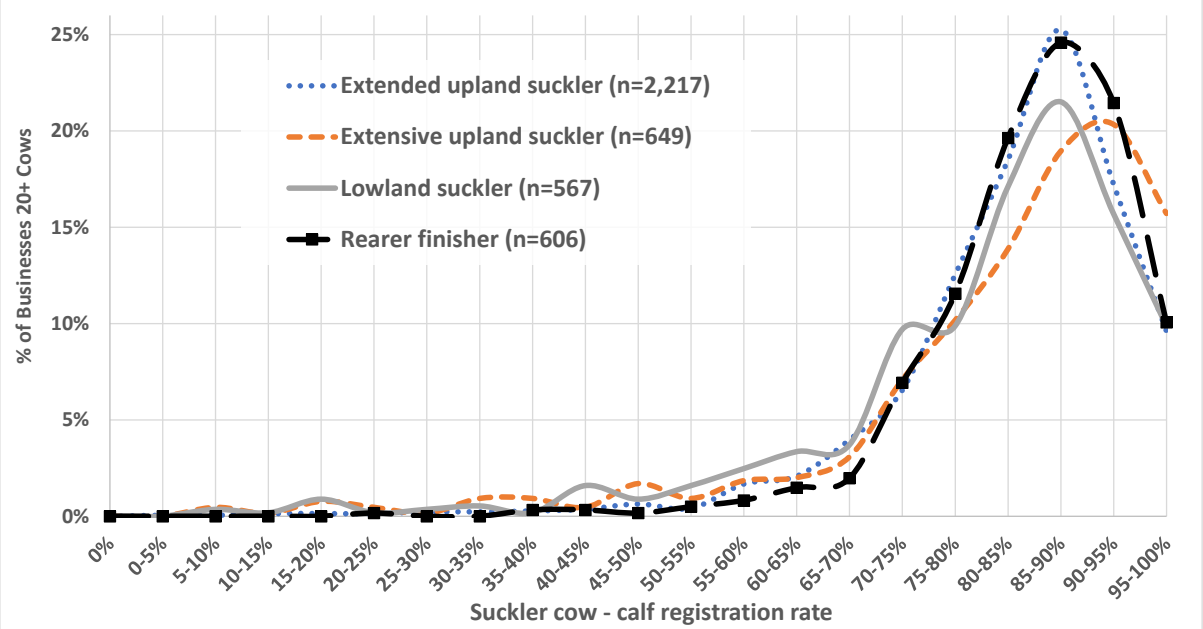
	20-49 cows	50-99 cows	100-249 cows	250+ cows
BRNs	1,843	1,598	984	126
Upper Quartile	92.4%	91.0%	89.6%	89.6%
Median	86.1%	85.3%	85.1%	85.4%
Mean	83.0%	83.0%	82.6%	80.1%
Lower Quartile	77.3%	78.6%	79.0%	80.0%

54. Figure 18 shows how the distribution of calf registration rates differs between businesses in different production systems in 2017. This differs from Table 7 as here the proportion of businesses falling in each calf registration rate band is reported whereas Table 7 reports the calf registration rate across all cows within each system.

- The distribution curves for each system differ, most notably for extensive upland suckler producers where 16% of the businesses achieved calf registration rates of 95-100% compared to 10% in other systems. This likely reflects a higher proportion of smaller (20-49 cow) herds in the extensive upland system (55% of those used in this illustration - compared to 21% of rearer-finishers and 39% of extended upland producers).
- The extensive upland and rearer-finisher groups perform better at the upper quartile, with 25% of producers (with 20+ cows) achieving calf registration rates of over 92.5% and 91.5% respectively.
- The median calf registration rates across these systems ranges from 84.1% for the lowland suckler producers to 86.4% of the extensive upland producers (with 50% of the producers above and below the median performance figure.
- 25% of the lowland suckler producers had lower calf registration rates of 75% with the rearer-finishers performing better with a lower quartile of 80.5%. It is within the lower

quartile that the biggest efficiency gains, and there for reductions in emissions intensity can be achieved.

Figure 18: Distribution of calf registration rates to cows in suckler herds of 20+ cows by production system, 2017

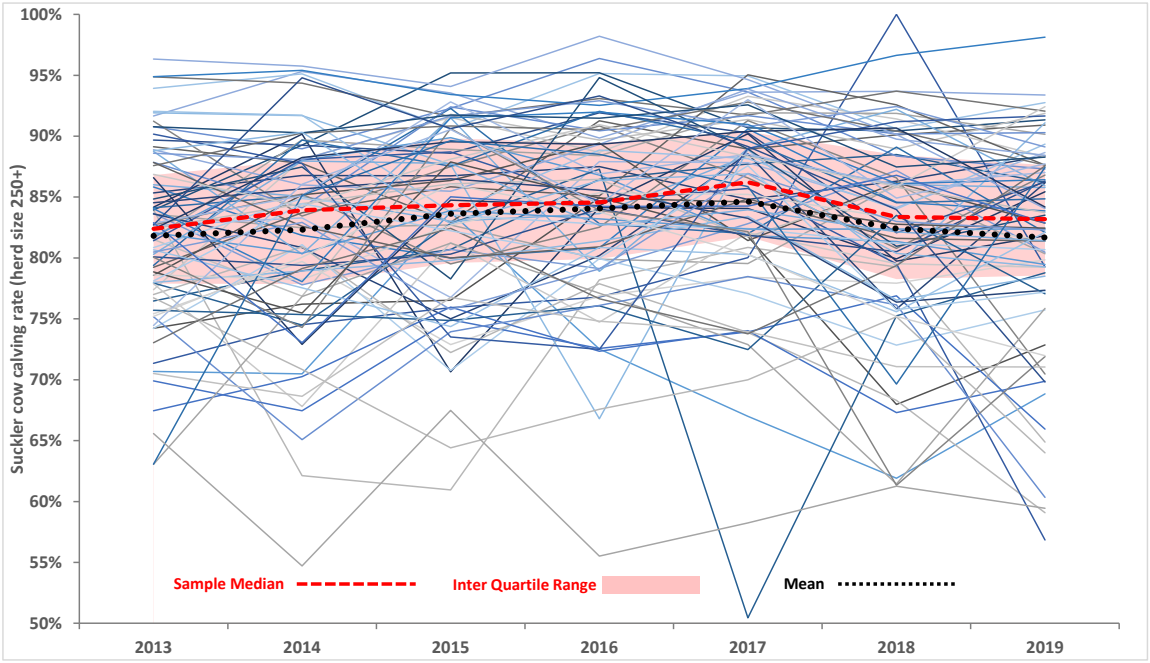


	Extensive upland suckler	Extended upland suckler	Lowland suckler	Rearer finisher
BRNs	649	2,217	567	606
Upper Quartile	92.5%	90.4%	90.4%	91.5%
Median	86.4%	85.4%	84.1%	86.2%
Mean	82.4%	83.1%	80.6%	84.8%
Lower Quartile	77.8%	78.8%	75.0%	80.5%

55. There is considerable variance in calf registration rates between herds within size groupings or production systems – but also importantly within herds between years.[21] In order to demonstrate the variability of calving rates within a herd Figure 19 illustrates the calf registration rate for each of the businesses with 250+ suckler cows as well as the interquartile range and average (median and mean) for the whole group between 2013 and 2019. Figure 19 highlights the in-herd variation that occurs with many businesses regularly moving in and out of the interquartile range, and having a 'poor' year.[22]

[21] This may be partially as a result of cows not successfully getting in calf (or aborting) and then being left barren to cycle back round for the next year in herds where there are not two distinct calving periods. Where there are two calving periods it is likely easier to cycle cows between calving seasons (Spring / Autumn).
[22] Picture: SRUC

Figure 19: Distribution of calving registration rates to cows by individual BRNs in suckler herds of 250+ cows (including mean, median and interquartile range) 2013-2019



56. In order to illustrate further the extent of within-herd variability in calf registration rate performance Table 8 shows how far above or below the individual herd 7-year mean calf registration rates were in each year.[23] In the 3,686 herds with 20+ suckler cows that were ever present, Table 8 reveals that:

- The annual calf registration rate only deviated from the mean by +/-3% for between 36% and 41% of businesses.
- Annually more than 10% of the businesses (rising to 19% in 2013) had calf registration rates of at least 7% lower than their 7-year average.
- Annually more than 10% of the businesses (rising to 16% in 2015 and 2016) had calf registration rates of at least 7% more than their 7-year average.

Table 8: Deviation from individual herd 7 year mean calf registration rate - % of businesses by % difference by year 2013-2019

Deviation from 7 year mean	2013	2014	2015	2016	2017	2018	2019
less than -7%	19%	13%	10%	10%	11%	17%	17%
-7% to -5%	7%	6%	5%	5%	5%	7%	6%
-5% to -3%	9%	8%	8%	8%	7%	9%	8%
-3% to +3%	**36%**	**40%**	**40%**	**39%**	**41%**	**39%**	**36%**
+3% to +5%	10%	11%	12%	13%	11%	11%	11%
+5% to +7%	7%	8%	10%	9%	9%	7%	7%
more than +7%	12%	15%	16%	16%	15%	10%	14%

[23] Only businesses with 20+ suckler cows and with calves born in every year were included. The mean calving rate was calculated for each businesses and then how farm each year deviated from the 7 year mean was calculated. The proportion of businesses then falling into deviation bands was calculated and is presented.

57. This illustrates the challenge in maintaining high calving rates. When examined at farm level the local impacts of weather events, and of other irregular events such as disease outbreak, means that monitoring of calving rates for any future scheme would need to be based on a three-year average, or some other means of smoothing the rate over time (e.g. 2 best years out of 3).

Calving periods

58. Riddell, et al (2017) highlight that: "*Although more calves may be reared by extending the mating period in any one year, this is likely to lead to the retention of less fertile cows, meaning the problem of lower conception rates is spread over a longer period. Some cows will not have calved by the time mating starts. These factors can only result in more complicated herd management and increased labour requirements.*" Riddell, et al (2017)[24] further highlight ways that shorter / tighter calving periods can benefit the farmer/crofter through improved technical performance – and these factors have direct links to the amount of emissions a cow (and its offspring) produces over its working life. These benefits are described as:

- *Fewer late-calving cows reduces risk of more difficult calvings due to over-fit cows/heifers*
- *Easier and more accurate rationing as stock at similar stages of growth, pregnancy and lactation*
- *Reduced risk of disease spread from older to more vulnerable younger calves*
- *Calves born earlier are heavier at weaning than later-born calves*
- *More even batches of store cattle…and finishing cattle sold earlier, with fewer tail-end calves*
- *A greater number of earlier-born calves increases the pool of heifer calves at suitable weight and maturity for bulling to calve at two years of age.*

59. Cows normally are expected to return to oestrus after about 6 weeks from calving with heifers normally taking a week longer. The quicker a cow returns to oestrus the more management opportunities exist and better managing of next year's calving period can take place. Factors like poor nutrition, difficulty calving, etc. can affect the time taken for a cow/heifer to return to oestrus and therefore if tight calving periods are targeted then sound herd management practices are required.

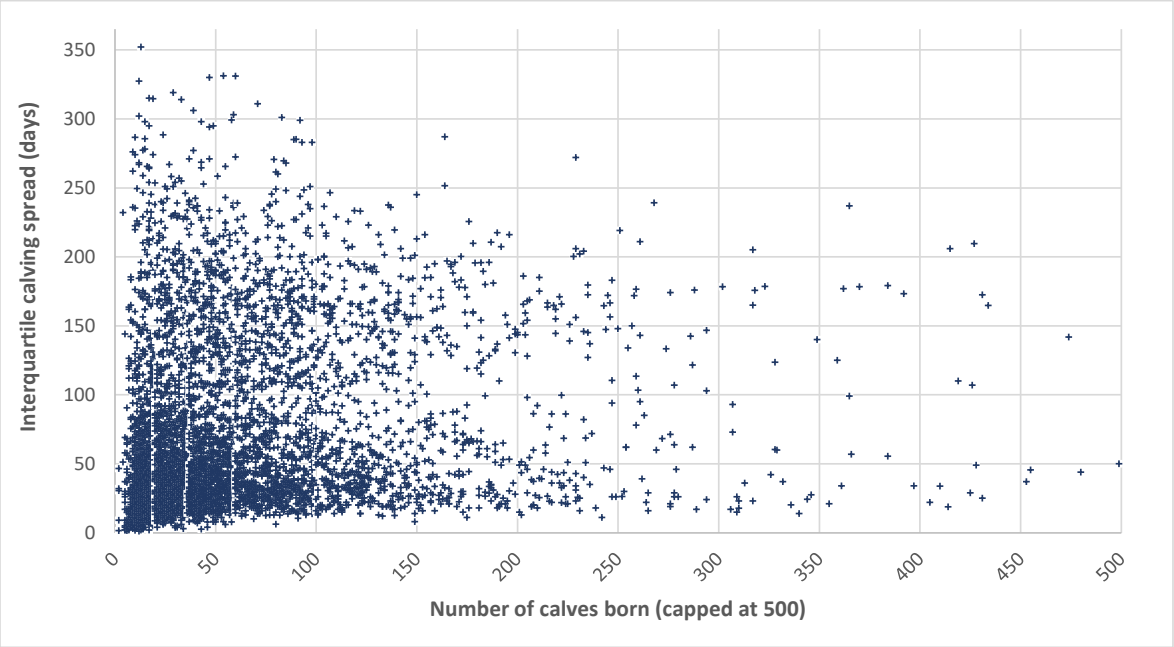
60. CTS data enables the date of all calves registered from a given herd, in a given year to be monitored. Technically the number of days between the first born and last born calves gives the full range of the calving period – yet intuitively, and from a practical perspective, a single out-of-season calf can impact on the range. As such the interquartile range provides an estimate of the time taken for the middle 50% of calves to be born and registered (this will be improved by tightening of this metric in later iterations of the analysis). This analysis acknowledges that some larger farms will have split calving systems (for example a spring and late summer calving cohorts – which are not identified here but would show up as long interquartile ranges).

61. Figure 20 shows the length of time for the middle 50% of calves to be registered (remembering registration can take place up to 28 days after birth) from suckler herds of 20+ cows in 2017. There is a large proportion of herds (49% of the herds) that registered the 75th percentile calf in under 50 days from the 25th percentile - and 72% fell under 100 days. However that means that 28% of the

[24] Iain Riddell, George Caldow, Basil Lowman, Ian Pritchard, Colin Morgan (2017) A Guide to Improving Suckler Herd Fertility. A booklet for QMS.
https://www.qmscotland.co.uk/sites/default/files/qm2879_suckler_herd_a5_brochure_issuu_517.pdf

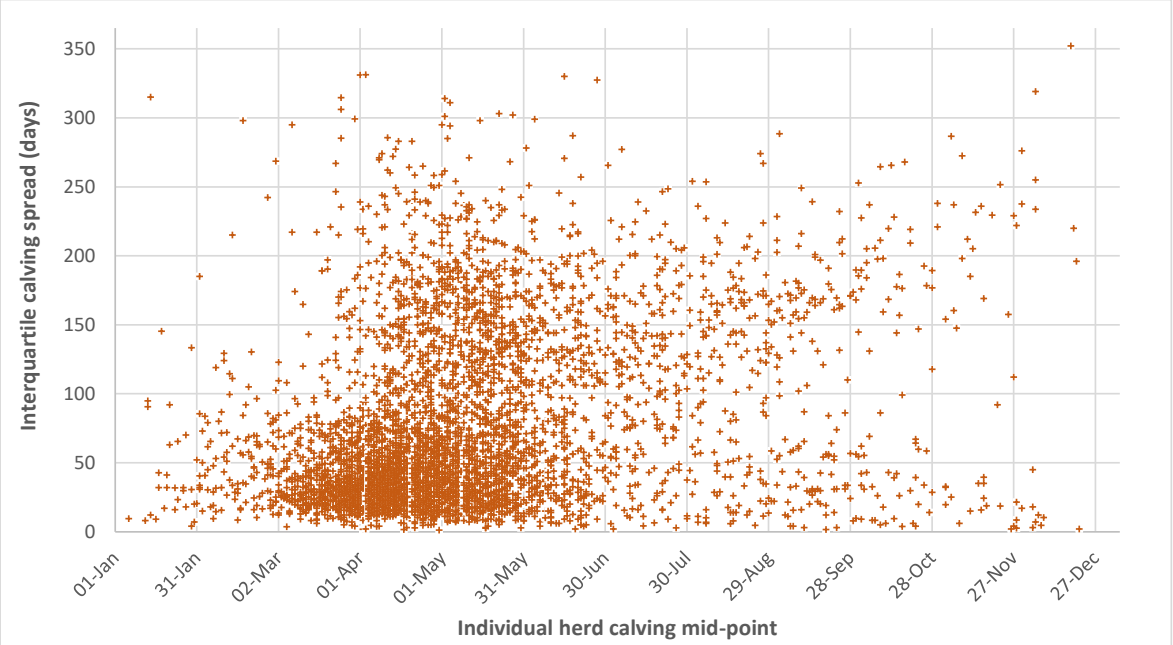
herds had prolonged calving periods with 9% extending beyond 180 days (6 months). Using this metric it has to be remembered that the first 25% and last 25% of calves born are excluded – in an attempt to reduce the influence of the occasional calf born out of synch with the rest of the herd.

Figure 20: Time taken for the 25th to 75th percentile of calves in herd to be registered by number of calves born in suckler herds with 20+ cows, 2017



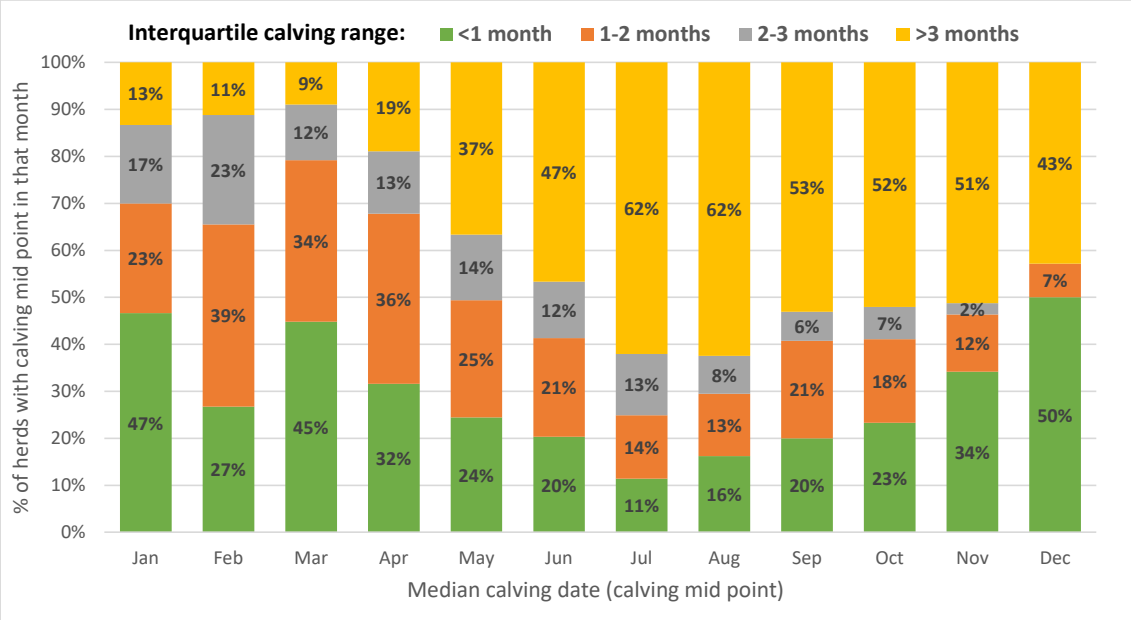
62. Figure 21 shows the interquartile calving spread of individual herds by the median (mid-point) of the calving period. This illustrates that there is a wide range of calving periods that are taking place throughout the year (and small herds with few calves born can appear to have very long interquartile calving periods at the start and end of the calendar year when there may be winter calving with cross over between years). Herds with calving mid points falling the summer months appear to have longer calving periods on average.

Figure 21: Time taken for the 25th to 75th percentile of calves in herd to be registered by median calving date in suckler herds with 20+ cows, 2017



63. Figure 22 (with associated table) confirms that in 2017 a higher proportion of suckler herds with 20+ cows with a calving mid-point falling in spring had tighter calving periods than those whose calving midpoint fell in the summer and autumn.

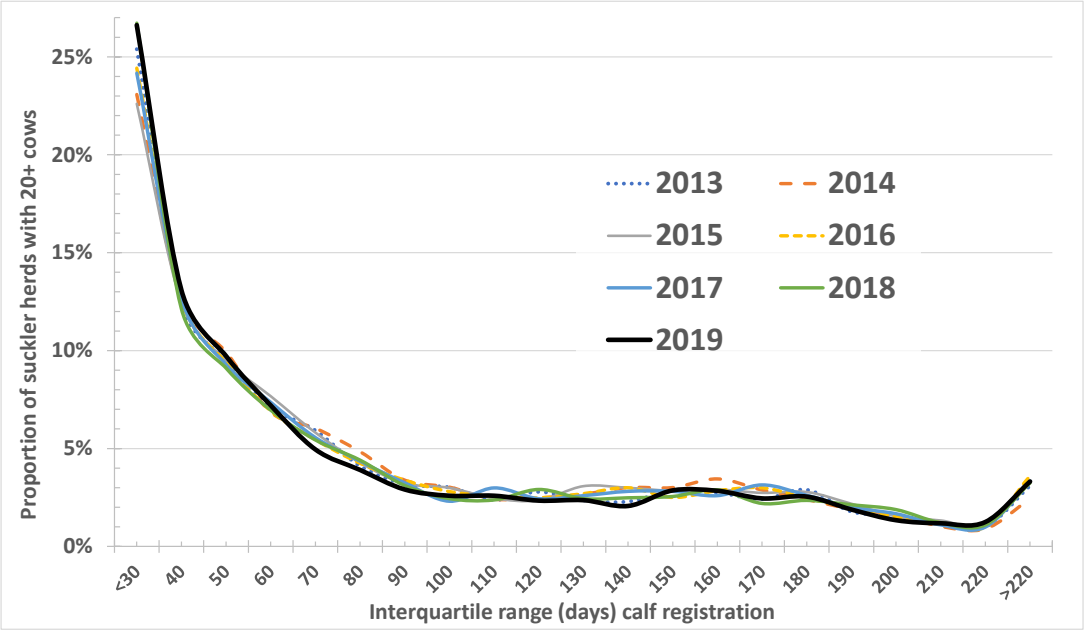
Figure 22: Proportion of suckler herds (20+cows) with different interquartile calving periods when by median calving month, 2017



Median calving month	Interquartile calving period				No. of Herds
	<1 month	1-2 month	2-3 month	>3 month	
Jan	47%	23%	17%	13%	30
Feb	27%	39%	23%	11%	116
Mar	45%	34%	12%	9%	692
Apr	32%	36%	13%	19%	1,739
May	24%	25%	14%	37%	1,280
Jun	20%	21%	12%	47%	448
Jul	11%	14%	13%	62%	237
Aug	16%	13%	8%	62%	173
Sep	20%	21%	6%	53%	130
Oct	23%	18%	7%	52%	73
Nov	34%	12%	2%	51%	41
Dec	50%	7%	0%	43%	14

64. Figure 23 reveals that the distribution of interquartile calving period remained very static between 2013 and 2019 - reiterating that suckler cow systems do not change very frequently. Marginal changes are observed – with for example – the proportion of herds with an interquartile calving period of less than 60 days increasing from 54% in 2013 to 57% in 2019. The proportion of suckler herds with interquartile calving periods of over 6 months remained stable at 9% (and may include larger herds with multiple cohorts with different calving focused calving periods throughout the year).

Figure 23: Distribution of interquartile calving periods of suckler herds (+20 cows) by year

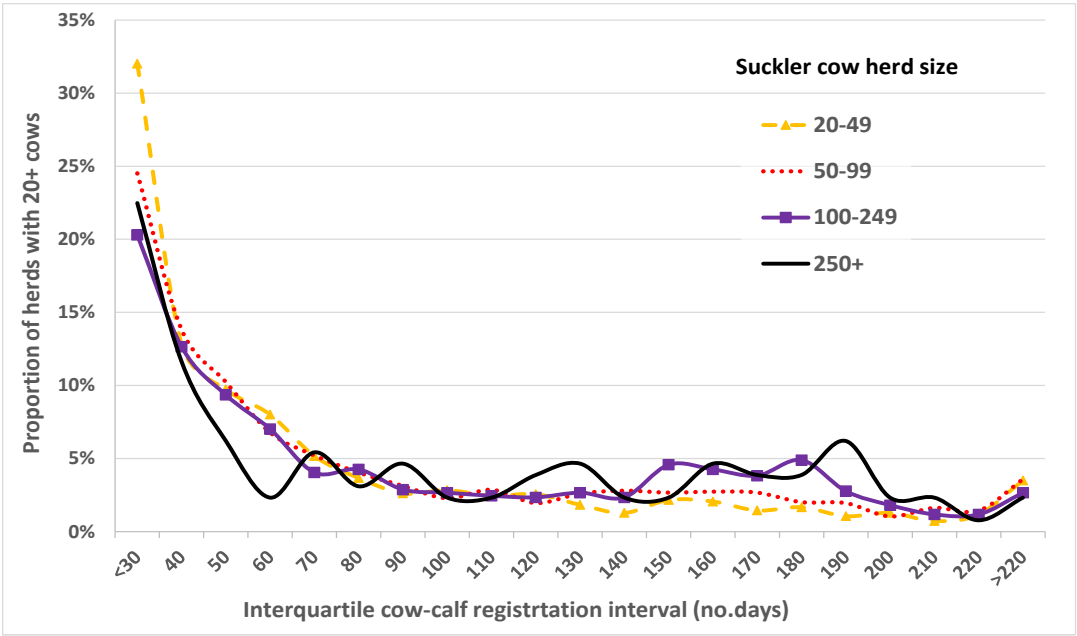


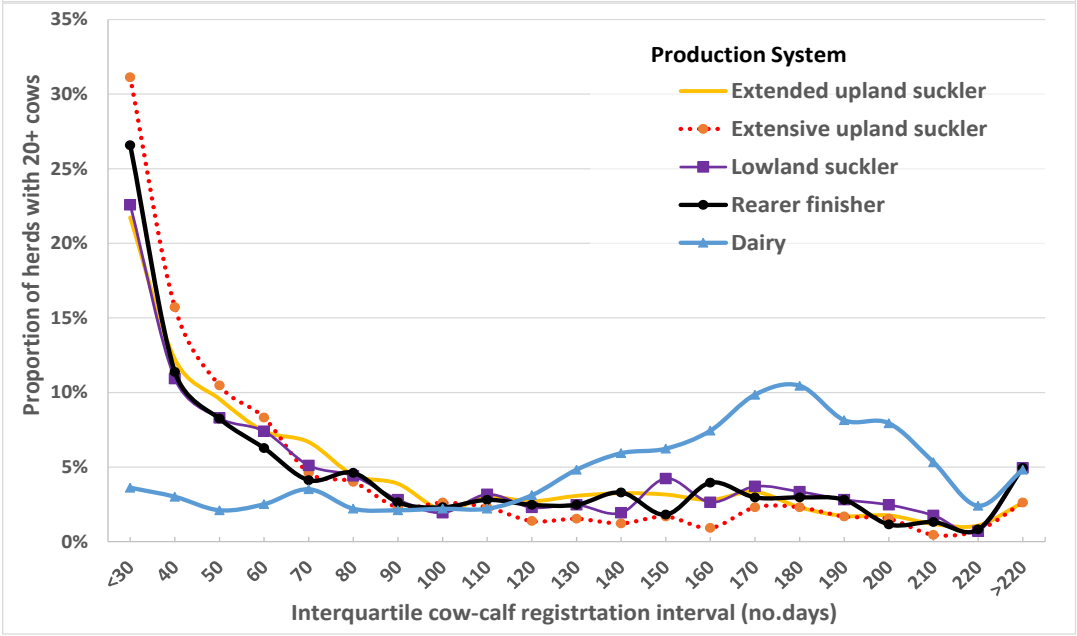
65. Intuitively smaller herds should have tighter calving periods and different production systems will also differ in terms of calving periods. Figure 24 confirms that a higher proportion of smaller herds (20 to 49 cows) indeed have shorter inter quartile calving periods compared to larger herds – with 32% of smaller herds having interquartile range of less than 30 days compared to 20 % of herds sized 100-249 and 22% of herds of 250+ cows. 63% of these smaller herds had interquartile calving ranges of less than 60 days compared to only 43% of the largest herds. As discussed earlier the larger herds may indeed have more than one calving period and hence a higher proportion have prolonged interquartile calving periods – with 44% with interquartile calving periods of over 90 days (3 months) and 14% over 6 months (the 100-249 cows grouping follow similar patterns but not to the same extent). This may limit the use of this CTS metric for larger herds, unless more detailed in herd analysis is conducted to identify specific calving periods of different.

66. Figure 24 also illustrates how the interquartile calving period differs between suckler cow production systems – with CTS marked dairy herds included for contrast. As expected, the dairy herds have an entirely different distribution reflecting different calving systems focused around milk supply. The extensive upland producers tend to have higher proportions with tighter interquartile calving ranges – 31% under 30 days and 66% under 60 days compared to 23% of lowland suckler producers under 30 days and 49% under 60 days. This perhaps reflects the need for tighter control over calving periods due to biophysical constraints – weather and grazing availability in more extensive systems selling calves at weaning.[25]

[25] picture by Xavier Turpain from Pixabay

Figure 24: distribution of interquartile calving periods of suckler herds (+20 cows) by (a) herd size, and (b) production system in 2017





[26]

[26] Picture – Rory Richardson/SRUC

Calving intervals

67. Calving rates and calving intervals are interlinked. If a cow fails to come into season or has a failed pregnancy there may be a reduction in the calf registration rate in a given year – but also it will impact of the calving interval – that is the number of days between successful calf registrations for each cow within a herd.

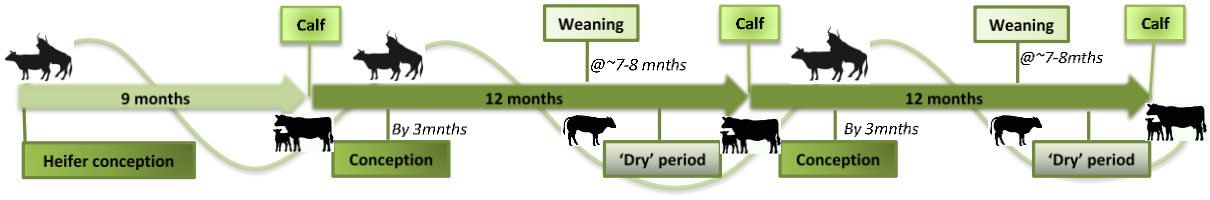
68. Scotland's Farm Advisory Service[27] suggest that producers should target 90% of their herd having a calving interval of 370 days. Proper management of the calving interval can improve the overall length of the calving period and make management of the herd easier for the farmer/crofter. Cows that consistently have extended calving intervals over 365-370 days are inefficient and add to the production costs - and should therefore be marked for culling. Woods (2011)[28] identifies that "cow condition score, bull fertility, the incidence of difficult calving and herd health are the main factors affect fertility" adding that "an outbreak of disease causing poor conception rates or an infertile bull can have a devastating impact on the bottom line for many years after the problem starts."

69. If a farmer is targeting 365 day calving interval then it is important that a cow conceives within 3 months of having previously calved (see Figure 25 for a simplistic illustration of key periods for a 365 day calving interval). Pritchard et al (2017)[29] suggest that suckler farmers should be targeting having most cows bulling within 50 days from calving – noting that it generally takes longer for fertility to return in heifers: "*Cows undergo a period of physiological recovery after calving before fertility resumes, i.e. coming into bulling. The uterus recovers from being stretched by a calf, the membranes and protective fluids. This takes around 40 days for cows, slightly longer for heifers, and is likely to take substantially longer if there were calving difficulties or uterine infections*."

    Whilst the presence of a suckling calf can impact on a cow's return to fertility, Pritchard et al (2017) suggest that there are many causes of delayed return to oestrus, including:

    - Calving difficulties
    - Poor body condition at calving
    - Poor nutrition, e.g. late grass growth
    - Size – underestimating the maintenance requirement of larger cows
    - Underestimating the nutritional requirements of first (and second) calvers which are still growing

Figure 25: Illustrative 12 month calving cycle



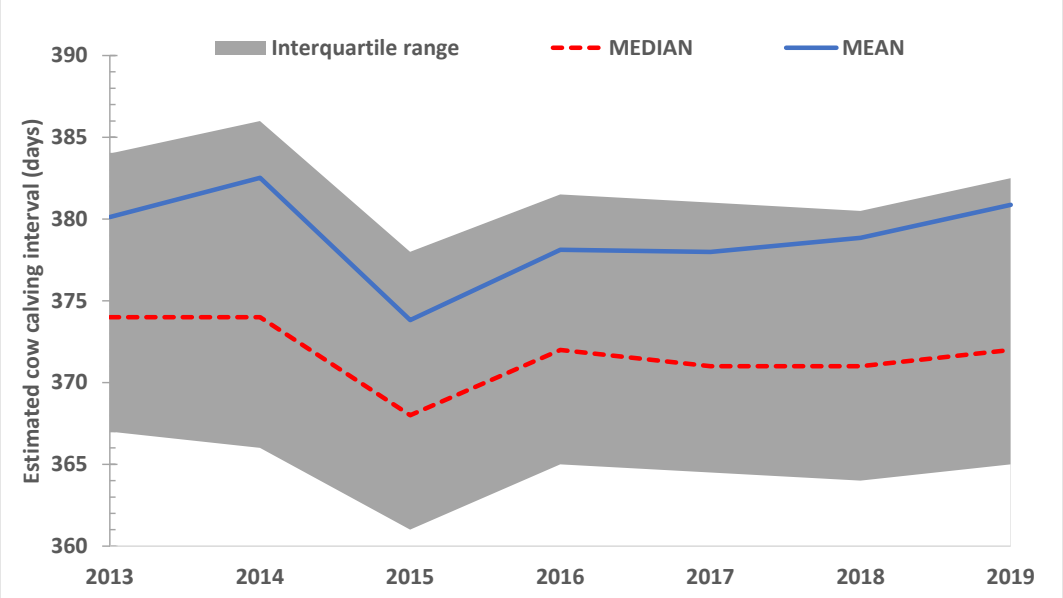
[27] https://www.fas.scot/downloads/an-introduction-to-benchmarking-cattle/

[28] Woods, A. Achieving 365 Day Calving Interval & 12 Week Calving Spread in Suckler Herds- BETTER Beef Farm Experience. Available from: https://www.teagasc.ie/media/website/publications/2011/Adam_Woods_Beef_Conf_Paper.pdf

[29] Ian Pritchard, Robert Logan, Gavin Hill, George Caldow (2017) A Guide To Improving Suckler Herd Fertility - Booklet prepared for QMS. Available at www.qmscotland.co.uk/sites/default/files/qm2879_suckler_herd_a5_brochure_aw_0817_single_0.pdf

70. Figure 26 summarises the average calving interval of individual suckler herds with more than 20+ cows (excluding heifers) between 2013 and 2019. The median herd was generally between 370 and 375 days over the period with the mean generally 6-9 days longer (between 375 and 383 days). This means that half the herds are performing better, but also that half the herds perform poorer – with extended calving intervals. The interquartile range shows the range in which half of Scotland's suckler herds average calving interval fell. In general terms 25% of the producers achieve average calving intervals across their suckler cows of under 365 days in any given year - with 25% of the herds averaging more than 380 days

Figure 26 Summary of average calving interval for all suckler producers with 20+cows (excludes heifers)

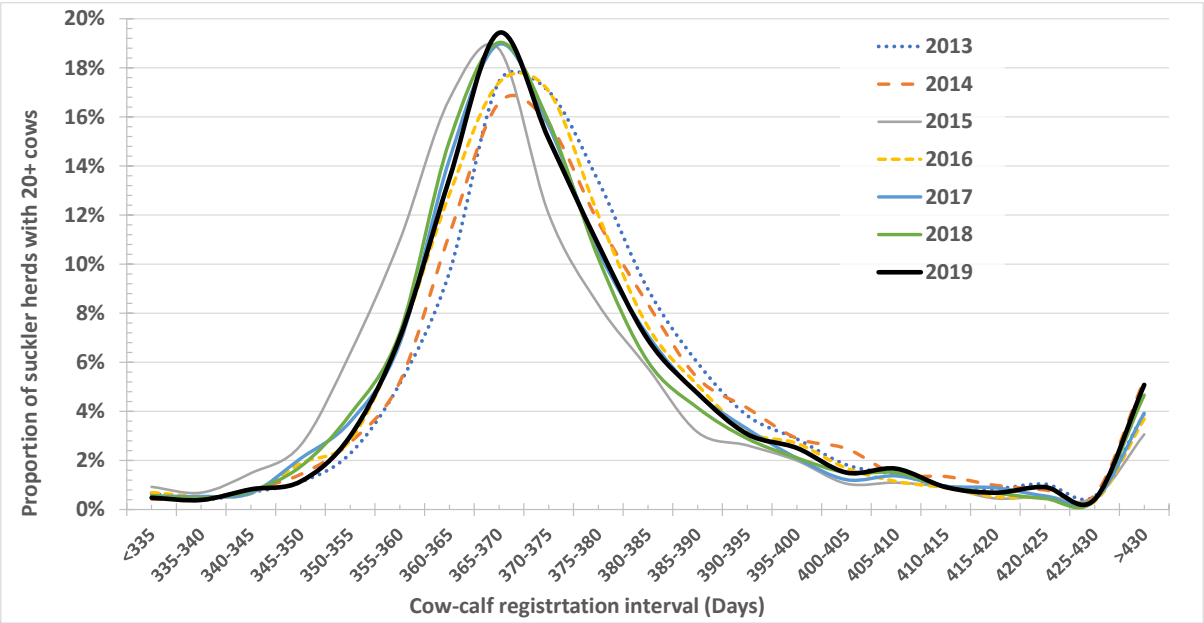


71. Figure 27 reveals the distribution of average herd calving intervals between 2013 and 2019. It is evident that 2013 and 2014 were poorer performing years – likely a legacy from the extreme weather and lack of winter feed many producers experienced in 2012/2013.

- The data suggests that on average producers are managing their herds relatively well with herd averages falling around the 365-370 days target (note that within herds this is the average so 50% of the cows perform worse that they average within each herd that is not reflected here).
- There is a very long tail with 3% to 5% producers having a median calving interval of over 430 days (14.1 months) and between 10% and 16% having median calving intervals of over 13 months - meaning half these herds calf beyond 13 months.[30]

[30] Photo by Jane Caigie from Pixaby

Figure 27: Distribution of average calving interval for all suckler producers with 20+cows (excludes heifers) 2013-2019



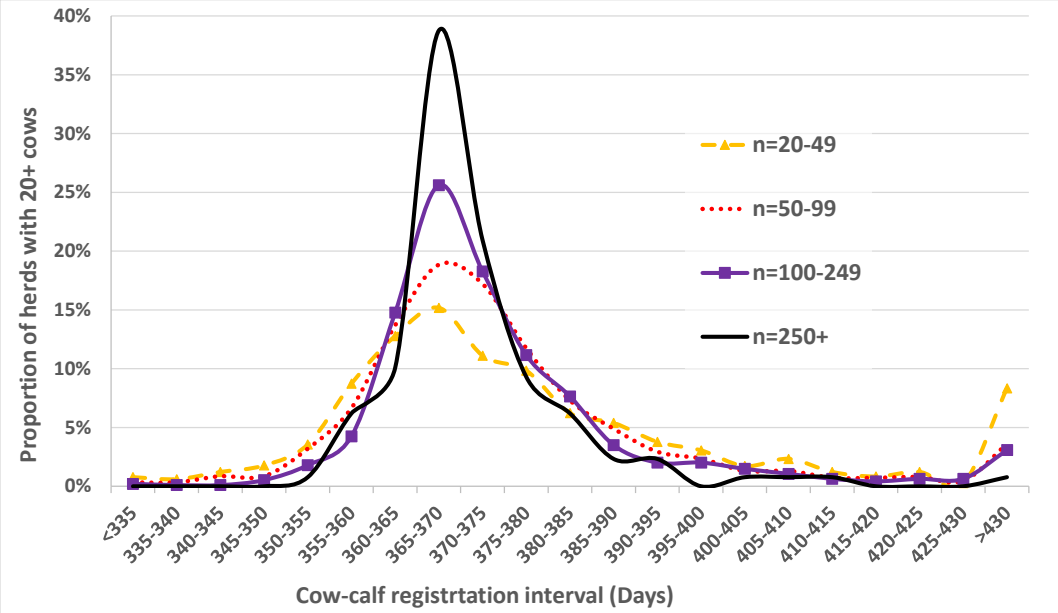
	2013	2014	2015	2016	2017	2018	2019
Businesses	4,846	4,752	4,668	4,631	4,536	4,460	4,391
Upper Quartile (days)	384	386	378	382	381	381	383
Mean (days)	380	383	374	378	378	379	381
Median (days)	374	374	368	372	371	371	372
Lower Quartile	367	366	361	365	365	364	365

72. Figure 28 reveals that there are considerable differences in the distributions of median calving intervals of herds of different sizes. 70% of the producers with 250+ cows had median calving intervals falling between 260 and 375 days – compared to only 39% of producers with 20-49 cows, 50% of those with 50-99 cows and 59% of those with 100-249 cows.

73. Figure 29 also reveals that there is a difference in the distribution of median calving intervals by production system. A higher proportion of rearer-finishers (60%) had median calving intervals of between 360-375 days – compared to 45% of lowland suckler producers and 47% of extended and extensive upland producers. In contrast to suckler herds the average calving interval on dairy herds is much longer – representing longer lactation periods that have evolved in the dairy sector.[31]

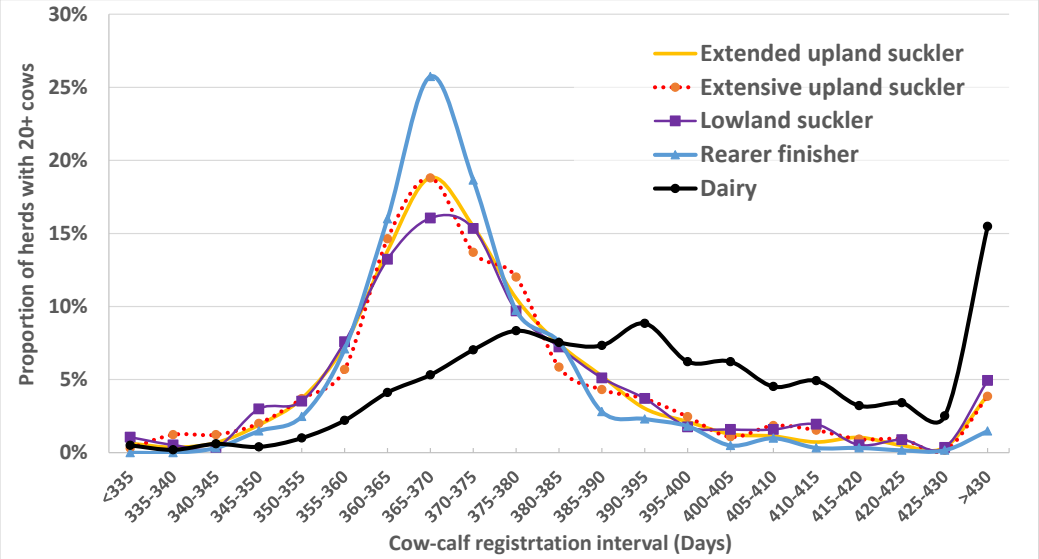
[31] Photo – S Thomson

Figure 28: Distribution of average calving interval for suckler producers with 20+cows by suckler cow size group 2017



	20-49 cows	50-99 cows	100-249 cows	250+ cows
Businesses	1,799	1,534	941	129
Upper Quartile (days)	389	381	379	375
Mean (days)	388	380	378	374
Median (days)	373	372	371	370
Lower Quartile	364	365	366	367

Figure 29: Distribution of average calving interval for suckler producers with 20+cows by production system 2017



	Extended upland suckler	Extensive upland suckler	Lowland suckler	Rearer finisher	Dairy
Businesses	2,217	649	567	606	995
Upper Quartile (days)	382	382	383	377	415
Mean (days)	378	379	380	374	405
Median (days)	371	371	372	370	394
Lower Quartile	365	365	364	365	378

Heifer replacement rates and age at first calving

74. All suckler herds require the continual replacement of older breeding cows in order to maintain performance (much like any depreciating capital asset – cows need a replacement schedule). Whilst farms and crofts may choose to bring in replacement cows from other herds, many will breed their own replacement heifers, or purchase in calf heifers from other farmers (bringing in new bloodlines). Heifer replacement rates provide an indication of the average breeding life of cows within a herd, system or at a national level. The effective heifer replacement can be calculated through the CTS using the number of heifers with first calf registrations and the number of breeding cows.

75. Table 9 shows that across Scotland heifers calving for the first time accounted for 18.6% of the suckler cow population in 2019 meaning cows are being replaced after 5 or 6 calves on average. This increased by 3% at a national level between 2013 and 2019, suggesting quicker herd replacement is taking place – that can be a sign of either premature culling due to disease or breeding problems, or strategically building a younger breeding herd. These changes mean that lowland suckler producers and rearer-finishers are now effectively replacing cows every 5 years (in 2019) whilst extended upland and extensive upland systems keep cows for a year longer on average (about 6 years).

Table 9: Calved heifers as proportion of suckler cows (dairy excluded)

Year	Extensive upland suckler	Extended upland suckler	Lowland suckler	Rearer-finisher	Scotland
2013	15.6%	15.3%	18.4%	17.9%	**16.5%**
2014	14.7%	15.8%	19.5%	17.6%	**17.0%**
2015	16.2%	16.8%	21.1%	18.3%	**18.0%**
2016	15.3%	16.8%	19.4%	17.8%	**17.7%**
2017	17.1%	16.7%	20.5%	18.6%	**18.3%**
2018	17.5%	16.1%	20.9%	19.4%	**18.2%**
2019	-	-	-	-	**18.6%**

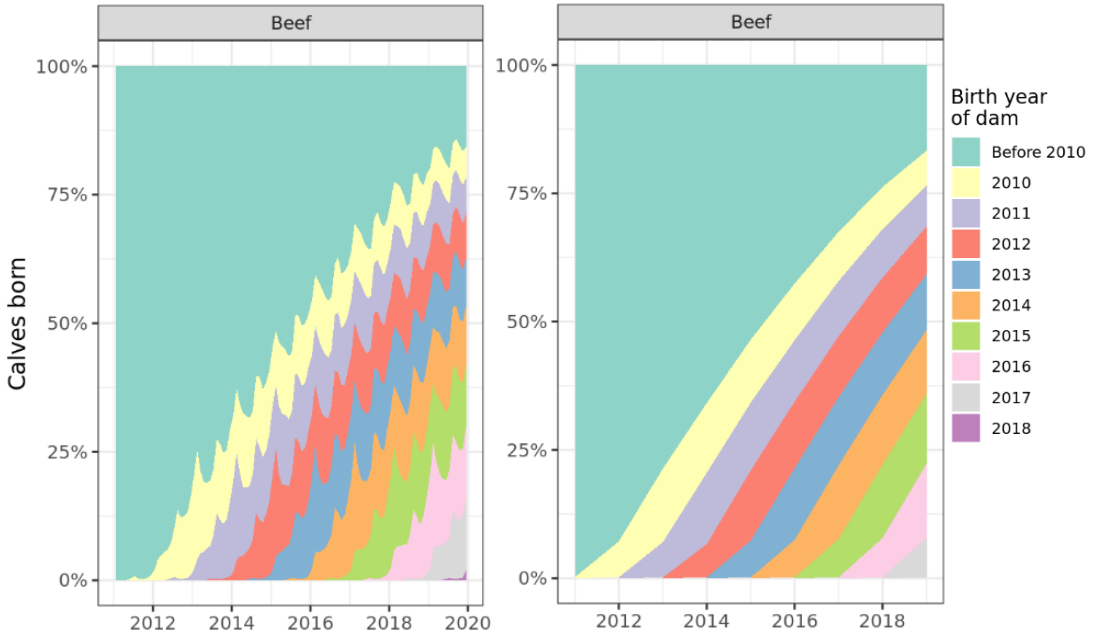
76. Figure 30 provides an age profile of the suckler cows with registered calves in any given year with the left-hand graphic showing data monthly data and the right hand graphic showing the data smoothed out annually. This profile excludes cows and heifers that were unsuccessful at producing a calf in a given calendar year- 20% of the suckler cow herd.

77. The age profile in Figure 30 demonstrates that around 20% of the suckler herd is over 10 years old, showing longevity in the breeding herd – which is likely positive providing the animals remain productive on an annual basis.

78. Whilst it is tempting to compare and contrast the heifer replacement rates with the age profile of new breeding cohorts it should be stressed that heifers calving for the first time have a wide age distribution meaning that, for example, heifer replacements calving in 2019 may come from three or four birth year cohorts.[32]

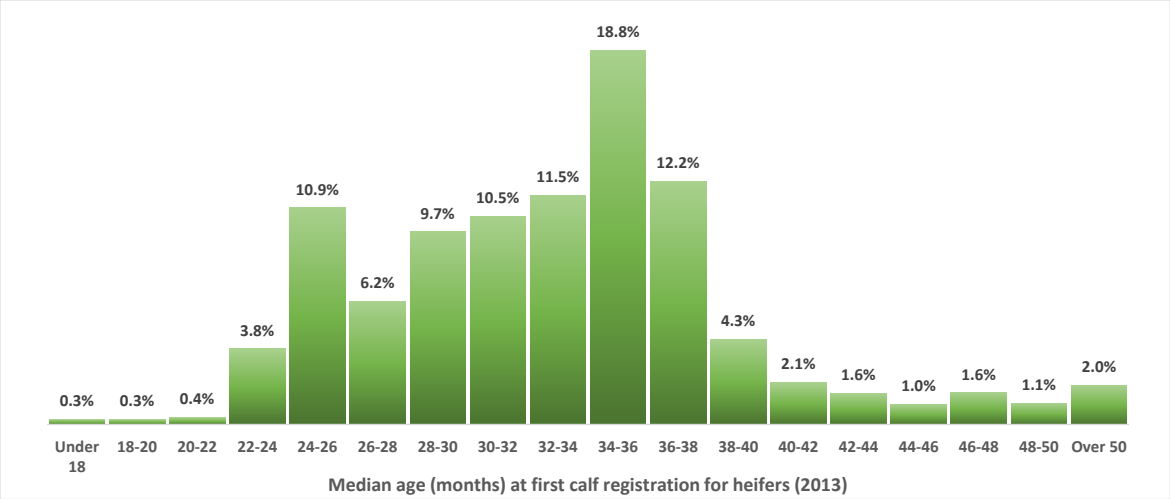
[32] Photo – SAC Consulting

Figure 30: Age profile of suckler cows calving in a given year



79. The age at which replacement breeding heifers first calf is an indicator of technical efficiency and also impacts on GHG emissions. There is a balance to be made - breeding heifers too young can come with calving problems and longer-term calving issues in the animal, whereas breeding later than average may lead to wasted breeding opportunities. Figure 31 provides a histogram of the distribution of the median age of calf registration dates for heifers[33] within individual herds in 2013.[34] Across herds there is a bi-modal distribution, with peaks around 24-26 months and 34-36 months (about 2 years and 3 years of age) that would correspond to fitting into the calving system they were born to. The median heifer calving age for bulk of the suckler producers falls between 2 and 3 years of age. The median heifer calving age was 25-36 months for 64% of the suckler herds, with 10% of herds falling younger than 25 months and 26% of herd's mid-heifer-calving ages falling over 36 months.

Figure 31: Median age of first calving in suckler herds, of heifers born in 2013



[33] i.e. when ages are lined up youngest to oldest this is the middle heifer within a herd.
[34] Due to staffing changes we have not yet re-run this analysis for all subsequent years.

80. Figure 32 shows the distribution of businesses based on their median calving age of heifers that were born in 2013. Whilst there is a consistent upturn around 36 months for all suckler systems it is particularly noticeable for extensive upland and extended upland producers – with 34% of extensive upland producer having median age of 35-38 months (and 29% of extended upland producers). Rearer-finishers have 17% of producers with median heifer calving age of under 25 months (compared to 6% of extended upland producers and 9% of extensive upland producers. The distribution of median heifer calving ages across dairy herds is much more of a normal distribution – more evenly spread over 26 to 36 months.

81. Figure 33 illustrates how larger herd size groups have a higher proportion of businesses with lower median first calving ranges. There are more pronounced medians for the larger size groupings around 25 months, 32 months and 36 months – perhaps reflecting targeted phasing for heifer calving ages.

Figure 32: Median age of first calving for 2013 registered heifers in of 20+ cows (including dairy)

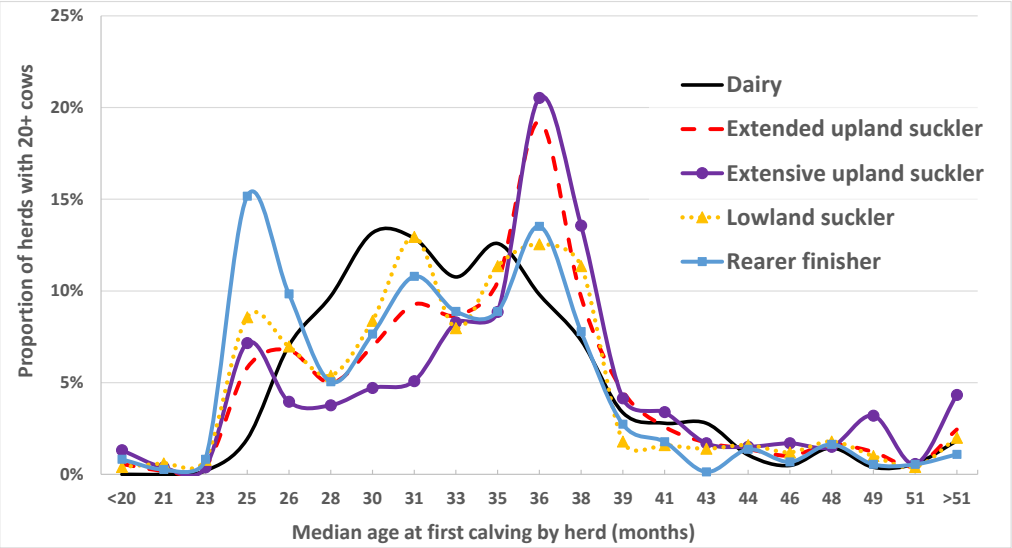
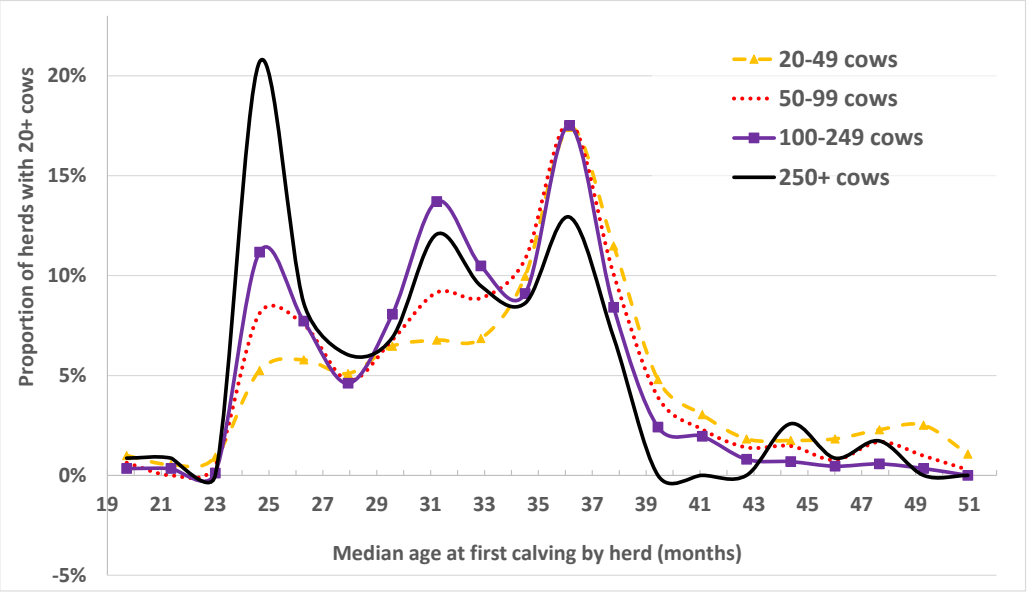


Figure 33 Median age at first calving for heifers born in 2013 by suckler cow herd size (excluding dairy)



On-farm mortality

82. On farm mortality represents waste, with young stock deaths representing a loss of potential prime animals for the human food chain, and breeding cow mortality representing premature end to a breeding cycle and a loss of beef (in the form of cull cows) to the supply chain. Both affect farmer profitability and represent inefficiencies in terms of greenhouse gas emissions.

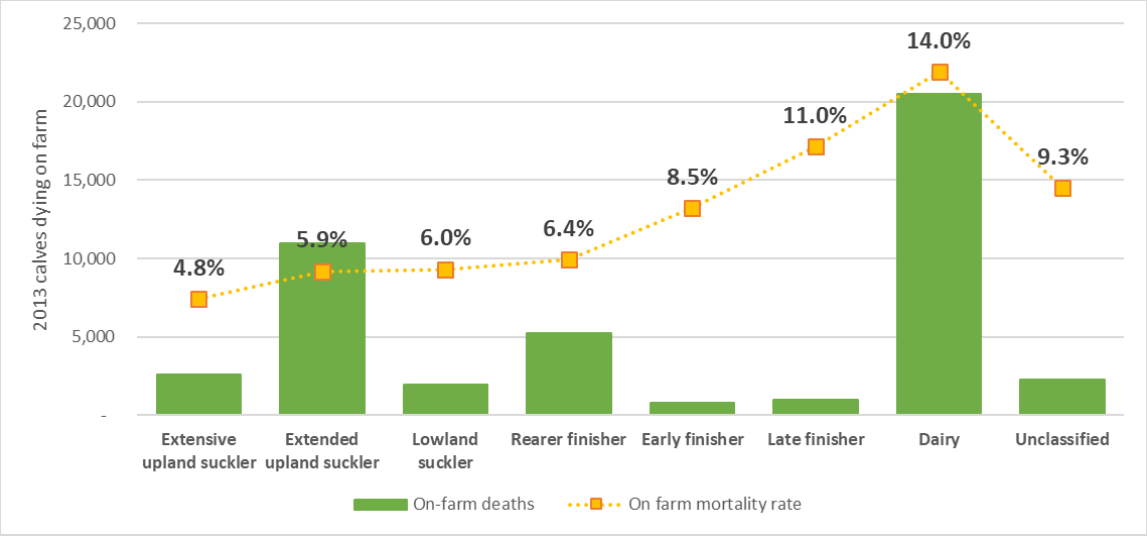
2013 Cohort of calves

83. Of the 543,817 calves born in Scotland in 2013, 55,564 (10.2%) died on-farm. Moreover, 43,368 (8%) of these occurred before the age of 36 months, representing a significant loss of potentially prime animals for the human food chain. Table 10 reports the distribution by breed type, illustrating the much higher on-farm mortality experienced by dairy animals, but a still notable rate for beef breeds born in 2013. Figure 34 expands this to different production systems, confirming the higher dairy mortality rate but also revealing higher rates for finishers than breeders.

Table 10: on-farm mortality rates for the 2013 cohort of calves, by breed type

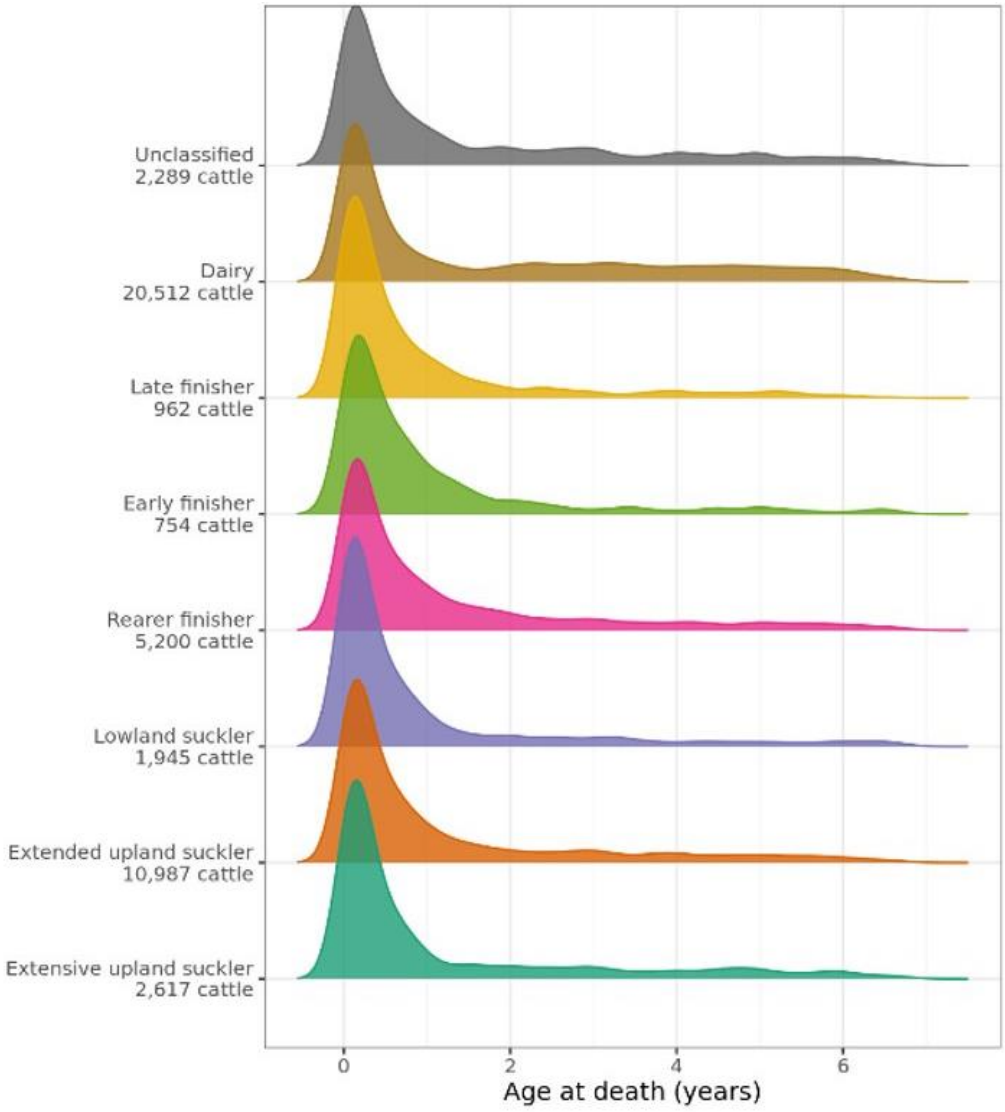
Type	Calves Registered	On-farm deaths	Percent
Suckler	**432,073**	**26,711**	**6.2%**
Dairy	99,224	17,294	17.4%
Dual Breed	12,520	1,261	10.1%

Figure 34: on-farm mortality rates for the 2013 cohort of calves, by production system



84. There was also a marginally higher mortality rate for female beef animals over male ones – reflecting breeding mortality. Figure 35 reveals the age of on-farm-death distribution by farming system – illustrating the majority of deaths occur in the early months post registration with longer tails into mid age groups for specialist finishers and long, but relatively few breeding cow on-farm deaths (particularly in dairy systems).

Figure 35: Distribution of age of on-farm-death from 2013 calf cohort by production system



Mortality Rates

85. Moving beyond a single cohort of calves to ascertain their fate, it is possible to examine mortality that occurs on farms and crofts within each calendar year. Table 11 shows the total number of calves and steers (under 36 months) and breeding cattle (36+ months) that were registered as dying on farms and crofts between 2013 and 2018. The data shows that:

- Between 46,158 and 55,995 cattle died on suckler farms and crofts annually with 60% of the deaths, on average, occurring in calves and steers under 36 months of age.
- Between 26,924 and 31,031 cattle died on businesses marked as dairy in CTS with 60% of the deaths, on average, over the period occurring in stock under 36 months of age.
- Overall mortality levels ranged from a low of 75,099 in 2014 to 83,408 in 2013.

As with calving rates – the mortality levels appear to be affected by weather – with both 2013 and 2018 again having higher than normal on-farm mortality levels.

Table 11: On-farm mortality levels 2013-2019 (all herd sizes)

Year	Dairy			Suckler			Scotland		
	< 36 months	36+ months	Total	< 36 months	36+ months	Total	< 36 months	36+ months	Total
2013	15,919	11,494	27,413	**31,775**	**24,220**	**55,995**	47,694	35,714	83,408
2014	16,034	10,890	26,924	**29,130**	**19,045**	**48,175**	45,164	29,935	75,099
2015	17,219	11,285	28,504	**29,319**	**18,600**	**47,919**	46,538	29,885	76,423
2016	18,393	11,721	30,114	**29,449**	**19,802**	**49,251**	47,842	31,523	79,365
2017	18,360	11,463	29,823	**29,553**	**20,214**	**49,767**	47,913	31,677	79,590
2018	18,789	12,242	31,031	**27,883**	**18,275**	**46,158**	46,672	30,517	77,189

Calf Mortality Rates

86. Using these mortality figures alongside the number of calves born can provide estimates of the calf mortality rate by rearing system[35] between 2013 and 2018 (shown in Table 12). It is estimated that calf mortality ranged from:

- 4.3% to 5.4% in extended upland systems
- 5.2% and 6.6% in extended upland systems
- 7% to 9.3% in lowland systems
- 4.8% to 6.8% in rearer finishing systems

This means that estimated mortality rates varied between 5.7% and 6.5% in Scotland's suckler rearing systems - that equates to one in 15 to 18 calves dying on farms and crofts.

Table 12: On-farm calf mortality levels and rate by suckler rearing system 2013-2019

Year	Extensive upland suckler		Extended upland suckler		Lowland suckler		Rearer-finisher		Scotland^	
2013	2,597	5.4%	11,538	6.4%	3,570	7.4%	5,686	6.8%	23,391	6.5%
2014	2,139	4.3%	9,572	5.2%	4,120	9.2%	4,597	5.5%	20,428	5.7%
2015	2,187	4.4%	10,655	5.7%	3,738	7.7%	4,643	5.9%	21,223	5.8%
2016	2,418	4.7%	10,771	5.9%	3,517	7.0%	3,966	5.7%	20,672	5.8%
2017	2,173	4.5%	10,384	5.8%	3,402	7.0%	3,955	5.8%	19,914	5.8%
2018	2,742	5.3%	10,950	6.6%	3,673	7.4%	1,037	4.7%	18,402	6.3%

^ excludes unclassified and finisher systems

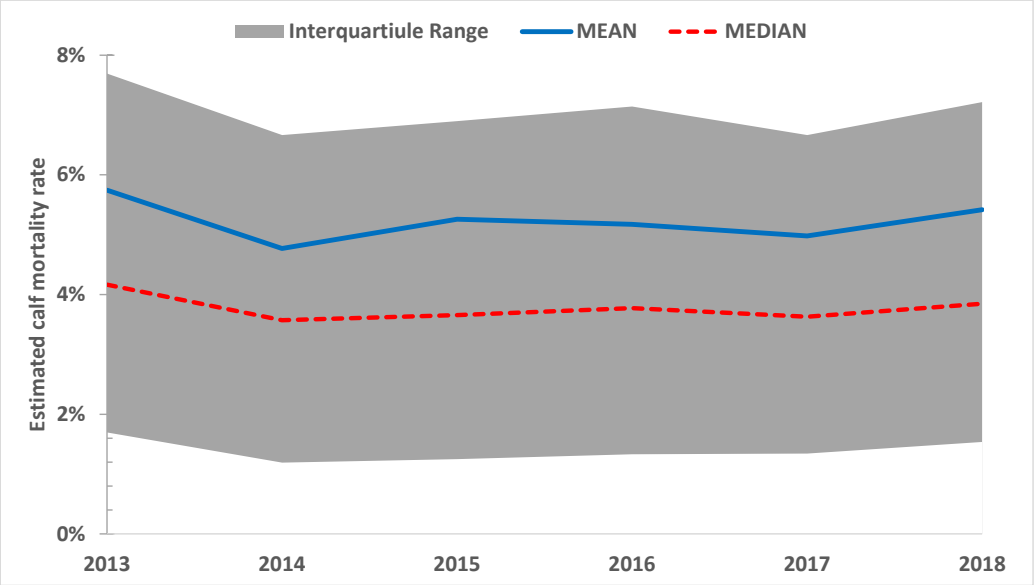
87. Whilst variation in calf mortality levels between production systems provides useful insights it simply highlights average mortality levels across all producers and fails to illustrate the range of mortality levels that occur. At a national level Figure 36 provides an estimate of the average calf mortality rate (and interquartile range – where 50% of the producer fall) for individual suckler rearers with 20+ cows[36]. Immediately it is noticeable that both 2013 and 2018 experienced higher mortality levels –

[35] This uses mortality under 36 months – but as the majority of on farm mortality in these systems occurs in the first year it is deemed a sufficient indicator. Where there are older calves / steers present within a system then the calf mortality rate is likely over estimated as a proportion of the deaths will be in the 12 to 36 month old cohorts. Further iterations of the analysis will look at mortality in age cohorts under 12 months, 12 to 36 months and over 36 months of age. For specialist finishers the mortality rate within this section uses the finished throughput to assess mortality rates.

[36] For smaller herd numbers a few deaths can unduly affect mortality rates and skew figures when looking at business level differences – i.e. a business with 2 calves registered and 1 on farm death returns 50% calf mortality rate.

reiterating that technical performance is impacted by nature. The mean was invariably 1.3-1.4% above the median indicating that it is skewed by some very high mortality levels. The mean fluctuated between 4.8% and 5.7% whilst the median ranged from 3.6% to 4.2%. The best 25% performing producers fall below the lower quartile figure – meaning a quarter of producers had calf mortality levels at 1.5% or less in every year with the exception of 2013. In contrast, 25% of producers had calf mortality levels higher than the upper quartile (6.7% rising to 7.7% - or between 1 in 13 to 15 calves).

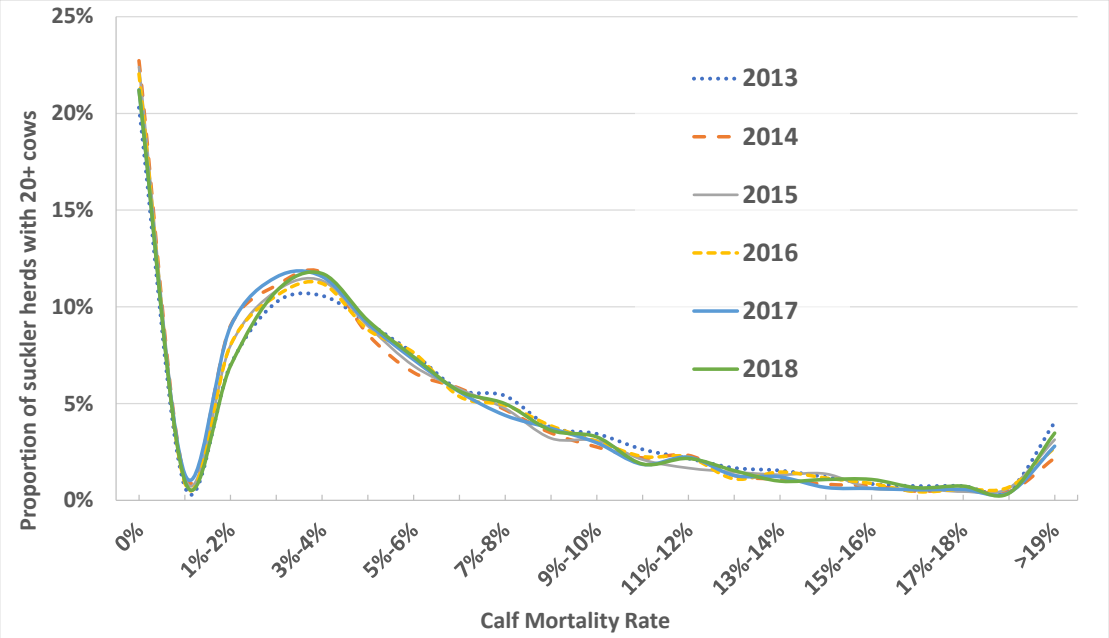
Figure 36: Estimated calf mortality in suckler producers with 20+ cows (excludes specialist finishers and unclassified) 2013 -2018



	2013	2014	2015	2016	2017	2018
Businesses	4,482	4,418	4,359	4,229	4,030	3,505
Upper Quartile	7.7%	6.7%	6.9%	7.1%	6.7%	7.2%
Mean	5.7%	4.8%	5.3%	5.2%	5.0%	5.4%
Median	4.2%	3.6%	3.7%	3.8%	3.6%	3.9%
Lower Quartile	1.7%	1.2%	1.3%	1.3%	1.3%	1.5%

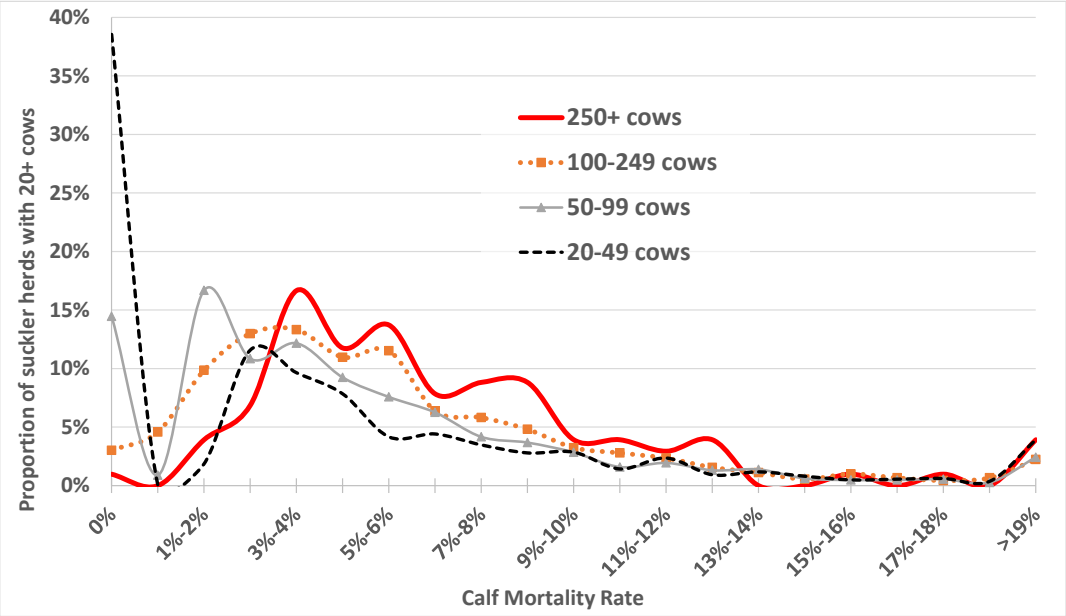
88. Whilst Figure 36 provides a better understanding of the performance of the middle 50% of producers it fails to provide insights at the extremes. Figure 37, therefore, reveals the distribution of calf mortality rates across suckler calf producers with 20+ cows between 2013 and 2018. There is a very consistent distribution, with between 20% and 23% of producers having no on-farm/croft calf deaths in a given year (principally made up of producers with smaller herds). The large dip at 0-1% mortality reflects the larger of producers with less than 100 calves that technically cannot fall into this category. It is noteworthy that the tail is very long indeed with a about 13-14% of producers with calf mortality rates over 10% (which for smaller herds may only mean two calves out of 20) with 3% consistently over 19%. Further investigation into the causes of such variation in calf mortality rates is merited and, as with calving rates, it likely prudent to average rates over multiple years to smooth year by year variation.

Figure 37: Distribution of calf mortality rates in suckler producers with 20+ cows (excludes specialist finishers and unclassified) 2013-18



89. Figure 38 shows the distribution of calf mortality rates by different suckler cow herd sizes with 20+ cows in 2017. 39% of the producers with 20-49 cows and 14% of those with 50-99 cows had no calf deaths recorded in 2017. Only 5% of the producer with 250+ cows and 18% of those with 100-249 cows managed to achieve calf mortality rates under 2%. Whilst there were only 102 herds in the 250+ group 13% recorded mortality levels over 10% and 4% over 19% - about 11% of other groups had mortality rates over 10%. Some ground truthing of the data on some of these farms, and trying to ascertain causes of mortality and if the data are accurate merit further investigation.

Figure 38: Distribution of calf mortality rates in suckler producers with 20+ cows by herd size, 2017

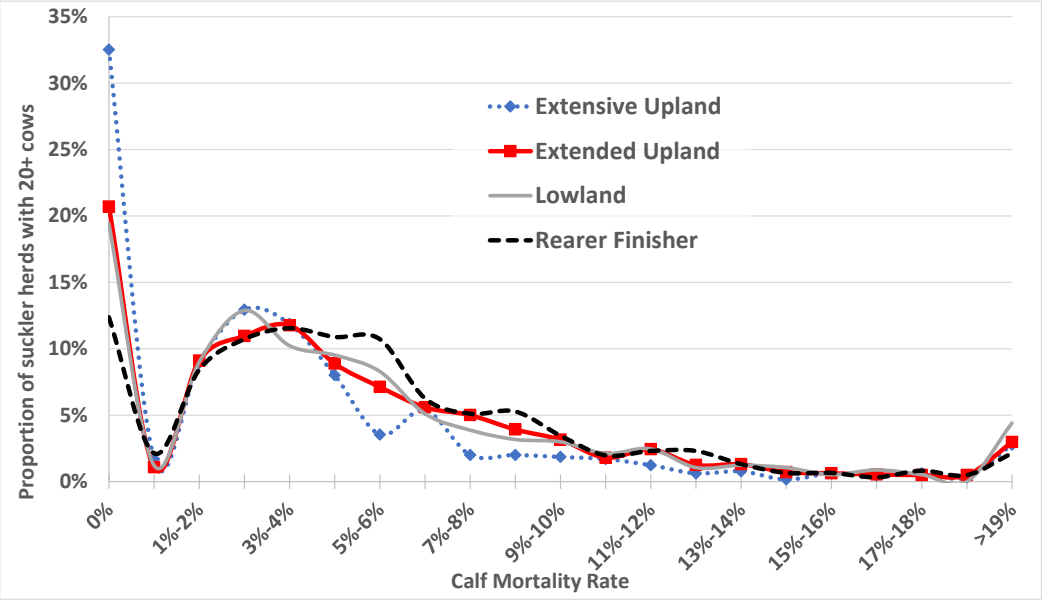


90. Figure 39 reveals that it appears, at first glance, that there were similar distributions of calf mortality between production systems in 2017. However, on closer inspection it can be observed that, with a

higher proportion of smaller producers, considerably more extensive upland producers (33%) had zero mortality and 43% with less than 2% mortality. In contrast the rearer-finishers (that were larger on average) only had 12% with zero calf mortality and 22% with under 2% mortality.

- It is, however, worth recalling here recalling that extensive upland producers returned the lowest calving rates (on average), whilst the rearer-finishers performed best (on average) with calving rates.

Figure 39: Distribution of calf mortality rates in suckler producers with 20+ cows by production system, 2017



91. Whilst there is some very low calf mortality rates across the industry, these results suggest that there remains scope for improvement across the sector – particularly as lower on-farm mortality reduces the wasted overhead of emissions from animals never entering the food chain. When calf mortality rates of consistently over 10% are also brought into consideration, the scope for greater throughput of dairy-beef that can further reduce emissions from Scottish agriculture is clear.

Cow mortality rates

92. In addition to calf mortality, Table 11 also revealed potential beef supply chain inefficiencies in the form of on-farm/croft mortality levels in older cattle (over 36 months). Table 13 illustrates the total breeding cattle (36+ months of age) mortality rate within the main suckler rearing systems as well as for dairy businesses. Breeding cattle mortality levels ranged from:

- 3.8% to 5.5% in extended upland systems
- 4.1% to 5.5% in extended upland systems
- 4% to 5% in lowland suckler systems
- 3.5% to 4.5% in rearer-finisher systems
- 4.7% and 6% for all suckler systems
- 7.4% to 8% in dairy systems

The poor weather years of 2013 and 2018 are, again, noticeable in these mortality rates – particularly in suckler systems. These rates suggest that about 1-in-20 breeding cattle (bulls, cows and heifers) die on-farm/croft.

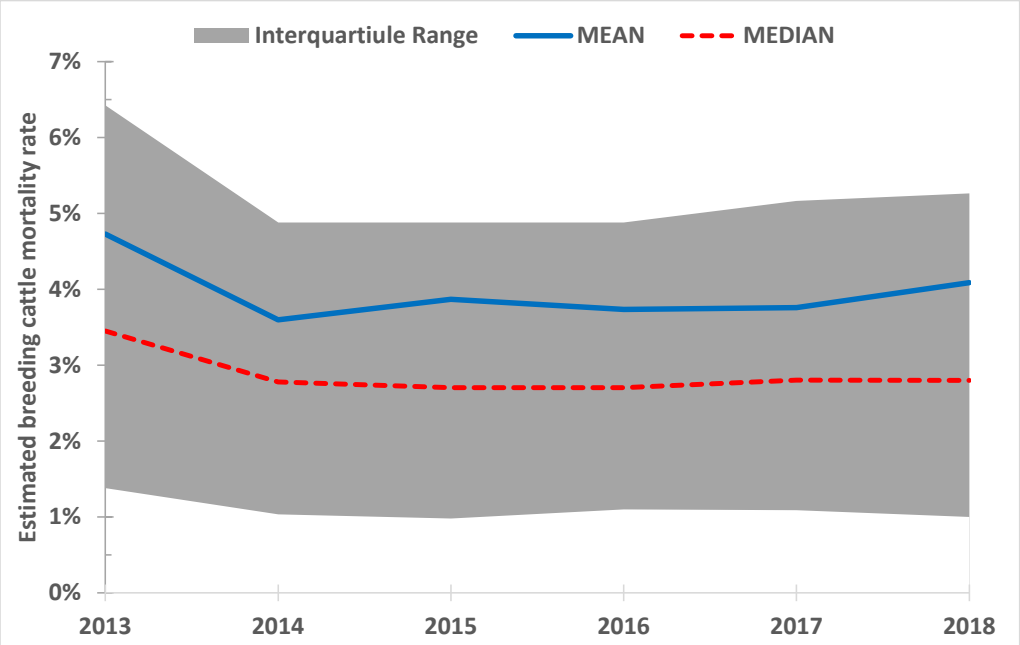
Table 13: Suckler breeding cattle (36+ months) mortality rates

Year	Extensive upland suckler	Extended upland suckler	Lowland suckler	Rearer-finisher	Scotland Sucklers^	*Dairy*
2013	5.5%	5.5%	5.0%	4.5%	**6.0%**	*7.4%*
2014	4.0%	4.1%	4.3%	3.7%	**4.8%**	*7.4%*
2015	3.8%	4.5%	4.2%	3.7%	**4.7%**	*7.4%*
2016	4.5%	4.4%	4.0%	3.6%	**5.0%**	*7.6%*
2017	4.2%	4.5%	4.6%	3.5%	**5.1%**	*7.4%*
2018	4.9%	4.9%	4.7%	-	**4.7%**	*8.0%*

^ Scottish figures include breeding cattle on unclassified and specialist finishers

93. As with calf mortality, the average breeding cattle mortality rates figures within a system provide useful insights as to sectoral performance but does not demonstrate the range of mortality levels that occur. Figure 40 provides an estimate of the average breeding cattle mortality rate (and interquartile range – where 50% of the producer fall) for individual suckler producers that have 20+ cows. The mean generally was about 1.2% higher than the median suggesting some higher herd mortality rates skew the mean. The median illustrates that half the producers had breeding cow mortality rates under 2.8% in 2018 and the lower quartile demonstrates that 25% of producers generally have breeding cattle mortality rates of under 1% in 2018. In contrast 25% of producers had higher mortality levels than the upper quartile (5.3% in 2018). The impact of poor weather and shortage of winter fodder is apparent in this summary.

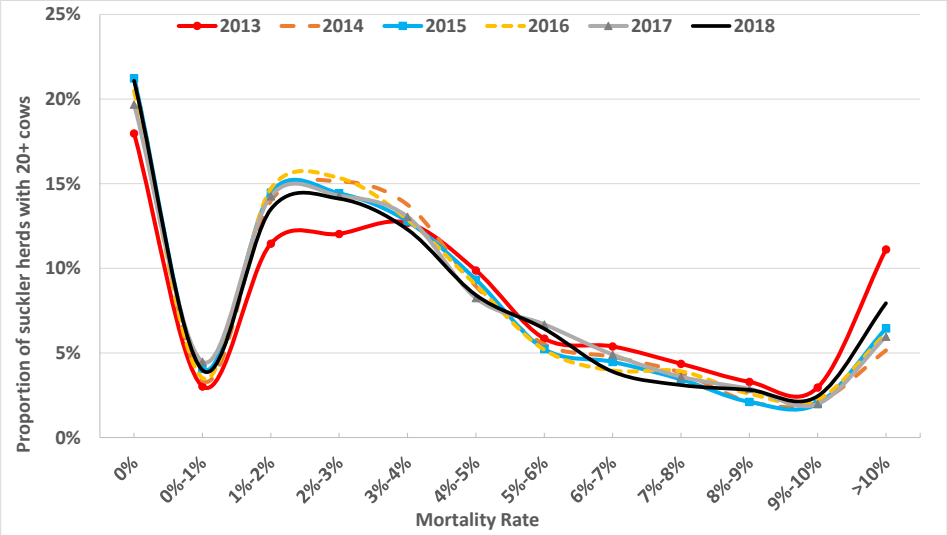
Figure 40: Breeding cattle mortality rate in sucker herds of 20+ cows (excluding dairies and specialist finishers)



	2013	2014	2015	2016	2017	2018
Businesses	4,496	4,426	4,359	4,238	4,039	3,515
Upper Quartile	6.4%	4.9%	4.9%	4.9%	5.2%	5.3%
Mean	4.8%	3.7%	3.9%	3.8%	3.9%	4.1%
Median	3.4%	2.8%	2.7%	2.7%	2.8%	2.8%
Lower Quartile	1.4%	1.0%	1.0%	1.1%	1.1%	1.0%

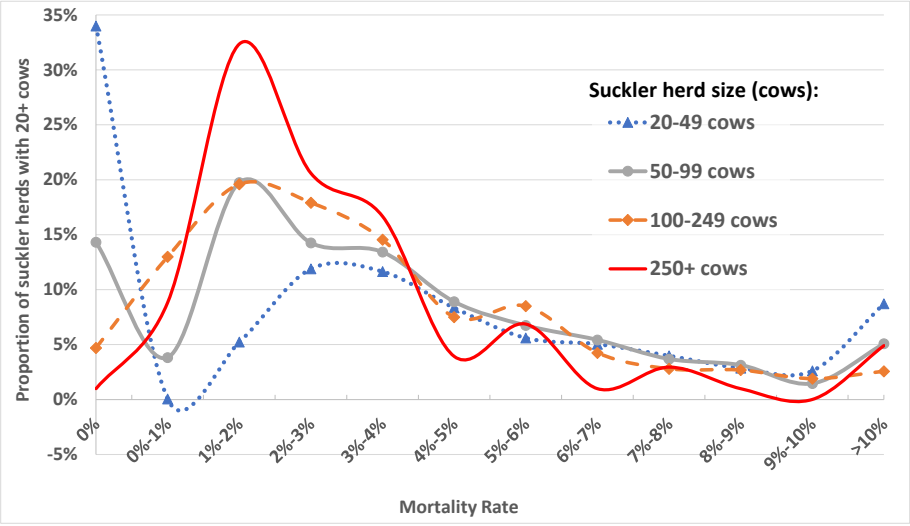
94. Figure 41 shows the wide variation in breeding cattle mortality rates at a producer level (excluding herds under 20 cows and excluding specialist finishers and producers 'unclassified'). 2013 noticeably stands apart from the other years. In the poor weather year of 2103 there were fewer businesses achieving no deaths (18% compared to a norm of 20-21%) and more producers (11%) had 10%+ mortality rates compared to 6% in other years (except 2018 where 8% of producers had high mortality levels). To put that in context, 8% of producers lost at least 1-in-10 of their breeding stock in 2018. As with calf mortality rates – the large dip for 0-1% mortality is a reflection of the high proportion of herds that have fewer than 100 cows.

Figure 41: Distribution of breeding cattle mortality rates in suckler producers with 20+ cows (excludes specialist finishers and unclassified) 2013-18



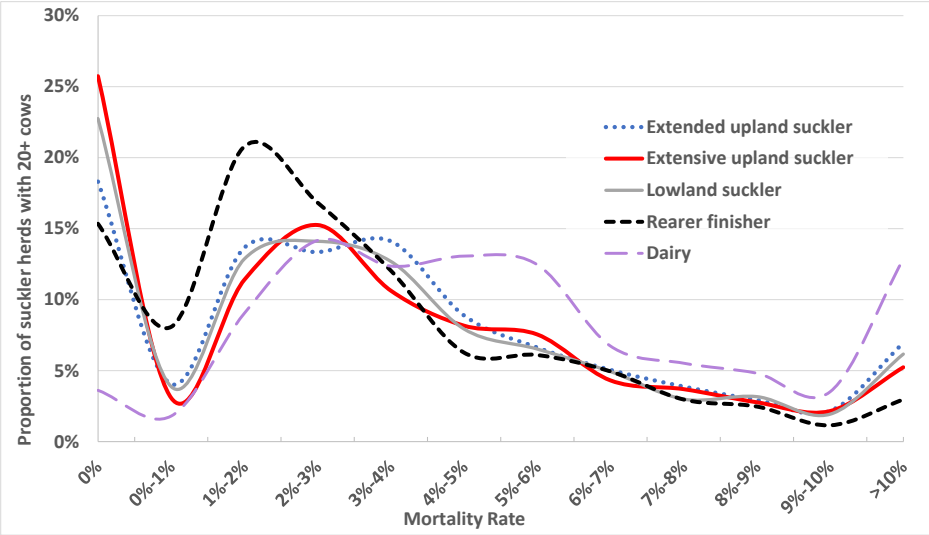
95. Figure 42 shows the distribution of breeding cattle mortality rates by herd size in 2017 for producers with 20+ cows. 34% of the producers with 20-49 cows had no on-farm/croft breeding mortality (14% of producers with 50-99 cows, 5% with 100-249 cows and only 1% for those with 250+ cows). That said, in 2017 42% of the largest herds had breeding mortality rates lower than 2% and 79% were under 4%. For all size groupings there was long tail and 9% of producers in the 20-49 cow bracket had over 10% breeding cattle mortality (with 3-5% of producers in other size categories)

Figure 42: Distribution of breeding cattle mortality rates in suckler producers with 20+ cows by herd size, 2017



96. Figure 43 shows the distribution of on-farm/croft breeding mortality for suckler rearer producers in 2017 alongside dairy producers for contrast. The rearer-finisher distribution appears different from the other suckler systems and 73% of these producers achieved less than 4% breeding mortality in 2017 – compared with 64-66% for other suckler systems. Dairy producers had higher rates of on-farm mortality with only 41% achieving less than 4% mortality and 13% having mortality rates of over 10%.[37]

Figure 43: Distribution of breeding cattle mortality rates in suckler producers (and dairy) with 20+ cows by production system, 2017



Timing of on-farm/croft mortality

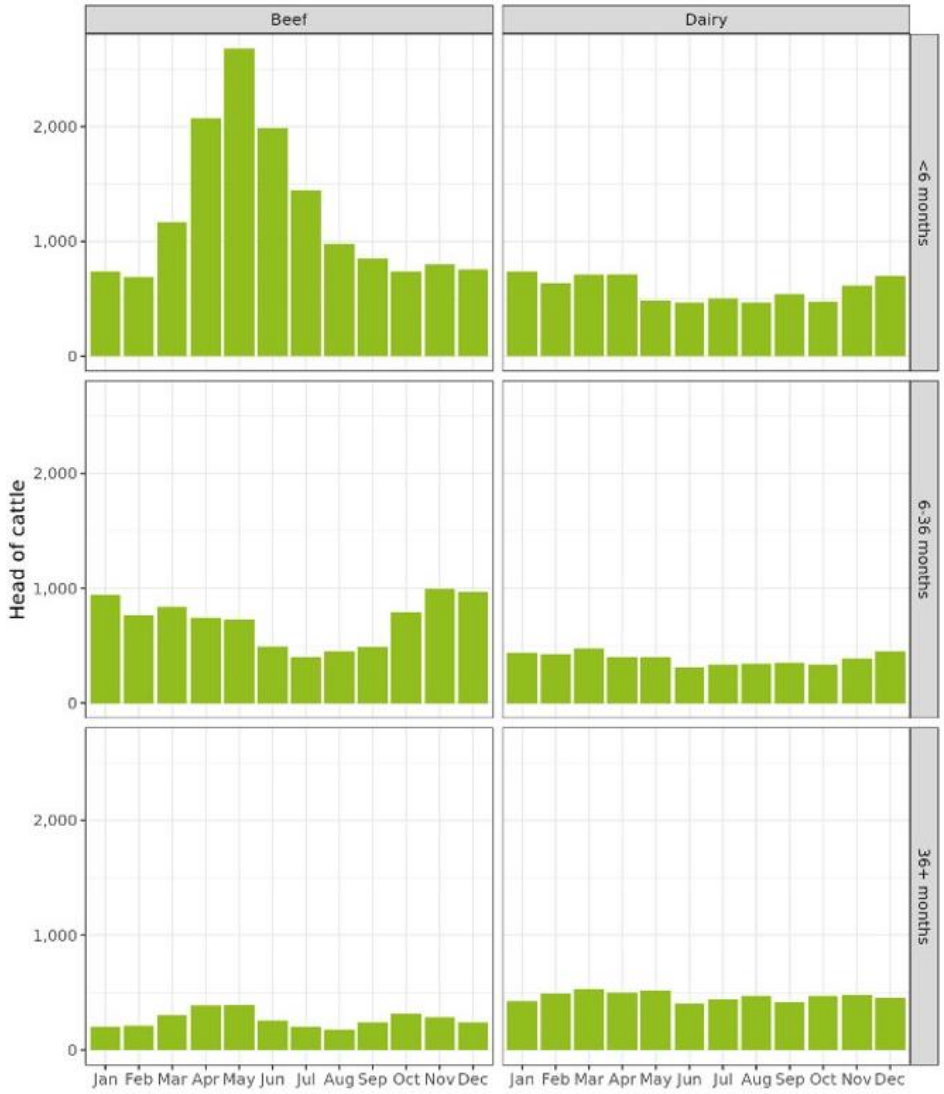
97. The timing of death on a farm/croft can likely provide some pointers as to the contributory factors of death. Neo-natal death may be due to poor colostrum intake, scour, dystocia, hypothermia, etc. whereas death of older calves during winter months may be due to respiratory disease such as pneumonia arising from indoor systems.)

98. Figure 44 shows the month (multi-year) in which cattle born in 2013 died on farm/crofts. This is further split by age bands for the cattle and for dairy and suckler producers. The top graph shows the month of death for calves registered in 2013 that were under 6 months of age[38] and it shows a similar distribution to calf registrations, suggesting that most deaths occur around the time of calving. The middle graphs shows the month of on farm/croft death for cattle aged 6 to 36 months and the up-turns for suckler beef systems in autumn and winter months suggest higher mortality rates due to issues arising from housing (pneumonia, etc.). For breeding cattle (over 36 months of age) there is relatively stable mortality levels across the year, but for suckler cattle there are uplifts in spring and autumn – that perhaps reflect cow/heifer deaths around calving.

[37] It is acknowledged that whilst CTS may mark some of these businesses / holdings as dairy due to their cattle breed mix they may not be run as commercial dairy units.

[38] Remembering with 28 days for a birth to be registered legally, a 6-month old calf in CTS can in effect actually be 7 months of age.

Figure 44: Month of death by age group – 2013 cohort of calves



[39]

[39] Photo: SRUC

The finishing sector

99. The beef finishing sector is even more concentrated than the suckler cow herd, with economies of scale and specialism both key attributes for the largest finishers. The specialist finishers act as the intermediary between suckler calf producers and the abattoirs, and they manage the supply of finished 'prime' calves to the abattoir sector. As such, they play a vital role in determining the age of cattle at slaughter through how they manage their cattle - daily liveweight gain differs depending on feeding regime – and they can influence the age at which store animals are sold from suckler producers through the market (the premise being the earlier a finisher gets a calf the better they can manage its growth to best meet target weights, confirmation, and - maybe in the future – finished age.

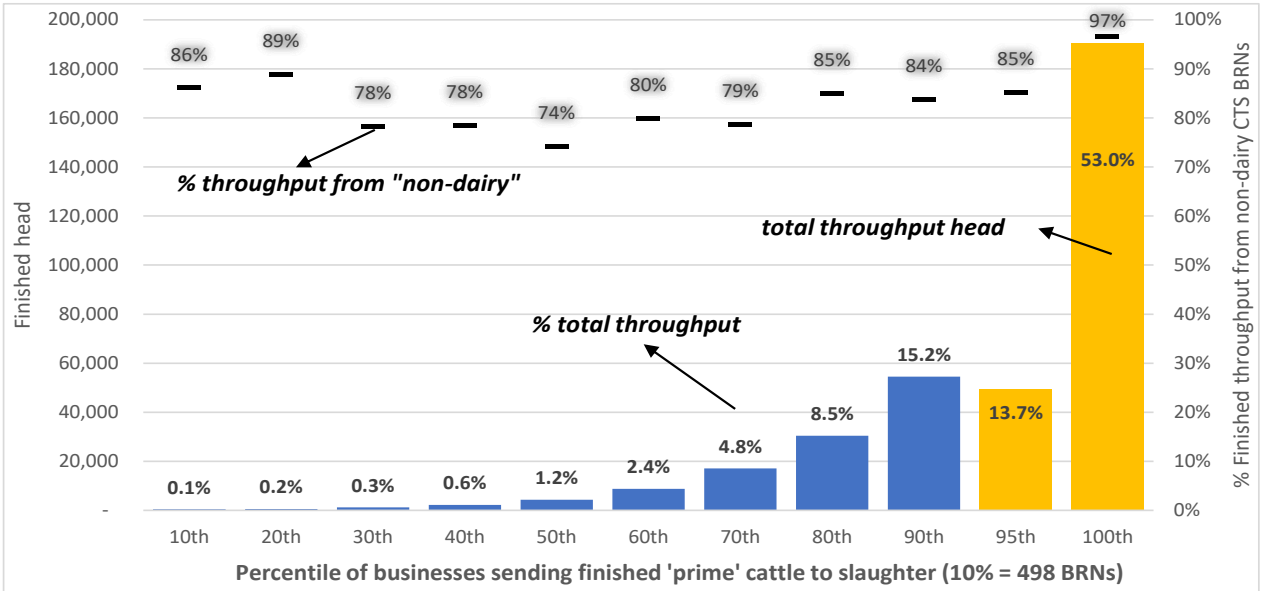
100. The section illustrates the extent of concentration in the finishing sector and for analytical purposes cattle sent to slaughter under 36 months that have not had a calf registered are considered "prime". This section does not disaggregate whether the finished cattle are 'dairy reared beef' or 'suckler reared beef' other than when finished cattle throughput is presented by production system. This means that no account is taken of the genetic origin of the cattle – rather it is the businesses that that are moving cattle to slaughter that are categorised. The use of 36 months as a cut off means these 'finished cattle' data may include heifers that were earmarked for breeding that may have failed to conceive or had failed pregnancy, or had lactation issues (particularly in the dairy sector) it is considered an adequate proxy for finished 'prime' cattle that were born in Scotland.

101. Figure 45 emphasises the highly concentrated nature of the finishing sector. A small proportion of very large finishers dominate the sector.

- Of the 4,963 Scottish businesses that produced at least one finished 'prime' animal in 2019 only 5% (250 businesses) accounted for 53% of the total abattoir throughput of Scottish born finished cattle - with only 3% of the cattle sourced directly from CTS labelled dairy businesses.
- A further 5% of finishers accounted for 13.7% of throughput (with 15% from dairy farms) meaning that the largest 10% of businesses (n=499) producing 'prime' animals were responsible for two-thirds of Scottish throughput.
- If the next decile of producers are added it means that 20% of businesses (n=997) with finished animals accounted for 82% of Scottish finished 'prime' cattle (combined throughput of over 290,000 head).
- In stark contrast 50% of the businesses only accounted for 2.5% or 8,908 head of finished cattle - these businesses all send fewer than 12 animals (average of 3-4) under 36 months of age for slaughter – perhaps for home consumption or local added-value sales.

102. The data highlights that any future policy interventions that are focused on finished cattle (such as incentives to reduced slaughter age) can be targeted at a relatively small population of businesses to impact on the majority of the cattle.

Figure 45: Distribution of 'prime' cattle slaughtered by BRN percentiles and proportion of throughput from non-dairy BRNs, 2019



	BRN Percentile										
	10th	**20th**	**30th**	**40th**	**50th**	**60th**	**70th**	**80th**	**90th**	**95th**	**100th**
Finishing BRNs	498	498	498	499	498	498	499	498	498	**249**	**250**
% BRNS non-dairy	*86.1%*	*90.0%*	*79.3%*	*79.4%*	*74.3%*	*79.7%*	*78.8%*	*84.9%*	*83.7%*	***85.5%***	***94.0%***
Prime cattle (Head)	498	627	1,203	2,205	4,375	8,755	17,111	30,466	54,564	**49,258**	**190,439**
% prime cattle	0.1%	0.2%	0.3%	0.6%	1.2%	2.4%	4.8%	8.5%	15.2%	**13.7%**	**53.0%**
% head non-dairy	*86.1%*	*88.8%*	*78.2%*	*78.5%*	*74.2%*	*79.9%*	*78.8%*	*85.0%*	*83.8%*	***85.2%***	***96.6%***

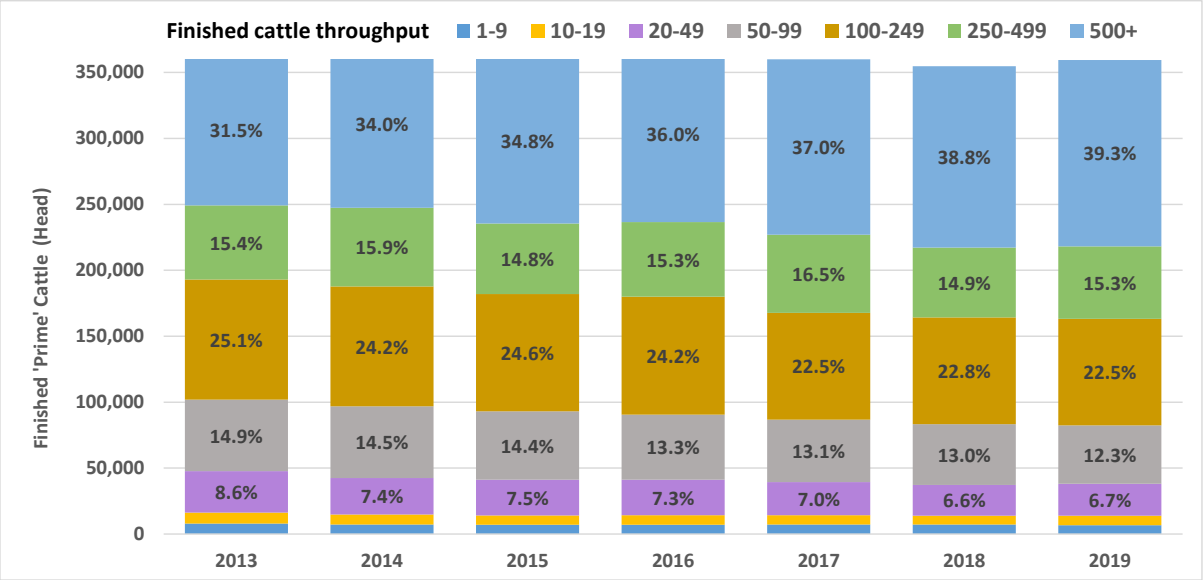
- The number of with more than 500 head throughput increased from 103 in 2913 to 111 in 2019
- The number of businesses supplying more than 1,000 head of prime cattle to abattoirs annually increased from 39 in 2013 to 49 in 2019. These businesses collectively accounted for 99,028 cattle (31% of Scottish total) in 2019 - a 41% increase in throughput from businesses in finishing more than 1,000 head since 2013.

103. Figure 46 (with data in Table 14*)* shows the distribution of finished cattle throughput from different finishing size categories between 2013 and 2019.

- Overall finished throughput remained relatively stable over the period (only 1% decline).
- There was a 16.3% decline in the numbers of businesses presenting at least 1 prime animal to abattoirs. They only presented 6,751 prime animals for slaughter in 2019.
- There were 17% fewer businesses (to 3,545 in 2019) finishing fewer than 50 head prime cattle between 2013 and 2019 – the throughput from this group fell by 20% to 38,187 cattle in 2019.
- The proportion of total finished abattoir throughput sourced from larger herds (500+ head) increased from 31.5% in 2013 to 39.3% in 2019. This equated to a 23.5% increase in the total finished throughput from finishers with more businesses than 500 head delivered to abattoirs between 2013 and 2019. The number of with more than 500 head throughput increased from 103 in 2913 to 111 in 2019
- The number of businesses supplying more than 1,000 head of prime cattle to abattoirs annually increased from 39 in 2013 to 49 in 2019. These businesses collectively accounted

for 99,028 cattle (31% of Scottish total) in 2019 - a 41% increase in throughput from businesses in finishing more than 1,000 head since 2013.

Figure 46: Distribution of prime cattle slaughtered, by farm size, 2013-2019



104. Figure 47 and Table 15 provide details on the finished cattle throughput by production system. This confirms that specialist finishers, rearer-finishers and dairy farms accounted for 86% of the 'prime' cattle presented to abattoirs in 2017.

- In 2017 rearer-finishers accounted for 13% of businesses presenting prime cattle to abattoirs and 16% of the cattle (down from 19% of the throughput in 2013)
- Dairy businesses consistently delivered for 9% of the prime cattle (including heifers without calf registrations) throughput in 2017.
- Late finishers accounted for 32% of the finished cattle in 2017 (down from 34% in 2013) and were 9% of the businesses presenting prime cattle to abattoirs.
  Early finishers accounted for 29% of the prime cattle (and 7% of the businesses) in 2017 – up from 25% throughput in 2013.

Figure 47: finished cattle throughput by production system, 2013 to 2017

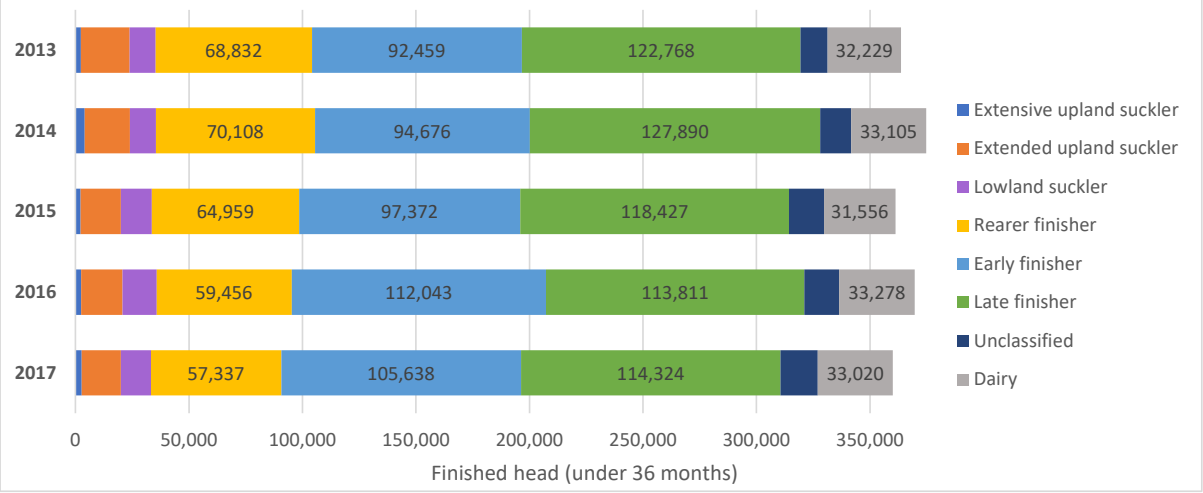


Table 14 Annual throughput of total finished 'prime' cattle by throughput quantity, 2013-2019

Finished Throughput	2013		2014		2015		2016		2017		2018		2019	
	Head	%	Head	%	Head	%	Head	%	Head	%	Head	%	Head	%
1-9	7,994	2.2%	7,285	1.9%	6,957	1.9%	7,076	1.9%	7,197	2.0%	7,257	2.0%	6,751	1.9%
10-19	8,312	2.3%	7,474	2.0%	7,126	2.0%	7,106	1.9%	7,054	2.0%	6,673	1.9%	7,191	2.0%
20-49	31,374	8.6%	27,780	7.4%	27,069	7.5%	26,970	7.3%	25,077	7.0%	23,345	6.6%	24,245	6.7%
50-99	54,268	14.9%	54,349	14.5%	51,939	14.4%	49,307	13.3%	47,340	13.1%	46,006	13.0%	44,256	12.3%
100-249	91,107	25.1%	90,807	24.2%	88,824	24.6%	89,500	24.2%	81,054	22.5%	80,948	22.8%	80,766	22.5%
250-499	56,155	15.4%	59,726	15.9%	53,636	14.8%	56,526	15.3%	59,247	16.5%	52,993	14.9%	54,950	15.3%
500+	114,406	31.5%	127,362	34.0%	125,769	34.8%	133,226	36.0%	133,052	37.0%	137,576	38.8%	141,342	39.3%

Finished Throughput	BRNs	%	BRNs	%	BRNs	%	BRNs	%	BRNs	%	BRNs	%	BRNs	%
1-9	2,756	46.5%	2,564	45.9%	2,433	45.6%	2,446	45.9%	2,480	47.6%	2,488	48.7%	2,285	46.0%
10-19	593	10.0%	538	9.6%	509	9.5%	511	9.6%	500	9.6%	481	9.4%	522	10.5%
20-49	941	15.9%	839	15.0%	819	15.3%	812	15.2%	756	14.5%	709	13.9%	738	14.9%
50-99	767	13.0%	756	13.5%	727	13.6%	694	13.0%	659	12.6%	645	12.6%	614	12.4%
100-249	597	10.1%	600	10.7%	578	10.8%	587	11.0%	533	10.2%	527	10.3%	531	10.7%
250-499	165	2.8%	174	3.1%	158	3.0%	163	3.1%	173	3.3%	152	3.0%	162	3.3%
500+	103	1.7%	116	2.1%	113	2.1%	117	2.2%	110	2.1%	111	2.2%	111	2.2%

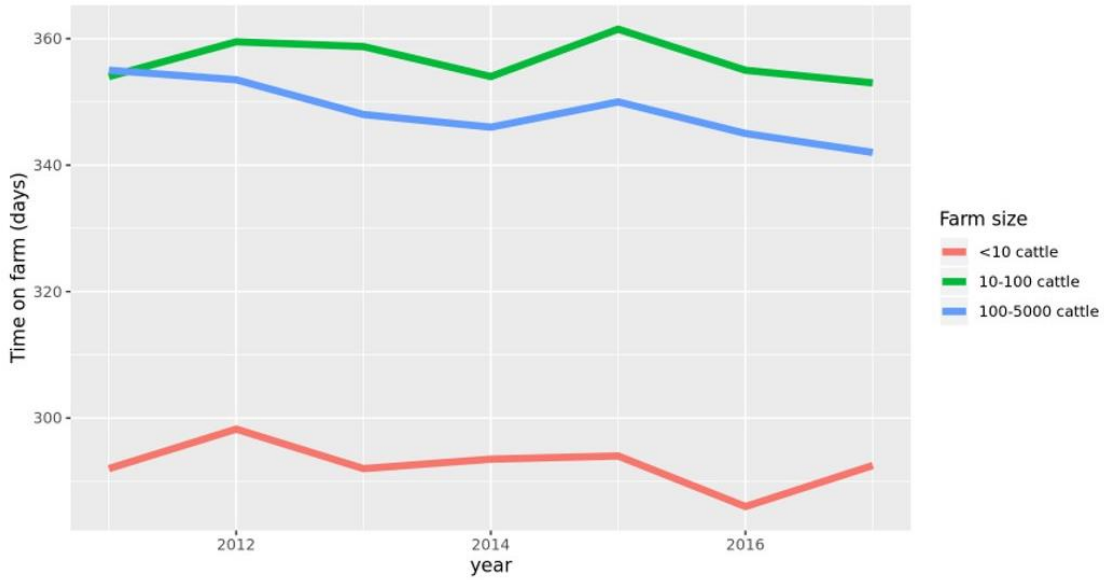
Table 15 finished cattle throughput by production system, 2013 to 2017

		Extensive upland suckler	Extended upland suckler	Lowland suckler	Rearer-finisher	Early finisher	Late finisher	Unclassified	Dairy
BRNs with finished cattle	2013	319	1,730	638	**921**	**416**	**569**	392	943
		5%	29%	11%	**16%**	**7%**	**10%**	7%	16%
	2014	294	1,630	556	**893**	**427**	**549**	346	903
		5%	29%	10%	**16%**	**8%**	**10%**	6%	16%
	2015	294	1,504	575	**823**	**420**	**493**	354	881
		6%	28%	11%	**15%**	**8%**	**9%**	7%	16%
	2016	336	1,514	593	**741**	**400**	**489**	377	887
		6%	28%	11%	**14%**	**7%**	**9%**	7%	17%
	2017	303	1,490	555	**674**	**372**	**491**	438	895
		6%	29%	11%	**13%**	**7%**	**9%**	8%	17%
Finished Cattle	2013	2,363	21,443	11,541	**68,832**	**92,459**	**122,768**	11,981	32,229
		1%	6%	3%	**19%**	**25%**	**34%**	3%	9%
	2014	4,072	19,876	11,422	**70,108**	**94,676**	**127,890**	13,634	33,105
		1%	5%	3%	**19%**	**25%**	**34%**	4%	9%
	2015	2,243	17,706	13,669	**64,959**	**97,372**	**118,427**	15,388	31,556
		1%	5%	4%	**18%**	**27%**	**33%**	4%	9%
	2016	2,418	18,326	15,042	**59,456**	**112,043**	**113,811**	15,337	33,278
		1%	5%	4%	**16%**	**30%**	**31%**	4%	9%
	2017	2,721	17,193	13,387	**57,337**	**105,638**	**114,324**	16,401	33,020
		1%	5%	4%	**16%**	**29%**	**32%**	5%	9%

Buying in store animals and length of time to finish

105. One aspect of Scotland's stratified beef sector is the reliance on the specialist finishers to take store calves through to finishing (as described above). Different finishers operate in different ways, as do suckler calf rearers – often driven by systems of production that are constrained by the availability of forage and cereals. Figure 48 illustrates the median time that store calves spent on farms and crofts by herd size. On average it is apparent that herds containing less than 10 calves keep animals for 290 to 300 days over the 2011 to 207 period whilst herds with 10-100 calves kept calves for 350-360 days on average and those with more than 100 calves tended to sell marginally younger at 340-350 days. The smallest herds therefore, on average, sell calves about 2 months younger than those with medium and large herds (perhaps reflecting lack of fodder options for extensive upland producers). It is noticeable that after 2015 there appears to have been an average declines of 10 days in both the medium and large suckler calf categories – perhaps some minor change arising from the weight penalties abattoirs introduced to finishers.

Figure 48 Median length of time cattle destined for slaughter spend on suckler rearer farms



106. This is also presented as boxplots for 2013-2018 (although the shorter periods in 2108 reflect some cattle had yet to be finished by data cut-off point).

107. Figure 49 shows the median time spent on businesses that moved 'prime' cattle (under 36 months) to an abattoir. It shows that specialist finishers in the largest two size groupings have cattle on their holdings for the shortest period of time prior to slaughter move. This is also presented as boxplots for 2013-2018 (although the shorter periods in 2108 reflect some cattle had yet to be finished by data cut-off point).

Figure 49 Median length of time cattle destined for slaughter spend with finishers

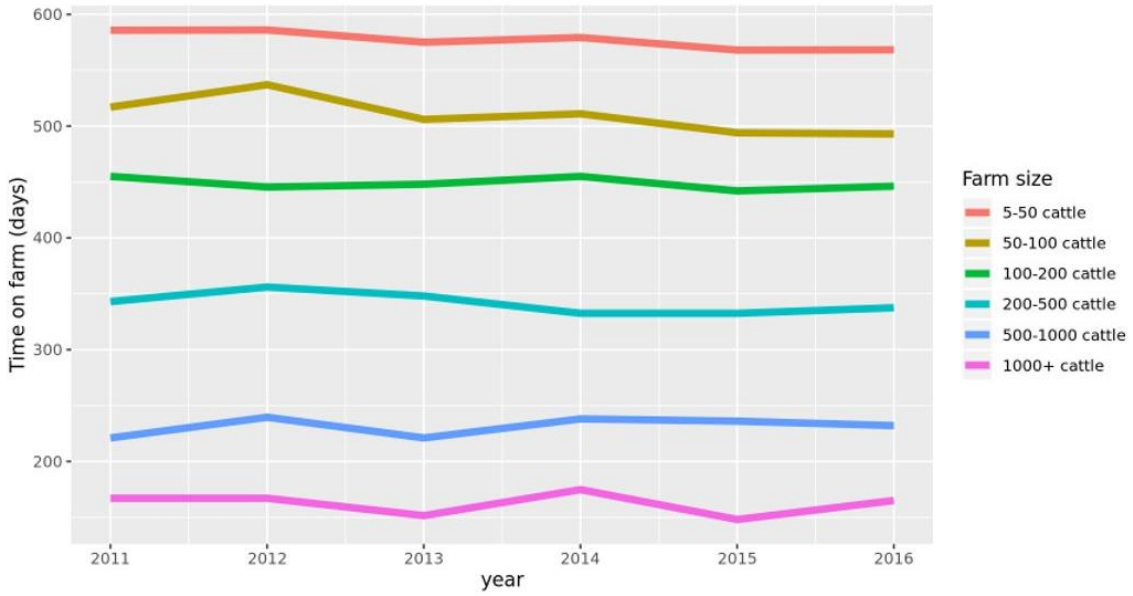
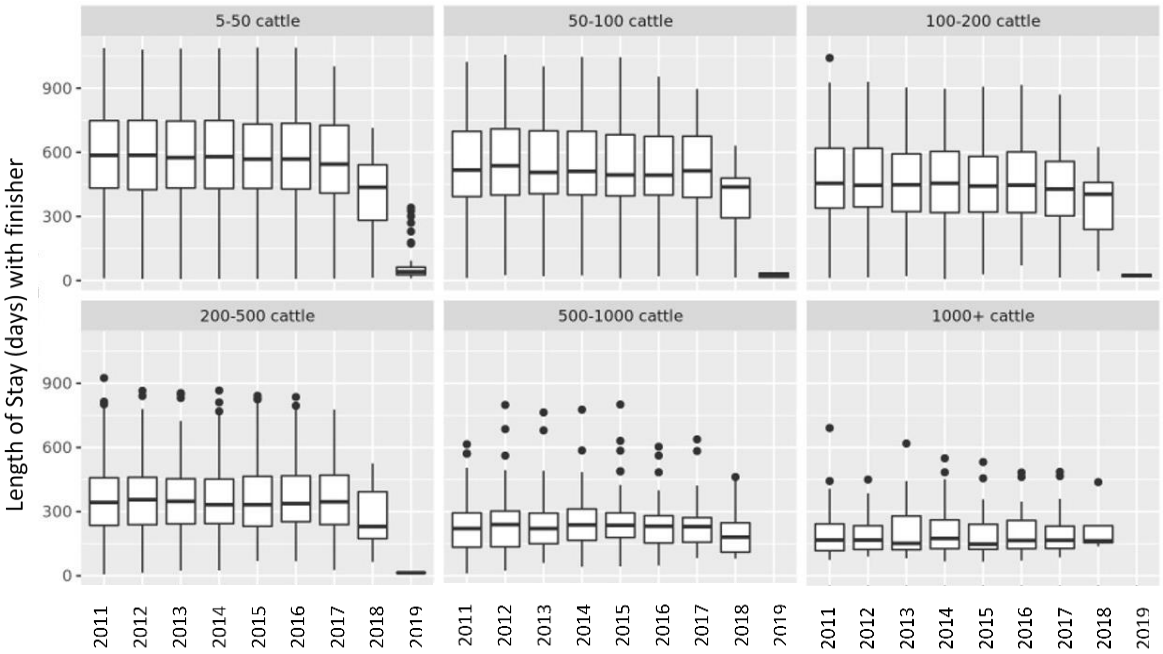
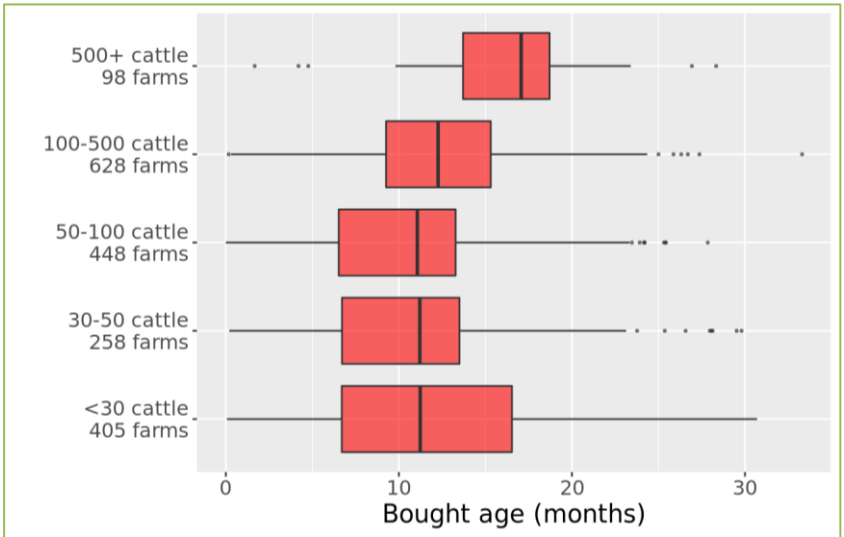


Figure 50 Boxplot of time moved cattle spend on finishing farms pre slaughter



108. Whilst it is tempting to say that these larger finishers simply are more efficient it is worth noting that they, on average bring cattle into their businesses at an older age. Figure 51 illustrates that the largest specialist finishers indeed bought cattle born in 2013 destined for slaughter at an older age (on average) than other finishers (the red box represents the interquartile range and the line the median). The median age of on-moves to the larges finishers was 17 months compared to 11-12 months for the others, with shorter average lengths of stay associated (7 months) with those older cattle

Figure 51 Boxplot of age of cattle born in 2013 brought onto finishers (last move prior to abattoir move)



Finished cattle	Median bought age	Median stay	Median finished age
<30 cattle	11	20	24
30-50 cattle	11	20	24
50-100 cattle	11	17	23
100-500 cattle	12	14	23
500+ cattle	17	7	24

Slaughter age

109. Large variance is finishing times suggests inefficiencies in part of the 'beef system' yet it must be acknowledged (as discussed above) that part of this relates to the largest finishers smoothing supply to the abattoirs thereby allowing allow consistent throughput. There are, however undoubted opportunities for emissions efficiency gains to be had from the finishing sector. The following provides an extract from Thomson et al (2020) [40] which examined the slaughter age of prime cattle for the cohort of calves born in 2013 - with some additional insights provided to illustrate how slaughter ages have changed in recent years.

110. Thomson et al 2020 reported that of the calves destined for slaughter by 36 months from registration that 27% were slaughtered in 2014, 65% in 2015 and 8% in 2016. This helps to illustrate both the length of production cycle of within the sector (remembering there is an approximate 9 month gestation period – during which the previous year's calf is also suckling for the first 4 to 5 months) and also high levels of variance in finishing ages. Figure 52 shows the month in which 2013 born calves were slaughtered, with the main peak in the first half of 2015.

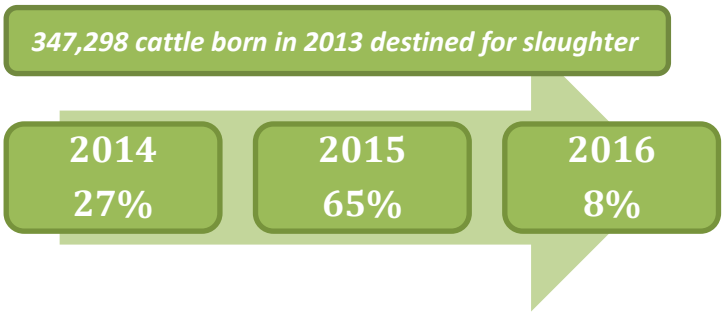
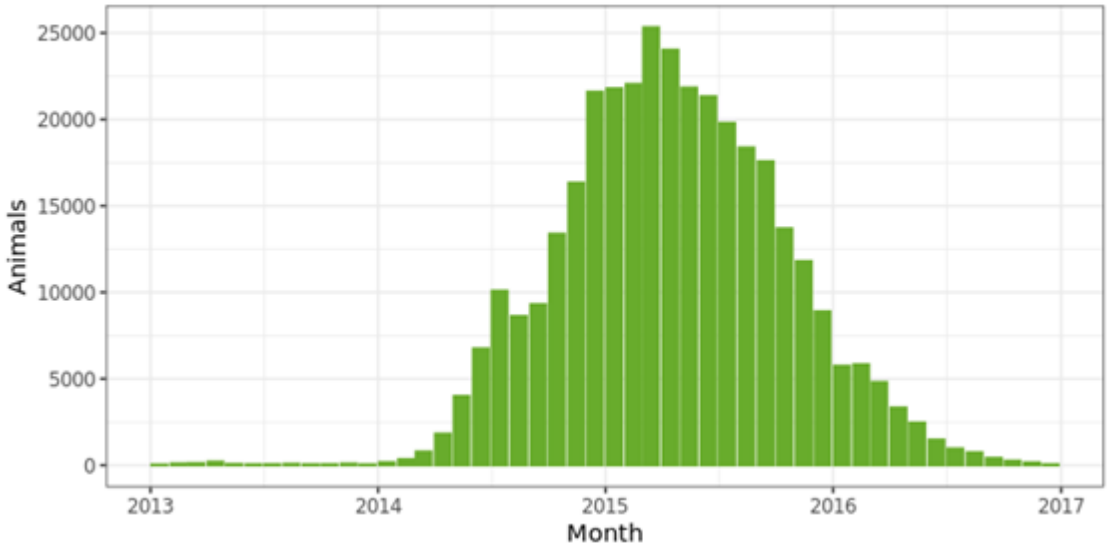


Figure 52 Month of slaughter of prime cattle born in Scotland during 2013

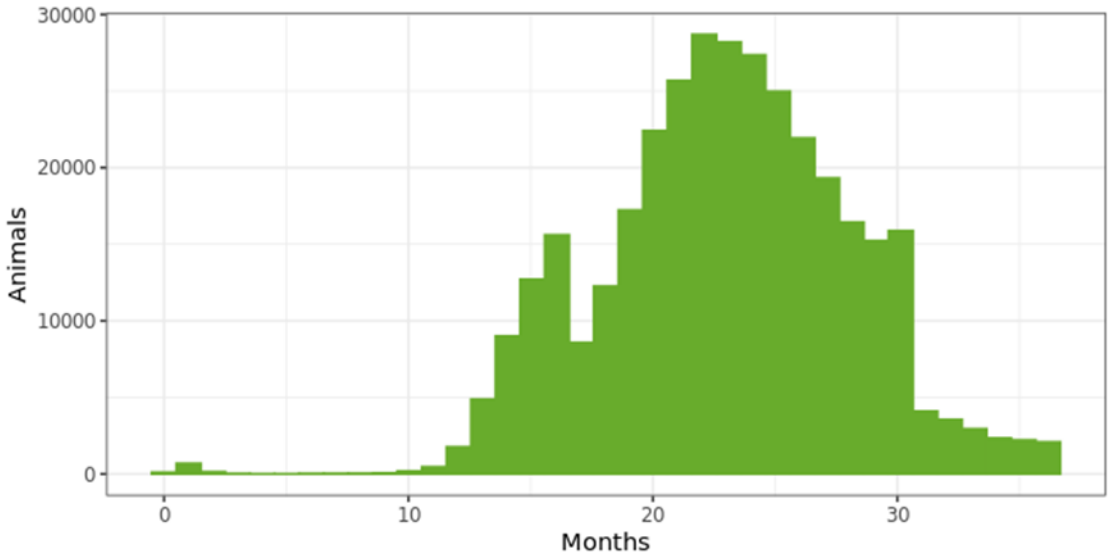


111. Figure 53 shows the wide variation in slaughter age across all cattle born in 2013 that were slaughtered before they were 36 months old. The number of very early finished cattle increased from about 2,500 at 13 months to nearly 15,000 at 16 months of age. There was a notable drop back in the number being slaughtered at 17 and 18 months of age before a steady increase to 28,000

[40] Steven Thomson, Mike Spencer & Aaron Reeves (2020) Scottish Beef Finishing – Evidence from 2013 born animals. Cattle Network Briefing Note 1. Available at: https://www.ruralbrexit.scot/future-policy/scottish-beef-finishing-cattle-network-briefing-note-1/

being slaughtered at 22 months of age and similar amounts for 23 and 24 months before the numbers taper off to 13,000 being slaughtered at 30 months of age.

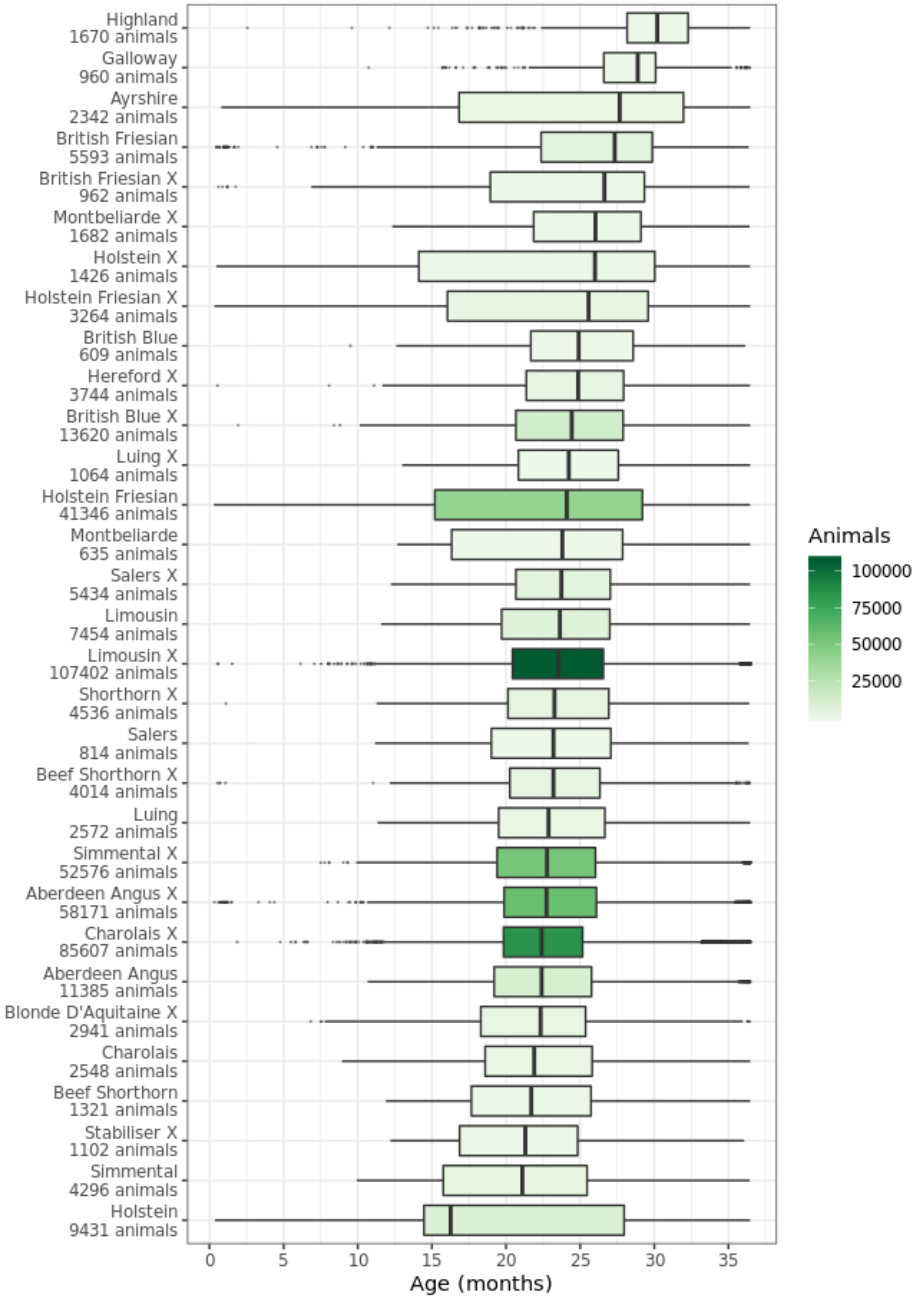
Figure 53 Age at slaughter of cattle born in Scotland in 2013 (beef and dairy)[41]



112. It is perhaps convenient to think that the bulk of the variance in slaughter age is related to the breed of cattle, and to some extent it is with slower maturing breeds naturally taking longer to finish (also carcase weights, carcase conformation and meat yield will differ between breeds but CTS does not record this). Figure 54 shows the box plots of the slaughter age of 2013 born cattle by breed – with the vertical line showing the median slaughter age – the box shows the spread of the middle 50% of cattle (the interquartile range) whilst the lines indicate the lower and upper values and the dots any outliers. A tighter box and whiskers indicates a greater uniformity in the age of the cattle slaughtered within a breed. In Figure 54 the breeds with the highest median slaughter age are at the top and those with lowest median age at the bottom. The darkest boxes indicate the most popular breeds in terms of abattoir throughput. Perhaps unsurprisingly, the slow maturing Highland and Galloway breeds that often graze rough grazing hill areas take longest to finish. Many of the dairy breeds also take relatively longer than the main beef breeds to finish, although there are often quite large variances.[42]

[41] The data implies some very young slaughtering that we believe are a result of data errors
[42] Photo: SRUC

Figure 54: Box plot of slaughter age of 2013 born cattle – by breed

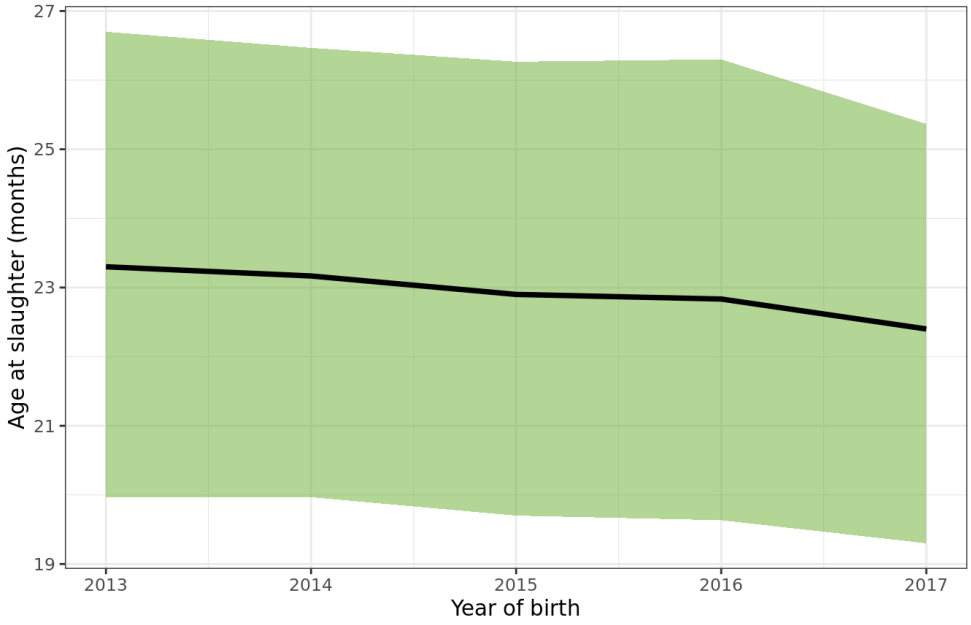


113. Figure 55 illustrates how the median slaughter age of prime cattle has only decreased marginally over the period 2011 to 2017, from just over 23 months to just over 22 months[43]. The interquartile range around the median has also drifted lower, but considerable variation remains and indeed 25% of the cattle remained older than 25 months at the point of slaughter (with 25% below 19.5 months). This suggests that there remains scope for further lowering of slaughter age, which can

[43] As the CTS data extract only included data up till the end of 2019 the figure for 2017 is artificially low as a proportion of the cattle born in 2007 had not been slaughtered by the end of 2019 (e.g. a calf born in Nov 2017 could would have been 25 months old and perhaps not slaughtered by the data extraction date).

help to reduce emissions (but note cautionary note above in relation to smoothing supplies over the year).

Figure 55 Variation in median and interquartile slaughter age of prime cattle by year or birth: 2013 - 2017



Conclusion

114. CTS data represent a rich source of information from which insights can be gained into key performance indicators of Scottish beef producers. The analysis presented here reveals considerable variation across farms, implying industry-wide scope for improvement to deliver both production and emission benefits.

115. However, the analysis also reveals the complexity and diversity of the Scottish beef sector. As such, further analysis is required to refine and, ideally, to ground-truth findings. Nevertheless, the results presented here are sufficient to indicate key metrics for policy to focus on and are consistent with the direction of travel recommended by both the Suckler Beef Climate Group and the Farming for 1.5 Degrees[44] group.[45]

[44] https://www.farming1point5.org/
[45] Photo: SRUC

Glossary of acronyms and terms

APHA: Animal and Plant Health Agency

BCMS – British Cattle Movement System

Calving Rate – measured by number of calves registered as a proportion of the breeding herd. Calf registrations are a proxy for successful calving but it is acknowledged that this underestimates live births as neonatal (first 28 days) deaths may never be registered.

Cow with calf - female cattle that had a calf registered in a given year

Cows – any female that has previously had a calf registered to it (i.e. in year n-1)

CTS: Cattle Tracing System of the British Cattle Movement Service

EPIC: Epidemiology, Population health and Infectious disease Control (EPIC) is Scotland's Centre of Expertise on Animal Disease Outbreaks

Finishing Cattle / Throughput – animals sold off a farm that are slaughtered in an abattoir within 7 days of leaving the holding

Heifer – a female with its first calf registered to it

Heifer Replacement Rate – a proxy the proportion of breeding cows are replaced in a given year.

JAC: June Agricultural Census

Mortality rate – number of animals that are registered as having died on a businesses as a proportion of calves, cows, finishing herd.

RESAS: Rural and Environment Science and Analytical Services

Suckler Cow – suckler cows are specifically kept for the purpose of beef production as opposed to dairy cattle which are kept for the primary purpose of milk production where beef is a secondary product. Scotland is distinctive in its high proportion of prime cattle being sourced from its suckler herd.

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