SRUC

Economic Advice & Related Services to Support Development of a New Rural Support Scheme for Scotland

RESAS/005/21

Calving Intervals in Scottish Cattle – Potential Conditionality Options

Calving Intervals in Scotland's Cattle Population: Conditionality Options

An output to RESAS as part of commissioned project on Economic Advice & Related Services to Support Development of a New Rural Support Scheme for Scotland

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This works draws on BCMS's Cattle Tracing System data held by EGENES under data sharing agreement with APHA that is being analysed as part of the RESAS 2022-2027 Strategic Research Programme

Key Points

- The Scottish Government is committed to developing a future framework of direct agricultural support payments with enhanced conditionality attached. Particular attention is being paid to reducing greenhouse gas emissions from the beef herd.
- Calving Interval is a key efficiency metric for beef production, along with heifer calving age, mortality rates, age at slaughter and time to dispose of cows at the end of their breeding life. Longer calving intervals equate to longer periods during which a cow is incurring maintenance costs (e.g., feed, veterinary care) but also emitting greenhouse gases without contributing to actual beef production.
- Using CTS data, calving intervals were estimated for all animals in the Scottish beef breeding herd over the period 2015-21. Comparative analysis of calving intervals is presented here in tabular, chart and map form, for different structural and geographical categories.
- The mean calving interval across all animals is c.400 days, higher than the median of less than 370 days due to a long tail of longer intervals. For example, the worst 10% of animals have a calving interval of c.480s days. This equates to each of them emitting c.0.9t CO2e more between calvings than the median animal.
- Within this national picture, there is considerable variation both within and across categories. For example, herd type and size, region and breed type. Confounding factors (i.e., interactions) are likely to be present, but the estimates nevertheless indicate widespread scope for technical performance improvements to calving intervals and hence to greenhouse gas emissions.
- Under current Scottish Suckler Beef Support Schemes the only conditions that farmers have to meet are that a calf has 75% beef genetics and is alive in the business for 30 days from birth.[1] Extending these to include calving interval offers an opportunity to introduce meaningful conditionality, and would help to deliver 50% of support having enhanced conditionality by 2025.
- Although headage payments are envisaged as lying within Tier 4 of the proposed 4-tier model of support, they will operate in tandem with Tier 1 and Tier 2 area payments and offer an obvious way of imposing conditionalities on beef production.
- However, given variation in current calving intervals, choice of appropriate performance intervals will need careful consideration– not least in the context of the Islands (Scotland) Act 2019.
- There is scope to 'ramp-up' any introduced calving interval conditionality over time in order to support a 'just transition' whilst targeting support towards this and other technical efficiency measures that can reduce emissions from the suckler breeding herd.
- Potential emissions savings from improved calving interval conditionality threshold are difficult to estimate. However, it is estimated that every 5 day reduction in mean calving interval from the 2021 average of 400 days would lead to estimated 39.2kg CO_2e per cow (on average) or 12.5kt CO_2e (1.25%) being saved from total 2021 cow (excluding heifers) emissions of 996 kt CO^2e.

[1] Estimates presented here show that only a very small percentage of calves fail to meet these conditions.

Introduction

1. The Scottish Government have made announcements that Scotland's future agricultural support framework will require more cross-compliance-type conditions to be met by farmers and crofters. In addition, the Scottish Government have announced that new conditionality options for existing support schemes will be introduced in 2025 to meet the commitment that 50% of all support will have enhanced conditionality by 2025.

2. Calving Interval (CI) is a measure of cow fertility and is a condition that can readily be attached to coupled beef support payments. It is generally accepted that CIs of 365 days[2] should be the target KPI for suckler herds and seasonal dairy herds. Where CI is greater than 365 days it points to fertility / management issues that lead to wasted GHG emissions and production costs. Common issues such as poor bull performance / selection can lead to fertility issues and extended calving intervals that could be better controlled on farm / croft through more proactive management measures and improved breeding decisions.

Methods

3. Using raw Cattle Tracing System (CTS) data held by SRUC's EGENES a panel database was built that that listed a number of key variables for each location and calendar year for every bovine animal in Scotland (2015-2021 inclusive). Variables included date of birth, age at first calving, and calving ages to enable calf registration and heifer calving events, along with the calving interval of cows (those dams that have previously had a successful calf registration) to be detailed at individual animal level.

4. Individual animal data was aggregated to provide summary data at a variety of levels: (i) holdings; (ii) farming system; (iii) breed; (iv) breed purpose; (v) parish; (vi) agricultural region; (vii) Scotland. Assessment at these different levels permit robust insights into the potential use of calving interval measures.

5. Existing conditions for the current Scottish Suckler Beef Support Scheme (Mainland and Islands) include that eligible calves must be registered on the holding of birth, be of 75% beef genetics, be alive for 30 days and not be transferred off the holding within 30 days of birth. To replicate the SBSS 30-day scheme conditions the (a) date of death, and (b) date of first off movement were used to create markers for any calf that had (i) died within 30 days of registration and/or (ii) been moved off the holding

[2] See https://ahdb.org.uk/knowledge-library/an-introduction-to-maternal-matters-managing-suckler-cows

of birth within 30 days of registration[3]. To assess sensitivity of these 30 day rules, further markers were developed for calves that (i) died within 60 days of birth on the holding, and (ii) were moved off the holding of birth before 60 days of since registration.[4]

6. Using the approach developed by Thomson et al (2021)[5] holdings were classified into 10 different farm systems as detailed in Annex 1. For the purpose of this report a consolidated "Farm Type" variable was created for analytical purposes to include: (i) Beef; (ii) Dairy (iii) Finisher (iv) Trader (v) Grower. **Only the results from the farms classed as 'Beef' farm types are included and barren cows within any year are not included in the data.**

Findings

National Level

7. Between 2015 and 2021 there was relative stability in the number of dams and calves on registered 'beef holdings' across Scotland (see Table 1). The number of calves registered on the 'beef' holdings ranged from 401k to 413k, with the peak in 2017 and the low point in 2018 (likely reflecting the impact from "the beast from the East"). The total number of dams calving in a given year was between 383k and 394k with heifers accounting for 18-19% of total dams. With more calves registered than dams giving birth it is estimated that the twin rate varied between 3.3% and 5.4%.

Table 1 Dams, heifers and calf registrations on "Beef" holdings 2015-2021

Year	Calves Registered	Calved Dams	Calving Cows	First Calving Heifers	Heifers as Dams	Estimated Twin rate
2015	407,948	387,025	317,646	69,379	17.9%	5.4%
2016	407,158	387,458	318,603	68,855	17.8%	5.1%
2017	413,886	394,625	321,656	72,969	18.5%	4.9%
2018	401,252	383,544	312,441	71,103	18.5%	4.6%
2019	401,457	385,299	313,611	71,688	18.6%	4.2%
2020	403,648	390,740	317,630	73,110	18.7%	3.3%
2021	407,293	392,173	317,627	74,546	19.0%	3.9%

[3] It is worth noting that any potential within business (BRN) level moves (i.e. between different holdings controlled by a single BRN) are not observable using this method. As registrations generally relate to the Main Location Code (MLC) it is considered unlikely that any such movement would be common.

[4] Noting the 28 day period provided to farmers to register calf births and likely inaccuracies in recording actual birth dates means there are some inaccuracies in this data.

[5] Thomson et al (2021)

8. Using dams that had previously had a calf registered against them (cows) their calving interval from its previous calf registration[6] was calculated. A summary of the spread of CIs is provided in Table 2. The mean CI remained relatively stable at about 400 days over the 2015-2021 period, with the increase in 2019 to 405 days likely a legacy impact from the "beast form the East". However, the much lower median (generally lower by about 30 days or 1 month) demonstrates that there is a very large tail of high CIs pulling the average up (with a biological minimum meaning the mean can never be skewed downwards).

9. 50% of cows on 'beef holdings' (the median) had CIs of less than 370 days, performing efficiently. Performing very efficiently, 10% of the cows consistently had CIs of less than c.336 days (11 months) and 25% had CIs less than c.353 days. In contrast 25% of the cows consistently had CIs over c.400 days (see the 75th percentile) and 10% of the cows had CIs over c.480 days (the 90th percentile) suggesting a barren year for the cow, or cows that slip, for example between spring and autumn calving cohorts.

Table 2 Calving Interval (days) percentiles and mean from Scottish 'beef' holdings, 2015-2021

Year	Cows calving	Percentile					Mean
		10th	25th	50th (median)	75th	90th	
2015	317,646	333	350	**369**	398	487	**400.5**
2016	318,603	335	353	**372**	401	484	**402.1**
2017	321,656	336	353	**372**	401	488	**402.8**
2018	312,441	336	353	**371**	400	484	**401.7**
2019	313,611	336	354	**372**	402	504	**405.4**
2020	317,630	333	350	**369**	396	479	**399.4**
2021	317,627	336	353	**371**	399	475	**400**

10. The distribution of CIs of cows on Scottish 'beef' holdings in 2021 is shown in Figure 1 and Figure 2 where Figure 2's x-axis has been truncated to provide a more focused view of CI performance across the bulk of the 'beef' herd. Each bar represents a CI day, and median of around 370 days is apparent.

11. Using GHG estimates provided by Moxey and Thomson (2020)[7] of 7.85kg CO2e per cow day the 90th percentile CI cow on average (2015-2021) emits an additional 1.18 tonnes of CO2e between successful calf registrations compared to the 10th percentile cow. The difference between the 90th percentile and median cow equates to 903kg CO2e on average (2015-2021) of additional emissions from poor fertility. With an

[6] Noting that calf registration and birth dates may differ on some holdings

[7] Moxey, A. and Thomson, S. (2020) Estimated Suckler Beef Climate Scheme effects within the National GHG 'Smart' Inventory (www.gov.scot)

average of 31.7k cows performing worse than the 90th percentile cow and 79.3k cows with longer CIs than the 75th percentile there is considerable potential to save emissions from improved fertility.

Figure 1 Frequency distribution of CIs (days) on 'beef' holdings, 2021 (min 300, max 1,095 days)

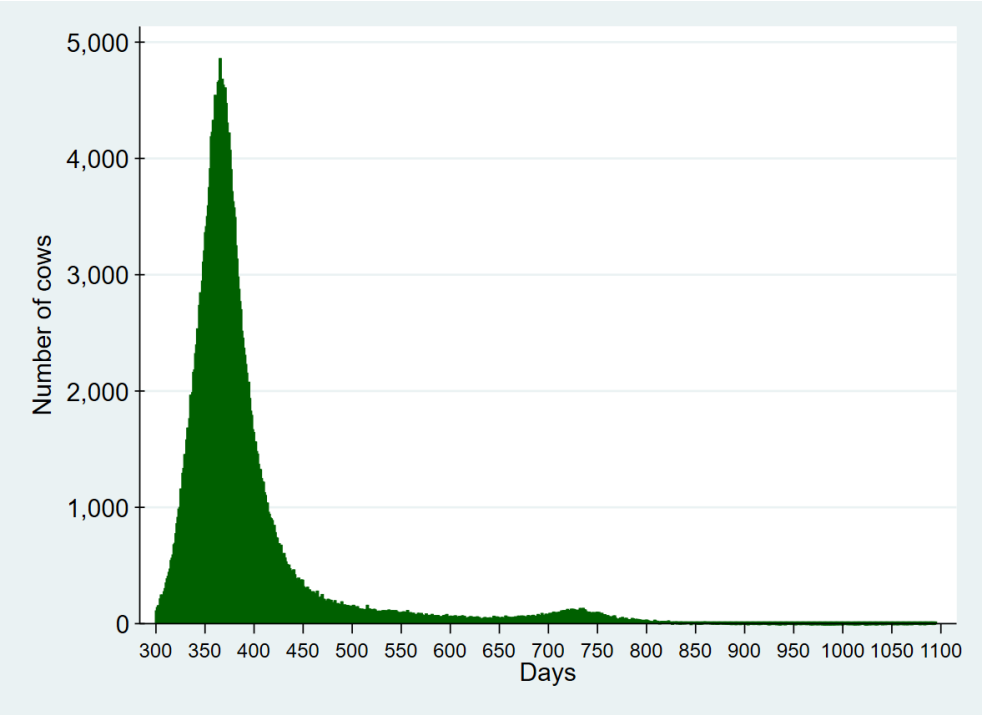
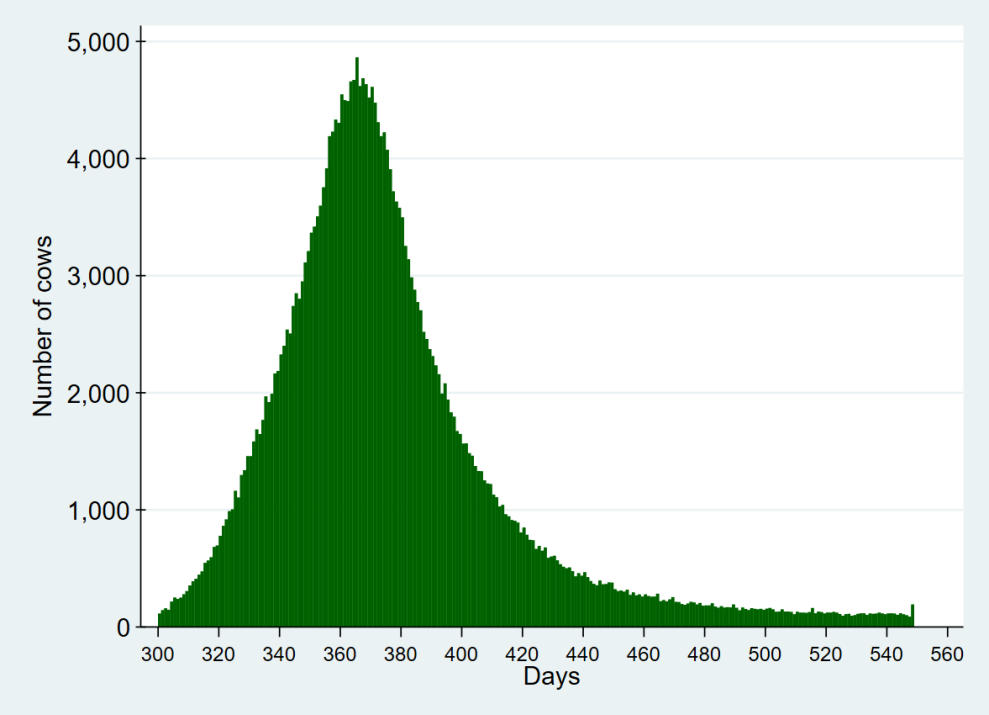


Figure 2 Frequency distribution of CIs (days) on 'beef' holdings, 2021 (min 300, max 550 days)



Existing SBSS conditions

12. Within the existing scheme a beef calf must be alive for 30 days on the holding of birth to be eligible. From Table 3 the relatively small numbers of calves that die on beef holdings, or are moved off holding (i.e. sold) within 30 days of registration is evident – ranging from 0.98% to 1.22% (combined) of calves born in any given year. This small proportion of total calves would, currently be ineligible for SBSS – failing the existing scheme conditionality rules.

13. If the calf retention period was increased to 60 days Table 3 shows that it would increase the number of ineligible calves to between 2.9% and 3.2% of those registered in any given year. Such a move to increase the basis of these conditions could focus greater attention on calf health and wasted emissions from dams that produce calves that subsequently die on holding. An unintended consequence of such an increase in the calf retention period could be to affect those selling cows with calf at foot.

Table 3 Number and percent of registered calves on 'beef holdings' that move off holding or die on holding within 30 and 60 days of registration, 2015-2021

Year	Calves Registered	Moved off holding in <=30 days		Dead on holding in <=30days		Moved off holding in <=60 days		Dead on holding in <=60 days	
2015	407,948	1,024	0.25%	3,818	0.94%	4,519	1.11%	8,297	2.03%
2016	407,158	1,134	0.28%	3,758	0.92%	4,743	1.16%	7,904	1.94%
2017	413,886	1,255	0.30%	3,788	0.92%	5,433	1.31%	8,126	1.96%
2018	401,252	1,113	0.28%	3,777	0.94%	4,694	1.17%	8,199	2.04%
2019	401,457	843	0.21%	3,174	0.79%	4,557	1.14%	6,991	1.74%
2020	403,648	1,081	0.27%	3,006	0.74%	4,892	1.21%	6,888	1.71%
2021	407,293	1,198	0.29%	2,782	0.68%	4,907	1.20%	6,773	1.66%

14. Figure 3 and Figure 4 show histograms of the number of calves transferred off the holding of birth and those that died on holding respectively. The frequency bars each reflect calf age in days.

Figure 3 Frequency distribution of calves moved off 'beef' holdings[8] by calf age (days) at transfer (capped at 100 days), 2020[9]

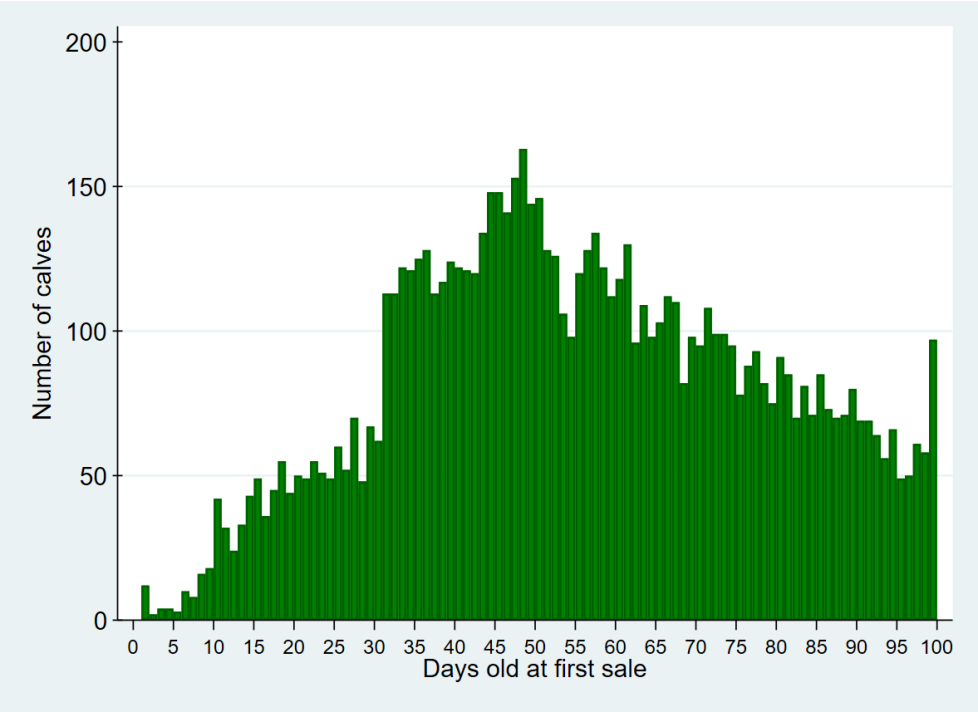
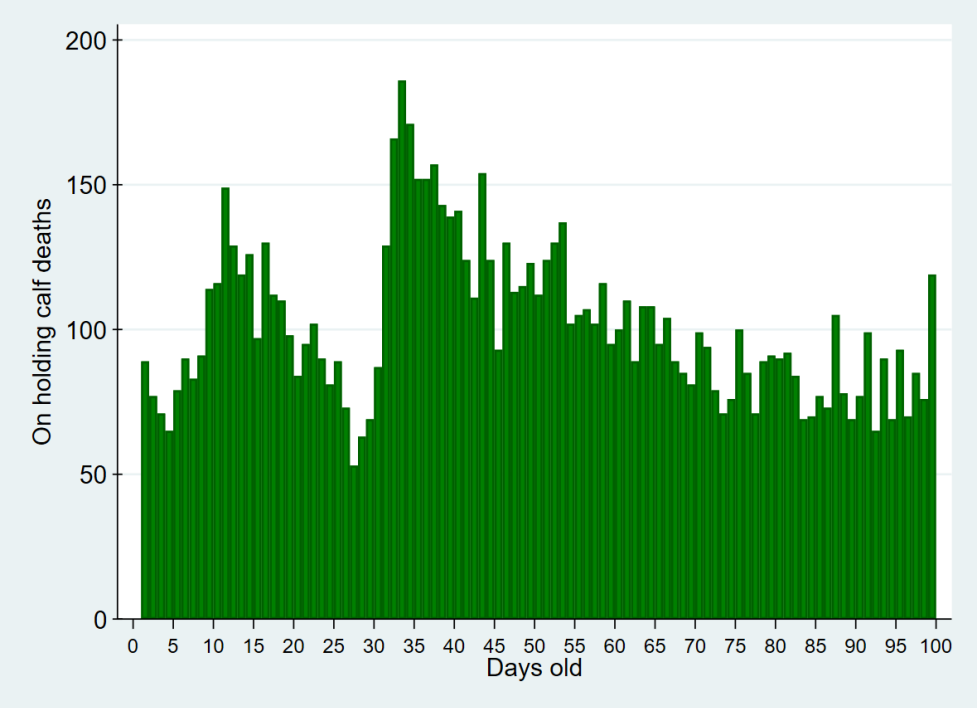


Figure 4 Frequency distribution of calves died on beef holdings by calf age (days) at time of death registration (capped at 100 days), 2020



[8] This only includes moves to another holding and does not include any slaughter moves

[9] 2020 is used as the data extract only runs to 31st Dec 2021 meaning data on some calves may be missing if 2021 was used

Potential Calving Interval Conditionality Thresholds

15. To encourage improved herd fertility, enhanced conditionality on SBSS eligibility criteria could be introduced in the future (e.g. in 2025 as a transition and in any future coupled beef scheme). Such enhanced conditionality could take the form of each eligible calf having to be born to a dam that meets a CI threshold. Thus, any calf born to a dam with a CI exceeding the threshold would be ineligible for SBSS (or future scheme) support – thereby introducing a climate change metric into coupled beef support.

16. Northern Ireland have published policy decisions[10] on new coupled support conditions for their 'Beef Sustainability Package'. Whilst this includes thresholds for suckler heifer calving age and age at slaughter for clean beef animals there is also reference to suckler beef calving intervals, as shown in Table 4: Northern Ireland have decided to introduce quantitative quotas for the CI and age at slaughter components of the scheme, to maintain WTO Blue Box Compliance.

Table 4 Northern Ireland beef sustainability package conditions

Year of Scheme	Max. calving Interval	Max. heifer calving age	Max. age at slaughter
1	415 days	34 months	30 months
2	405 days	32 months	28 months
3	395 days	30 months	27 months
4	385 days	29 months	26 months

National dimension

17. Table 5 and Figure 5 show the proportion of dams that meet different CI thresholds (2015-2021), noting that all heifers meet the criteria. The data shows that with every 10 day CI increment the proportion of dams meeting the criteria increases at a decreasing rate (as expected from a slightly skewed distribution).

18. A range of factors affect CIs, in particular bull performance and dam health, but also management decisions (timings) and climate. Over the seven-year period, on average 59% (+/- 2.1%) of dams (including first calving heifers) met the 370 day CI threshold (meaning 41% did not). 68.6% (+/- 1.7%) met the 380 day threshold, whilst 75.4% (+/- 1.4%) met the 390 day, 80% (+/- 1.2%) the 400 day, 83.3% (+/- 1.0%) the 410 day, 85.7% (+/- 0.9%) the 420 day and 87.4% (+/- 0,.8%) the 430 day thresholds.

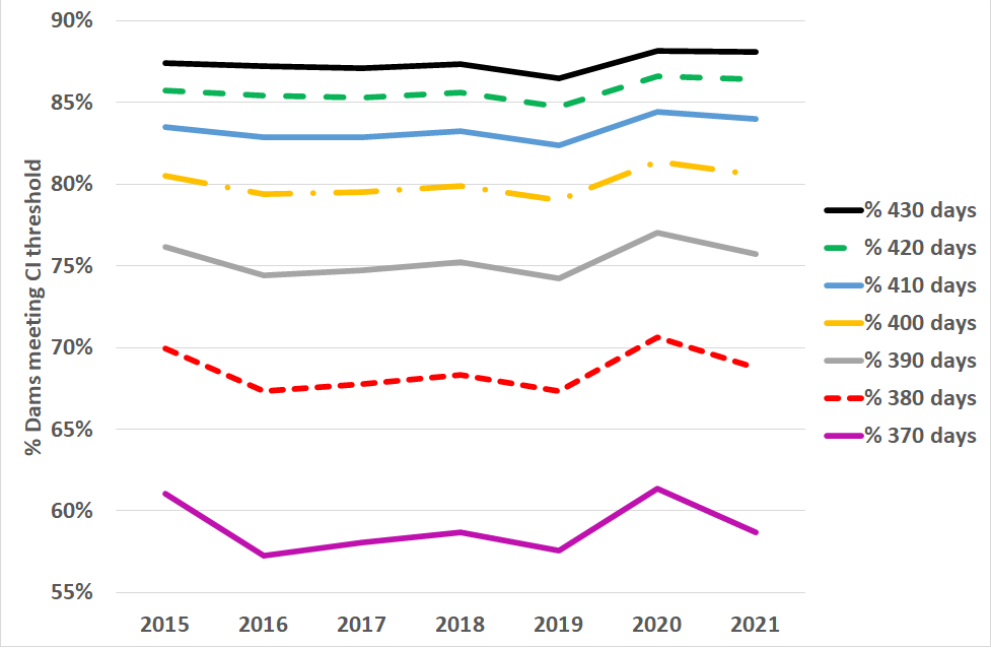
[10] https://www.daera-ni.gov.uk/publications/future-agricultural-policy-decisions-northern-ireland

19. This would mean that if a CI conditionality threshold of 370 days was introduced then between 2015-2021, on average, c.176k dams would not meet the criteria, dropping to c.66k dams if a 430 day CI threshold was utilised.

Table 5 Proportion of dams (including heifers) meeting CI threshold of animals reaching conditions, 2021

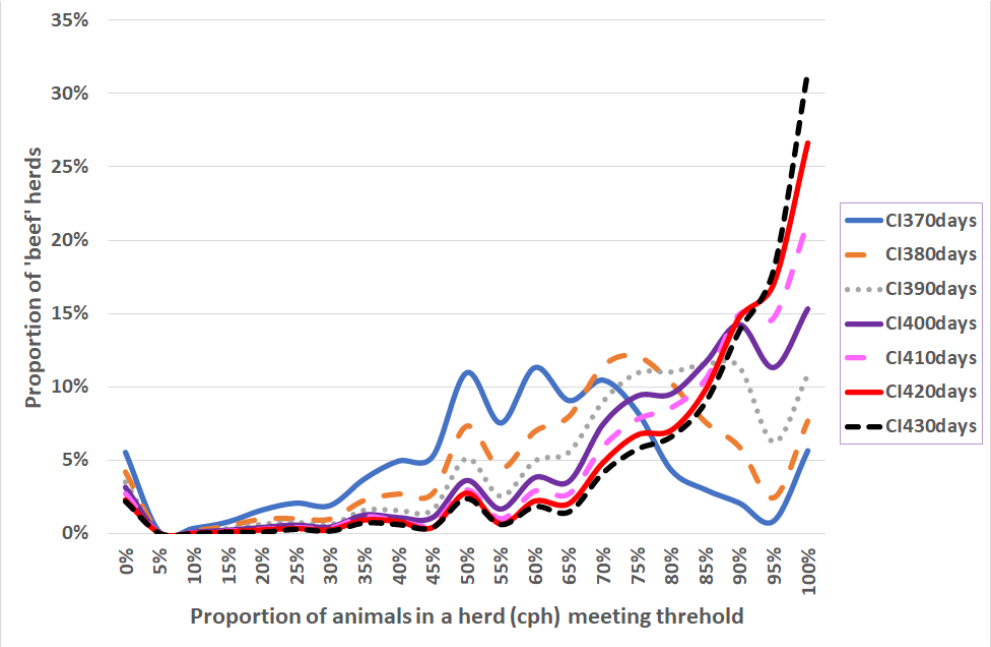
Year	Dams	CI 370 days	CI 380 days	CI 390 days	CI 400 days	CI 410 days	CI 420 days	CI 430 days
2015	387,025	61.1%	69.9%	76.2%	80.5%	83.5%	85.7%	87.4%
2016	387,458	57.3%	67.3%	74.4%	79.4%	82.9%	85.4%	87.2%
2017	394,625	58.1%	67.7%	74.7%	79.5%	82.9%	85.3%	87.1%
2018	383,544	58.7%	68.3%	75.2%	79.9%	83.2%	85.6%	87.3%
2019	385,299	57.6%	67.3%	74.2%	79.0%	82.4%	84.7%	86.5%
2020	390,740	61.4%	70.6%	77.0%	81.4%	84.4%	86.6%	88.2%
2021	392,173	58.7%	68.8%	75.7%	80.6%	84.0%	86.4%	88.1%
Average	**401,556**	**59.0%**	**68.6%**	**75.4%**	**80.0%**	**83.3%**	**85.7%**	**87.4%**

Figure 5 Proportion of dams (including heifers) meeting CI threshold of animals reaching conditions, 2021



20. Figure 6 summarises how all 'beef' holdings performed against different CI thresholds in 2021. The x- axis shows the proportion of animals within a herd that met each of the CI thresholds whilst the y-axis reveals the proportion of herds that fell into each x-axis band (in 5% increments) for the CI thresholds. There were 5.5% of herds (412) that had no dams meeting the 370 day CI threshold in 2021, compared to 2.2% of herds (164) failing entirely to meet the 430 day CI threshold. In contrast, there was 5.7% of herds (420) where 100% of cows met the 370 day CI threshold compared to 31.5% of herds (2,337) where 100% of dams met the 430 day CI threshold.

Figure 6 Frequency distribution - % of animals in a herd meeting CI thresholds



Herd Size Dimension

21. Table 6 shows the distribution of holding by herd size (based on the number of dams) in 2021. Of the 7,426 classified CTS 'beef' holdings 32.8% had under 15 cows, with 3.8% of the total dams. 1,141 (15.4%) holdings with 100+ dams accounted for 50.9% of total 'beef system dams, with the 3.6% of holdings with 200+ dams accounting for 20.9% of dams. The largest 'beef' holdings had a higher proportion of heifers as first time mothers in 2021. The very large herd also tended to have higher registered calf mortality levels.

Table 6 Distribution of dams by 'beef' holding size with 30 day mortality and off-move rates, 2021

Herd Size	Holdings		Dams		Heifer rate	Off 30 rate	Off60 Rate	Death 30 rate	Death 60 rate
1-14	2,439	32.8%	14,770	3.8%	19%	0.4%	1.6%	0.6%	1.2%
15-29	1,201	16.2%	25,624	6.5%	17%	0.3%	1.3%	0.7%	1.3%
30-59	1,530	20.6%	66,168	16.9%	17%	0.2%	1.0%	0.6%	1.4%
60-99	1,115	15.0%	85,972	21.9%	18%	0.2%	0.9%	0.6%	1.5%
100-199	873	11.8%	117,590	30.0%	20%	0.3%	1.3%	0.6%	1.6%
200+	268	3.6%	82,049	20.9%	21%	0.4%	1.5%	0.9%	2.0%
Scotland	**7,426**	**100%**	**392,173**	**100%**	**19%**	**0.3%**	**1.2%**	**0.7%**	**1.6%**

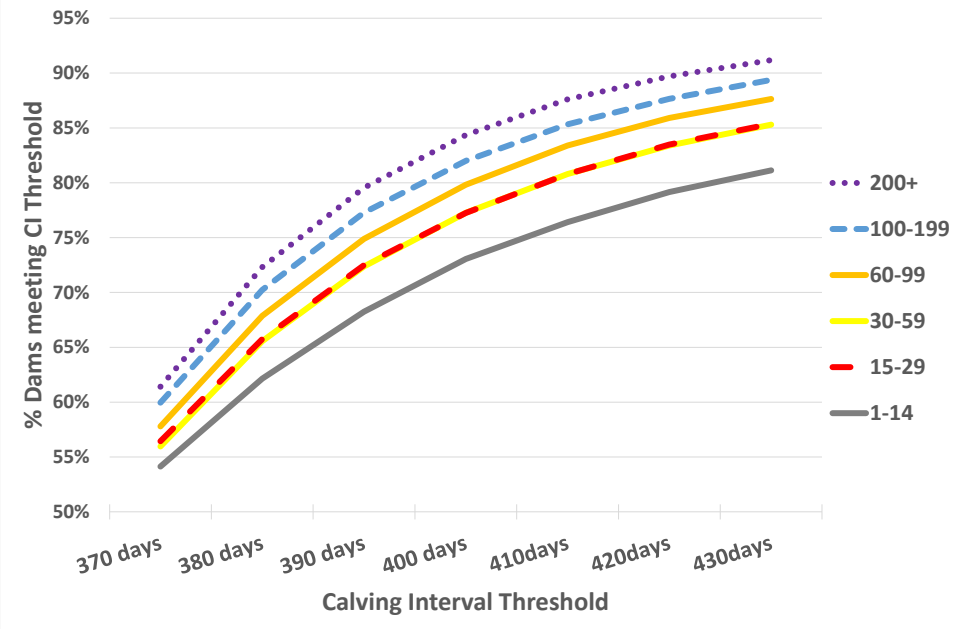
22. Table 7 and Figure 7 illustrate that the larger 'beef' herds, on average, have higher proportions of dams meeting every CI threshold in 2021 For example, with a 270 day CI threshold only 54% of dams in the <15 dams group would have met the criteria in

2021 compared to 61% in the 200+ size category. This holds true for all CI thresholds, with only 81% of dams in the <15 category meeting the 430 day category compared to 91% in the 200+ group. This clearly has implications for smaller holdings which have, on average, higher proportions of dams failing to meet any given CI thresholds– noting those in the 15-29 and 30-59 groups have practically identical distributions.

Table 7 Proportion of dams meeting CI thresholds on 'beef' holdings by herd (dams) size, 2021

Herd Size (dams)	Calves	Dams	CI Threshold						
			370 days	380 days	390 days	400 days	410 days	420 days	430 days
1-14	15,658	14,770	54%	62%	68%	73%	76%	79%	81%
15-29	26,818	25,624	56%	66%	72%	77%	81%	83%	85%
30-59	68,798	66,168	56%	66%	72%	77%	81%	83%	85%
60-99	89,318	85,972	58%	68%	75%	80%	83%	86%	88%
100-199	122,063	117,590	60%	70%	77%	82%	85%	88%	89%
200+	84,638	82,049	61%	72%	80%	84%	88%	90%	91%
All	**407,293**	**392,173**	**59%**	**69%**	**76%**	**81%**	**84%**	**86%**	**88%**

Figure 7 Proportion of dams meeting CI thresholds on 'beef' holdings by herd (dams) size, 2021



23. Figure 9 shows how individual 'beef' herds in 2021 performed against 4 of the CI thresholds. The x-axis represents herd size (based on the number of dams in 2021) whilst the y-axis shows the proportion of dams within each herd that met the CI threshold. This demonstrates that the majority of herds with no dams meeting the CI threshold were in small herds. However, it is evident that there remain some large

herds (the largest have been excluded to avoid disclosure) with relatively poor CI performance.

24. The change in the herd patterns across the 4 graphs illustrate how changes in any future coupled beef support conditionality CI threshold may significantly affect the number of herds and dams affected (based on 2021 performance).

Geographic Dimension

25. Scotland's beef herds are not distributed evenly across the regions. Table 8 shows that Dumfries and Galloway, North East Scotland and the Borders contain 48% of dams on 'beef' holdings. These regions host 35% of total 'beef' holdings. In contrast, Eileanan an Iar and Shetland only contain 0.9% of total dams on beef holdings, despite having 5.7% of the total beef holdings. Figure 8 shows the regional and within region variation in the distribution of 2021 dams on holdings classified as beef breeding.

Figure 8 Parish variation in number of dams present on classified beef holdings, 2021

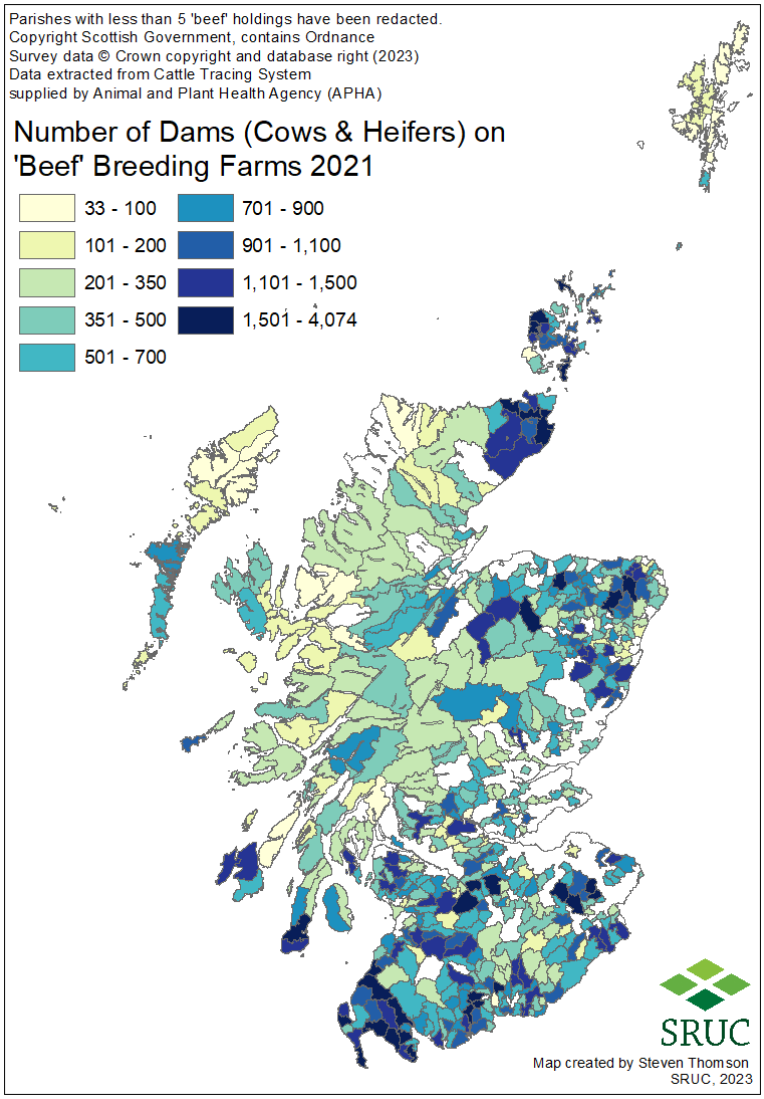
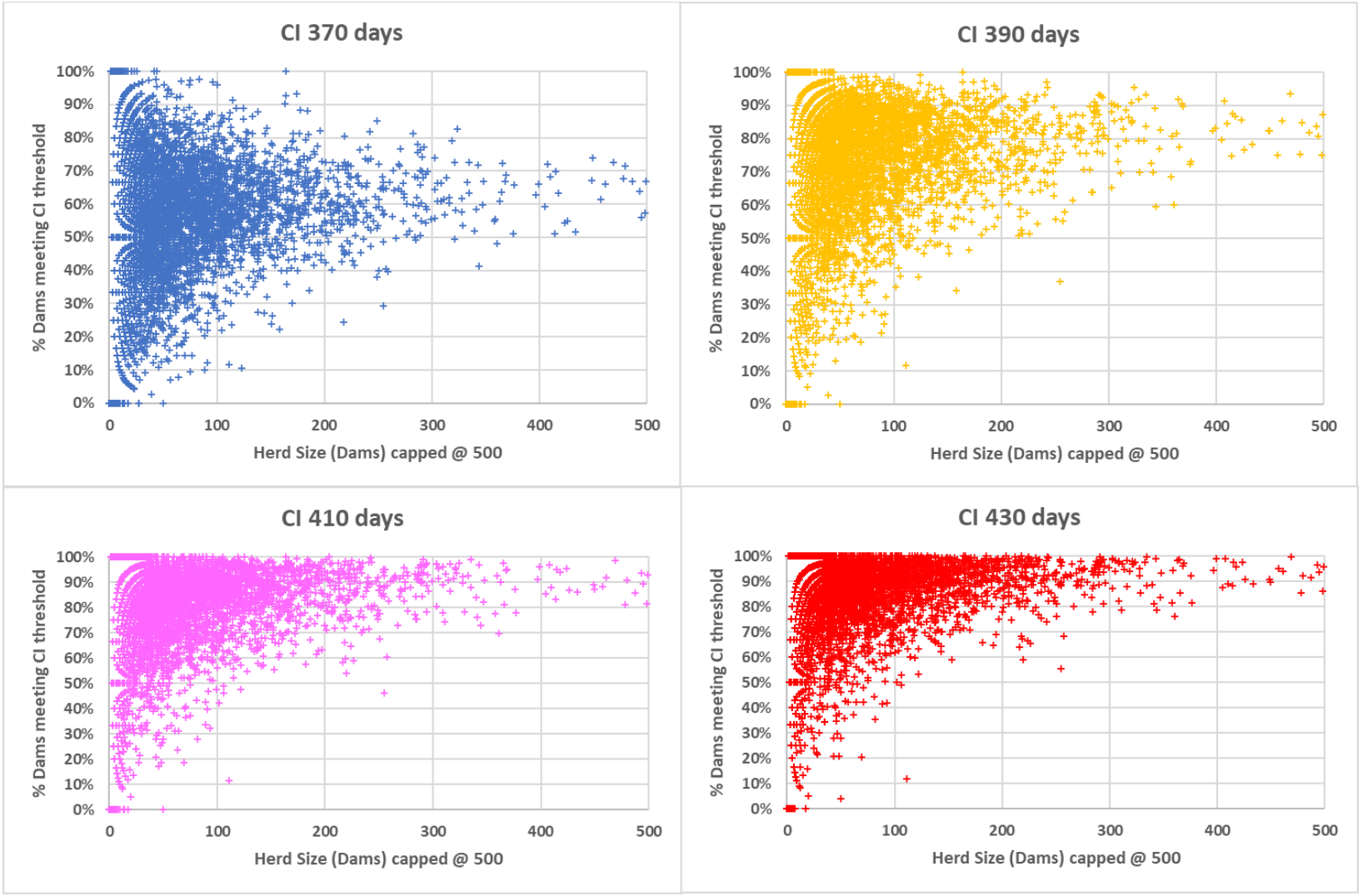


Figure 9 Distribution of herd size v % of herd meeting various CI thresholds 2021 (each + represents a herd)



26. The heifer replacement rate does vary between regions, perhaps reflecting different herd structures, farming systems and practices. For example, in 2021 only 16% of dams were heifers in Highland, compared to 21% in Dumfries and Galloway. There are also differences in off-movements and on-farm death rates after 30 and 60 days between regions. Higher off movements, may be related to how farm types are assigned and the higher areas may contain some dairy animals (noting the dairy Dumfries and Galloway has the highest off moves), or it may reflect the practice of selling heifers or cows with calf at foot, or herd dispersals / restructuring. On farm mortality rates at 30 days range from an average of 0.2% in Shetland and Orkney to 1% in Dumfries and Galloway, whilst the 60-day on-farm mortality levels range from 0.6% in Eileanan an Iar to 2.1% in Dumfries and Galloway.

Table 8 Distribution of 'beef' dams by RPID region with 30 day mortality and off-move rates, 2021 (sorted by number of dams)

RPID Region	Holdings		Dams		Heifer rate	Off 30	Off 60	Death 30	Death 60
Dumfries & Galloway	922	12.4%	76,476	19.5%	21%	0.6%	2.2%	1.0%	2.1%
NE Scotland	1,214	16.3%	71,803	18.3%	19%	0.1%	0.8%	0.6%	1.8%
Scottish Borders	485	6.5%	39,836	10.2%	19%	0.1%	0.7%	0.5%	1.1%
Highland	1,345	18.1%	38,813	9.9%	16%	0.2%	0.7%	0.3%	1.1%
Ayrshire	509	6.9%	29,805	7.6%	20%	0.3%	1.7%	0.8%	1.7%
Tayside	504	6.8%	29,251	7.5%	18%	0.1%	0.9%	0.8%	1.7%
Clyde Valley	517	7.0%	25,174	6.4%	19%	0.2%	1.3%	0.9%	2.0%
Orkney	426	5.7%	24,360	6.2%	17%	0.6%	1.0%	0.2%	1.2%
Argyll & Bute	481	6.5%	17,919	4.6%	18%	0.3%	0.9%	0.4%	1.0%
Lothian	172	2.3%	12,674	3.2%	18%	0.1%	0.9%	0.9%	1.8%
Fife	180	2.4%	11,905	3.0%	20%	0.1%	0.4%	0.9%	2.0%
East Central	251	3.4%	10,583	2.7%	19%	0.8%	2.0%	0.9%	1.5%
Eileanan an Iar	295	4.0%	1,974	0.5%	17%	0.2%	1.0%	0.4%	0.6%
Shetland	125	1.7%	1,600	0.4%	20%	0.6%	1.5%	0.2%	0.7%

27. Table 9 reveals that there were regional differences in CI performance across regions. Both Shetland and the Borders had 62% of dams (cows and heifers) meeting the 370 day CI threshold in 2021, compared to only 55% in Argyll and Bute and Eileanan an Iar. Shetland (93%) and the Borders (92%) also performed best for the 430 day CI threshold with only 8% and 9% of dams failing to meet the threshold respectively. In contrast in Argyll & Bute (84%) and Eileanan an Iar (83%) more than 15% of dams did not meet the 430 CI threshold.

28. Regional variations matter, as any future conditionality clause introduced on coupled beef support would have to consider the impact on Scottish Islands, per the Islands (Scotland) Act 2019. Annex 2 provides some Parish level maps that show the variation within regions (note parishes with less than 5 'beef' holdings have been redacted to meet disclosure requirements).

Table 9 Proportion of dams meeting CI thresholds on 'beef' holdings by RPID region, 2021 (ranked by 370 day CI performance)

Ag Region	Calves	Dams	Calving Interval Threshold						
			370 days	380 days	390 days	400 days	410 days	420 days	430 days
Shetland	1,632	1,600	62%	73%	80%	85%	89%	91%	93%
Scottish Borders	40,893	39,836	62%	73%	81%	86%	89%	91%	92%
Orkney	25,315	24,360	60%	71%	78%	83%	86%	89%	91%
Dumfries & Galloway	78,497	76,476	60%	70%	76%	81%	84%	86%	88%
Lothian	13,277	12,674	60%	71%	79%	84%	87%	89%	90%
Tayside	30,279	29,251	59%	70%	77%	82%	85%	88%	89%
NE Scotland	75,542	71,803	58%	68%	75%	80%	84%	86%	88%
Fife	12,252	11,905	58%	69%	76%	81%	85%	88%	89%
Clyde Valley	26,341	25,174	58%	66%	73%	78%	81%	84%	85%
East Central	10,946	10,583	57%	67%	74%	79%	82%	85%	86%
Ayrshire	31,052	29,805	57%	66%	72%	77%	80%	83%	85%
Highland	40,692	38,813	57%	67%	74%	79%	83%	86%	87%
Argyll & Bute	18,495	17,919	55%	65%	71%	76%	79%	82%	84%
Eileanan an Iar	2,080	1,974	55%	63%	70%	75%	79%	82%	83%

Breed Dimension

29. As well as a herd size dimension it appears that there is also a breed dimension to CI performance. Indeed, many farmers now specifically select breeds based on dam fertility Estimated Breeding Values (EBVs). Table 10 shows the proportion of dams (heifers and cows) by breed in 2021 that met the CI thresholds, ordered by 370 day CI performance. The number of dams are included, and the table represents all CTS breeds with more than 1,000 dams in 2021.

30. There are clearly wide ranges in dam fertility between breeds, that may be down to genetic selection, but also management practices. For example, Stabilisers, Beef Shorthorn and Salers perform particularly well in comparison with Charolais, Blonde d'aquitaine cross, and Highland.

Table 10 Proportion of dams (cows + heifers) meeting CI thresholds by dam breed, 2021

Breed	Dams	Calving Interval Threshold						
		370 days	380 days	390 days	400 days	410 days	420 days	430 days
Stabiliser	2,052	69%	80%	87%	92%	94%	95%	95%
Stabiliser X	3,077	68%	78%	86%	90%	92%	94%	95%
Beef shorthorn X	11,795	65%	74%	81%	85%	88%	90%	92%
Beef shorthorn	4,037	64%	72%	79%	83%	86%	88%	89%
Salers	4,286	63%	73%	80%	84%	88%	90%	92%
Salers X	15,412	63%	74%	81%	86%	89%	91%	92%
Hereford	1,626	62%	71%	77%	81%	84%	85%	86%
Aberdeen angus X	67,662	62%	73%	80%	84%	88%	90%	91%
Aberdeen angus	16,490	62%	72%	78%	83%	86%	88%	90%
Luing	8,596	62%	74%	82%	87%	90%	92%	93%
Hereford X	10,026	61%	72%	79%	83%	86%	88%	89%
Luing X	2,462	61%	71%	78%	84%	87%	90%	91%
Blue grey	2,199	59%	70%	78%	82%	85%	87%	89%
Belted galloway	1,195	59%	67%	71%	75%	79%	81%	83%
Whitebred s/horn X	2,566	58%	70%	79%	84%	87%	89%	90%
Limousin X	70,745	57%	68%	75%	80%	84%	86%	88%
Simmental	9,778	57%	66%	73%	78%	81%	84%	85%
Simmental X	75,387	57%	68%	76%	81%	85%	87%	89%
British blue X	13,172	57%	67%	74%	79%	82%	84%	86%
Charolais X	7,660	56%	66%	73%	78%	82%	85%	86%
Shorthorn X	10,029	55%	68%	75%	80%	84%	87%	89%
Galloway	2,965	55%	63%	69%	74%	77%	80%	81%
Limousin	9,306	54%	63%	70%	75%	79%	82%	85%
Highland	4,724	53%	60%	66%	71%	75%	78%	80%
Blonde d'aquitaine x	1,153	53%	63%	70%	76%	81%	84%	85%
Charolais	2,698	50%	59%	64%	69%	73%	77%	79%

31. Confounding factors (i.e., interactions) are likely to present in the results presented above. For example, geographical variation is likely to be entangled with variation in herd size but also breed differences. Nevertheless, the estimates presented reveal variation within as well as across all structural and geographical categories, indicating widespread scope for technical performance improvements to calving intervals and hence to greenhouse gas emissions.

Potential Emissions Reductions

32. It is very challenging to predict the emission reduction potential from the introduction of CI thresholds as: (a) cows exceeding CI thresholds may simply be kept on holding without a claim on its calf, and (b) some tightening of practices may mean falling CIs in those below the threshold. The very CI long tail, and the nature of production (i.e., fertility issues, abortions, neonatal and postnatal mortality) mean that it is impossible for all animals to meet any CI threshold.

33. However, it is possible to demonstrate indicative emissions reductions per calving cow that could be achieved from reducing the mean CI (400 days in 2021). Based on Moxey and Thomson (2020)[11] estimate of 2,863 kg CO_2e per breeding cow per year that equates to 7.84kg CO_2e/cow/day,[12] and implies higher emissions for animals with poorer CIs. CI emissions are a function of CI days and the number of cows, but for this exercise the number of cows (excluding heifers) is 317,627 (2021).

34. Table 11 shows that for each 5 day improvement (or worsening) in the mean CI from the 2021 mean of 400 days an estimated 39.2kg CO_2e per cow (on average) or 12.5kt CO_2e (1.25%) could be saved (added) from total dam emissions in 2021 of 996 kt CO^2e. The figures above 400 mean CI act as a reminder that any worsening of average CI in the herd would cause emissions to rise.

Table 11 Estimated emissions reduction from changes in mean calving interval in beef herd, based on 2021 calving cows.

Mean CI	Mean kgCo2e/ Calving Cow	National Herd ktCO2e	Compared to 400 day CI		
			kgCO_2e / cow change	National Herd ktCO2e	% change in CO_2e
370	2,902	921.8	235.3	-74.7	-7.50%
375	2,941	934.3	-196.1	-62.3	-6.25%
380	2,981	946.7	-156.9	-49.8	-5.00%
385	3,020	959.2	-117.7	-37.4	-3.75%
390	3,059	971.7	-78.4	-24.9	-2.50%
395	3,098	984.1	-39.2	-12.5	-1.25%
400	**3,138**	**996.6**	**0.0**	**0.0**	**0.00%**
405	3,177	1,009.0	39.2	12.5	1.25%
410	3,216	1,021.5	78.4	24.9	2.50%
415	3,255	1,033.9	117.7	37.4	3.75%
420	3,294	1,046.4	156.9	49.8	5.00%
425	3,334	1,058.9	196.1	62.3	6.25%
430	3,373	1,071.3	235.3	74.7	7.50%

35. Improving the mean CI is the goal of any CI conditionality threshold. Whilst there is potential for improved CI performance across the national herd to lead to more calves born in any given year, the overall emissions intensity and emissions per dam would be reduced.

[11] https://pure.sruc.ac.uk/en/publications/estimated-suckler-beef-climate-scheme-implications-for-cattle-num

[12] This is a simplification since emissions will differ according to stage in the breeding cycle, but as a first approximation the figure per day is sufficient to illustrate the general point.

Annex 1 - Defining Farm Systems from CTS

36. The data extract uses the classification system adopted by Thomson et al (2021). Two separate datasets were combined to allow herd categorisation. The first dataset included all CTS animal records for the calendar year of interest (for all holdings), and the second dataset only contained CTS records for the 1st of May in the year of interest (i.e. it only included animals that were on each Scottish holding on that date).

37. Using a series of rules that utilised CTS breed data and counts of days between cattle movements, birth registration and slaughter events it was possible to classify every holding as falling into one of ten cattle production systems. The steps in the systems classification model are shown in Table 12 and the systems are described as:

- **Beef Breeder** – 50% or more of the adult females had calved previously on the holding AND less than 25% of the adult females were of dairy breed on 1st May AND less than 50% of the off moves were registered dead at an abattoir within 7 days of the off move.
- **Beef Breeder / Finisher** - 50% or more of the adult females had previously calved on the holding AND less than 25% of the adult females were of beef breed on 1st May AND more than 50% of the off moves had death registered at an abattoir within 7 days of the off move.
- **Store / Grower** – there were no adult females present on 1st May OR less than 50% or of the adult females had previously calved on the holding AND less than 50% of the off moves had death registered at an abattoir within 7 days of the off move**.**
- **Finisher** – there were no adult females present on 1st May OR less than 50% or of the adult females had previously calved on the holding AND less 50% or more of the off moves had death registered at an abattoir within 7 days of the off move.
- **Dairy Breeder (Seasonal)** 50% or more of the adult females had calved previously on the holding AND 75% or more of the adult females were of dairy breed on 1st May AND less than 5% of calf registrations take place in the 4 months with least calf registrations during the year.
- **Dairy Breeder (Non-Seasonal)** 50% or more of the adult females had previously calved on the holding AND 75% or more of the adult females were of dairy breed on 1st May AND more than 5% of calf registrations take place in the 4 months with least calf registrations in the year.
- **Unclassifiable (no animals)** – no animals were present on the holding on 1st of May.

- **Trader** – over 50% of off moves had a stay length of under 30 days.
- **Unclassifiable (breeding herd no calvings)** – breeding cows were present on 1st May but there were no calves registered during the calendar year.
- **Mixed Breeder** –50% or more of the adult females had calved previously on the holding AND between 25% and 75% of the adult females were of dairy breed on 1st May.

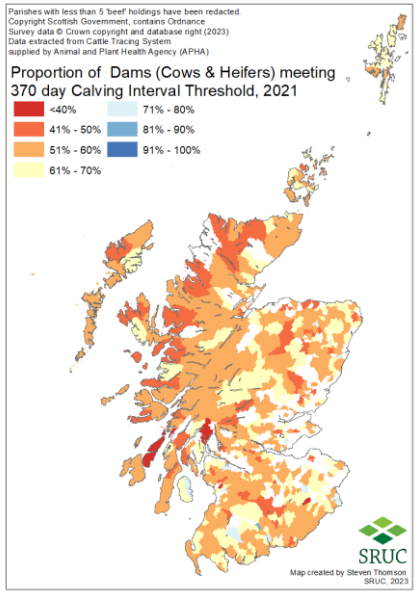
38. For the purpose of this report a consolidated "Farm Type" variable was created for analytical purposes that listed holdings as Beef, Diary, Finisher, Trader or Growers.

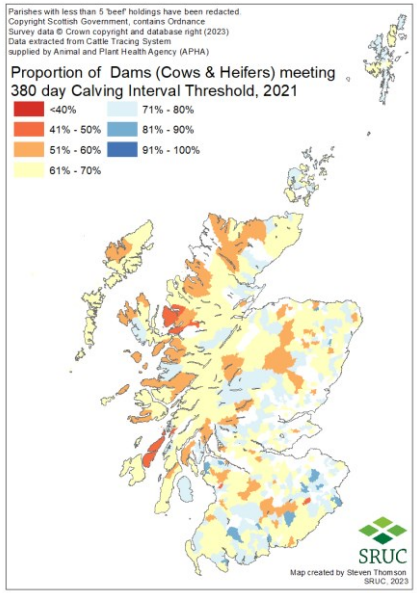
- **Beef** = Beef Breeder, Beef Breeder Finisher, Breeding Herd with no Calvings, Mixed Breeder, No Animals First May
- **Dairy** = Dairy Breeder, Dairy Breeder Non-Seasonal
- **Finisher** = Finisher"
- **Trader** = Trader
- **Grower** = Grower

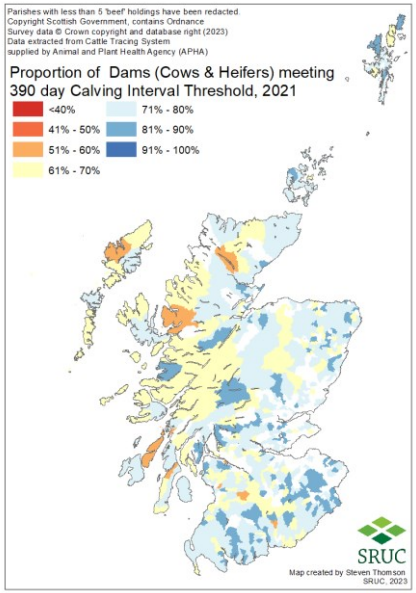
Table 12: Data and hierarchical logic rules used to categorise all agricultural holdings into one of 10 primary cattle enterprise systems & number of holdings in 2020

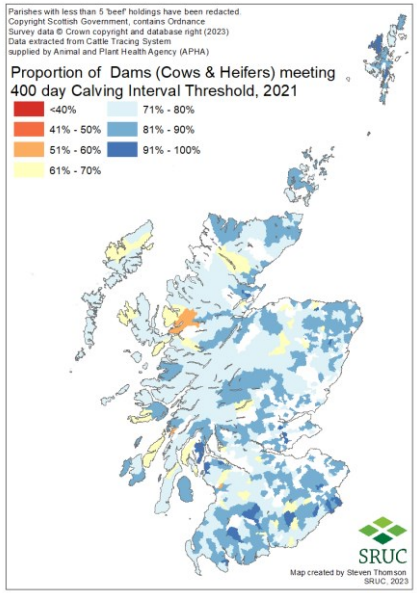
Step	*Data point*	Cut-off	Decision
	All agricultural holdings		
1	*All animals on holding on 1st May*	0	**Classify as UNCLASSIFIABLE (no animals)**
2		> 0	Continue to next step
3	*% off moves with stay length under 30 days*	≥ 50%	**Classify as TRADER**
4		< 50%	Continue to next step
5	*Number adult females on holding 1st May*	0	Continue to *Non-Breeding herd* section
6		> 0	Continue to next step
7	*% adult females that have ever calved on the holding*	≥ 50%	Continue to *Breeding herd* section
8		< 50%	Continue to *Non-breeding herd* section
	Breeding herds		
9	*Number calvings in 2020*	0	**Classify as UNCLASSIFIABLE (breeding herd no calvings)**
10		> 0	Continue to next step
11	*% adult females of dairy breed on 1st May*	< 25%	Continue to *Beef Breeder* section
12		≥25% but < 75%	**Classify as MIXED BREEDER**
13		≥ 75%	Continue to *Dairy Breeder* section
	Beef Breeding Herds		
14	*% off moves in 2020 killed at an abattoir within 7 days*	< 50%	**Classify as BEEF BREEDER (not finishing)**
15		≥ 50%	**Classify as BEEF BREEDER / FINISHER**
	Dairy Breeding Herds		
16	*% of calves born in 4 calendar months with least calves born*	< 5%	**Classify as DAIRY BREEDER (Seasonal)**
17		≥ 5%	**Classify as DAIRY BREEDER (Non-Seasonal)**
	Non-Breeding Herds		
18	*% off moves in 2020 killed at an abattoir within 7 days*	< 50%	**Classify as STORE / GROWER**
19		≥ 50%	**Classify as FINISHER**

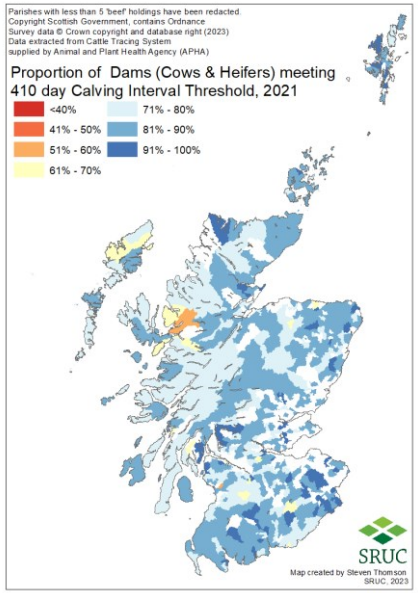
Annex 2 – Parish level CI Threshold Performance, 2021

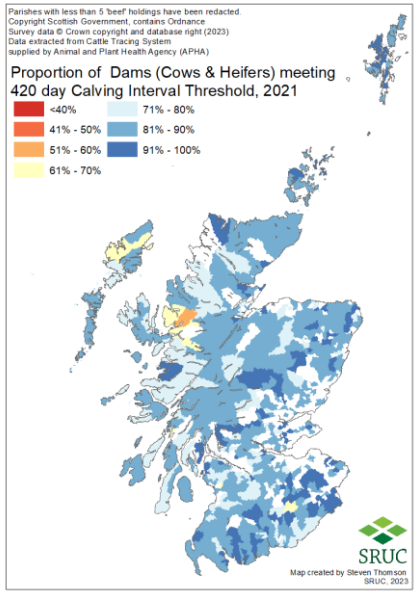


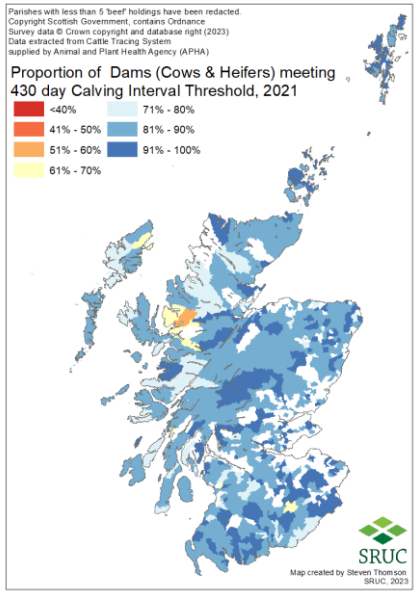












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