

Performance of First Lactation Cows in a Large Sample of UK Dairy Herds

Final

Dr Emma Taylor, Nick Taylor and Dr James Hanks

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InterHerd plus

PAN Livestock Services Limited,
School of Agriculture Policy & Development,
University of Reading, P.O.Box 237,
Reading, RG6 6EU
panveeru@panveeru.net

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Executive Summary

This study explores current and recent trends in the fertility, production and health performance of first lactation cows in UK dairy herds, including age at first calving and the proportion of first lactation cows that successfully re-calve. The study uses an InterHerd+ dataset derived from 500 milk recording herds selected as a representative cross-section of commercial black and white herds in the UK. Using data available in the database, parameters are generated to analyse performance of all heifers calving between 2016 and 2020.

The herd demographic changed little between 2016 and 2020. The proportion of first lactation cows exiting the herd (16.7% - 16.9%), as well as the proportion served before exit (60.1% - 64.1%) remained largely unchanged year on year. For first lactation cows leaving the herd, the median days post-partum (DPP) at exit decreased between 2018 and 2020 from 278 to 252 days. Median 305 day milk yields increased over the five years from 7412 kg (2016 calving heifers) to 8004 kg (2020 calving heifers), with corresponding increases in protein and fat (%). Average somatic cell counts (SCC) across the first lactation reduced during the period, with the biggest change in Q3 which reduced from 103 to 89. Although the age at 1st calving decreased from a median of 800 days in 2016 to 785 days in 2020, values for other fertility parameters remained similar. The proportion of dams of first lactation cows with a Johne's Disease (JD) milk ELISA test(s) history increased from 62.3% to 77.9% and proportion of first lactation cows which were bred from a dam with known low JD risk (J0 or J1) increased from 52% to 68%.

In summary, while the age at first calving for first lactation cows has decreased from 2016 to 2020, fertility parameters remained unchanged and the proportion of first lactation cows exiting the herd before second lactation was constant at just below 17%. First lactation milk yield, alongside subsequent protein and fat content (%), are increasing. JD testing has become more widespread so that the JD status of the dams of dairy replacements is increasingly known.

Introduction

Data prepared by the University of Reading for the annual 500-herd Key Performance Indicator (KPI) reports (Hanks & Kossaibati, 2020) indicate that the median percentage of first lactation cows in a herd is consistently around 29%. Assuming herd sizes are stable, this equates roughly to 29% of the herd being replaced each year.

Questions arise regarding the performance of these first lactation cows, most importantly: “what percentage of first lactation cows are successfully bred to remain and re-calve in the herd?”. This study was funded by the Agriculture and Horticulture Development Board (AHDB) to address this and related questions.

To fully understand longevity and retention of cows in the herd it would also be necessary to look at progression from lactation 2 to lactation 3 and lactation 3 to lactation 4 etc., which could be addressed in a future study.

Objectives

PAN Livestock Ltd was asked to examine the following parameters for first lactation cows calving between 2016 and 2020:

- **Remain within or exit the herd**
 - Overall exit rate (%)
 - Proportions of exits following service vs no service recorded (as proxies for intention to breed)
 - Distribution of exit dates by days post-partum (DPP)
 - Exit rate ≤ 100 DPP (%)
- **Milk yield and composition**
 - Lactation length (DPP)
 - 305-day milk yield (kg)
 - 305-day protein yield (kg)
 - 305-day fat yield (kg)
 - 305-day SCC (cells/ml x 1000)
 - 305-day protein (%)
 - 305-day fat (%)
- **Fertility**
 - Age at 1st calving (days)
 - Served by 80 DPP (%)
 - Served by 100 DPP (%)
 - Conceived by 80 DPP (%)
 - Conceived by 100 DPP (%)
 - Number of services to conception
 - Conception rate (%)
 - Conception rate at 1st service (%)
 - Lactation length (DPP)
 - Re-calving interval (DPP)
- **Johne's Disease**
 - Milk ELISA status of first lactation cow dams

Methodology

Data source

This study made use of the large InterHerd+ dataset used for the annual 500-herd Key Performance Indicator (KPI) reports produced by the University of Reading (Hanks & Kossaibati, 2020). The 500 herds in this dataset were selected from herds in UK that routinely milk record with National Milk Records (NMR), excluding a small number of herds known to be following a New Zealand style production system. The criteria for selection were that the herds were predominantly comprised of black and white breeds (Holstein, Holstein-Friesian, Friesian) and had good quality monthly milk recording data for a minimum of two years. Herds meeting these criteria were selected using random numbers to ensure a representative cross-section of herds. Following the initial random selection carried out for the first KPI report in 2010, the same herds were retained within the sample for each subsequent annual report. However, each year around 10% of the sample of herds either ceased recording or failed to meet data quality criteria. To maintain the sample size at 500 herds, these herds are replaced by randomly selecting new herds.

Analytical framework

For the main parts of this study the most recent 500 herd dataset was used: i.e. the herds selected for the 2021/2022 annual report. This dataset was queried with the SQL query that is used in InterHerd+ to generate the 'cow list' in the 'cow performance by calving period' report. This query produces summary data for each cow-lactation including data on milk production, services, conception, next calving date or exit date. The query included filters to restrict output to first lactations only, with calving dates between 1st January 2016 to 31st December 2020. The source database contained data on services, conception, re-calving or exit up to August 2022, providing a follow-up period of at least 20 months from first calving to determine the final outcome of each lactation. The output was arranged in five Microsoft Excel spreadsheets to split the first calving heifers into five cohorts calving in the calendar years 2016, 2017, 2018, 2019 and 2020. The data from these cows were used to examine the outcome of lactations (retention/re-calving or exit from the herd), milk production and quality and fertility performance. Relevant parameters were calculated for each first lactation cow and summarised for each calendar year cohort using the median and quartile values and occasionally arithmetic mean. Results are shown as a time series to illustrate any trends over the five calendar years. In addition, some background information on herd size and the % of cows in first lactation was obtained directly from the data prepared for the annual 500 herd reports and a comparison of conception rates between services of cows in different lactations was obtained by analysing data for all services recorded in the 500 herds during 2020. For clarity these additional data sources are mentioned alongside the relevant results.

Parameter calculations

Definitions for the parameters calculated for each cohort of first lactation cows are shown in the grid below.

Parameter	Description
Exits from the herd	
Exit 'rate' (%)	For each calendar year cohort: The proportion of first lactation cows calving in that year that have a subsequently recorded exit date without recording a second calving.
Proportion of exits without any service attempt recorded (% exit 0 serve).	Count of first lactation cows which exited the herd without being served divided by the total count of first lactation cows which exited the herd.
Proportion of exits after at least one service attempt (% exit >=1 serve).	Count of first lactation cows which exited the herd after being served divided by the total count of first lactation cows which exited the herd.
Exit days (DPP)	The difference between the date that the cow exited the herd and the first calving date.
Exit 'rate' <=100 DPP (%)	For each calendar year cohort: The proportion of first lactation cows calving in that year that have a subsequently recorded exit date within 100 DPP.
Milk yield and composition	
Lactation length (DPP)	The difference between the recorded dry date and the first calving date.
Lactation milk yield (kg)	The total production recorded for lactation 1 for each cow. NOTE: In InterHerd+ cumulative milk production is estimated by interpolating between monthly milk recordings. Only data from the first lactation cows that re-calved in the herd are used in the calculation of the summary statistics (mean, median quartiles) reported here.
Lactation protein yield (kg)	In InterHerd+ cumulative protein and fat production is estimated by first multiplying the milk yield by measured % of protein or fat recorded at each monthly milk recording and then interpolating between milk recordings.
Lactation fat yield (kg)	
Lactation average protein (%)	The lactation protein or fat yield (kg) divided by the lactation milk yield (kg), as %.
Lactation average fat (%)	
305 day yield (kg)	The 305 day production recorded for lactation 1 for each cow. As for lactation yield, this is estimated by interpolating between monthly milk recordings. Only data from the first lactation cows that reached 305 DPP are used in the calculation of the summary statistics (mean, median quartiles) reported here. Data from cows with an exit date or dry date falling before 305 DPP are excluded.
305 day protein (kg)	Calculated as for lactation protein and fat yields up to 305 DPP. Only data from the first lactation cows that reached 305 DPP are used in the calculation of the summary statistics (mean, median quartiles) reported here. Data from cows with an exit date or dry date falling before 305 DPP are excluded.
305 day fat (kg)	
Average SCC ('000 cells/ml) for whole lactation or for 305 days	The weighted average somatic cell count of all milk recorded during the lactation or up to 305 DPP. The average is weighted by factoring in the milk volume (1kg = 1 litre) recorded at each milk recording. The units '000 cells/ml are applicable throughout.

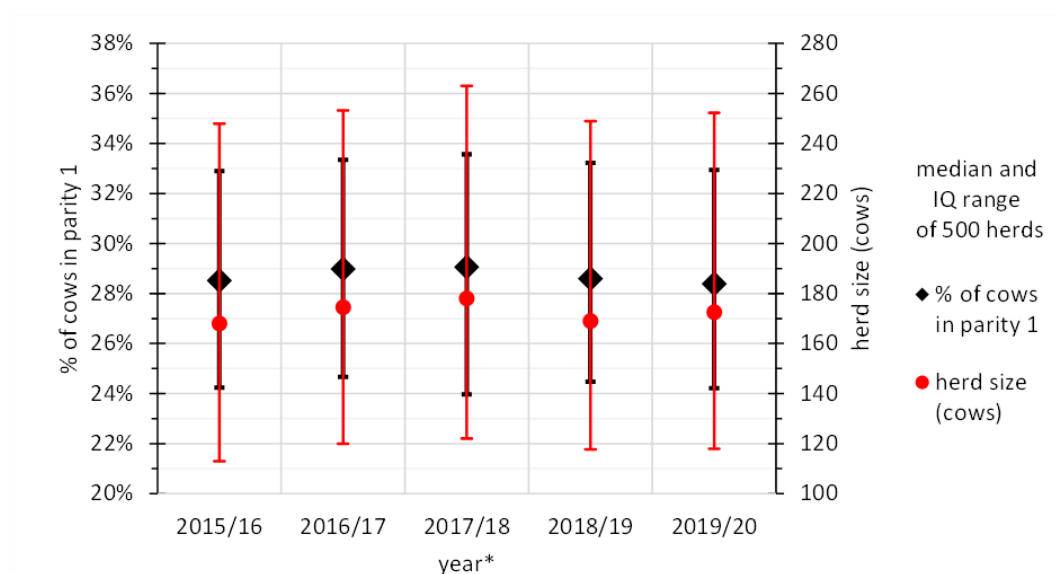
Fertility	
Age at 1 st calving (days)	The difference between the first calving date and the birthdate of the heifer.
1 st service (DPP)	The difference between the first calving date and the recorded first service date.
Served by 80 DPP (%)	For each calendar year cohort: The percentage of cows with a 1 st service recorded within 80 DPP.
Served by 100 DPP (%)	For each calendar year cohort: The percentage of cows with a 1 st service recorded within 100 DPP.
Conception (DPP)	The difference between the first calving date and the last subsequently recorded service date for a cow identified as conceived.
Conceived by 80 DPP (%)	For each calendar year cohort: The percentage of cows identified as conceived AND with a last service recorded within 80 DPP.
Conceived by 100 DPP (%)	For each calendar year cohort: The percentage of cows identified as conceived AND with a last service recorded within 100 DPP.
Number of services	The total number of services recorded in the lactation record of the first lactation cow (whether conceived or not).
Services per conception (mean, median)	For each calendar year cohort: The mean or median number of services recorded in the lactation record of the first lactation cows identified as conceived.
Conception 'rate' (%)*	For each calendar year cohort: The number of cows identified as conceived as a percentage of the total number of services recorded in the first lactation records of all cows in the cohort.
1 st service conception rate	For each calendar year cohort: The number of cows identified as conceived after 1 service as a percentage of the total number of cows which were served at least one.
Johne's Disease (J Classifications)	<i>Where known, the most up to date Johne's Disease status of the first lactation cow's dam is available in the first lactation cow's lactation record.</i>
J0	Repeat ELISA negative – minimum two tests (within the 2 year qualifying window).
J1	ELISA negative - one test only (within the 2 year qualifying window).
J2	Single ELISA positive followed by at least two negative – 2 negative recent and consecutive tests negative, but with a single positive test in the previous 4 tests (within the 2 year qualifying window).
J3	Single ELISA positive followed by one negative – The last test negative and last-but-one positive. Also, if there are more tests, there can be only one positive in the recent 4 (within the 2 year qualifying window).
J4	First ELISA positive – most recent test is the first positive test within a sequence of 4 tests.
J5	Repeat ELISA positive - two or more positive results in any four consecutive tests at any time in individual cow test history. Once J5, J5 for life.

* Conception rates were also calculated for services carried out within the 2020 calendar year, broken down by lactation of the cow served. This was by cross-tabulating all services recorded by lactation and result (conceived Yes or No) within the InterHerd+ programme.

Part 1 - Parameters for first lactation cows calving between 2016 and 2020

1.1 Introduction

Data prepared for the annual 500 herd reports for the years 2016 to 2020 indicate that for all these years the median percentage of first lactation cows was around 29% and the median herd size (number of cows excluding youngstock) was around 170 (Figure 1: 1). Trends in the count of first lactation cows calving in each herd remained broadly stable. The median count of first lactation cows calving/herd/year fluctuated between 47 and 51 (Figure 1: 2). The seasonal pattern of first lactation calvings was similar from year to year. The monthly proportion of first lactation calvings was lower between January and June, before increasing to a peak in September and gradually decreasing until December (Figure 1: 3).



*NOTE: the annual 500 herd reports are based on 12 months from September to August

Figure 1: 1 Median and IQ range of herd size and % cows in first lactation (n=500 herds), based on data prepared for the annual 500 herd reports 2016 to 2020.

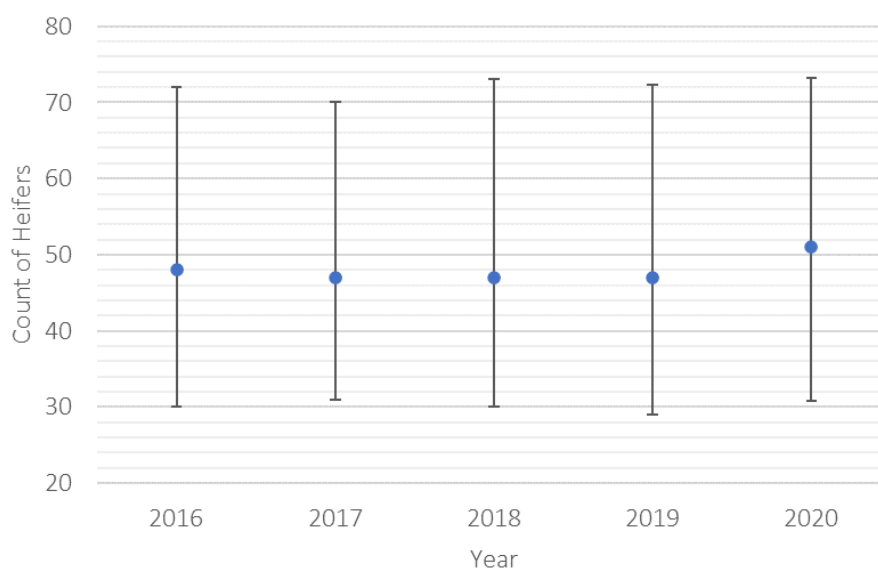


Figure 1: 2 The number of first lactation cows calving in each herd from 2016 to 2020. The error bars represent the interquartile ranges.

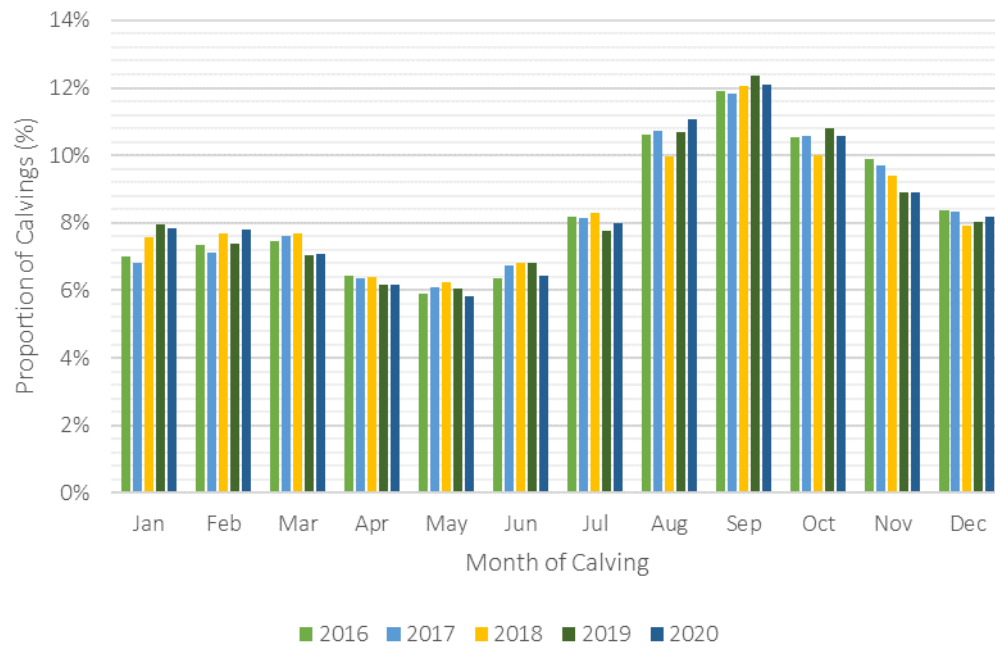


Figure 1: 3 Calving pattern of first lactation cows calving from 2016 to 2020.

1.2 Exit

Based on cows with exit dates, the proportion of first lactation cows known to have exited the herd was consistently 17% (Table 1: 1). Between 2018 to 2020 there is a trend for first lactation cows to exit earlier in lactation. The proportion of exits that left the herd ≤ 100 DPP increased from 23.5% to 27.1% (Table 1: 1) and the median exit date decreased from 278 to 252 DPP (Figure 1: 4). Of the exits in 2018, 2019 and 2020, 36%, 40% and 38% had no service recorded before exit. .

Table 1: 1 The proportion of first lactation cows which exited the herd and of the first lactation cows which exited the herd, the proportion which exited ≤ 100 DPP.

Year	N	Exit the herd		First lactation cows which exited the herd ≤ 100 DPP	
2020	30360	5077	16.7%	1374	27.1%
2019	29219	4933	16.9%	1303	26.4%
2018	29910	5061	16.9%	1190	23.5%

Note: Exit data were not available for the cohorts of 2016 and 2017

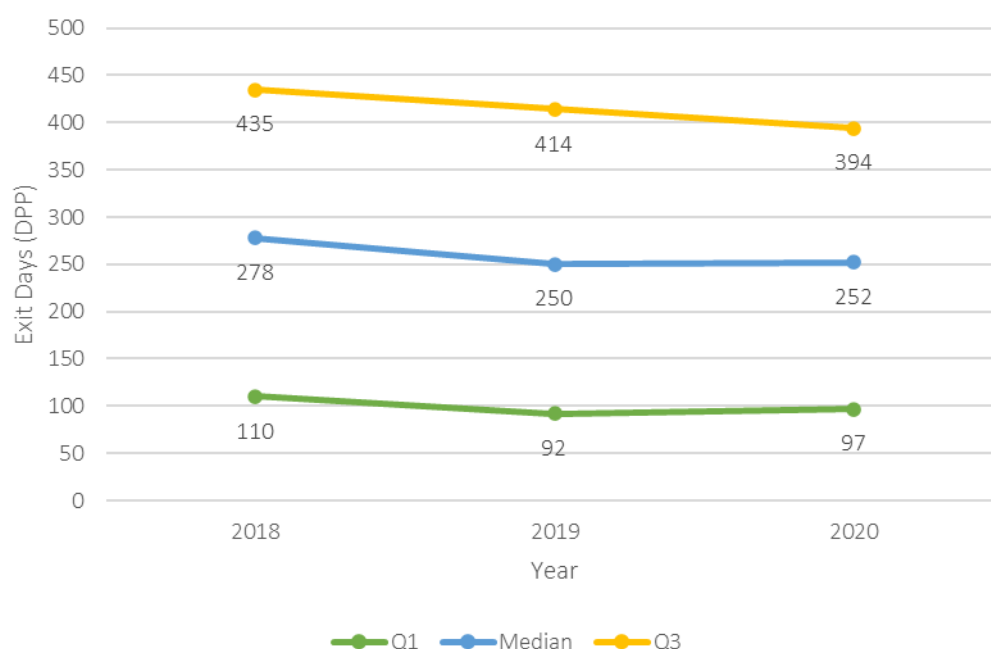


Figure 1: 4 Exit days (DPP) for first lactation cows which calved 2018 - 2020, and subsequently exited the herd.

1.3 Milk yield and composition

As summarized in Annex, Table 1: 1, the median 305 day milk yield value, for first lactation cows which reached 305 DPP, increased by 7.9% from 7412 kg to 8004 kg (Figure 1: 5). The median values for 305d protein (%) and 305d fat (%) values increased (Figure 1: 6, Figure 1: 7). The 305d average SCC broadly decreased, particularly the Q3 value which decreased by 13.5% from 103 to 89 (Figure 1: 8).

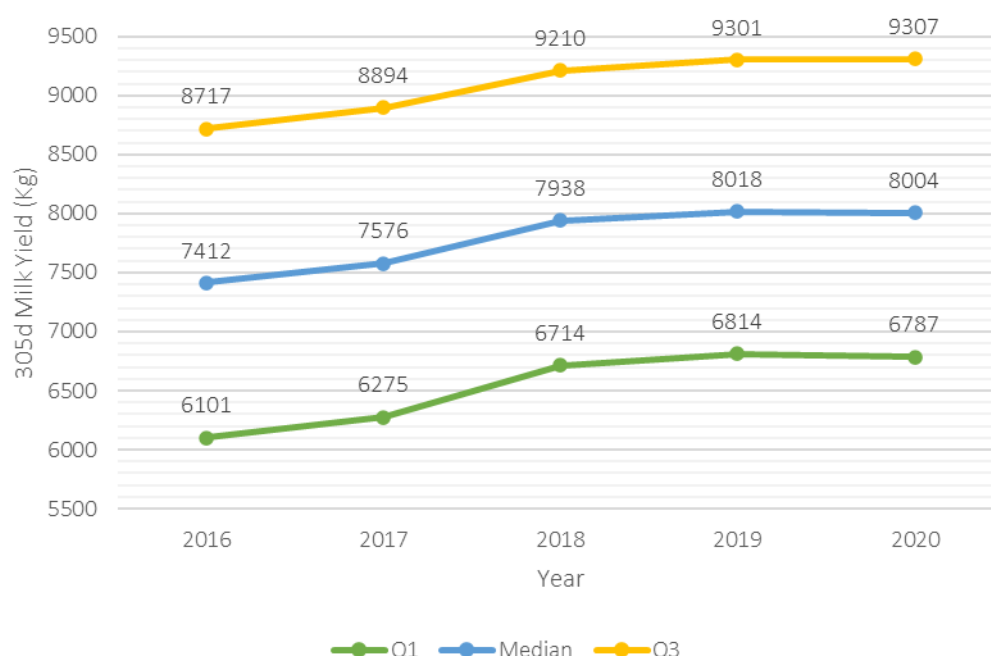


Figure 1: 5 The 305d milk yield (kg) for first lactation cows.

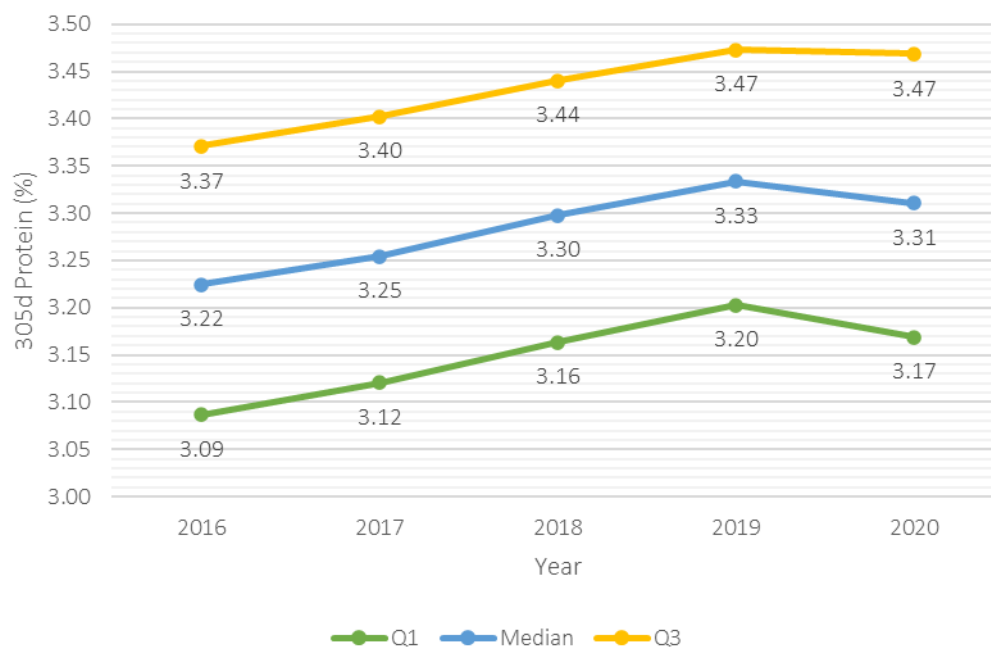


Figure 1: 6 The 305d protein (%) for first lactation cows.

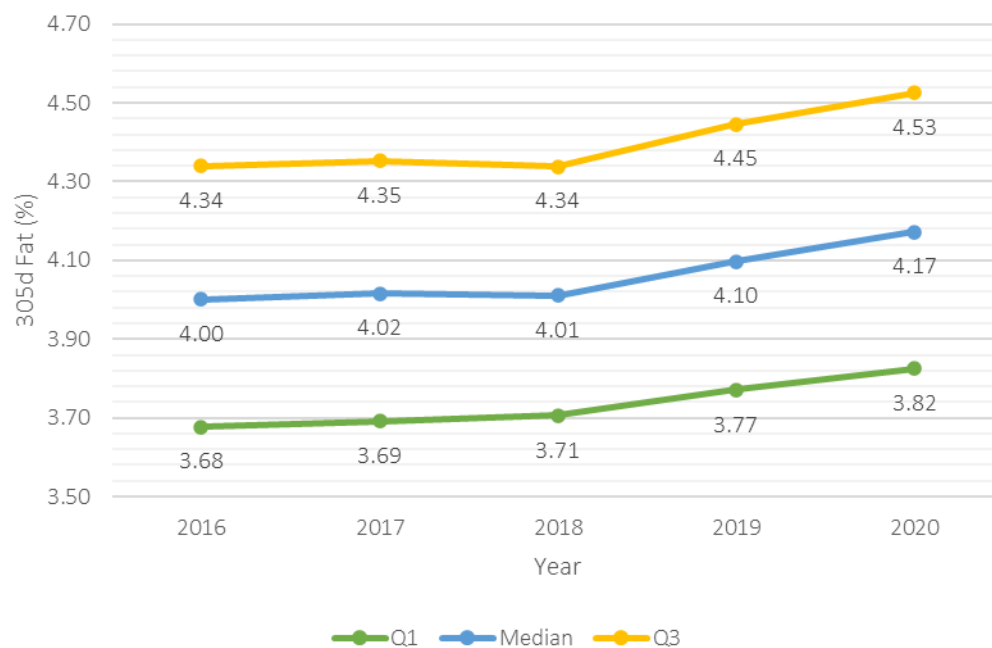


Figure 1: 7 The 305d fat (%) for first lactation cows.

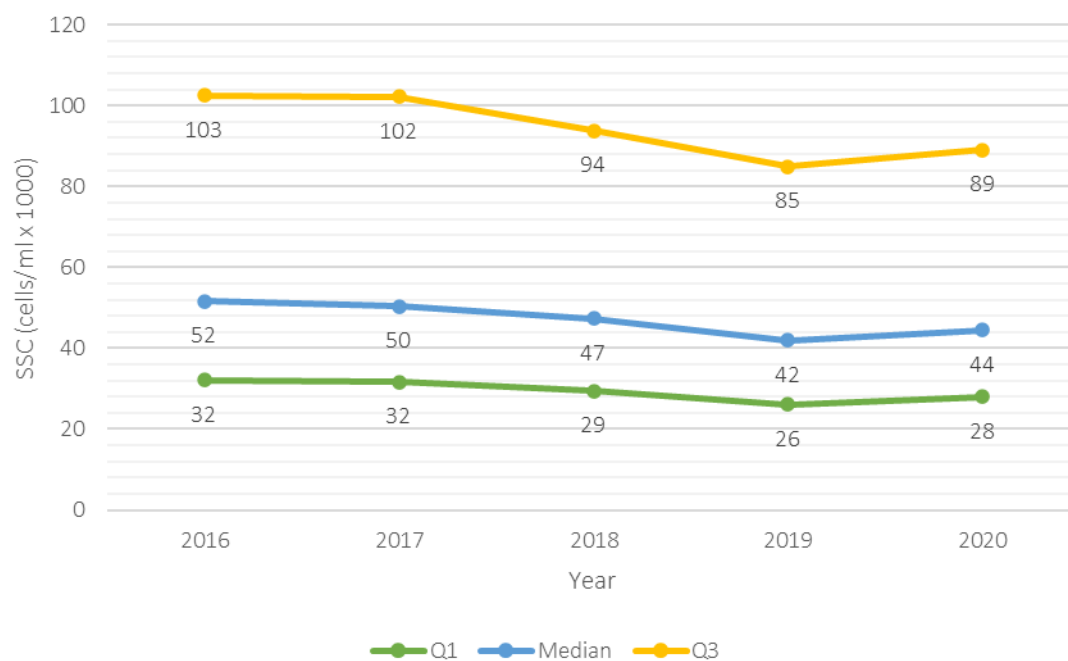


Figure 1: 8 The average 305d somatic cell count (SCC) (cells/ml x 1000) for first lactation cows.

1.4 Fertility

As summarized in Annex, Table 1: 2, the median value for age at 1st calving decreased by 1.9% from 800 days to 785 days (Figure 1: 9). Quartile values for other fertility parameters, including; DPP to 1st service and DPP to conception remained stable (Figure 1: 10, Figure 1: 11). Albeit, the Q3 value for conception improved from 154 DPP to 141 DPP (Figure 1: 11). Median values for lactation length and re-calving interval, based on cows which re-calved within the herd, were consistent (Figure 1: 12, Figure 1: 13)

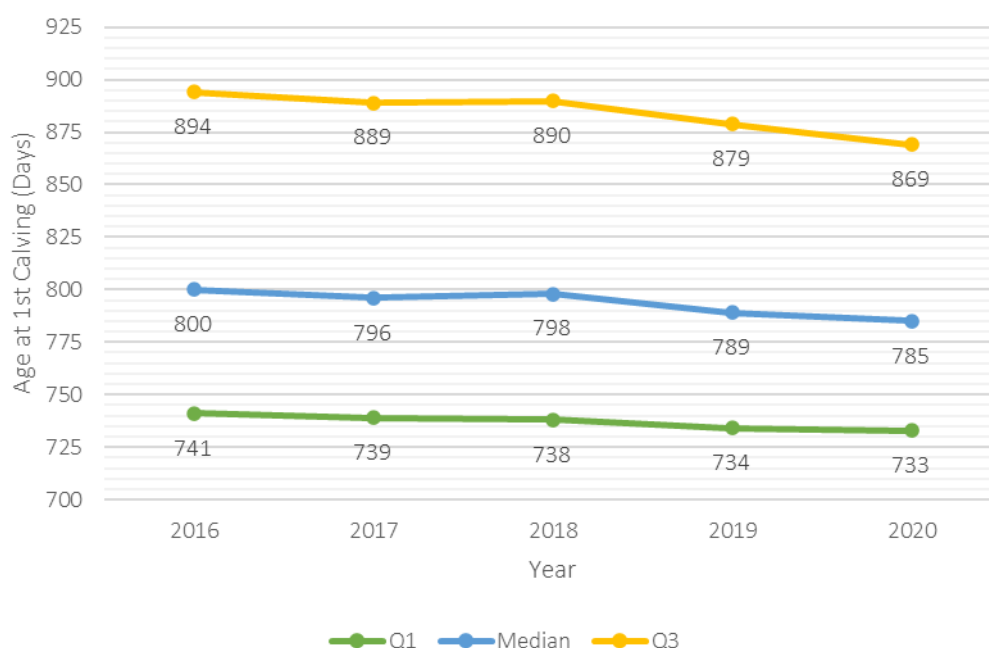


Figure 1: 9 The age at 1st calving (days) for first lactation cows.

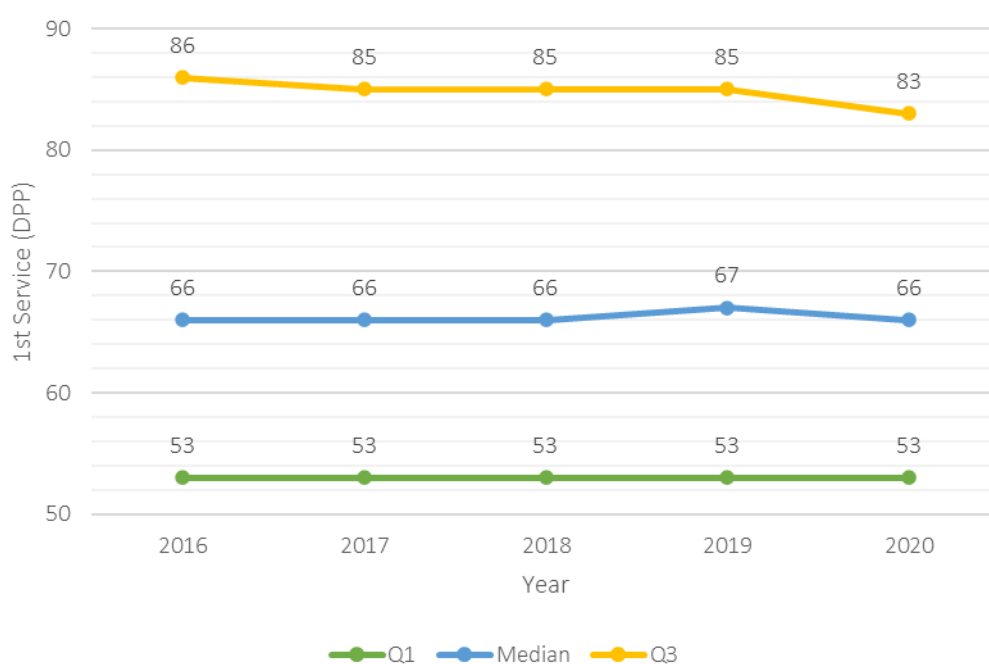


Figure 1: 10 Initial service after 1st calving (DPP) for first lactation cow served at least once.

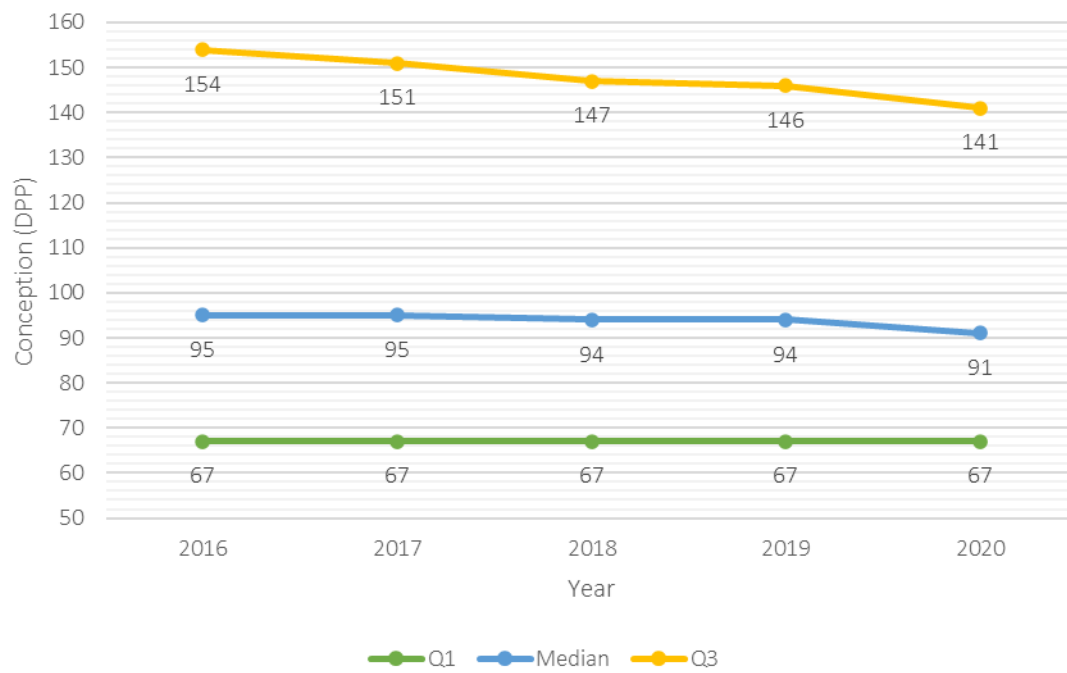


Figure 1: 11 Conception after 1st calving (DPP) for first lactation cows that conceived.

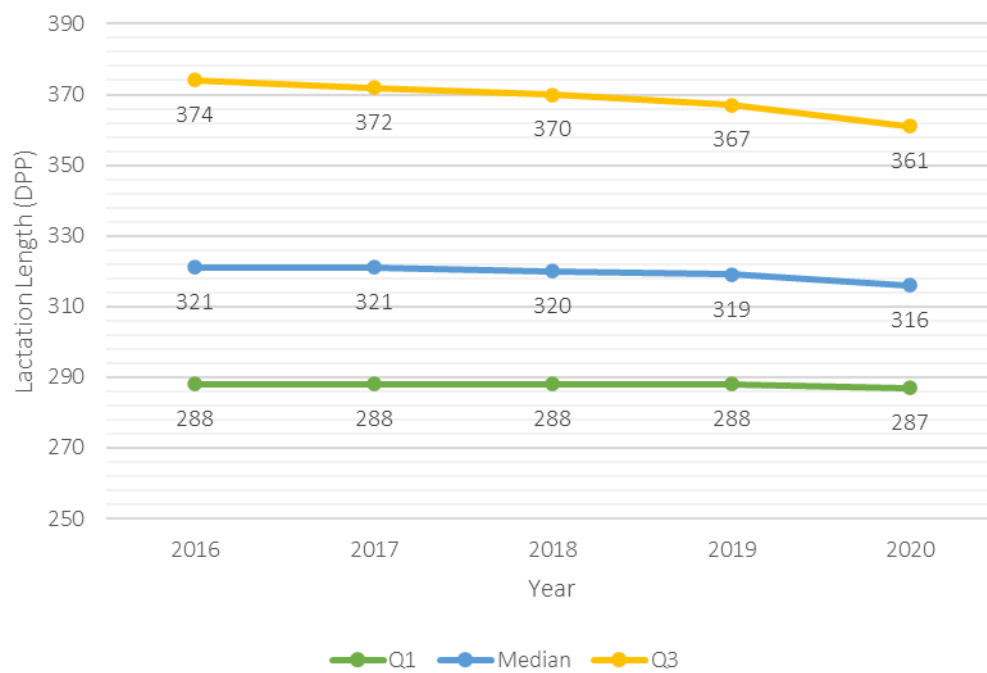


Figure 1: 12 Lactation length (DPP) for first lactation cows which re-calved within the same herd.

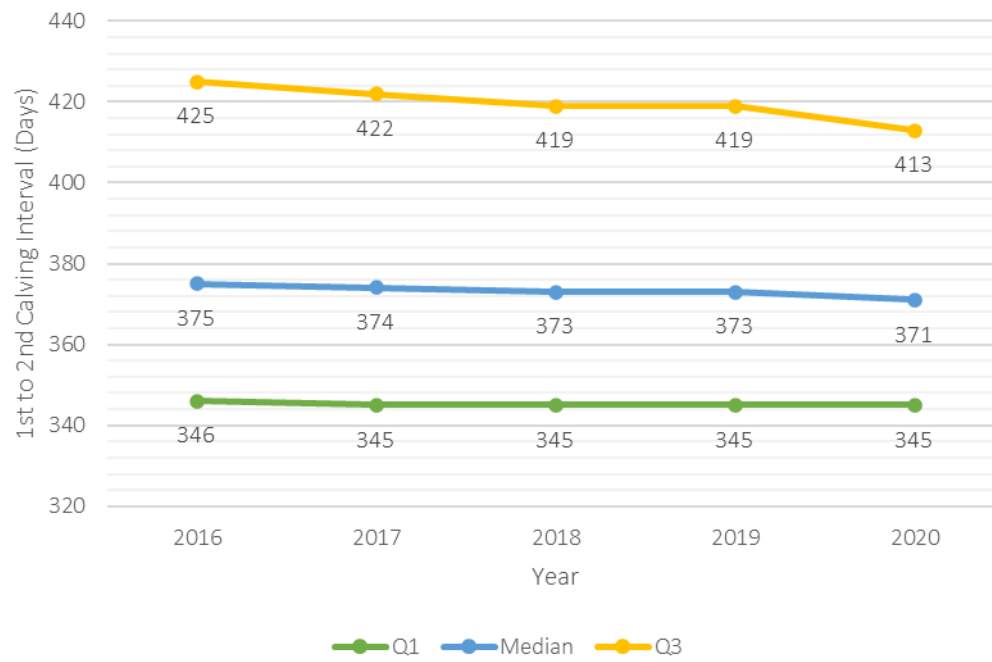


Figure 1: 13 Re-calving interval for first lactation cows which re-calved within the same herd.

1.5 Johne's Disease

The proportion of first lactation cows from Johne's Disease (JD) milk ELISA tested dams increased from 62.6% to 77.9%. The proportion of dams of first lactation cows classified as low risk (J0 or J1) increased from 52.3% to 67.9%. The proportion of dams of first lactation cows classified as high risk (J4 or J5) remained largely unchanged ranging from 2.23 – 2.93% and 4.18 – 5.13%, respectively (Table 1: 2, Figure 1: 14).

Note: J0, J1 and J5 cows are classified as cows which have demonstrated ≥ 2 negative (and no positive) milk ELISA results within 2 years, ≥ 1 negative (and no positive) milk ELISA results within 2 years and ≥ 2 positive results in any four consecutive tests at any time in individual cow test history, respectively.

Table 1: 2 Johne's Disease J classifications for the dams of first lactation cows.

J Classification	N	JNT	J0	J1	J2	J3	J4	J5
2016	17930	37.4	43.7	8.55	1.57	1.11	2.50	5.13
2017	19399	33.0	49.2	8.42	1.49	0.89	2.23	4.82
2018	21048	29.4	54.2	7.24	1.27	0.87	2.41	4.61
2019	21961	24.5	59.6	6.72	1.47	0.90	2.62	4.18
2020	23452	22.1	61.7	6.16	1.55	1.00	2.93	4.62

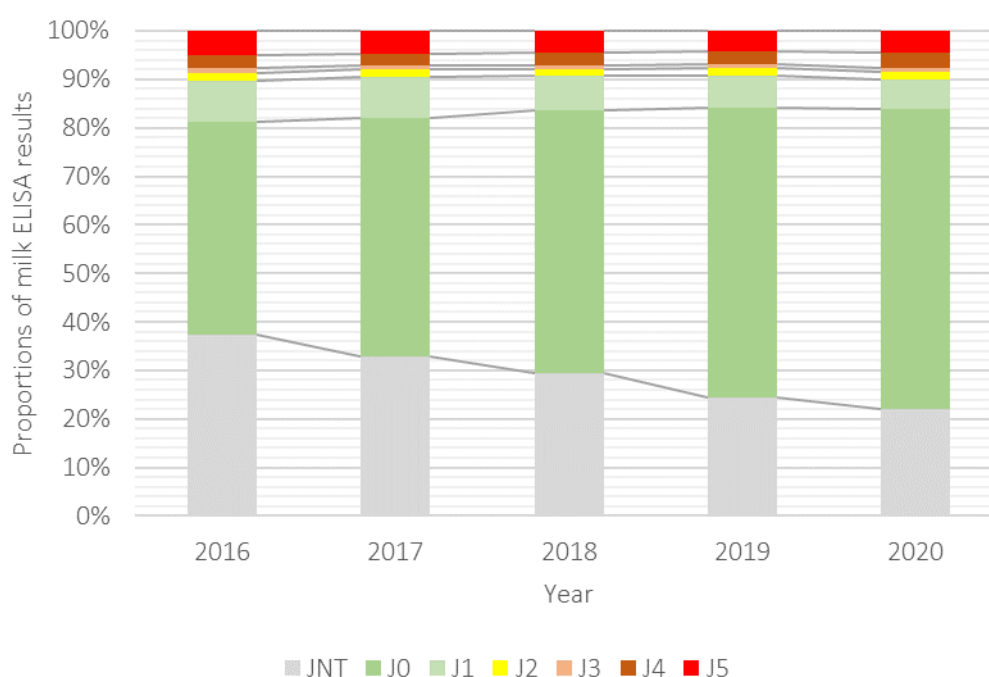


Figure 1: 14 Johne's J classifications for the dams of first lactation cows.

Part 2 – A comparison of conception rates between different lactations

A comparison of conception rates between services of cows in different lactations was obtained by analysing data for all services recorded in the 500 herds during 2020.

Conception rates (%) and 1st service conception rates (%) decrease as cows progress from first lactation to ninth lactation (Figure 2: 1, Figure 2: 2). The days to 1st service (DPP) and 1st to 2nd service interval broadly increase (Figure 2: 3, Figure 2: 4).

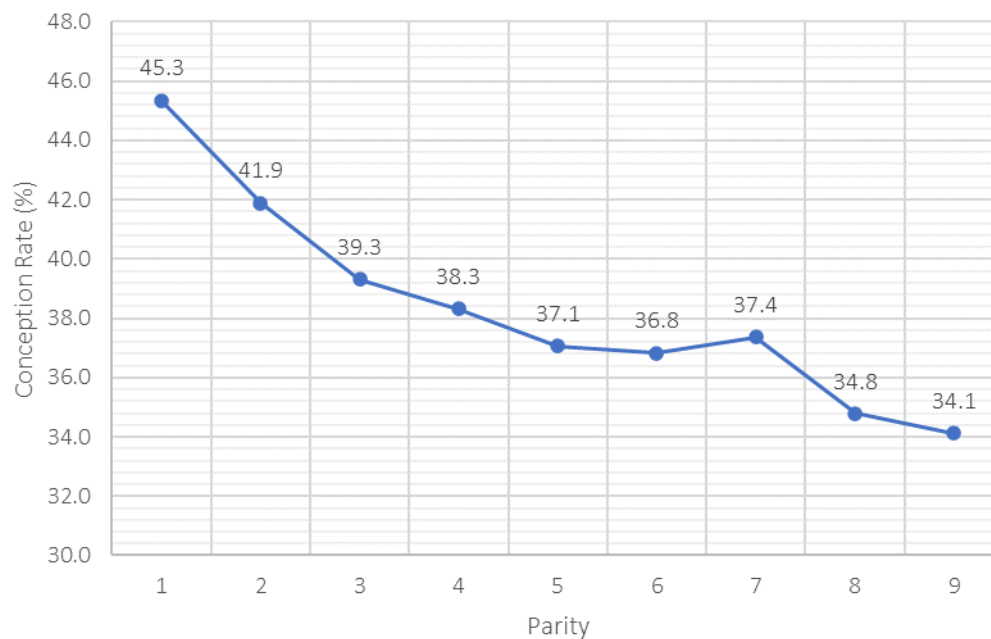


Figure 2: 1 Conception rate (%) within first lactation to ninth lactation cows.

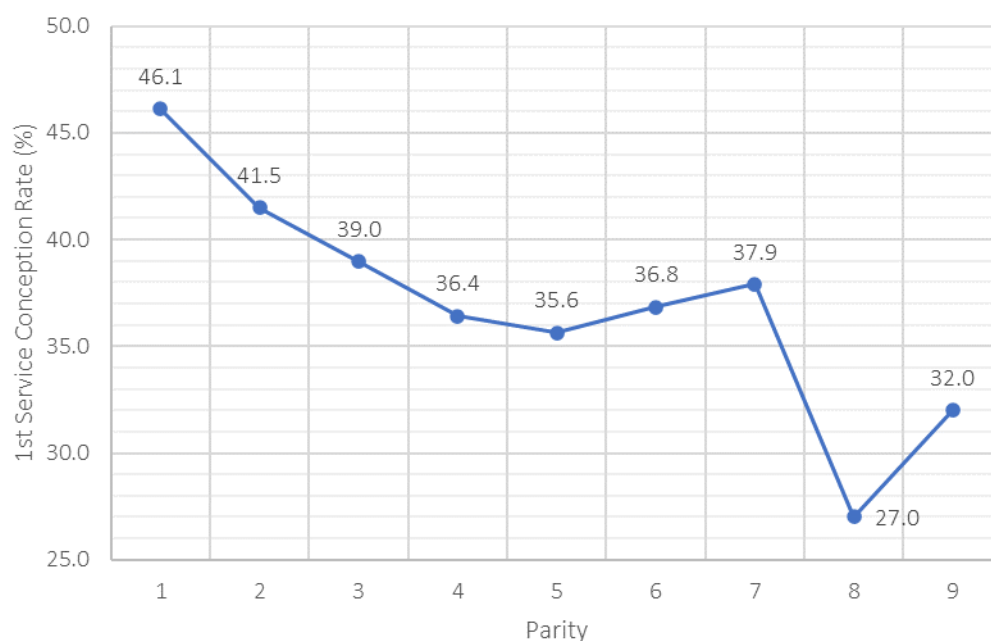


Figure 2: 2 1st service conception rate (%) within first lactation to ninth lactation cows.

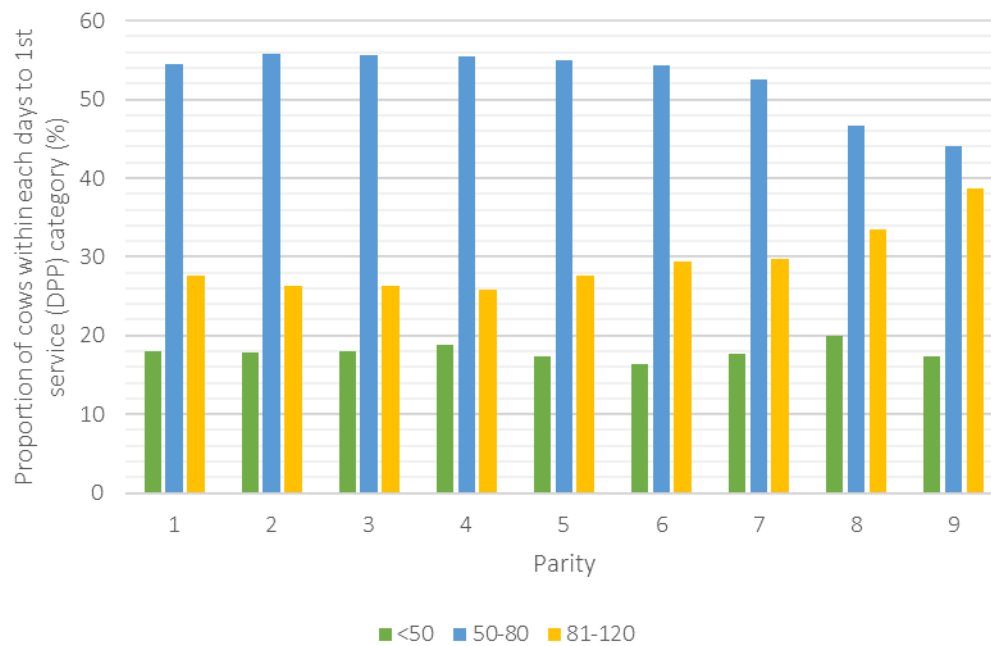


Figure 2: 3 Proportion of cows within each days to 1st service (DPP) category (%) within first lactation to ninth lactation cows.

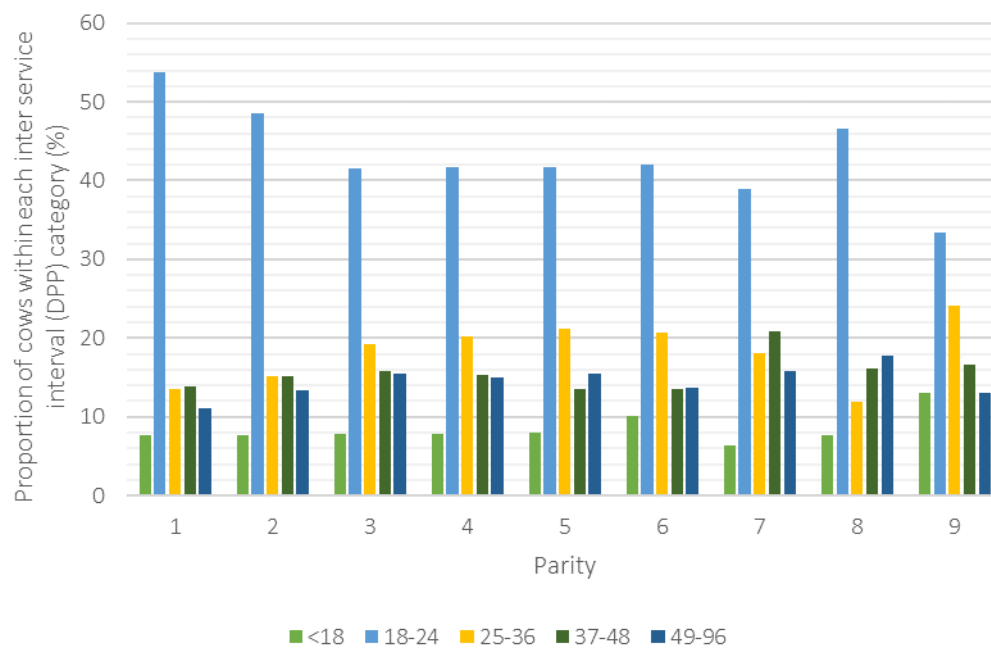


Figure 2: 4 Proportion of cows within each inter service (DPP) category (%) within first lactation to ninth lactation cows.

Conclusion

Overall, the herd demographic demonstrated consistency between 2016 and 2020. The proportion of first lactation cows exiting the herd, with or without being served remained unchanged, albeit cows that exited the herd without being served left earlier in lactation. Increases in 305d milk yields, protein (%) and fat (%) were observed but SCC reduced, particularly within Q3. Age of first lactation cows at 1st calving decreased but values for other fertility parameters remained stable. The proportion of first lactation cows that were bred from low risk dams increased and the proportion bred from a high risk dams and untested dams of unknown JD status decreased. Future work could examine these parameters in lactation 2 onwards.

Highlights

Parameter trends over 5 years for first lactation cows

- Herd demographic: the count/ratio of first lactation cows and calving patterns remained relatively constant
- Exits: the types of exits and exit rates were unchanged but cows exited the herd earlier in lactation
- Fertility: age at 1st calving decreased but other fertility parameters remained stable
- Milk yield/composition: milk yield, protein (%) and fat (%) increased and average SCCs decreased for cows which reached 305 DPP
- Johne's Disease: the proportion of dams with a Johne's Disease milk ELISA test increased

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Acknowledgements

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Annex 1

Annex, Table 1: 1 Summary of milk yield and milk composition first lactation cows.

Year		Lactation Milk Yield (Kg) ¹	305d Milk Yield (Kg) ²	305d Protein Yield (Kg) ²	305d Protein (%) ²	305d Fat Yield (Kg) ²	305d Fat (%) ²	305d Average SCC ³
2016	Q1	6857	6101	188	3.09	224	3.68	32
2017	Q1	6967	6275	196	3.12	232	3.69	32
2018	Q1	7127	6714	212	3.16	249	3.71	29
2019	Q1	7230	6814	218	3.20	257	3.77	26
2020	Q1	7173	6787	215	3.17	260	3.82	28
2016	Median	8264	7412	239	3.22	297	4.00	52
2017	Median	8421	7576	247	3.25	304	4.02	50
2018	Median	8580	7938	262	3.30	318	4.01	47
2019	Median	8708	8018	267	3.33	329	4.10	42
2020	Median	8625	8004	265	3.31	334	4.17	44
2016	Q3	9968	8717	294	3.37	378	4.34	103
2017	Q3	10156	8894	303	3.40	387	4.35	102
2018	Q3	10348	9210	317	3.44	400	4.34	94
2019	Q3	10400	9301	323	3.47	414	4.45	85
2020	Q3	10325	9307	323	3.47	421	4.53	89
2016	IQR	3111	2616	105	0.28	154	0.66	70.4
2017	IQR	3189	2619	107	0.28	155	0.66	70.5
2018	IQR	3221	2497	104	0.28	151	0.63	64.4
2019	IQR	3170	2487	105	0.27	157	0.68	59.0
2020	IQR	3152	2521	108	0.30	162	0.70	61.0

¹ Calculated using P1 cows which re-calved only: ² Calculated using P1 cows with lactation length of at least 305 days only: ³ = (cells/ml x 1000)

Annex, Table 1: 2 Summary of fertility for first lactation cows.

Year	Parameter	Age 1st Calving (Days)	No. of Services	1st Service (DPP)	Conception (DPP)	Lactation Length (DPP)*	Re-calving Interval (DPP)*
2016	Q1	741	1	53	67	294	346
2017	Q1	739	1	53	67	295	345
2018	Q1	738	1	53	67	295	345
2019	Q1	734	1	53	67	295	345
2020	Q1	733	1	53	67	294	345
2016	Median	800	2	66	95	324	375
2017	Median	796	2	66	95	325	374
2018	Median	798	2	66	94	324	373
2019	Median	789	2	67	94	324	373
2020	Median	785	2	66	91	320	371
2016	Q3	894	3	86	144	371	425
2017	Q3	889	3	85	142	369	422
2018	Q3	890	3	85	138	368	419
2019	Q3	879	3	85	137	368	419
2020	Q3	869	3	83	133	361	413
2016	IQR	153	2	33	77	77	79
2017	IQR	150	2	32	75	74	77
2018	IQR	152	2	32	71	73	74
2019	IQR	145	2	32	70	73	74
2020	IQR	136	2	30	66	67	68

**Calculated using first lactation cows which re-calved only*