

Key Performance Indicators for the UK national dairy herd

A study of herd performance in 500 Holstein/Friesian herds for the year ending 31st August 2022

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Executive Summary

This is the thirteenth annual study of Key Performance Indicators (KPI) from a cross-section of 500 dairy herds that milk record with National Milk Records (NMR). Starting in 2010, each study covers more than 70 different parameters describing aspects of fertility, production and health. The principal objective of the studies is to provide farmers and their technical advisers with accurate and current descriptions of performance levels as the basis for discussion and target setting at herd level.

The method of calculation for the majority of the 38 parameters described in this study is identical in all studies. Consequently the studies provide both a description of current performance of the national dairy herd, and how this has changed over the 13 year period.

For each parameter the 500 herds are arranged in ascending/descending order. The median is then the average of the middle two herds (herds in position 250 and 251). It follows that 50% of herds fall above and 50% of herds fall below this median value.

Herd size: Herd sizes have remained relatively stable for the last four years (*page 29*).

Median **herd size** in 2022 is **176** cows (*page 5*). One herd in four has more than 252 cows and one herd in four has fewer than 123 cows.

- While the median herd size has increased by 47 cows since 2010, the herd sizes have not changed markedly in the last 4 years (*page 29*).

Longevity: Longevity and culling rates have improved slightly in the year 2022, with slight increase in number of lactations at exit (*page 31*).

- The median **age at first calving** in 2022 is **799** days / **2.2** years (*page 14*). This is a reduction of 10 days on the previous year, and 95 days / 3 months earlier than in 2010
- The median **age at exit** is **6.0** years (2180 days) an increase of 14 days over 2021, but still 213 days earlier than the median in 2010 (*page 11*).
- The median **productive life** (age at exit – age at 1st calving) is 1359 days /3.7 years (*page 33*). In 2022 the age at first calving reduced, while age at exit increased, resulting in an increase in median productive life of 24 days compared to 2021. This is still 152 days shorter than in 2010. Significant improvements in somatic cell count (SCC), fertility and productivity shown by these studies are **not** resulting in cows having longer productive lives, as might be anticipated. The reasons, economic consequences and carbon footprint implications of this earlier exit need investigation. It is possible that farms are over-producing replacement heifers and, rather than selling surplus heifers, are removing healthy and productive older cows earlier than would be optimal.
- The median **lactations per cow at exit** for 2022 is **3.6**, up by 0.1 lactations compared to the previous year (*page 11*).
- The median **culling rate** in 2022 decreased to **26%**, compared to 28% in 2021 (*page 30*). While culling rates have remained fairly constant in the last five years (2016 -2021) they are generally 3-4% higher than in 2010-2015, contributing to the reduction in overall cow longevity (*page 30*). Annual culling rates are 32% or higher in a quarter of UK dairy herds.

Fertility: Most of the fertility parameters have continued to improve across the past 13 years

- The median **calving interval** in 2022 is **394** days (*page 13*), compared to 397 days in 2021. Calving interval is now lower by 30 days compared to that in 2010 (*page 36*).

- The median **conception rate** in 2022 is **38%** (*page 14*), an increase of 1% on the previous year. Variation in conception rate between herds remains high, ranging from below 32% of services in the bottom quartile of herds to over 45% of services in the best quartile. Over the past 13 years, the median conception rate has increased by 6% (*page 35*).
- **Heat detection:** the median rate of heat detection was **41%**, an increase of 2% on the previous year (*page 34*). This is measured as the % of inter-service intervals that are 18-24 days after the previous service, indicating the service was at the first available oestrus after a failure to conceive. This measure of heat detection has increased by 11% since 2010 (*page 34*). One herd in four still detects less than 32% of service returns at the first available oestrus, showing there is still plenty of opportunity to improve. **The median herd % of intervals that are greater than 50 days** (suggesting 2+ missed oestrus cycles) in 2022 is **19%** (*page 15*). This is an improvement of 1% on the previous year and 13% on 2010, showing heat detection continues to improve steadily.
- The median **submission rate** and **pregnancy rate** in 2022 are **41% and 16% respectively** (*page 16*). These directly reflect the improvements in heat detection and conception described above. Compared to performance in 2010, submission and pregnancy rates have increased by 14% and 7% respectively (*page 35 & page 36*).
- The median **% cows served by day 80** (after calving) in 2022 is **60%** (*page 12*). This is 14% higher than in 2010, with most improvement occurring before 2015 (*page 33*). In 2022 one herd in four served less than 49% of cows at least once by day 80 after calving.
- The median **% conceived by day 100** (after calving) in 2022 is **39%** (*page 12*). This is 2% higher than in 2020, and 13% higher in 2010 (*page 34*).

Milk production: Production per cow per year has tended to increase since 2010, until showing a small reduction in 2022, possibly due to the hot weather in the summer of 2022.

- The median **Lifetime milk per cow per day** (since birth) in 2022 is **12.7 kg** (*page 17*), slightly lower than that in 2021 – 13.1 kg. The top quartile of herds has increased every year between 2013 and 2021, with a reduction of 0.5 kg in 2022 compared to yield in 2021 (*page 37*).
- The median **Milk per cow per year** (milk per cow place) in 2022 is **8,708 kg** (*page 17*). This is 300kg lower than in 2020, but follows six consecutive annual increases from 2015. Since 2010 the median milk/cow/year has increased by 13.6% (1,043 kg). (*page 37*).
- The median **protein** content of milk is **3.33%** in 2022 (*page 18*) marginally higher than in 2021 (3.31%). In 2010 the protein content was 3.27%.
- The median **fat %** content of milk continues to increase, to **4.18%** in 2022 (*page 18*). While this has risen from 3.96% in 2010, the majority of the increase was in 2020 (0.11% increase from 4.02% in 2019). The fat yield (kg per cow per year) in 2022 is approximately 364 kg, an increase of 60 kg compared to 2010.

Somatic Cell Counts (SCC): The significant improvements in recent years are maintained. In half of the herds almost half of the cows now complete lactations without recording any high SCC.

- The median **herd SCC**, (in '000 cells/ml milk) for 2022 was 166, continuing a steady reduction over many years (*page 20*). The median herd SCC has reduced by 44 since 2010 (*page 38*). The outstanding progress is emphasised by the fact that in 2022 the average herd SCC of 77% of herds (386/500) was below the median SCC of 13 years earlier (210).
- **74%** (370/500) of the 500 herds had a herd SCC **below 200 in 2022**. This contrasts with 44% (218/500) of herds in the 2010 study.

- The median level of **chronic high SCC cows** in 2022 is **8%**, which is the same rate as that in the previous year (*page 22*). A chronic high SCC cow is one that was high at both the current and previous milk recording. However, there has been a consistent improvement (decline) from 14% in 2010 (*page 38*). The strong association ($R^2 > 0.7$) between the percentage of chronic high SCC cows and herd average SCC has been found in every study. As a demonstration of the dramatic improvement in milk quality in recent years:
 - In 2022, 41/500 (about **8%**) herds contained over 15% cows defined as chronic high SCC. This contrasts with 207 herds (**41%**) in the original 2010 study (*page 45*).
 - In 2022, 356/500 (71%) herds recorded less than 10% chronic cows, up from 121 (24%) in 2010 (*see page 45*).
- The median **percentage of cows completing lactations with no high SCC recordings** in 2022 is **49%** (*page 25*). So in half the study herds, almost half the cows (**49%**) completed lactations without recording a single high SCC. The equivalent in 2010 was a third of cows (**33%**) completing lactations without recording a single high SCC (*page 39*).

Mastitis: Cases are not consistently recorded across all 500 herds. Since 2016 a subset of the 500 herds (recording 5 or more cases/100 cows/year) has been included for analysis of mastitis incidence. In 2022 this included 243 herds.

- **Mastitis incidence** in the median herd in the year's 2022 subset is **25 cases per 100 cows per year**, a reduction of 11 cases per 100 cows per year since 2016 (*page 39*).
- In half the herds (with mastitis records) 83% of cows recorded no mastitis in the lactation (*page 9*), an increase from 79% in 2016.

Johne's disease: Milk recording is an important source of information on Johne's disease. The progress made in tackling this disease is described elsewhere, for example: Orpin, P.G., Sibley, D., Hanks, J. and Taylor, N. 2022. The National Johne's Management Plan: Using risk and data analysis to optimize Johne's control in dairy herds. *Livestock*. 27, 1, 2 - 7.

<https://doi.org/10.12968/live.2022.27.1.24>

Section 1: Description of the study and methods used

Introduction

This is the 13th annual study describing key indicators of production, fertility and health in commercial black and white dairy herds in the United Kingdom. The Key Performance Indicators (KPIs) are based on milk recording data from 500 commercial black and white herds for the 12 month period ending on 31st August 2022. Herd selection used random numbers to ensure a representative cross-section of all herds (good, bad and indifferent) that milk record with National Milk Records (NMR).

The range in performance across these herds is described for 38 parameters clearly showing the wide differences in performance, as well as huge potential for improvement, in commercial dairy herds. This includes six additional parameters (including mastitis rate/100 cows in milk/year) shown since the 2016 study. The principal objective throughout has been to provide farmers and technical advisers with accurate and up-to-date information on the variation in performance of commercial dairy herds.

The calculations used to generate these parameters are identical to those used by the InterHerd+ program allowing farmers and technical advisers to compare the performance of any milk recording herd directly with the 500 herd sample that is representative of the national performance. In other words, for each parameter: *“Is the performance of my herd typical/outlying, good/acceptable/poor when compared to the 500 herds?”*. This prompts discussion around: *“Why is a parameter where it is? Which parameters could/should we prioritise/improve and what are the likely implications?”* If this promotes discussion between farmers and their technical advisers into the different causes and options for improvement then the study has served its primary purpose.

Following the analysis of individual parameters there is a section on trends since 2010 for a selection of the KPIs. Further sections discuss their practical use by farmers and advisers. A KPI template of 80 parameters for use in InterHerd+ is also available for users to update the KPI parameters to the target values from the 2022 study.

Parameter description

For 35 parameters described in this study (out of total of 38), the performance level of each of the 500 herds (243 herds for mastitis rate) is presented as a bar chart. The herds are displayed from “best” to “worst”, in ascending or descending order depending on whether it is generally preferable to have a low value (e.g. SCC, calving interval) or a high value (e.g. dry period cure, conception rate). The “best” is always on the left side, nearest the vertical Y axis. For each parameter, a median (middle) value and inter-quartile range values (the level achieved by the middle 50% of herds) are also derived.

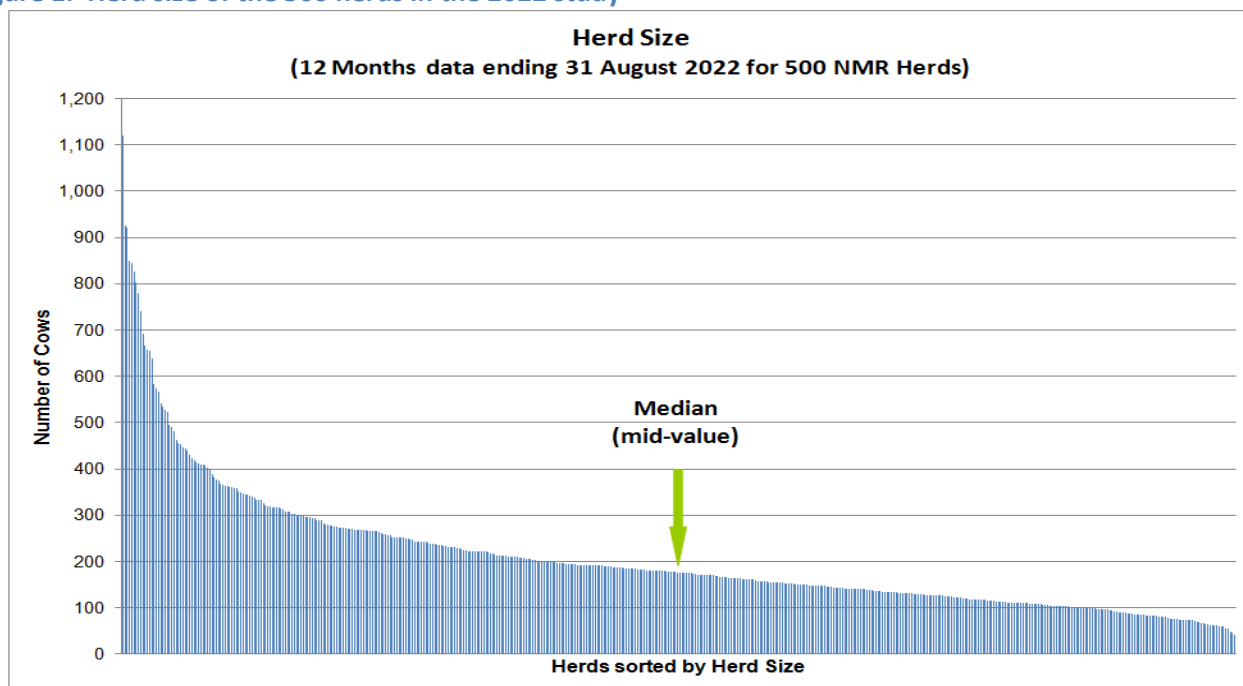
The **target** value proposed for each parameter (and included in the KPI template) is the level achieved by the **“best” 25%** of the herds for that parameter. In other words, **the target is set at a level that is currently achieved (or exceeded) by one in four dairy herds over the last year.**

The sample of herds

The source of data is the monthly milk records obtained by National Milk Records (NMR). The 500 herds used in the study all fully milk record on a monthly assisted basis and are approximately 10% of herds recorded by NMR. Herds were selected using random numbers to ensure a representative cross-section of the sample. The herds are all predominantly comprised of black and white breeds (Holstein, Holstein-Friesian, Friesian) and have recorded for a minimum of two years. Where possible the same herds used in the 2021 study were maintained for the 2022 herds’ sample. Herds with poorly recorded fertility data (inadequate recording of services and pregnancy diagnoses), as well as herds no longer recording, were replaced with new herds, again selected using random numbers. In total 449 herds (about 90%) were in both the 2021 and 2022 studies.

Herd size for the 500 herds in the 2022 study ranged from minimum 42 to maximum 1119 cows, with a median value of 176 cows, as shown in Figure 1. In the sample 61% of herds were comprised of less than 200 cows, with 40 herds containing over 400 cows.

Figure 1. Herd size of the 500 herds in the 2022 study



The parameters

To minimize the impact of short term seasonal variations, the key performance indicator values are calculated using data recorded over a full 12 month period. They represent the consolidated or average performance levels achieved by each herd for the period from 01 September 2021 to 31 August 2022. The definitions of each parameter are detailed in Appendix 1.

The results of the study are summarized in Tables 1(a) & 1(b). For each parameter, four statistics are presented:

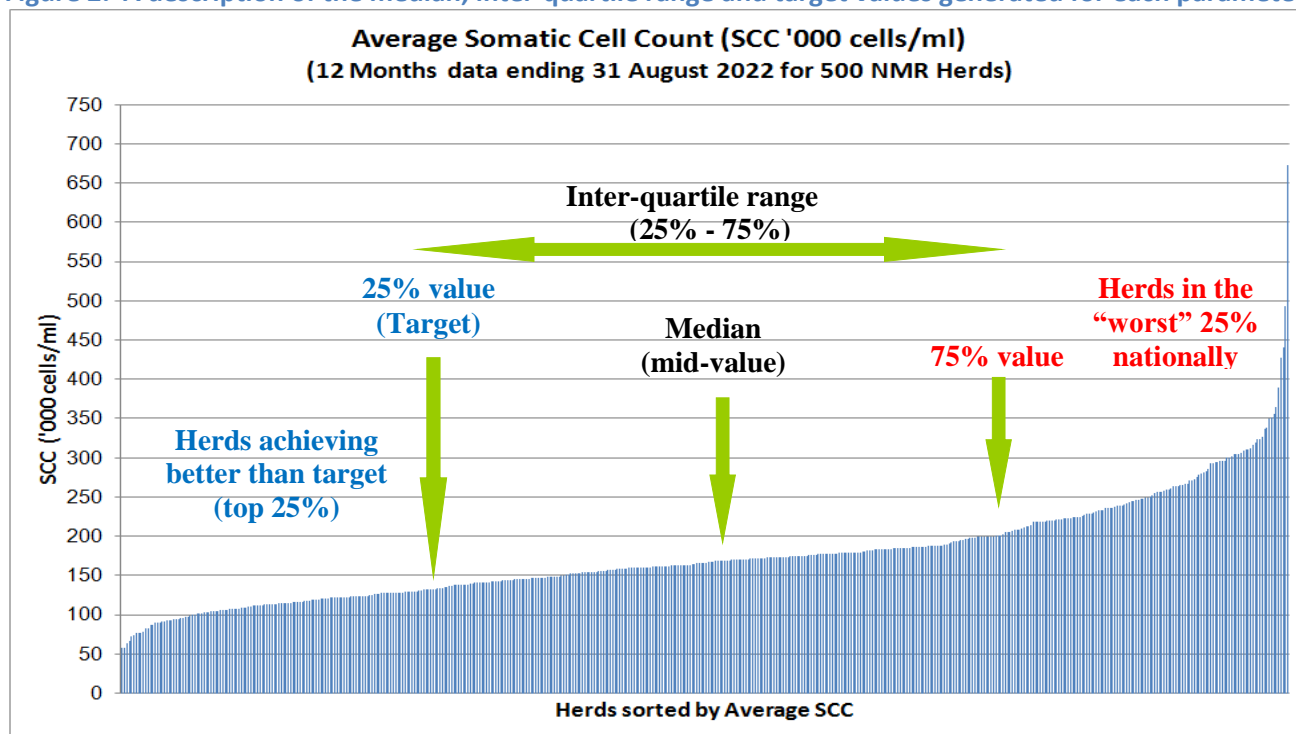
1. The **median**: The middle value. If the performance levels of all herds are arranged in ascending order, the median is the performance of the middle herd (or the average of the middle two herds in an even number of herds). Half the herds do better and half do worse than the median value.
2. The **first quartile (25% value) and third quartile (75% value)**. With the median, these split the herds into four equal groups. The first and third quartile values are the lower and upper limits of performance achieved by the middle 50% of herds. 25% achieve “better” and 25% achieve “worse” than the limits for that parameter.
3. The **target** value used by InterHerd+ is the level achieved or bettered by 25% of the herds in the study. This value is the “better” of the **first quartile (25%) or third quartile (75%) values**. For parameters like somatic cell count, culling % and calving interval the target will be the 25% (lower) value, while for others (conception %, protein %, dry period cure %) it will be the 75% (higher) value.
4. The **inter-quartile range** is the difference between the performance of the best and worst 25% of herds (i.e. the difference between the **first quartile (25% value) and third quartile (75% value)**). This gives an impression of how widely herds in the middle 50% differ.

The position of these values is graphically displayed in Figure 2.

Throughout this report the parameter value is displayed on the vertical Y axis and bars representing the study herds are arranged along the horizontal X axis. The “best” performing herd is nearest the vertical Y axis with the worst performing herd furthest away.

The parameter described in Figure 2 is the herd average SCC so the target value is at the lower end of the inter-quartile range (as a low average SCC is preferable to a high average SCC).

Figure 2. A description of the median, inter-quartile range and target values generated for each parameter



Changes to studies from earlier years

1. **Mastitis Key Performance Indicators:** The results of the study summarized in Tables 1(a) & 1(b) include 4 parameters relating to mastitis, including the herd overall Mastitis rate (cases/100 cows in milk/year). This is the seventh year that mastitis related parameters have been derived from the survey herds, reflecting the significant improvement in the level of reporting of mastitis by farmers in recent years. While in 2012 less than 20% of herds reported any mastitis, this has risen to 49% of herds in 2022. For the purpose of this study any herd that recorded over 5 cases/100 cows in milk/ year was considered to record mastitis. The mastitis KPIs in this report are calculated based on 243 of the 500 herds (about 49%) that qualified this year.
2. **305 day milk/protein/fat yields:** In previous reports up to that of 2015, 305 day yield parameters were calculated from all lactations, including lactations that were shorter than 305 days. In this report, as in all years since 2016, the lactation must be at least 305 days long for inclusion in the calculation. This report also details the 305 day yields (total yield up to and including the 305th day of lactation) of fat and protein. As with the milk yield, these parameters are calculated from lactations that were at least 305 days in length. Note that the exclusion of lactations shorter than 305 days does not apply to the calculation of the **overall lactation yield**. In some herds, when many cows have lactation lengths below 305 days, this can result in lactation yields smaller than the 305 day yields.

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Section 2: KPI results for the year ending 31 August 2022

Table 1(a) Summary of Key Performance Indicators derived from analysis of 500 NMR milk recording herds for the year ending 31 August 2022 – Culling, fertility & milk parameters.

Parameter	Median (1)	1 st - 3 rd quartile (25% - 75%) (2)	Target (3)	Inter-quartile range (4)
A. Culling rate	26%	22% - 32%	22%	10%
B. Percentage culled (off take) 100 days after calving	5%	3% - 7%	3%	4%
C(a). Age at exit (years)	6.0	5.4 - 6.7	6.7	1.3
C(b). Age at exit (days)	2180	1958 - 2442	2442	484
D. Age at exit by lactations	3.6	3.1 - 4.1	4.1	1.0
E. Percentage Served by day 80	60%	49% - 70%	70%	21%
F. Percentage conceived 100 days after calving	39%	29% - 46%	46%	17%
G. Calving to 1 st service interval (days)	80	70 - 95	70	25
H. Calving interval (days)	394	384 - 412	384	28
I(a). Age at 1 st calving (years)	2.2	2.1 - 2.4	2.1	0.3
I(b). Age at 1 st calving (days)	799	756 - 872	756	116
J. Conception rate	38%	32% - 45%	45%	13%
K. %Service intervals at 18-24 days (Heat detection)	41%	32% - 47%	47%	15%
L. Percentage service intervals >50 days	19%	13% - 28%	13%	15%
M. %Cows eligible for service served (Submission rate)	41%	30% - 53%	53%	23%
N. %Eligible for service that conceived (Pregnancy rate)	16%	12% - 21%	21%	9%
O. Lifetime milk / cow / day (kg)	12.7	10.6 - 14.7	14.7	4.1
P. Milk / cow / year (kg)	8,708	7,534 - 9,763	9,763	2,229
Q. Average protein%	3.33%	3.25% - 3.40%	3.40%	0.15%
R. Average fat%	4.18%	4.02% - 4.34%	4.34%	0.32%
S. 305-day milk yield (kg)	9,010	8,026 - 10,035	10,035	2,009
T. 305-day protein yield (kg)	299	263 - 329	329	66
U. 305-day fat yield (kg)	376	330 - 419	419	89

- (1) The median is the middle value (so 250 herds were better and 250 were worse than this value).
- (2) The **first quartile (25% value) and third quartile (75% value)** describe the lower and upper limits of performance achieved by the middle 50% of herds. 25%, or one in four, herds achieve “better” and 25% “worse” than the limits for that parameter.
- (3) The **Target** is set at the level achieved or bettered by the **“best” 25% of herds. One in four of the 500 herds in the sample achieved this level or better.**
- (4) The inter-quartile range is the difference between the **first quartile (25% value) and third quartile (75% value)**. This gives an impression of how widely herds in the middle 50% differ.

Table 1(b) Summary of Key Performance Indicators derived from analysis of 500 NMR milk recording herds for the year ending 31 August 2022 – Somatic Cell Count (SCC) and mastitis parameters.

Parameter	Median (1)	1 st - 3 rd quartile (25% - 75%) (2)	Target (3)	Inter-quartile range (4)
V. Herd SCC ('000 cells/ml)	166	130 - 201	130	71
W. % milk samples with High SCC (*)	16%	12% - 19%	12%	7%
X. % milk samples with SCC \geq 500,000 cells/ml	7%	5% - 8%	5%	3%
Y. % cows with High SCC at 1 st record in lactation (*)	15%	12% - 20%	12%	8%
Z. % Chronic milk samples (**)	8%	6% - 11%	6%	5%
ZA. Dry period cure (High:Low) (***)	78%	70% - 84%	84%	14%
ZB. Dry period protection (Low:Low) (***)	86%	81% - 90%	90%	9%
ZC. % Low at last recording of previous lactation (*)	78%	70% - 84%	84%	14%
ZD. % samples New SCC category (**)	5%	4% - 7%	4%	3%
ZE. % cows dried-off with no High SCC samples in the lactation (*)	49%	42% - 58%	58%	16%
ZF. Threshold Index new high / new low (****)	1.20	1.09 - 1.34	1.09	0.25
ZG. % of cows with New/First/Repeat sample that are Low SCC at next recording (**)	56%	51% - 61%	61%	10%
ZH. % of cows with Chronic sample that are low SCC at next recording (**)	21%	17% - 26%	26%	9%
ZI. Percentage drying off with no mastitis cases ⁺	83%	77% - 87%	87%	10%
ZG. Mastitis rate (cases/100 cows in milk/year) ⁺	25	15 - 36	15	21
ZK. Cows with Index mastitis case by Day 30 ⁺	4%	2% - 6%	2%	4%
ZL. Index mastitis rate after Day 30 ⁺	16%	10% - 24%	10%	14%

(*) **HIGH** SCC is a milk sample with \geq 200,000 cells/ml milk;

LOW SCC is a milk sample with below 200,000 cells/ml milk

(**) **CHRONIC** / **NEW** / **FIRST** and **REPEAT** are the Herd Companion categories describing high SCC cows. See Appendix 2 for definitions.

(***) **Dry period protection (High:Low)**: The percentage of cows finishing a lactation with a HIGH SCC sample that starts the new lactation with a LOW SCC sample;

Dry period cure (Low:Low): The percentage of cows finishing a lactation with a LOW SCC sample that starts the new lactation with a LOW SCC sample.

(****) **Threshold Index**: The total cows changing from Low to High SCC divided by the total cows changing from High to Low SCC at consecutive milk recordings.

(1) The median is the middle value (so 250 herds were better and 250 were worse than this value).

(2) The **first quartile (25% value)** and **third quartile (75% value)** describe the lower and upper limits of performance achieved by the middle 50% of herds. 25%, or one in four, herds achieve “better” and 25% “worse” than the limits for that parameter.

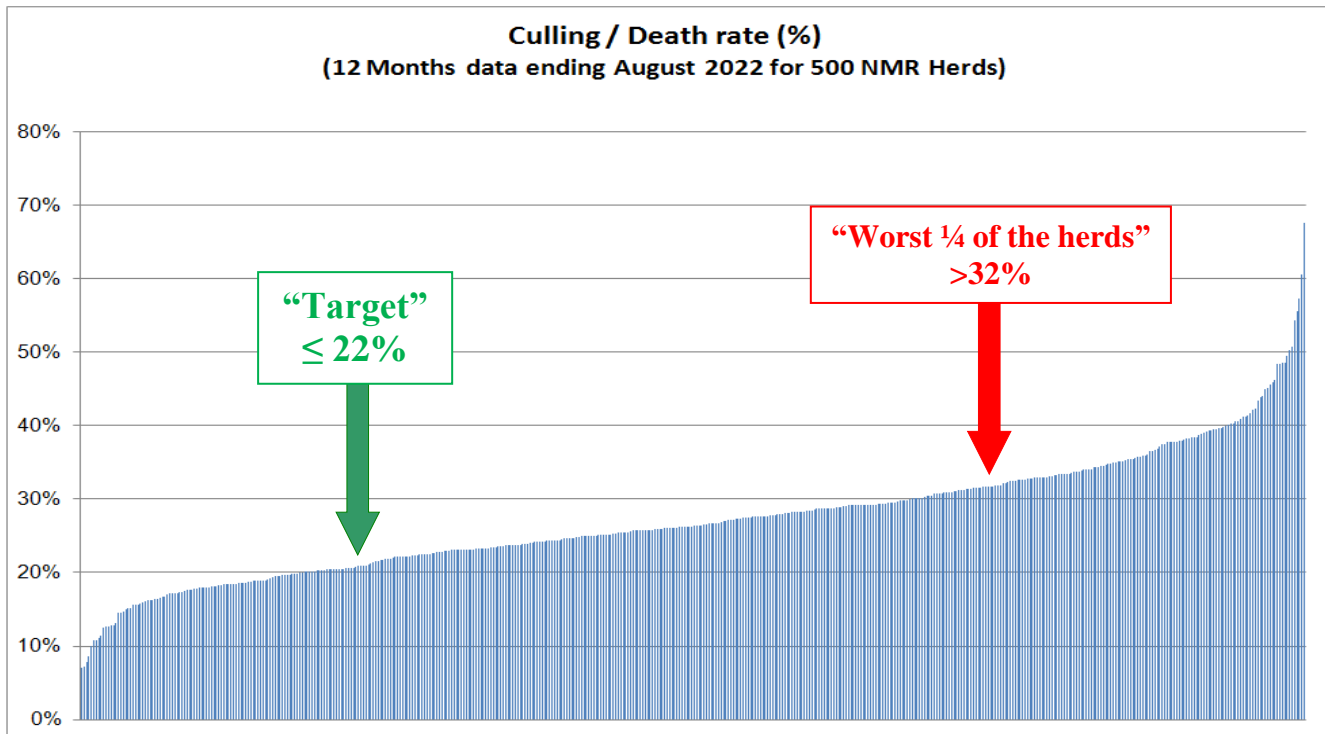
(3) The **Target** is set at the level achieved or bettered by the “**best**” 25% of herds. **One in four of the 500 herds in the sample achieved this level or better.**

(4) The inter-quartile range is the difference between the **first quartile (25% value)** and **third quartile (75% value)**. This gives an impression of how widely herds in the middle 50% differ.

+ The mastitis parameters are derived from a group of 243 herds (within the 500 herds in the study) where mastitis rate >5 cases per 100 cows in milk / year.

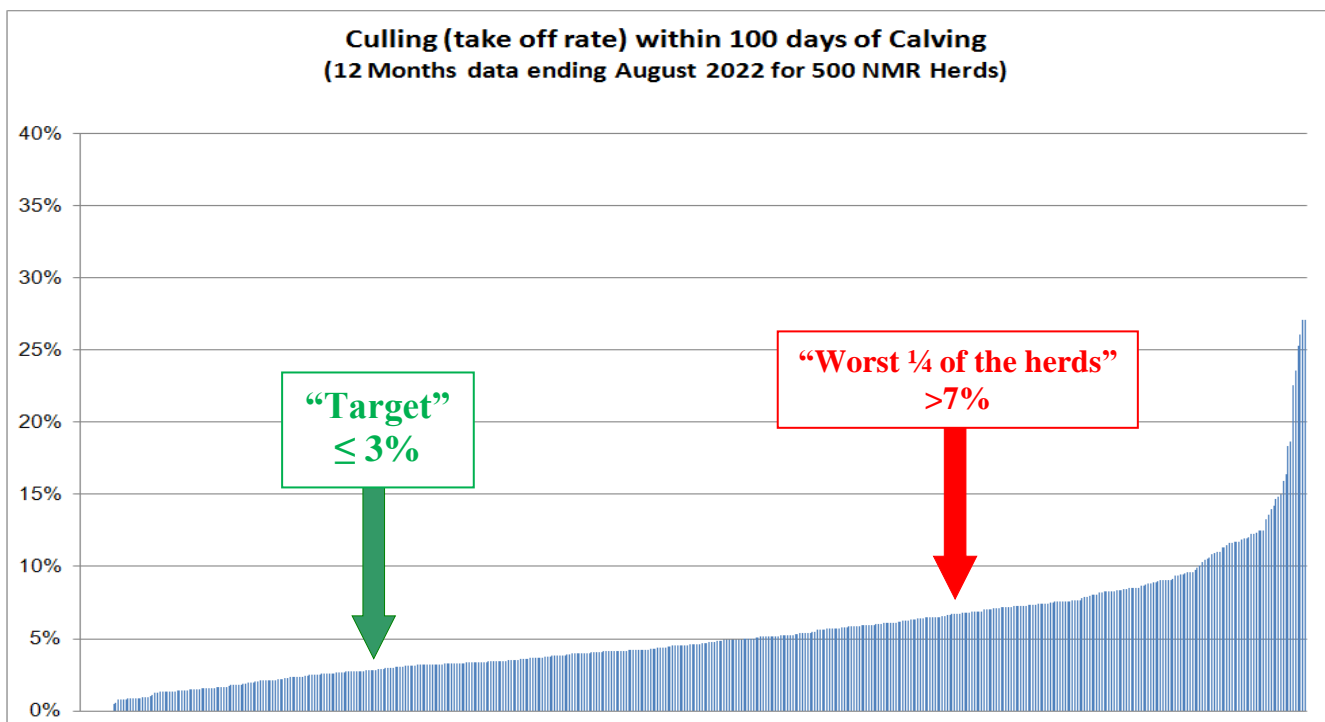
A. Culling/death rate: The % of cows that left the herd (culled/sold/died) in the last 12 months.

Target (top ¼ of herds' level): 22%
Median: 26%
75% level: 32%
Inter-quartile range: 10%



B. Percentage of cows/heifers calving during the last 12 months that were culled (off take) / died during the first 100 days after calving. A possible indicator of "involuntary culling".

Target (top ¼ of herds' level): 3%
Median: 5%
75% level: 7%
Inter-quartile range: 4%



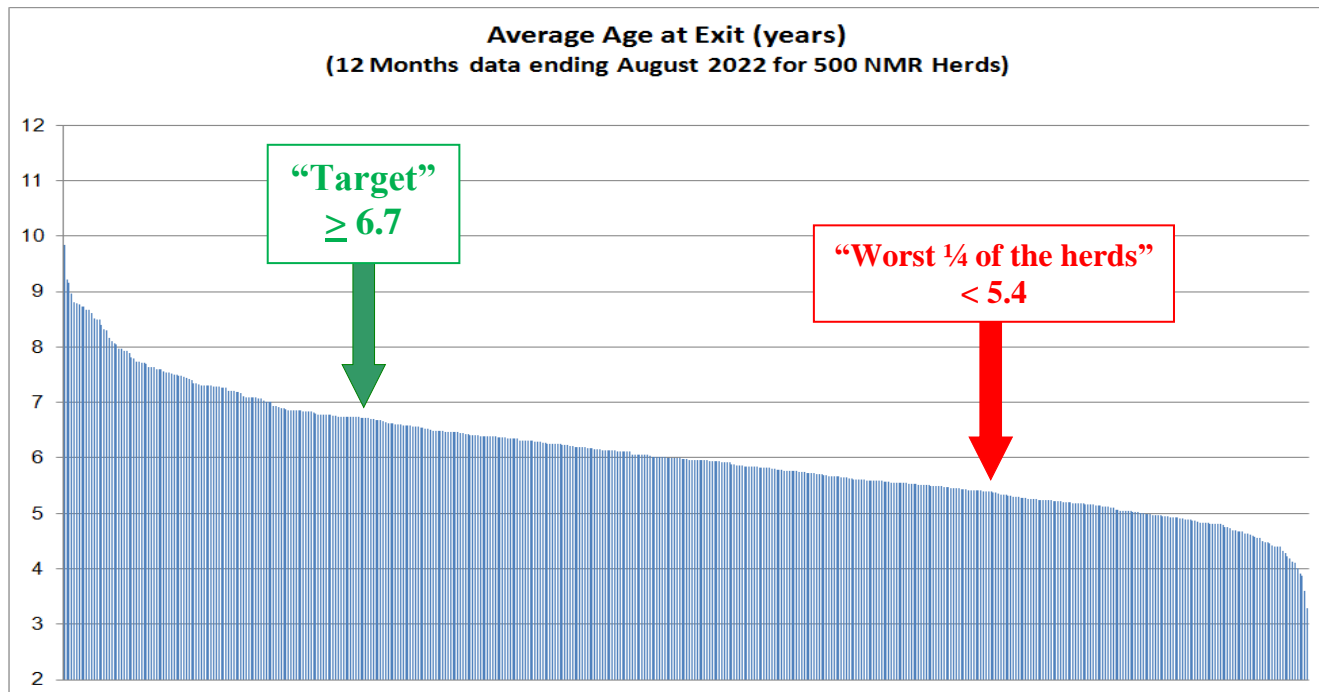
C. Average Age (in years) at exit: The average age of cows leaving the herd in the last 12 months at the time of exit. A potential measure of longevity.

Target (top ¼ of herds' level): 6.7 (2442 days)

Median: 6.0 (2180 days)

75% level: 5.4 (1958 days)

Inter-quartile range: 1.3 (484 days)



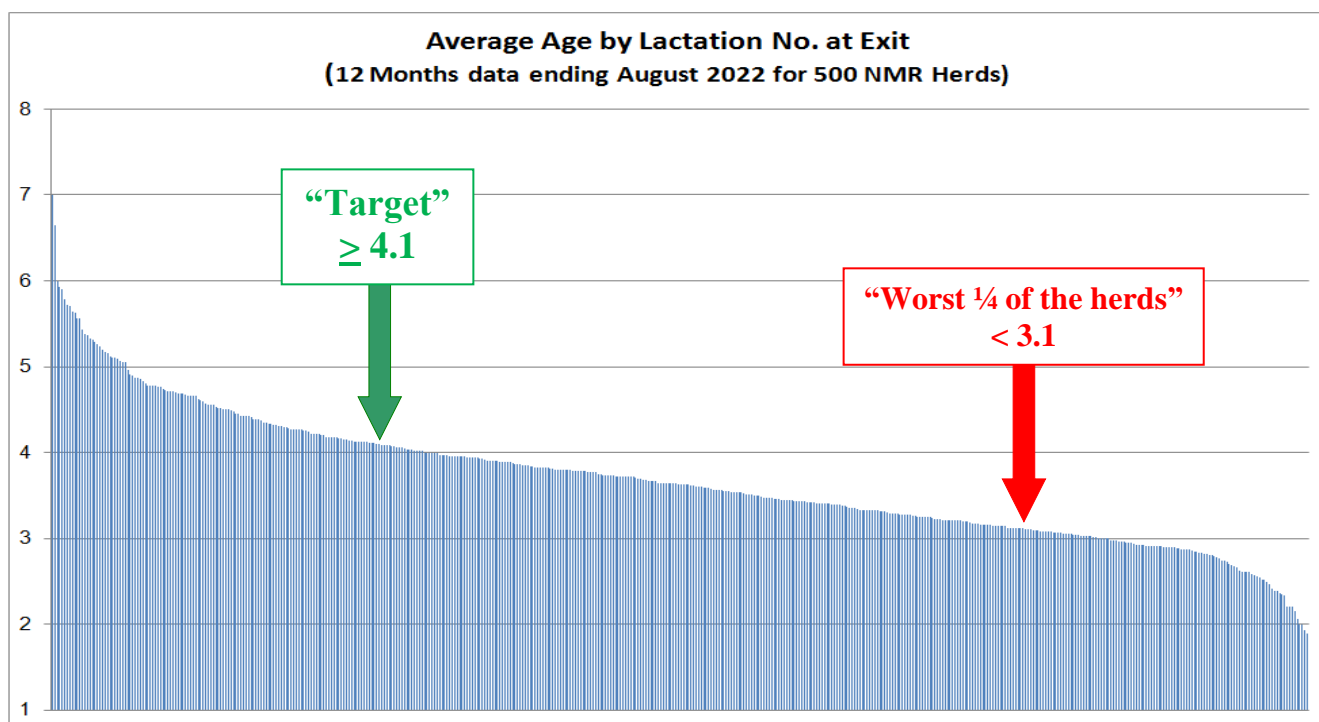
D. Average Age at exit by lactations: The average lactation number of cows leaving the herd in the last 12 months. A potential measure of longevity.

Target (top ¼ of herds' level): 4.1

Median: 3.6

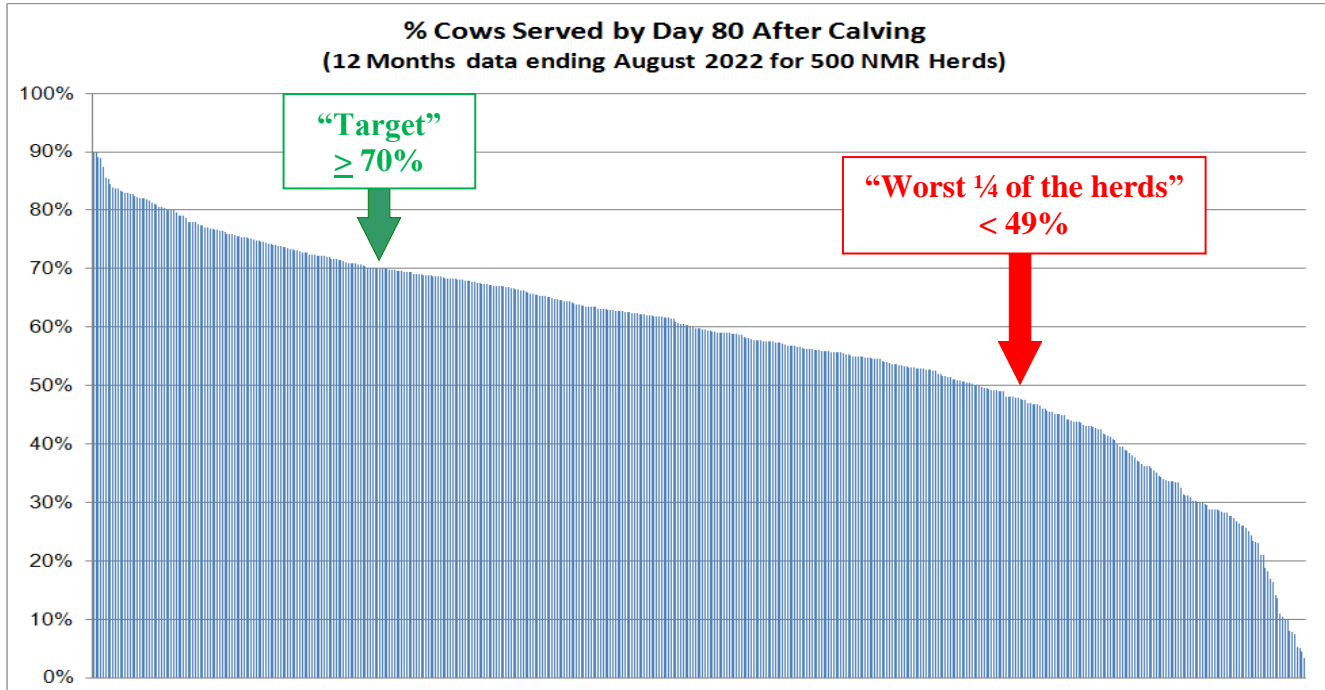
75% level: 3.1

Inter-quartile range: 1.0



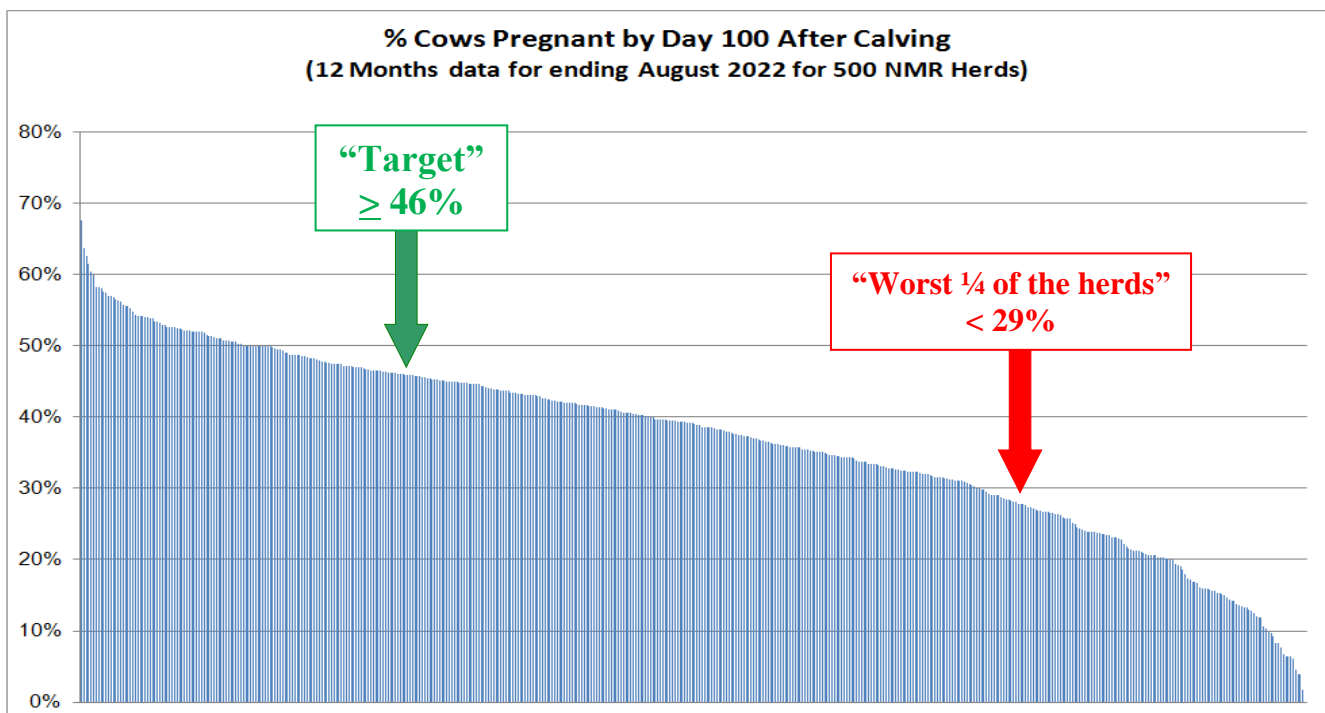
E. % Served by day 80: The percentage of calving cows served at least once within 80 days of calving.

Target (top ¼ of herds' level): 70%
Median: 60%
75% level: 49%
Inter-quartile range: 21%



F. % Conceived 100 days after calving: The percentage of calving cows that had conceived within 100 days of calving.

Target (top ¼ of herds' level): 46%
Median: 39%
75% level: 29%
Inter-quartile range: 17%



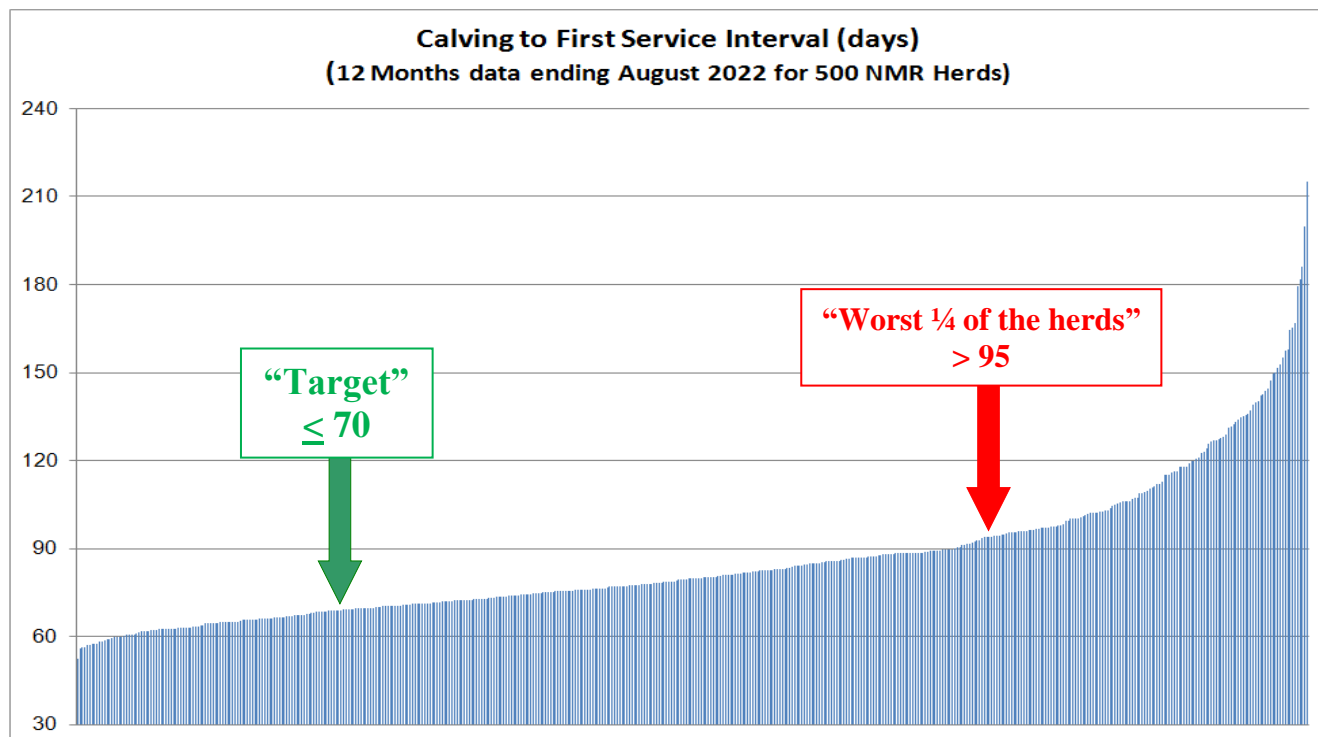
G. Calving to 1st service interval: The average number of days between calving and 1st service.

Target (top ¼ of herds' level): 70

Median: 80

75% level: 95

Inter-quartile range: 25



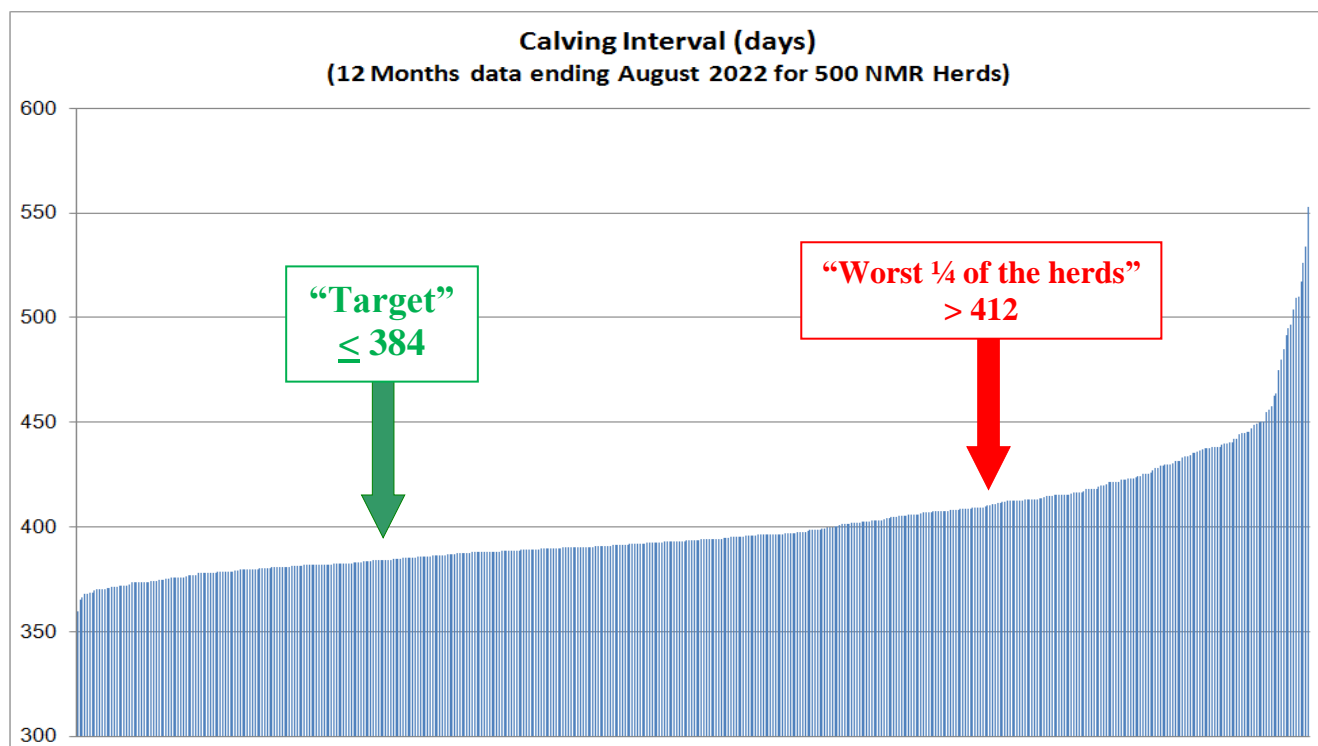
H. Calving interval: The average interval between consecutive calvings (in days).

Target (top ¼ of herds' level): 384

Median: 394

75% level: 412

Inter-quartile range: 28



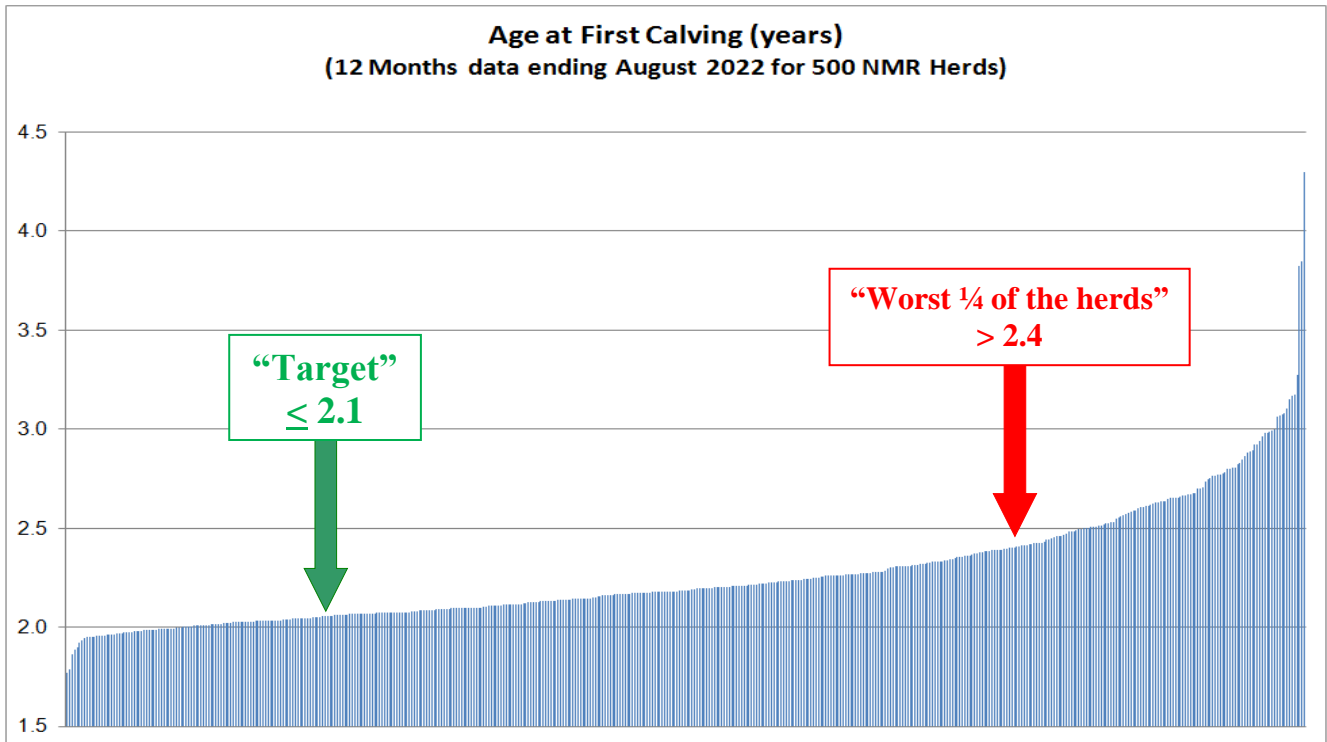
I. Age at 1st calving: The average age (in years) of heifers calving down over the last year.

Target (top ¼ of herds' level): 2.1 (756 days)

Median: 2.2 (799 days)

75% level: 2.4 (872 days)

Inter-quartile range: 0.3 (116 days)



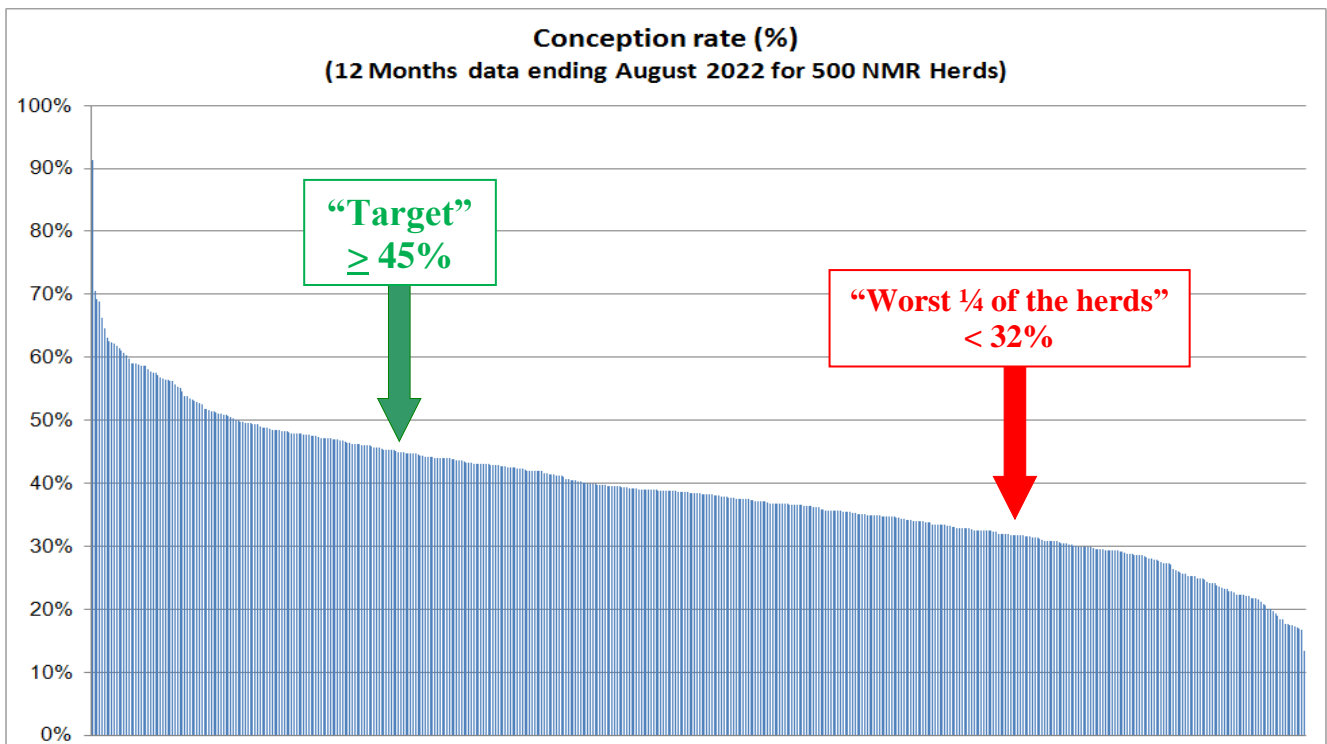
J. Conception rate: The average conception rate for all services in the last 12 months.

Target (top ¼ of herds' level): 45%

Median: 38%

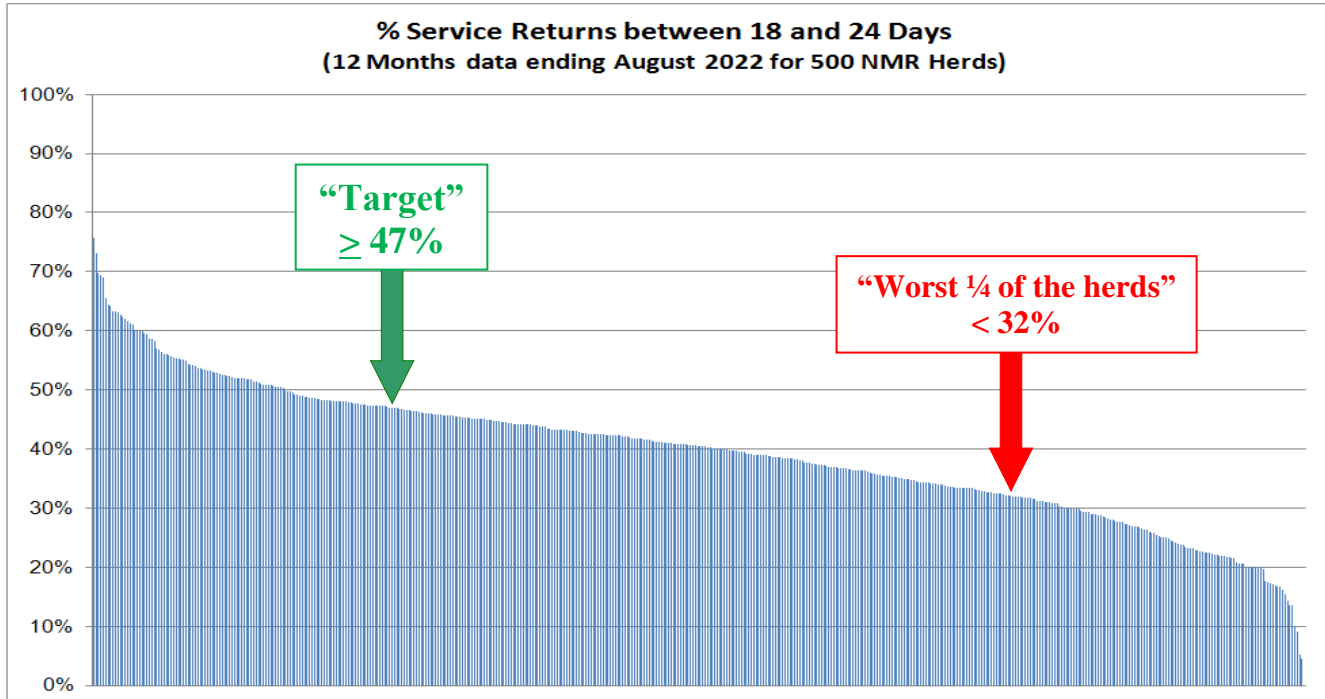
75% level: 32%

Inter-quartile range: 13%



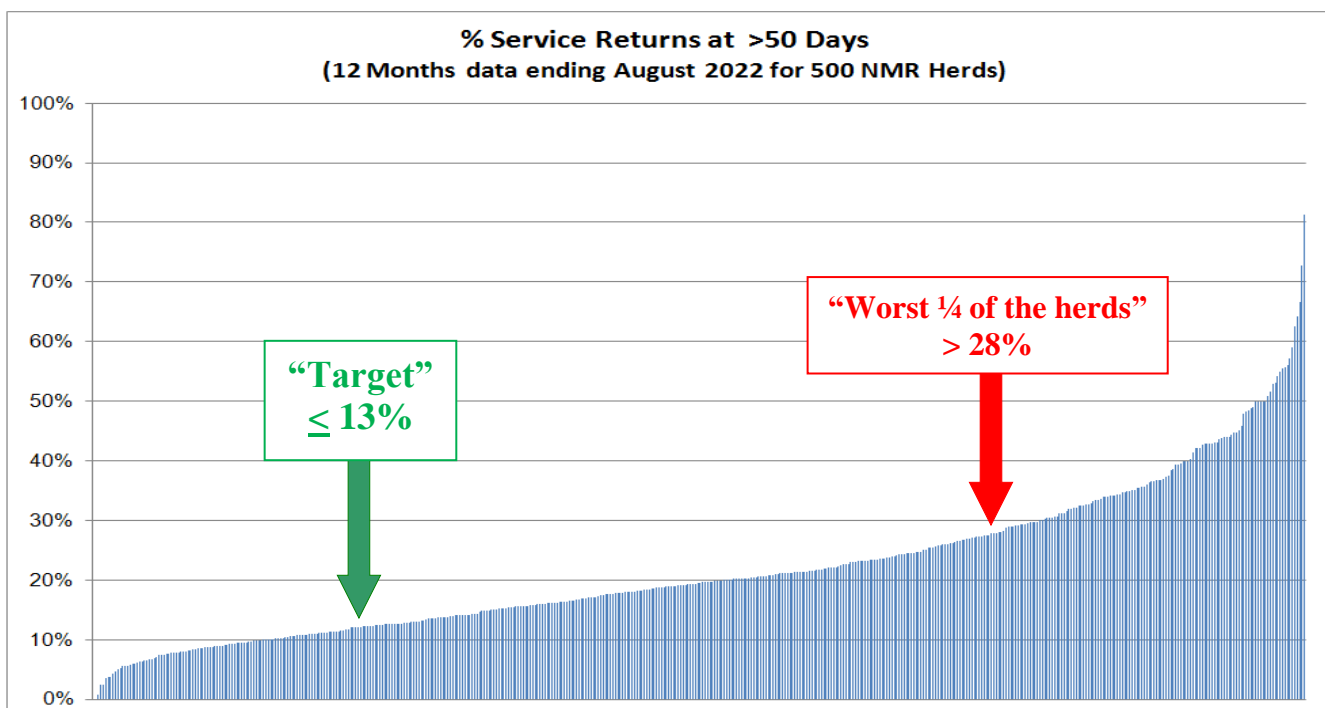
K. % service intervals at 18-24 days (Heat detection): The percentage of all repeat services occurring 18-24 days (one oestrous cycle) after the previous service.

Target (top ¼ of herds' level): 47%
 Median: 41%
 75% level: 32%
 Inter-quartile range: 15%



L. % service intervals >50 days: The percentage of all repeat services with an interval of over 50 days since the previous service. A potential indicator of poor heat detection.

Target (top ¼ of herds' level): 13%
 Median: 19%
 75% level: 28%
 Inter-quartile range: 15%



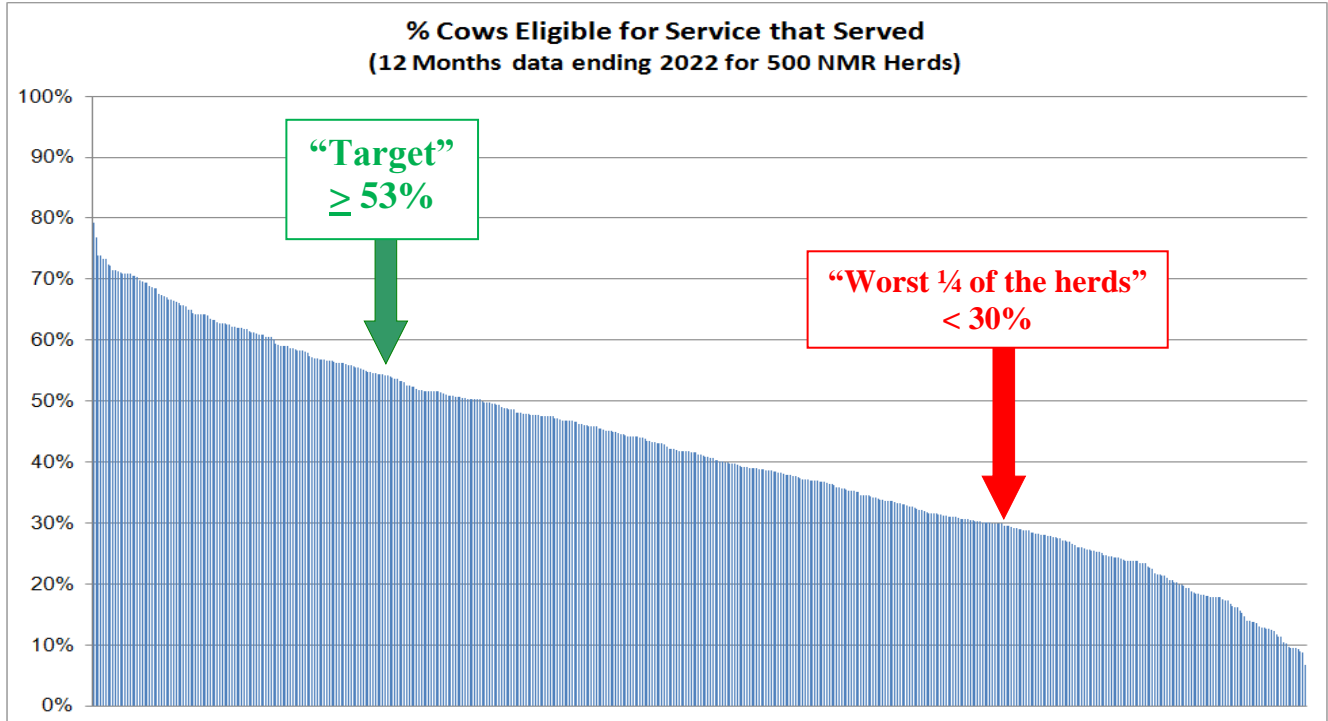
M. Percentage of cows eligible for service (>42 days calved, not barren, not pregnant) that were served per 21 day oestrous period (Submission rate).

Target (top ¼ of herds' level): 53%

Median: 41%

75% level: 30%

Inter-quartile range: 23%



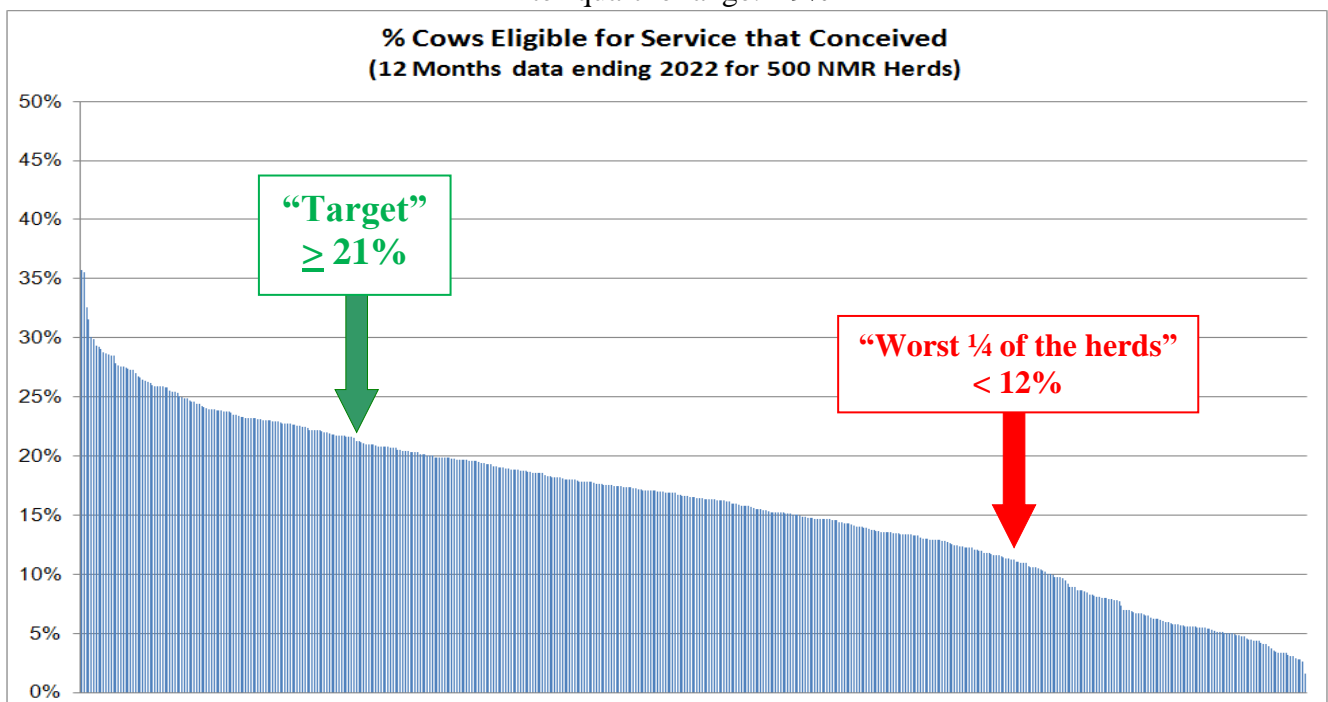
N. Percentage eligible for service (>42 days calved, not barren, not pregnant) that conceived per 21 day oestrus period (Pregnancy rate).

Target (top ¼ of herds' level): 21%

Median: 16%

75% level: 12%

Inter-quartile range: 9%



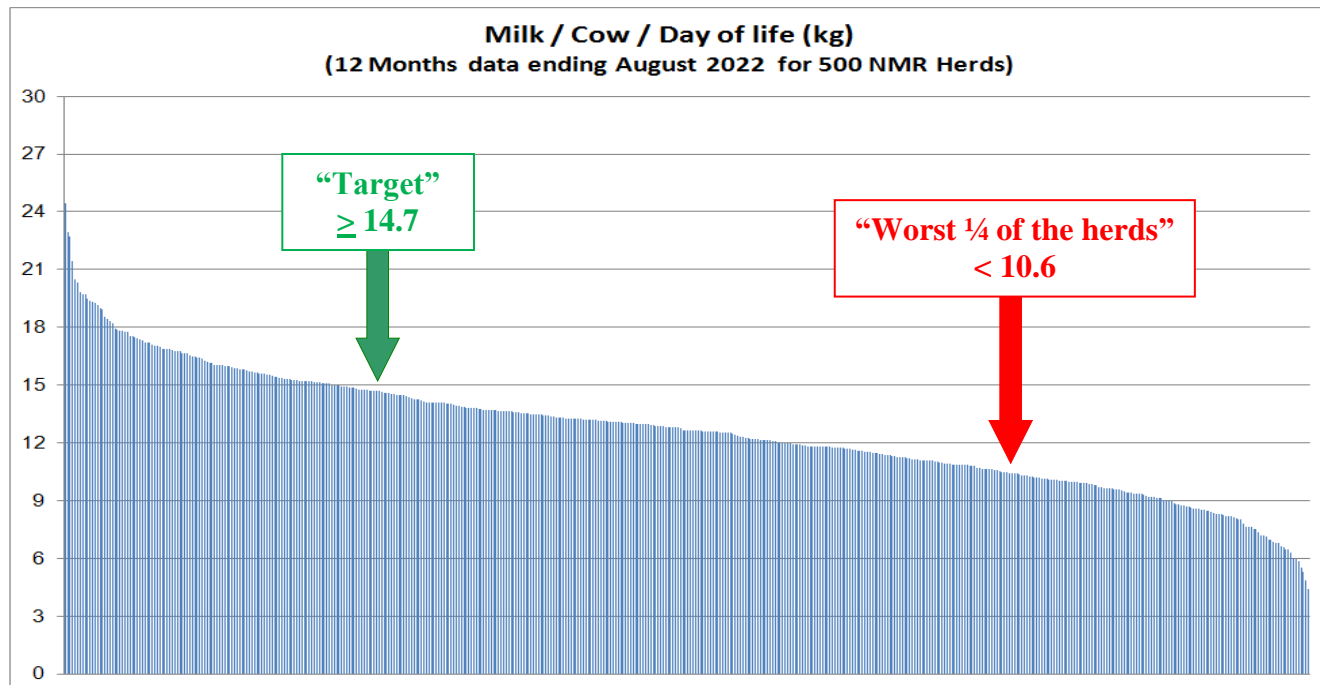
O. Lifetime milk / cow / day (kg): Equates to the average daily milk yield of cows across their whole lifetime (including unproductive periods: time as a heifer, dry periods).

Target (top ¼ of herds' level): 14.7

Median: 12.7

75% level: 10.6

Inter-quartile range: 4.1



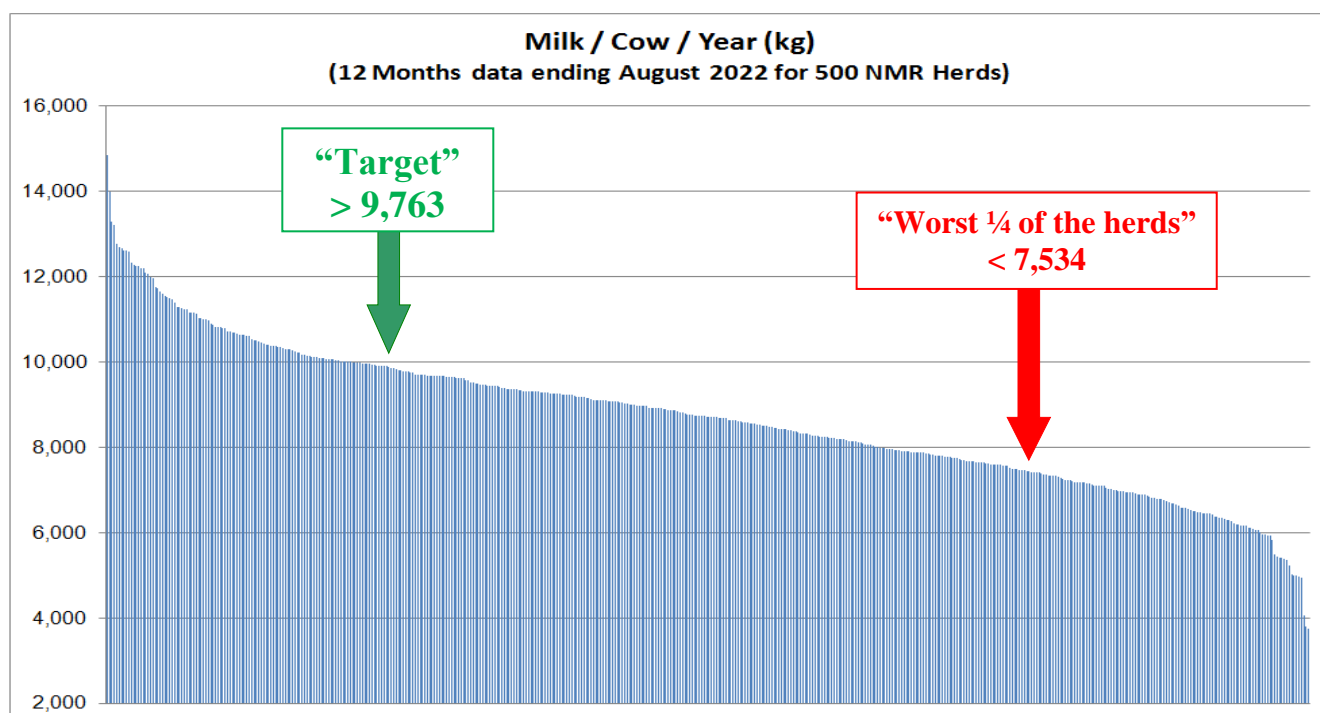
P. Milk / cow / year (kg): The average annual milk yield of all cows in the year. Total milk divided by the average cow population. A measure of milk yield per cow place in the herd.

Target (top ¼ of herds' level): 9,763

Median: 8,708

75% level: 7,534

Inter-quartile range: 2,229



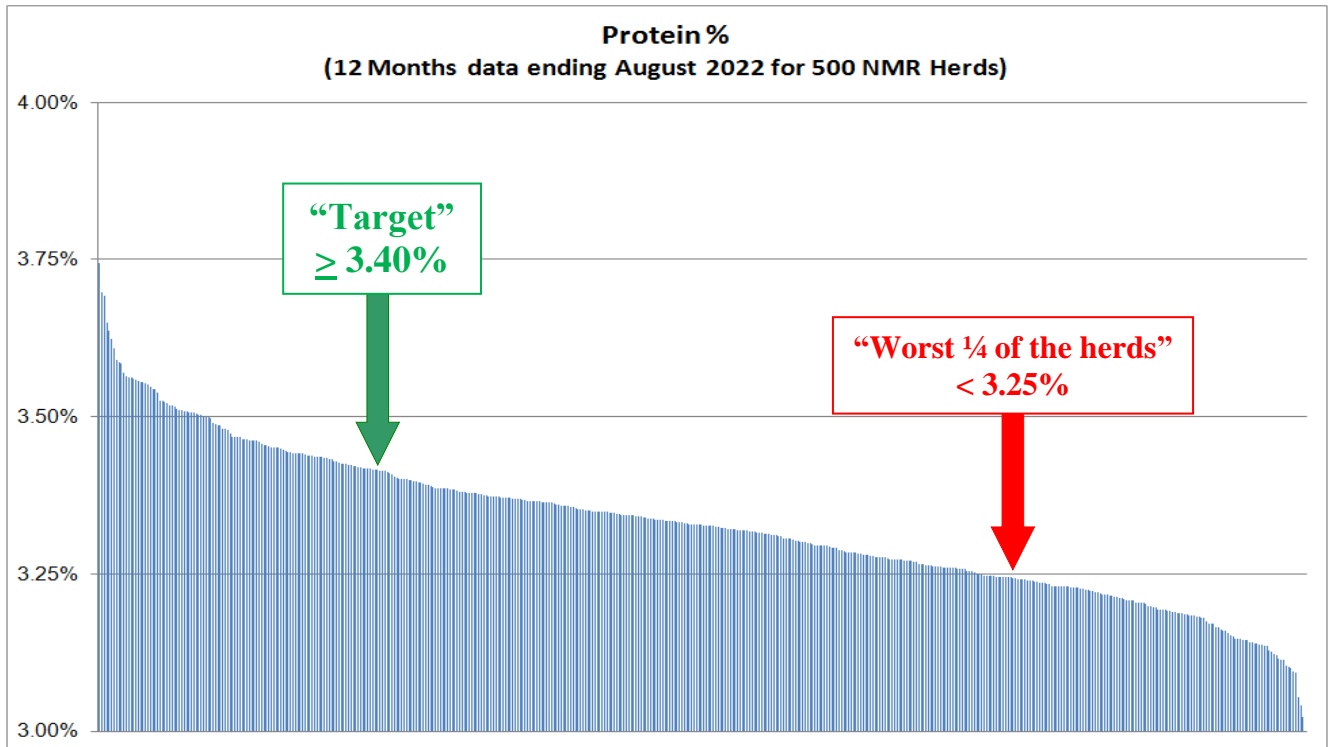
Q. Average protein (%): The average % protein of all milk samples taken over the year.

Target (top ¼ of herds' level): 3.40%

Median: 3.33%

75% level: 3.25%

Inter-quartile range: 0.15%



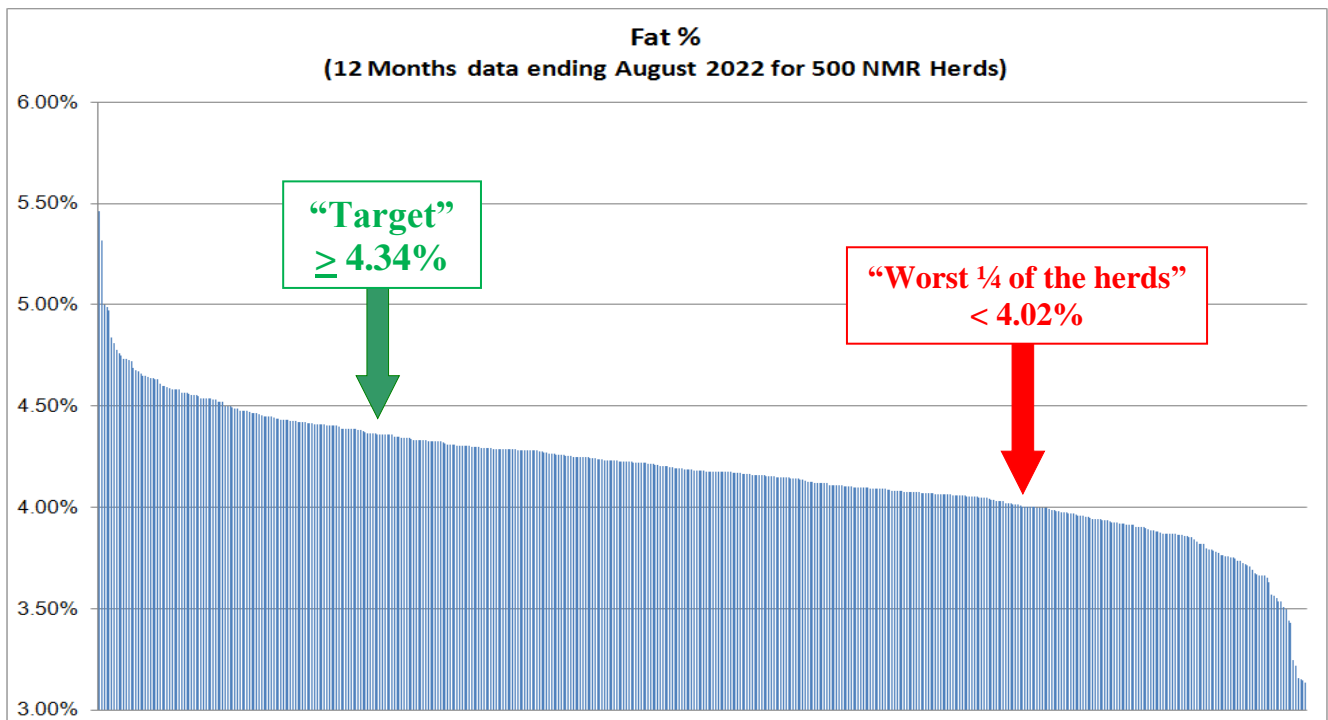
R. Average fat (%): The average % fat of all milk samples taken over the year.

Target (top ¼ of herds' level): 4.34%

Median: 4.18%

75% level: 4.02%

Inter-quartile range: 0.32%



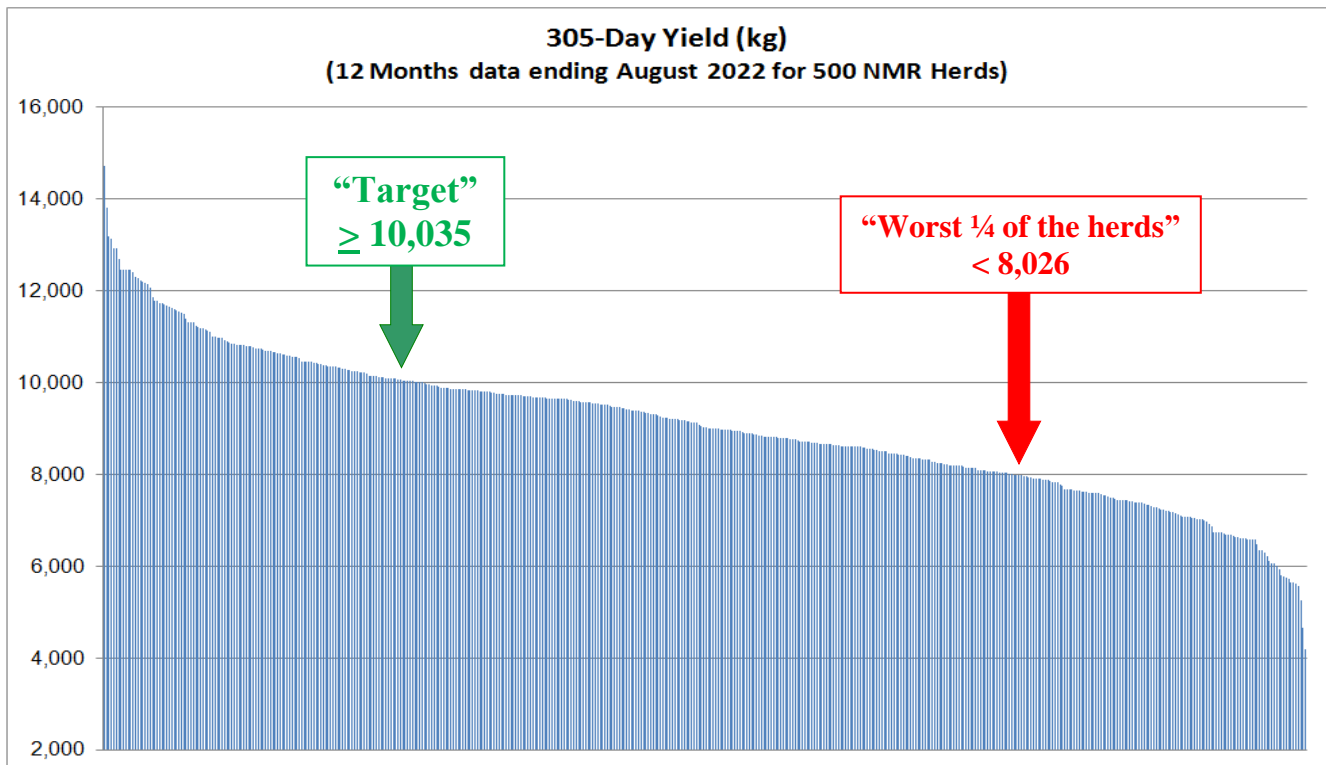
S. 305 day yield (kg): The average yield of cows by day 305 of the lactation.

Target (top ¼ of herds' level): 10,035

Median: 9,010

75% level: 8,026

Inter-quartile range: 2,106



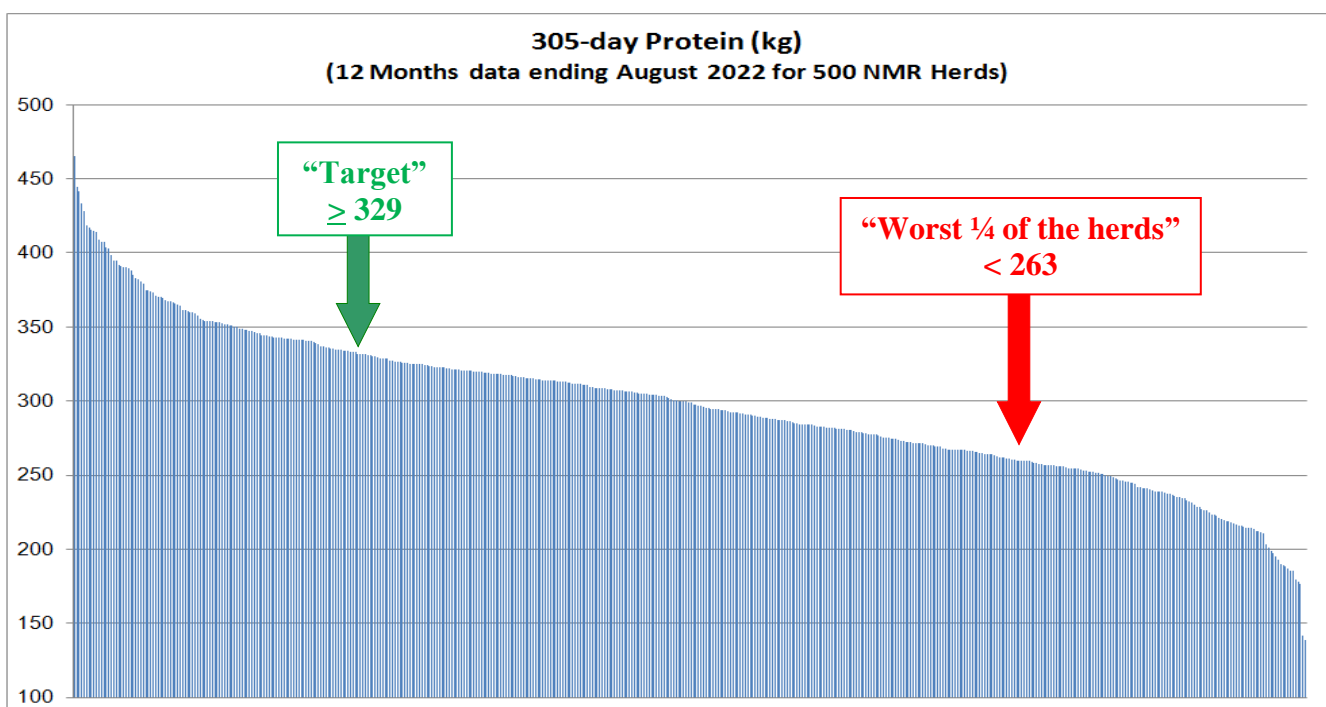
T. 305 day protein (kg): The average milk protein yield of cows by day 305 of the lactation.

Target (top ¼ of herds' level): 329

Median: 299

75% level: 263

Inter-quartile range: 66



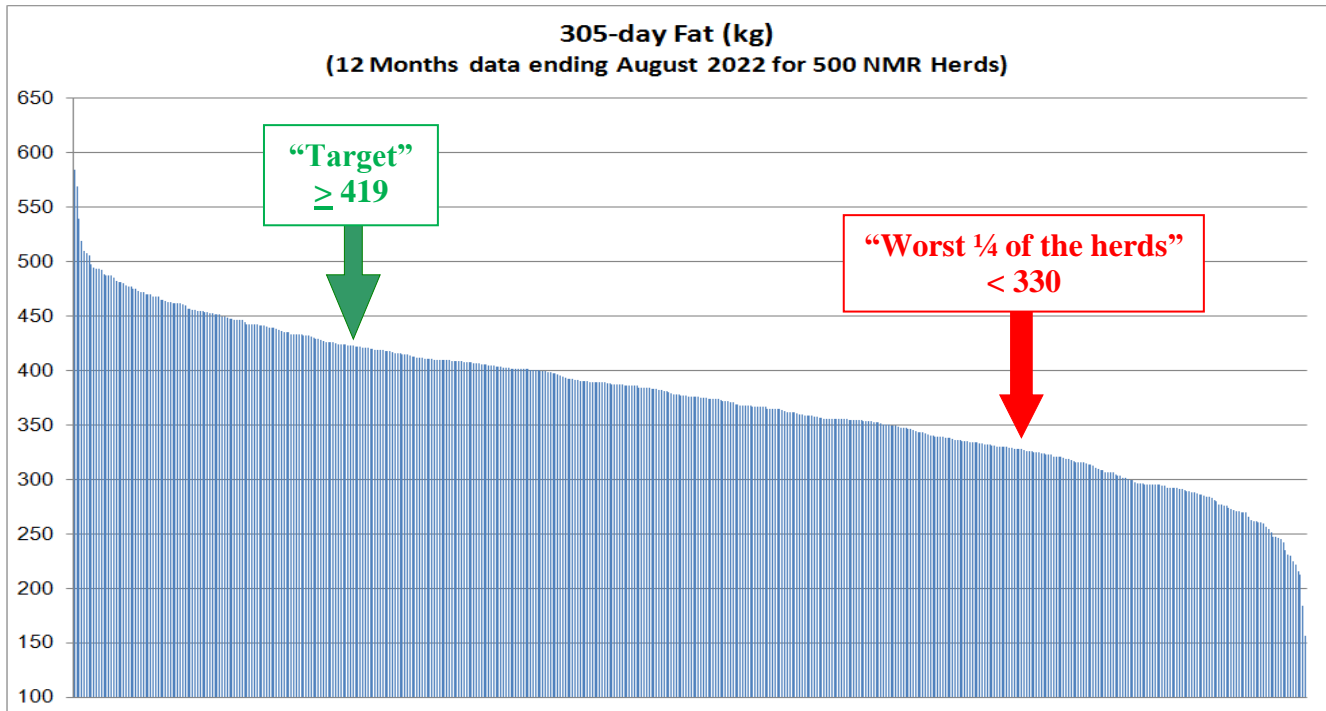
U. 305 day fat (kg): The average milk fat yield of cows by day 305 of the lactation.

Target (top ¼ of herds' level): 419

Median: 376

75% level: 330

Inter-quartile range: 89



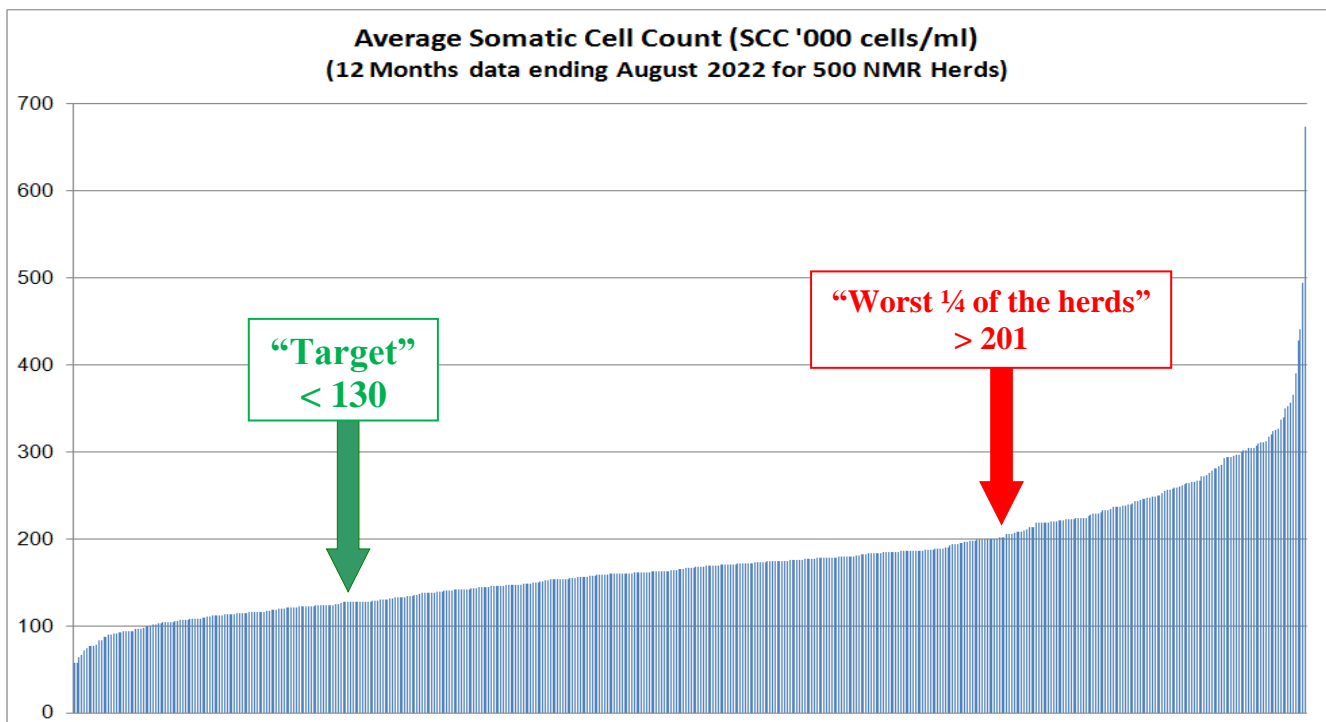
V. Herd SCC ('000 cells/ml): The weighted average SCC of all milk samples taken in the last 12 months (weighted for volume of production of each cow producing the sample).

Target (top ¼ of herds' level): 130

Median: 166

75% level: 201

Inter-quartile range: 71



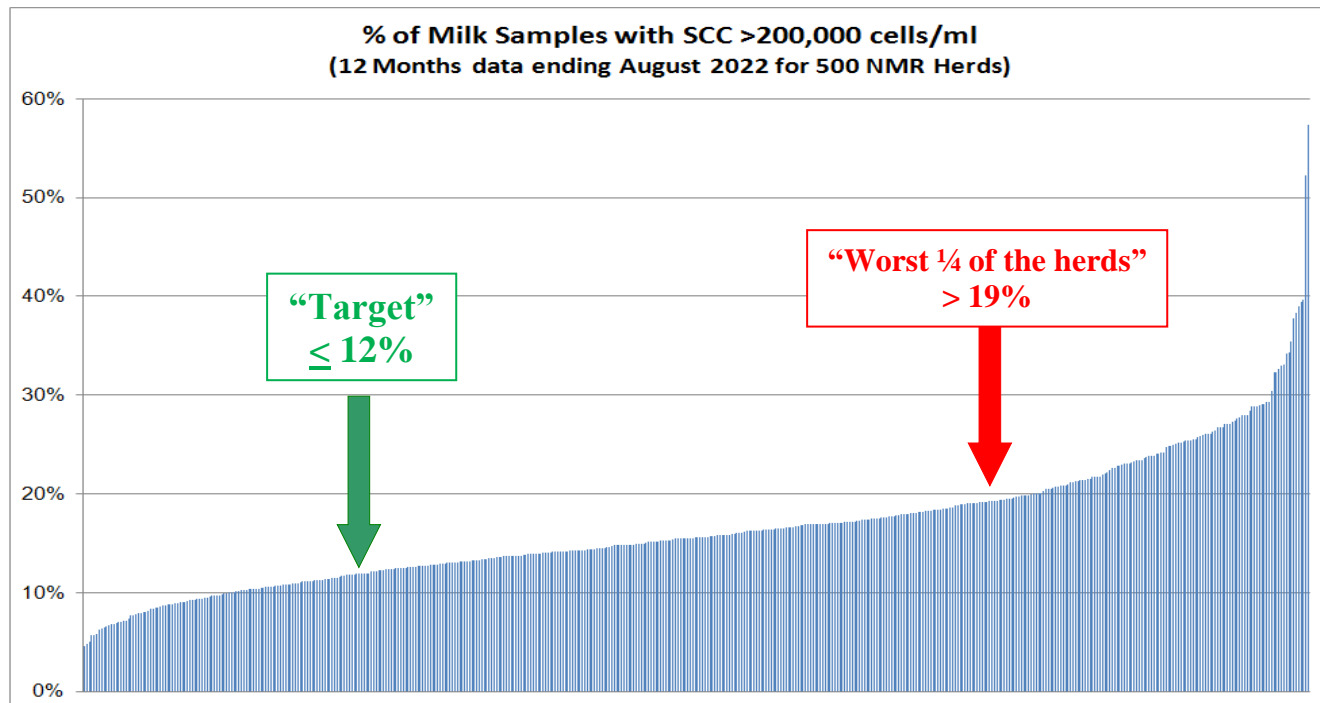
W. % of milk samples with high SCC: The percentage of milk samples in the last 12 months with a SCC $\geq 200,000$ cells/ml of milk. Indicates the size of any reservoir of infection.

Target (top $\frac{1}{4}$ of herds' level): 12%

Median: 16%

75% level: 19%

Inter-quartile range: 7%



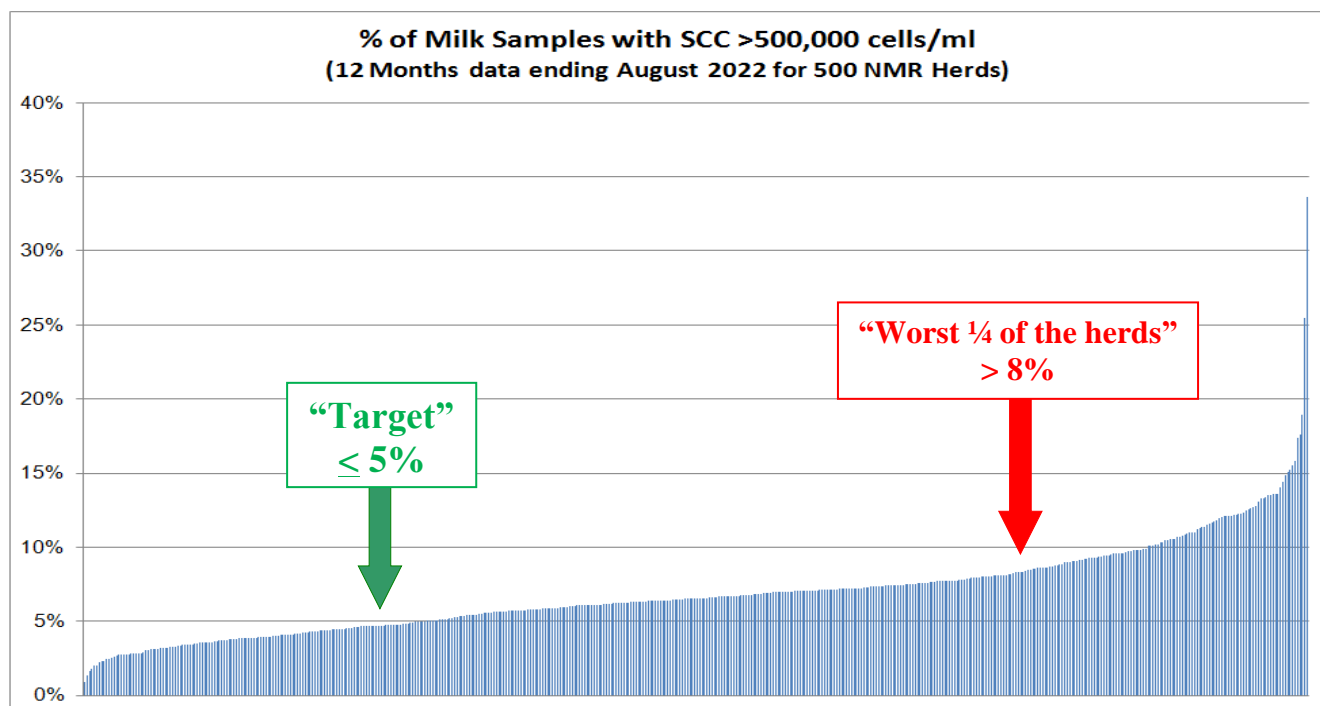
X. % of milk samples with SCC $\geq 500,000$ cells/ml: The percentage of milk samples taken in the last 12 months with a SCC $\geq 500,000$ cells/ml of milk.

Target (top $\frac{1}{4}$ of herds' level): 5%

Median: 7%

75% level: 8%

Inter-quartile range: 3%



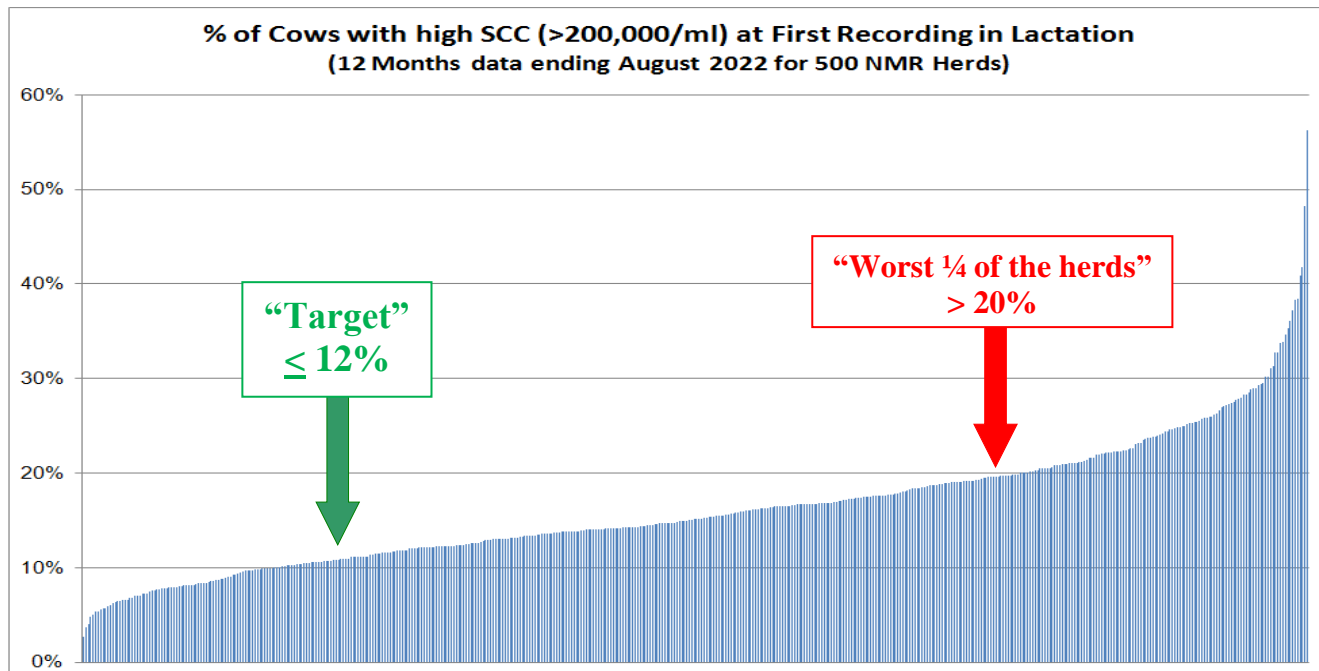
Y. % 1st recording SCC \geq 200,000 cells/ml: The percentage of new lactations in the last year starting with a high SCC (\geq 200,000 cells) at the first milk recording.

Target (top ¼ of herds' level): 12%

Median: 5%

75% level: 20%

Inter-quartile range: 8%



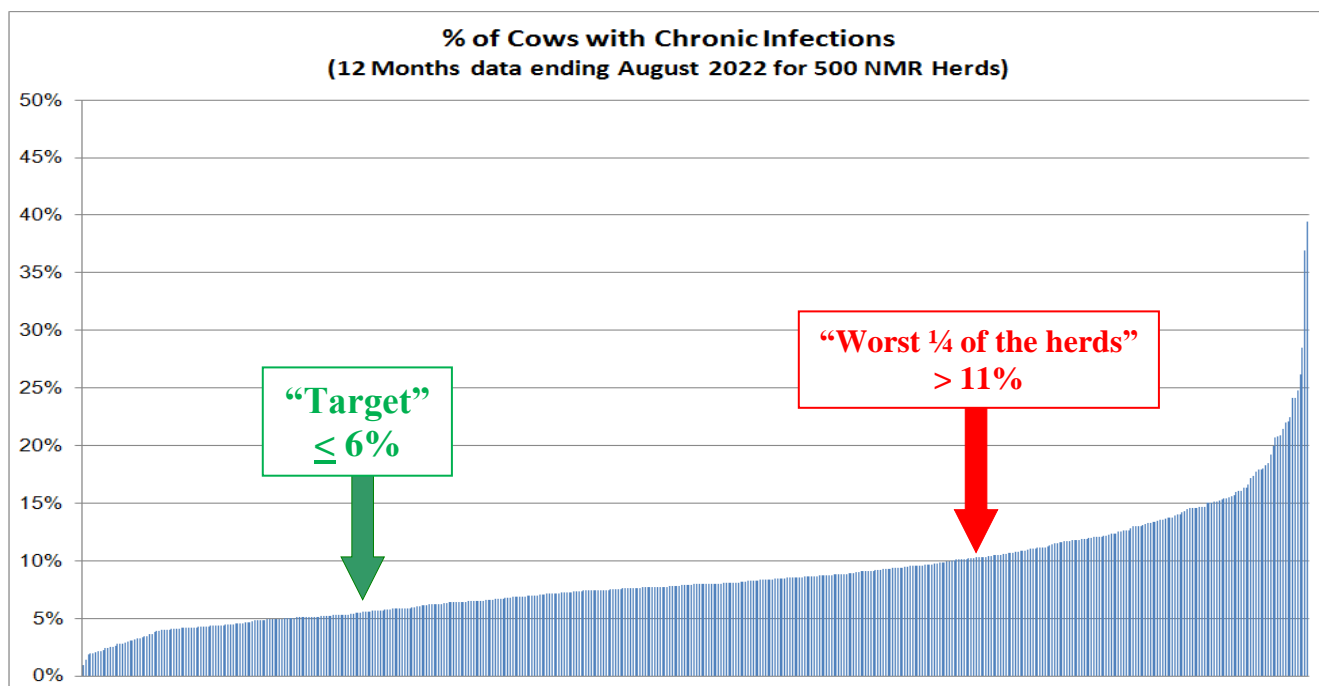
Z. Percentage chronic SCC \geq 200,000 cells/ml: The % of all milk samples taken over the last 12 months that were from CHRONIC cows (cows whose milk was \geq 200,000 cells at both the CURRENT AND PREVIOUS milk recordings).

Target (top ¼ of herds' level): 6%

Median: 8%

75% level: 11%

Inter-quartile range: 5%



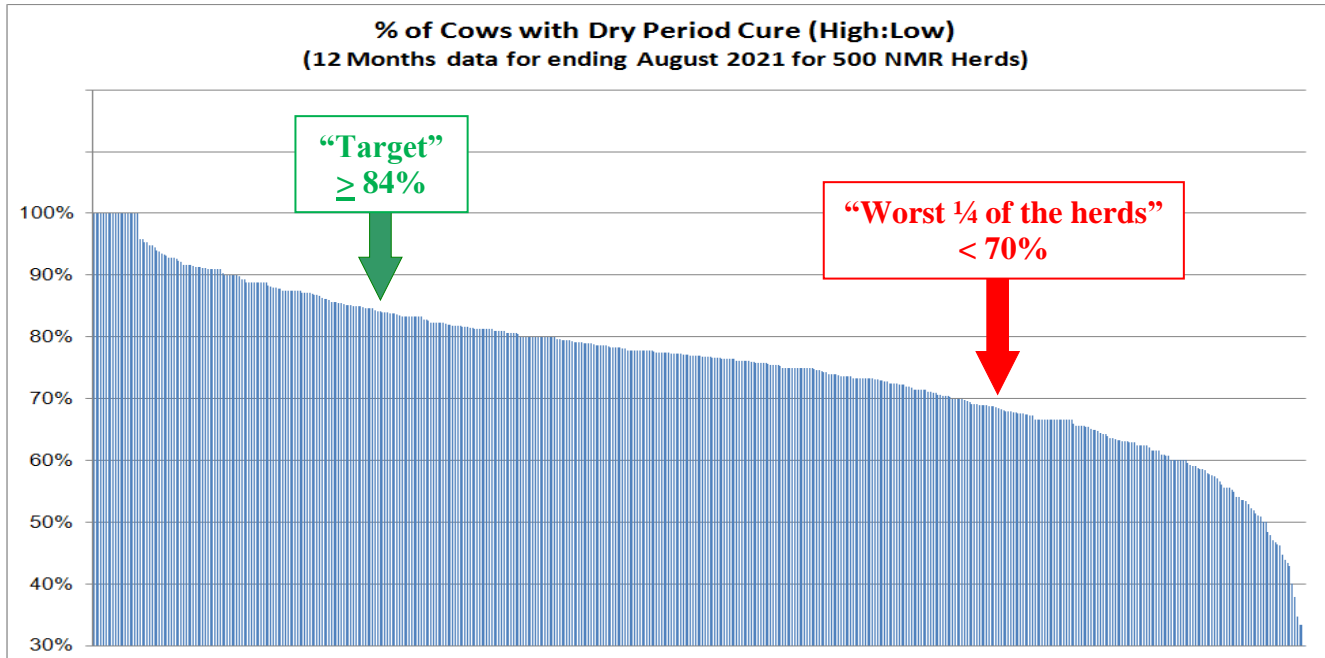
ZA. Dry period cure (High:Low): The % of cows calving in the last year that ended their previous lactation with a high SCC ($\geq 200,000$ cells), started the new lactation with a LOW cell count ($< 200,000$ cells). The % of high SCC cows “cured” in the dry period.

Target (top ¼ of herds’ level): 84%

Median: 78%

75% level: 70%

Inter-quartile range: 14%



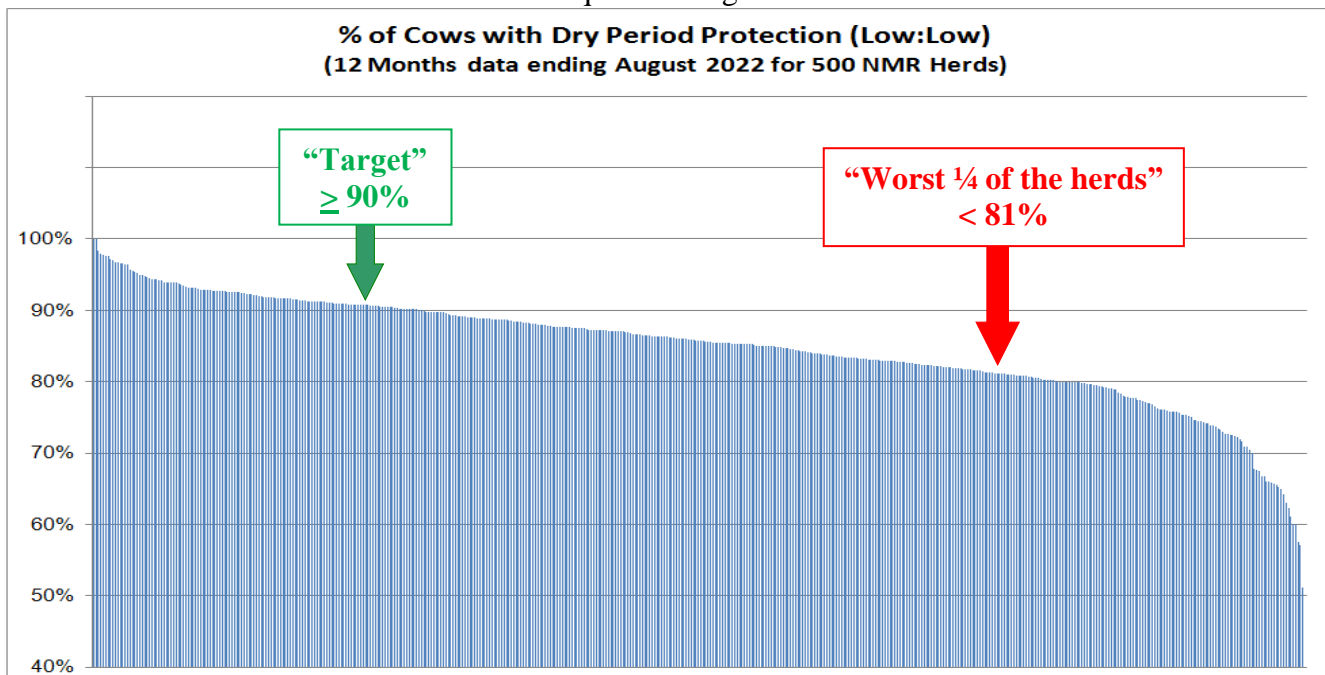
ZB. Dry period protection (Low:Low): The % of cows calving in the last year that ended the previous lactation with a LOW SCC ($< 200,000$ cells) then started the new lactation with a LOW cell count ($< 200,000$ cells). The % of low SCC cows “protected” in the dry period.

Target (top ¼ of herds’ level): 90%

Median: 86%

75% level: 81%

Inter-quartile range: 9%



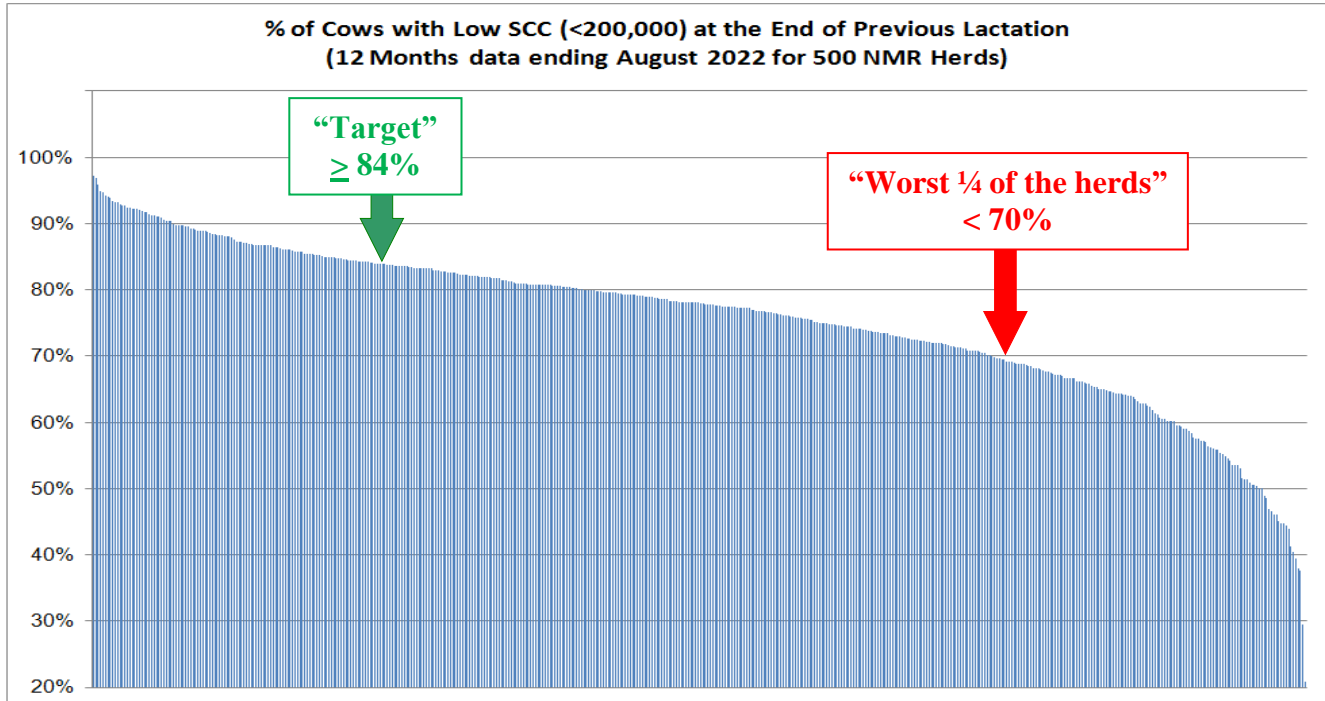
ZC. % Low at the end of previous lactation: The percentage of cows calving in the last year that ended their previous lactation with a LOW SCC (< 200,000 cells).

Target (top ¼ of herds' level): 84%

Median: 78%

75% level: 70%

Inter-quartile range: 14%



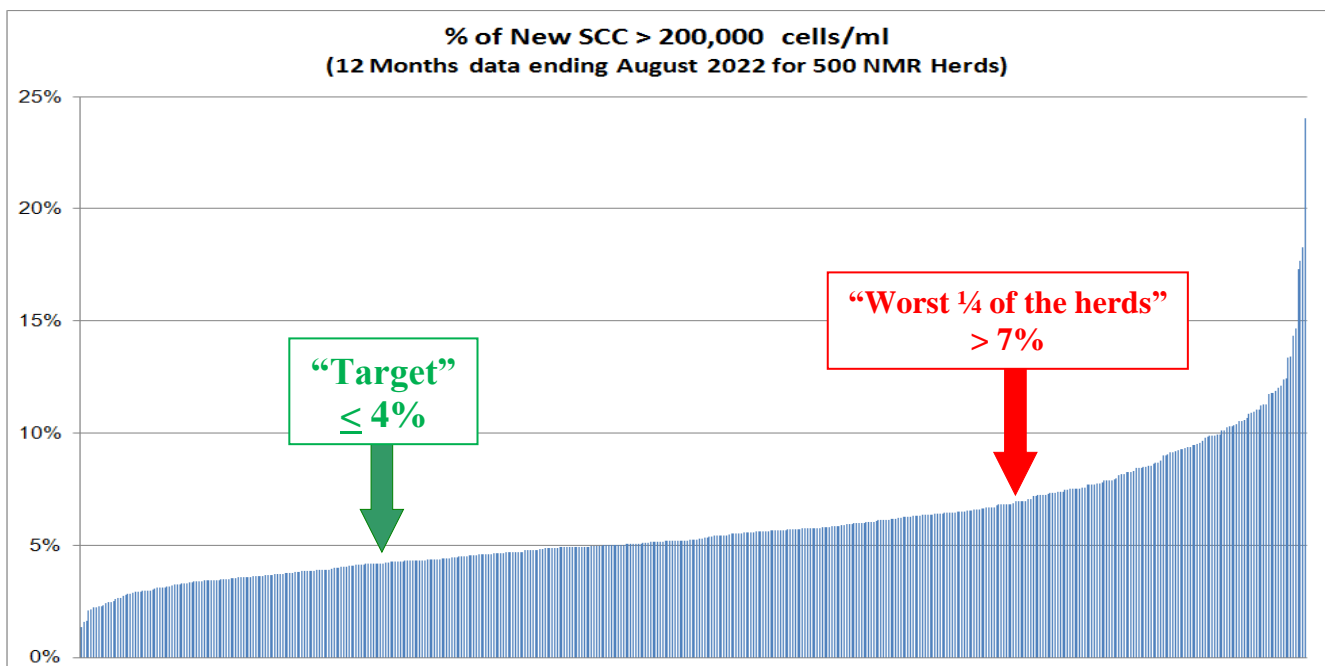
ZD. % NEW SCC milk samples: Of all milk samples, the percentage that were of the NEW Herd Companion SCC Category (the first HIGH SCC $\geq 200,000$ cells/ml) in a lactation following one or more low SCC samples).

Target (top ¼ of herds' level): 4%

Median: 5%

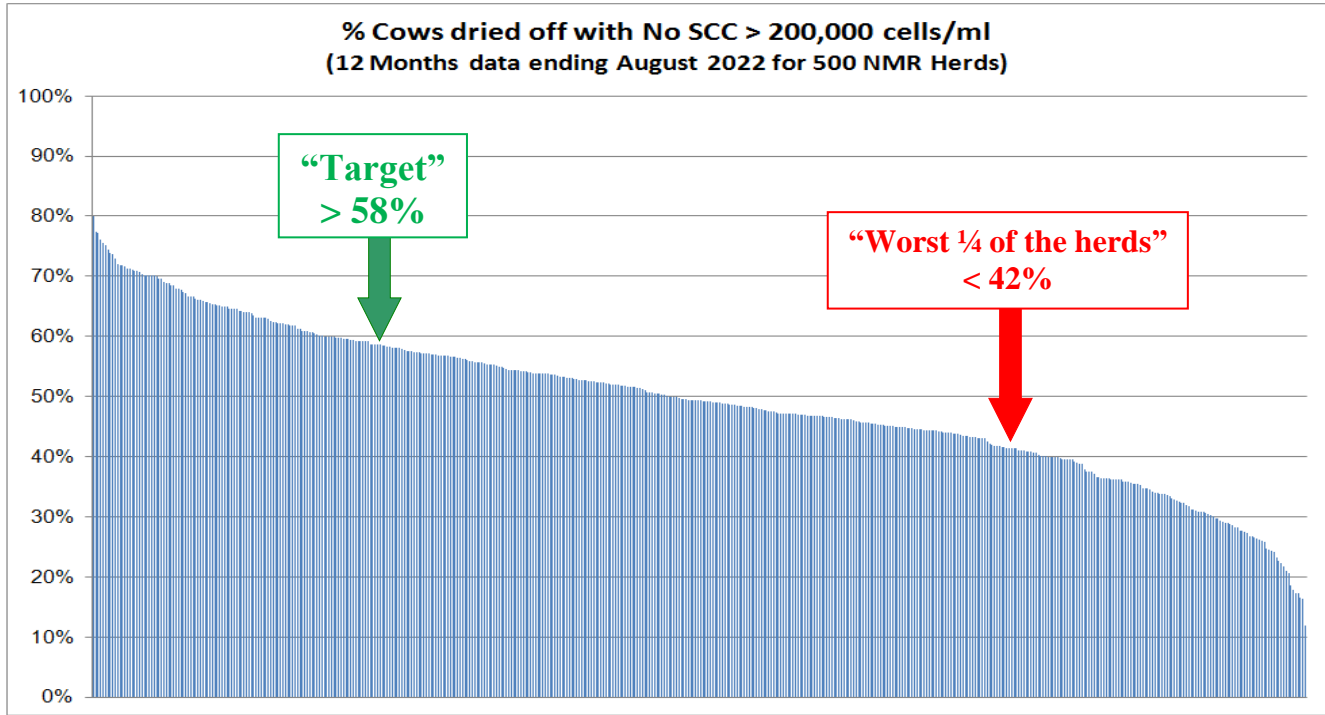
75% level: 7%

Inter-quartile range: 3%



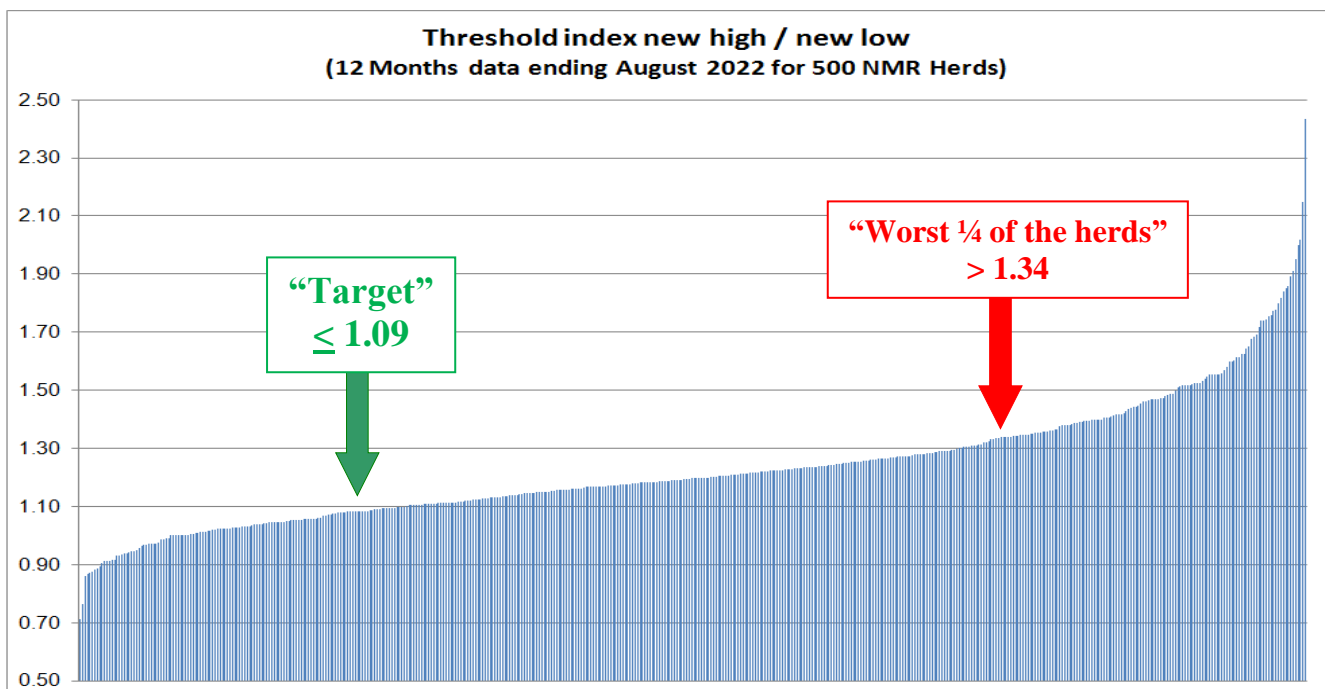
ZE. % dried-off with no SCC \geq 200,000 cells/ml: The percentage of cows recording only LOW SCC samples ($<$ 200,000 cells/ml) in completed lactations.

Target (top ¼ of herds' level): 58%
 Median: 49%
 75% level: 42%
 Inter-quartile range: 16%



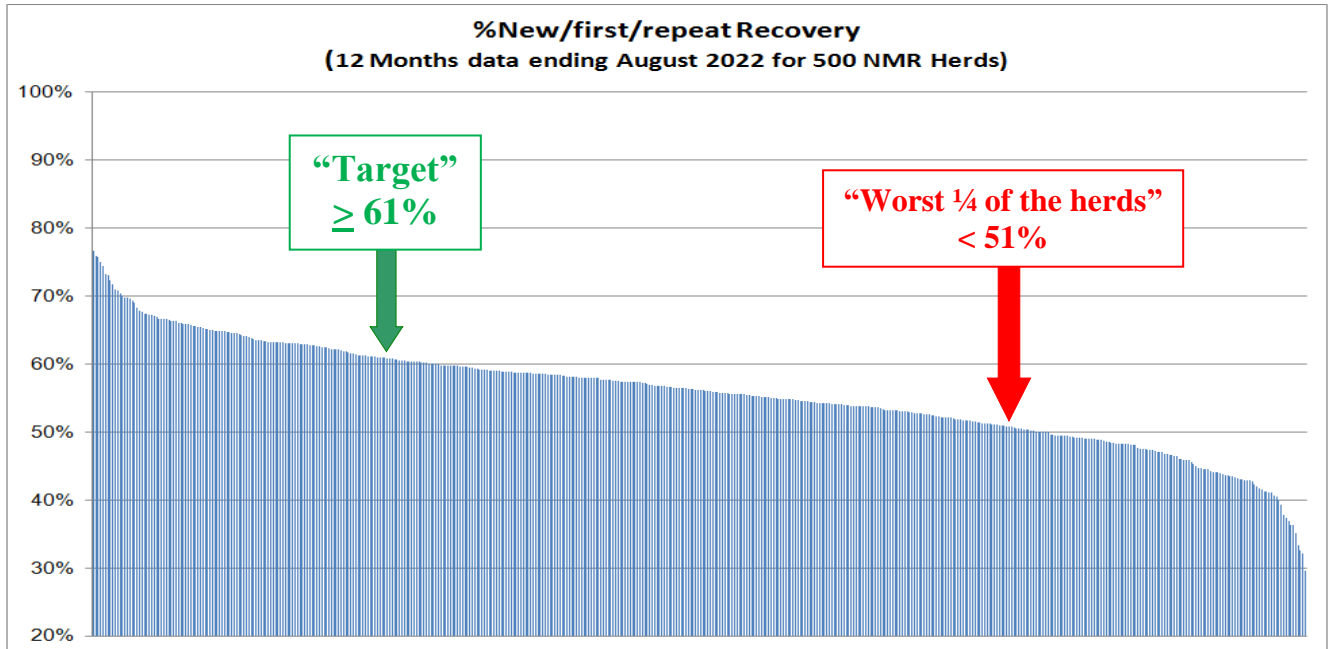
ZF. Threshold Index new high / new low: The total cows changing from Low to High SCC divided by the total cows changing from High to Low SCC at consecutive recordings.

Target (top ¼ of herds' level): 1.09
 Median: 1.20
 75% level: 1.34
 Inter-quartile range: 0.25



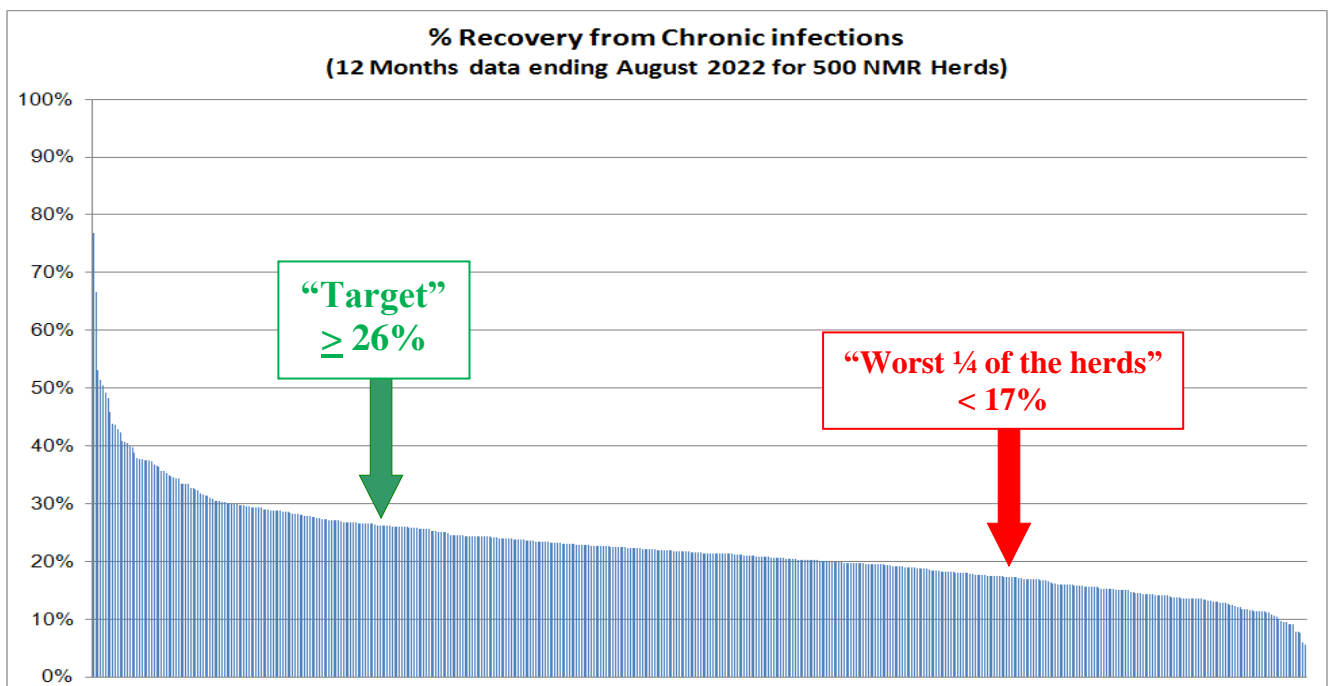
ZG. Recovery % of New/First/Repeat infections: Of HIGH SCC cows ($\geq 200,000$ cells/ml) that at the previous recording were either low SCC or not yet in milk, the percentage that were LOW SCC ($< 200,000$ cells/ml) at the following recording.

Target (top ¼ of herds' level): 61%
 Median: 56%
 75% level: 51%
 Inter-quartile range: 10%



ZH. Recovery % of chronic infections: Of cows with two or more consecutive HIGH SCC recordings ($\geq 200,000$ cells/ml), the percentage that recorded a LOW SCC ($< 200,000$ cells/ml) at the following recording.

Target (top ¼ of herds' level): 26%
 Median: 21%
 75% level: 17%
 Inter-quartile range: 9%



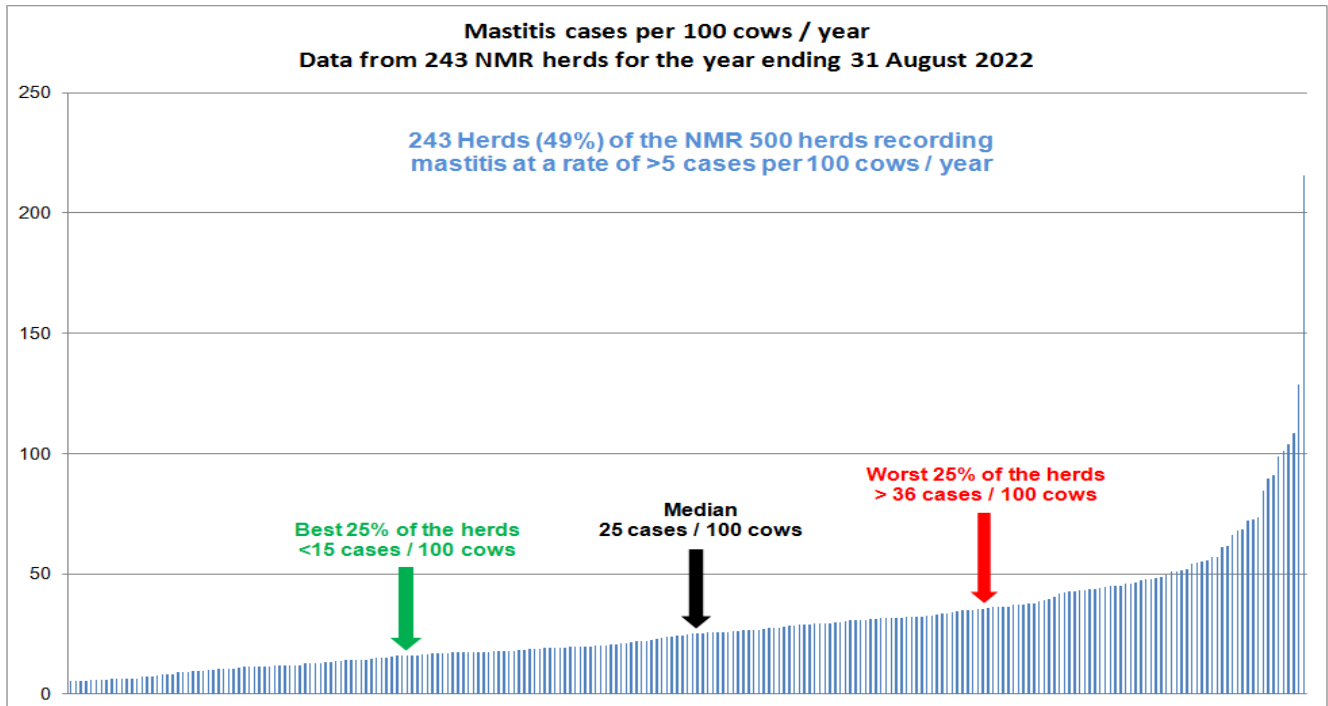
ZJ. Mastitis rate: Number of clinical mastitis cases per 100 cows in milk in the herd over a year.

Target (top ¼ of herds' level): 15

Median: 25

75% level: 36

Inter-quartile range: 21



Section 3: Trends in Key Performance Indicators 2010 to 2022

The target and median figures from the current study are compared with the results from the first study for the year ending 30 September 2010 and from last year's study. Table 2 below shows changes in the median and target (top 25% performance) values for each parameter over the period. The majority of parameters have improved (**green**) over the period with the exception of overall culling, age & number of lactations at exit which show some deterioration (**red**). Some of the parameters have continued to improve since last year (2021). There is no attempt at identifying any statistical significance in these changes. Median values for culling rate, age and number of lactations at exist indicate slight improvement in 2022 compared to figures from previous year (2021).

Table 2(a). Comparison of median and target values derived from the study of 500 NMR recording herds in 2021 with the original study in 2010, and with the current results as well. (Longevity and Fertility).

Parameter	Median			Target "Best 25%"			
	<i>Year of the Study</i>	2010	2021	2022	2010	2021	2022
A. Culling rate		24%	28%	26%	18%	23%	22%
B. Percentage culled (off take) / died 100 days after calving		7%	5%	5%	4%	3%	3%
C(a). Age at exit (years)		6.6	5.9	6.0	7.4	6.7	6.7
C(b). Age at exit (days)		2393	2166	2180	2699	2438	2442
D. Age at exit by lactations		3.9	3.5	3.6	4.5	4.1	4.1
E. Percentage Served by day 80		46%	61%	60%	59%	70%	70%
F. Percentage conceived 100 days after calving		26%	37%	39%	33%	44%	46%
G. Calving to 1 st service interval (days)		105	79	80	87	69	70
H. Calving interval (days)		424	397	394	409	387	384
I(a). Age at 1 st calving (years)		2.4	2.2	2.2	2.3	2.1	2.1
I(b). Age at 1 st calving (days)		894	809	799	828	766	756
J. Conception rate		32%	37%	38%	40%	43%	45%
K. %Service intervals at 18-24 days (Heat detection)		30%	39%	41%	38%	46%	47%
L. %Service intervals >50 days		32%	20%	19%	22%	14%	13%
M. %Cows eligible for service served (Submission rate)		27%	42%	41%	37%	54%	53%

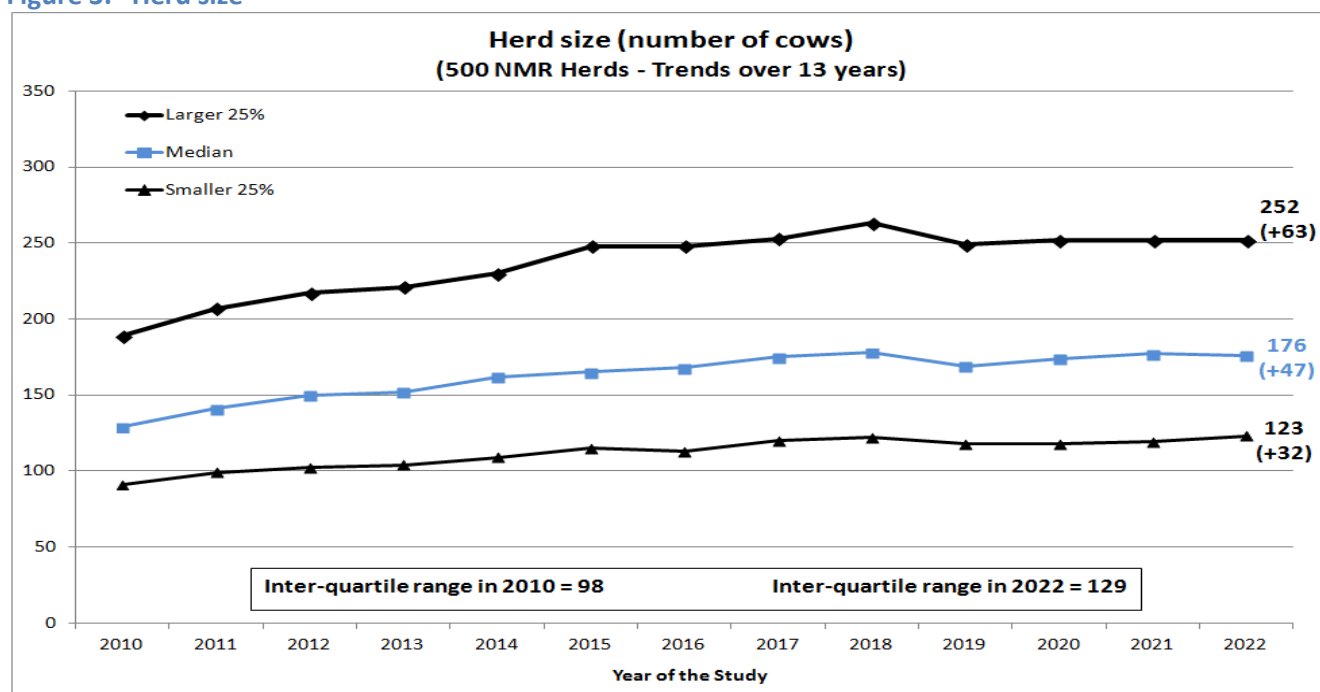
Table 2(b). Comparison of median and target values derived from the study of 500 NMR recording herds in 2021 with the original study in 2010, and with the current results as well. (Milk yield & SCC).

Parameter	Median			Target "Best 25%"			
	Year of the Study	2010	2021	2022	2010	2021	2022
O. Lifetime milk / cow / day (kg)		10.5	13.1	12.7	12.6	15.2	14.7
P. Milk / cow / year (kg)		7,665	9,008	8,708	8,760	10,025	9,763
Q. Average protein%		3.27%	3.31%	3.33%	3.33%	3.39%	3.40%
R. Average fat%		3.96%	4.16%	4.18%	4.12%	4.33%	4.34%
V. Average SCC ('000 cells/ml)		210	173	166	169	136	130
W. % SCC ≥200,000 cells/ml		24%	16%	16%	19%	13%	12%
X. % SCC ≥500,000 cells/ml		9%	7%	7%	7%	5%	5%
Y. % 1st recording SCC ≥200,000 cells/ml		20%	16%	15%	15%	13%	12%
Z. % chronic SCC ≥200,000 cells/ml		14%	8%	8%	10%	6%	6%
ZA. % Dry period cure (High:Low)		74%	77%	78%	80%	84%	84%
ZB. % Dry period protection (Low:Low)		84%	85%	86%	89%	89%	90%
ZC. % Low at end of previous lactation (SCC<200,000 cells/ml)		60%	77%	78%	70%	83%	84%

Changes in Herd size over the 13 annual KPI studies

Figure 3 below shows changes in herd size (number of cows) since 2010, indicating dairy herds in UK tended to increase in size over 8 years since 2010, but with almost no change in the last 4 years, with a large range between the larger and the smaller 25% of the herds.

Figure 3. Herd size



Changes in Key Parameters over the 13 annual KPI studies

The figures below show the changes over the thirteen annual KPI studies (2010 to 2022) for a number of important parameters. The three lines represent the “better” quartile, median and “poorer” quartile values each year for each parameter.

3.1 Trends in Culling & Longevity Parameters over the last 13 years

Figure 4. Culling rate

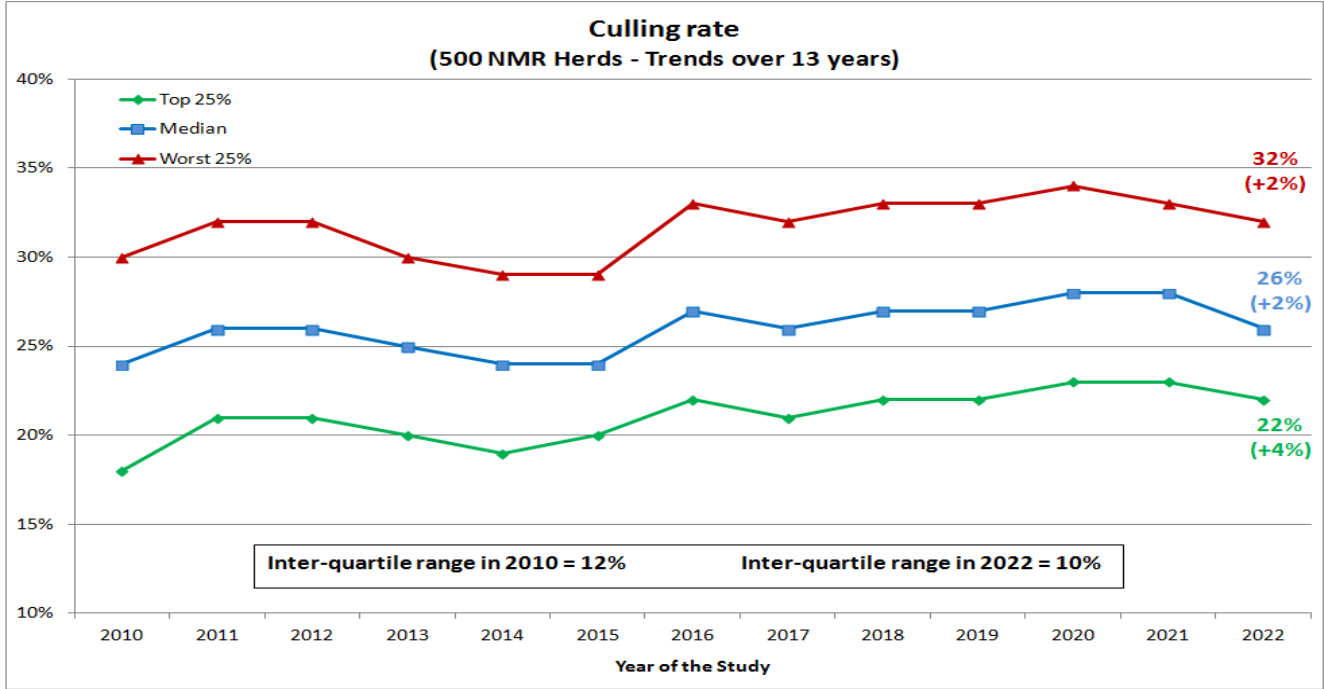


Figure 5. Culling (off take) / died in the first 100 days of lactation

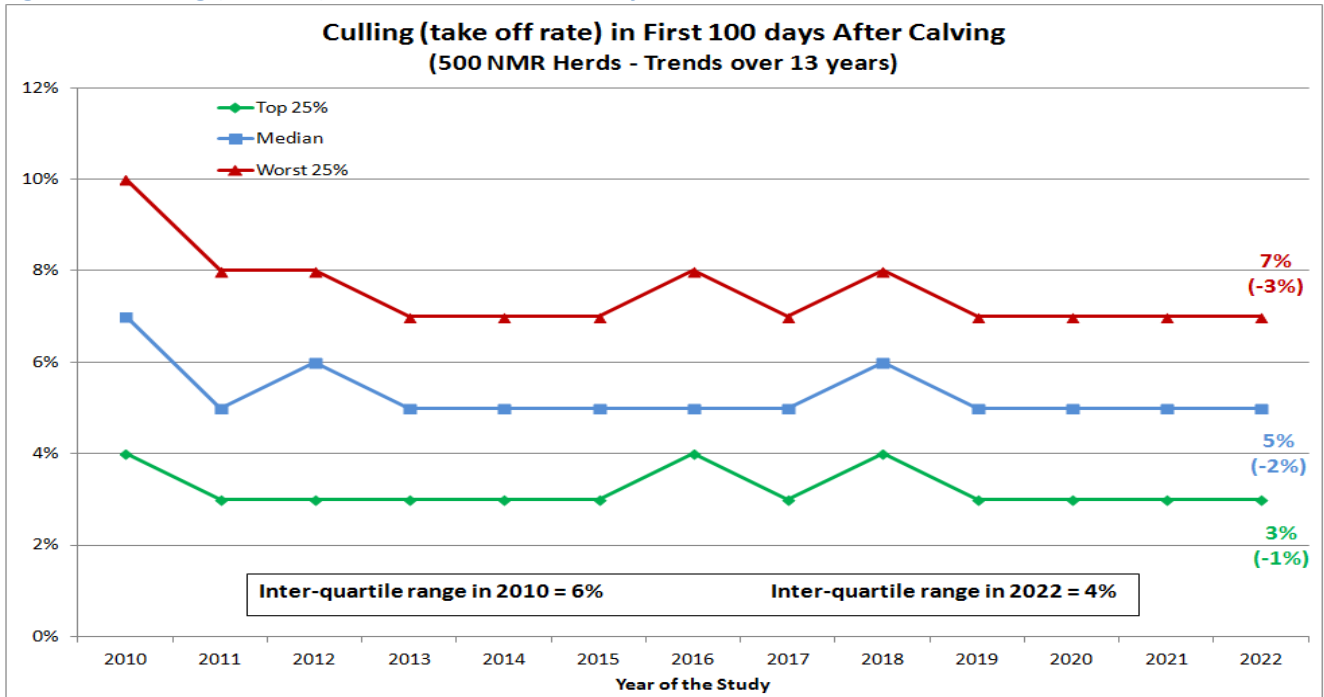


Figure 6. Age at exit (by number of Years)

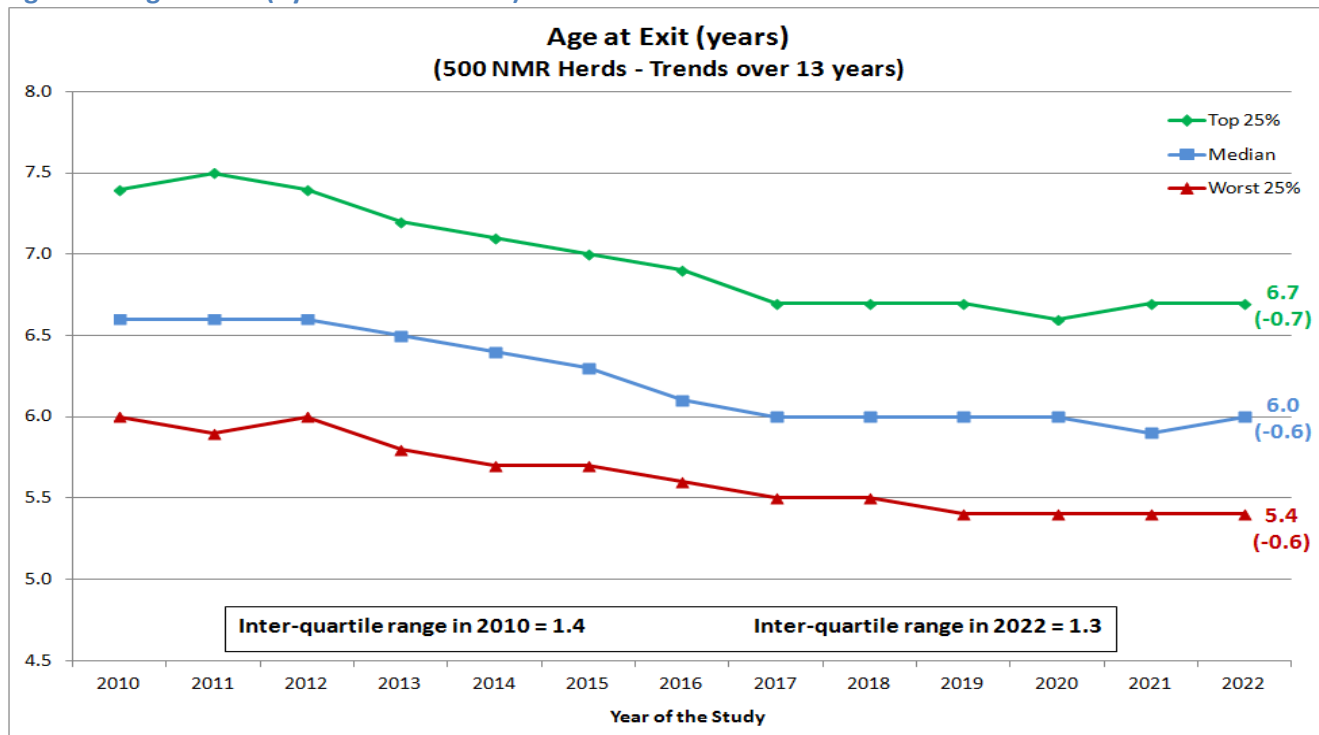
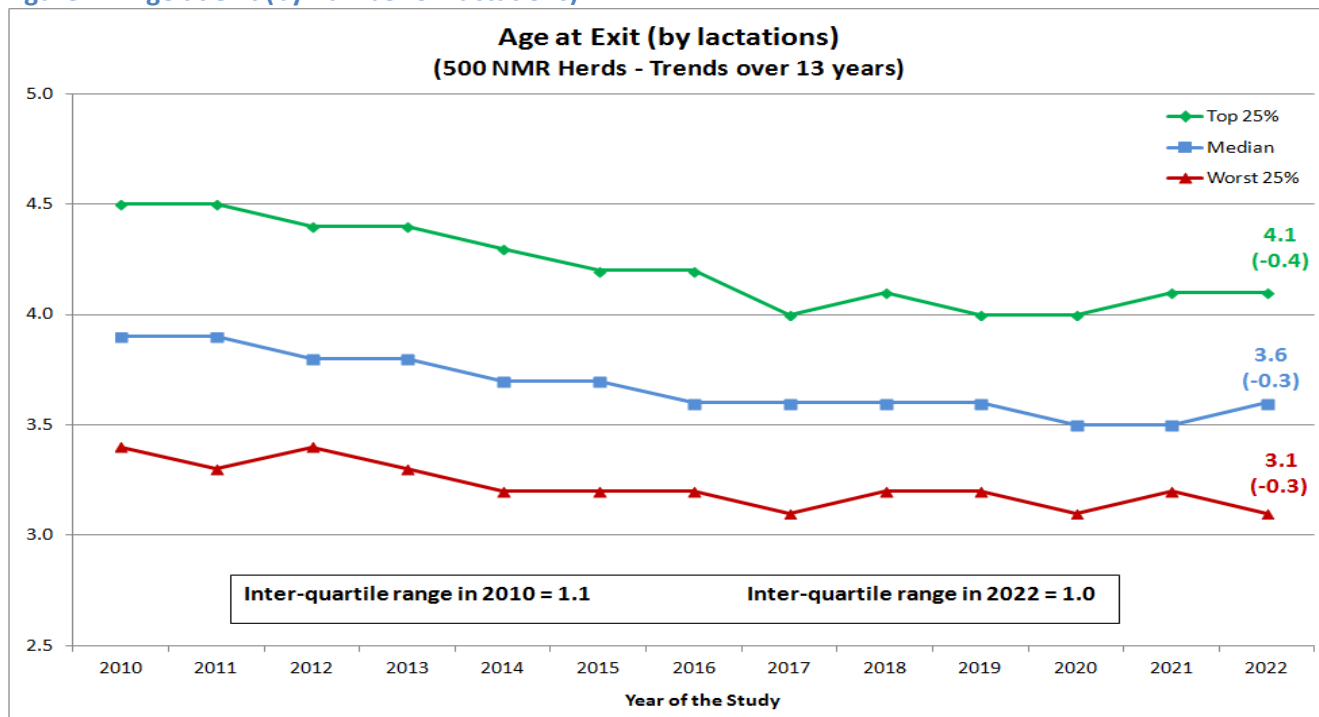


Figure 7. Age at exit (by number of Lactations)



3.2 Trends in Key Fertility Parameters over the last 13 years

Figure 8(a). Age at first calving (years)

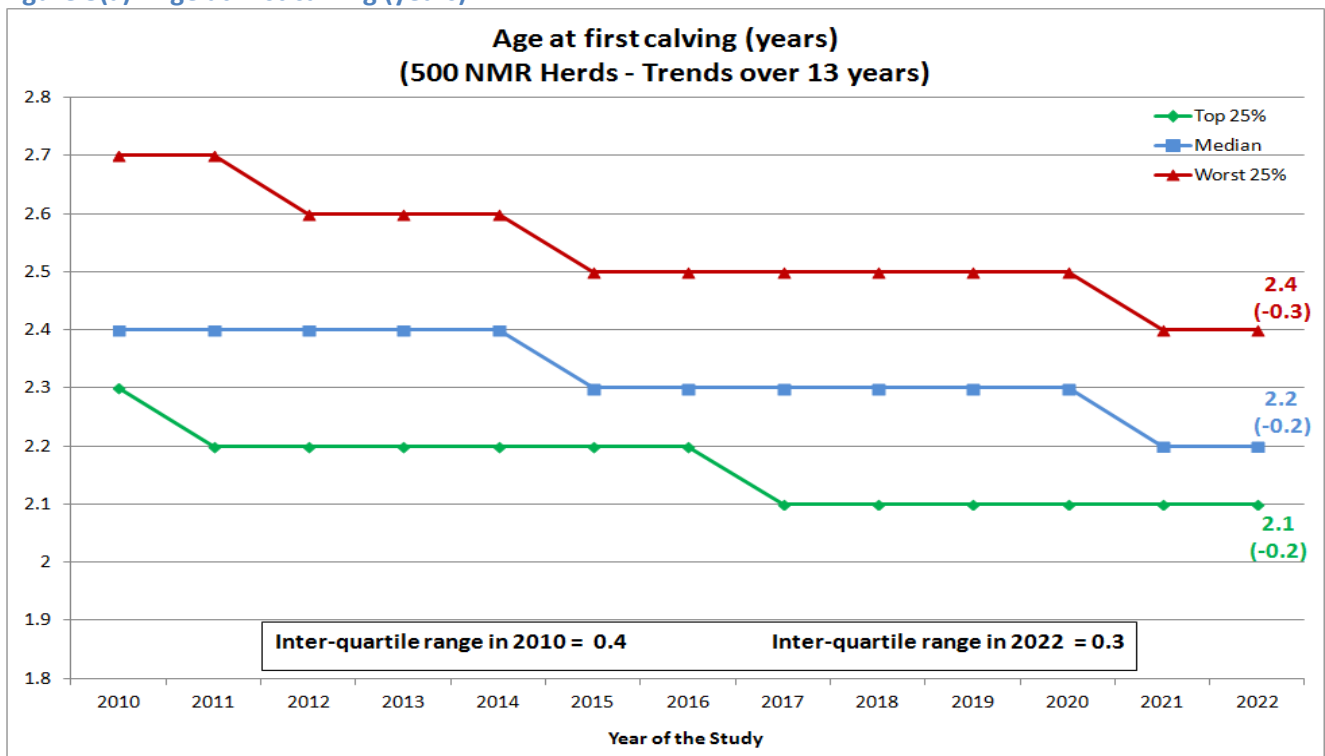


Figure 8(b). Age at first calving (in days)

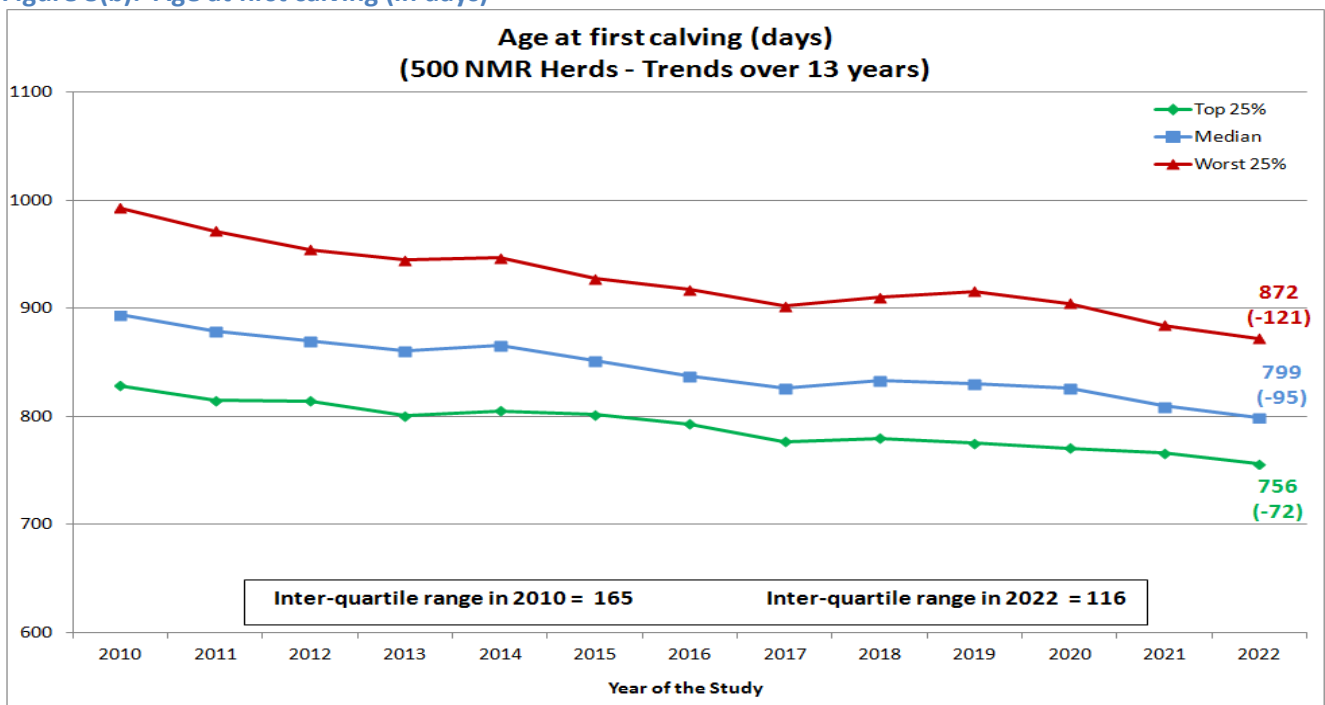


Figure 9. Length of Productive life, Age at exit - age at 1st calving (in days)

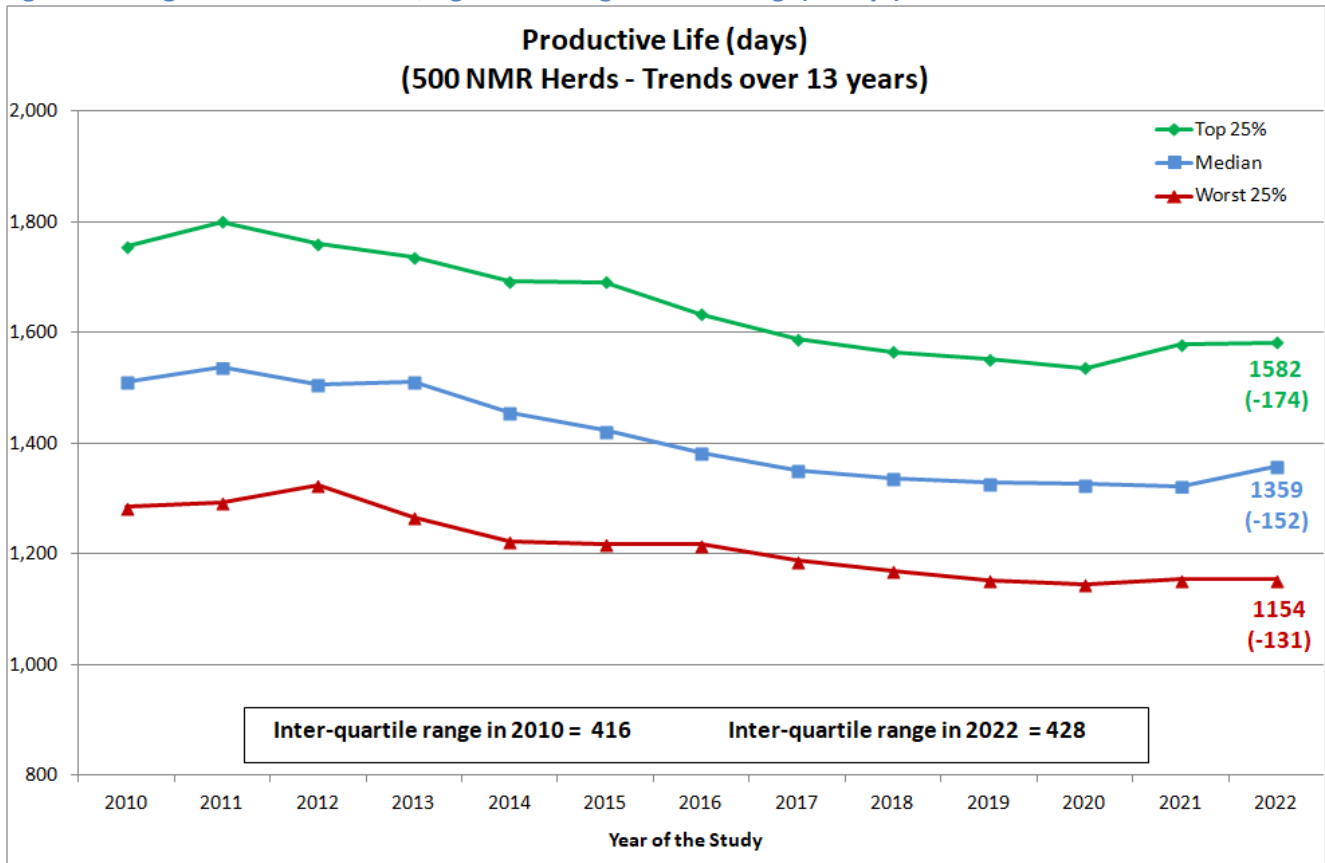


Figure 10. Percentage of cows served by Day 80 after calving

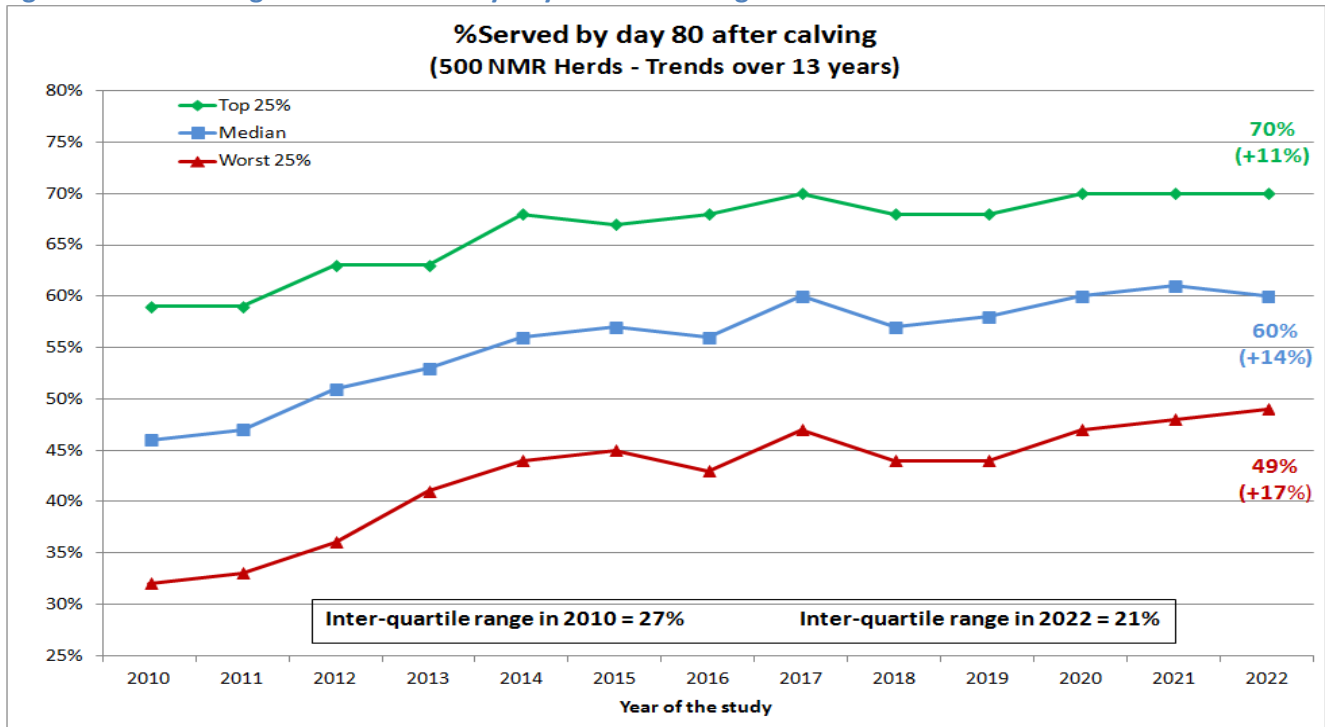


Figure 11. Percentage of cows pregnant (conceived) by Day 100 after calving

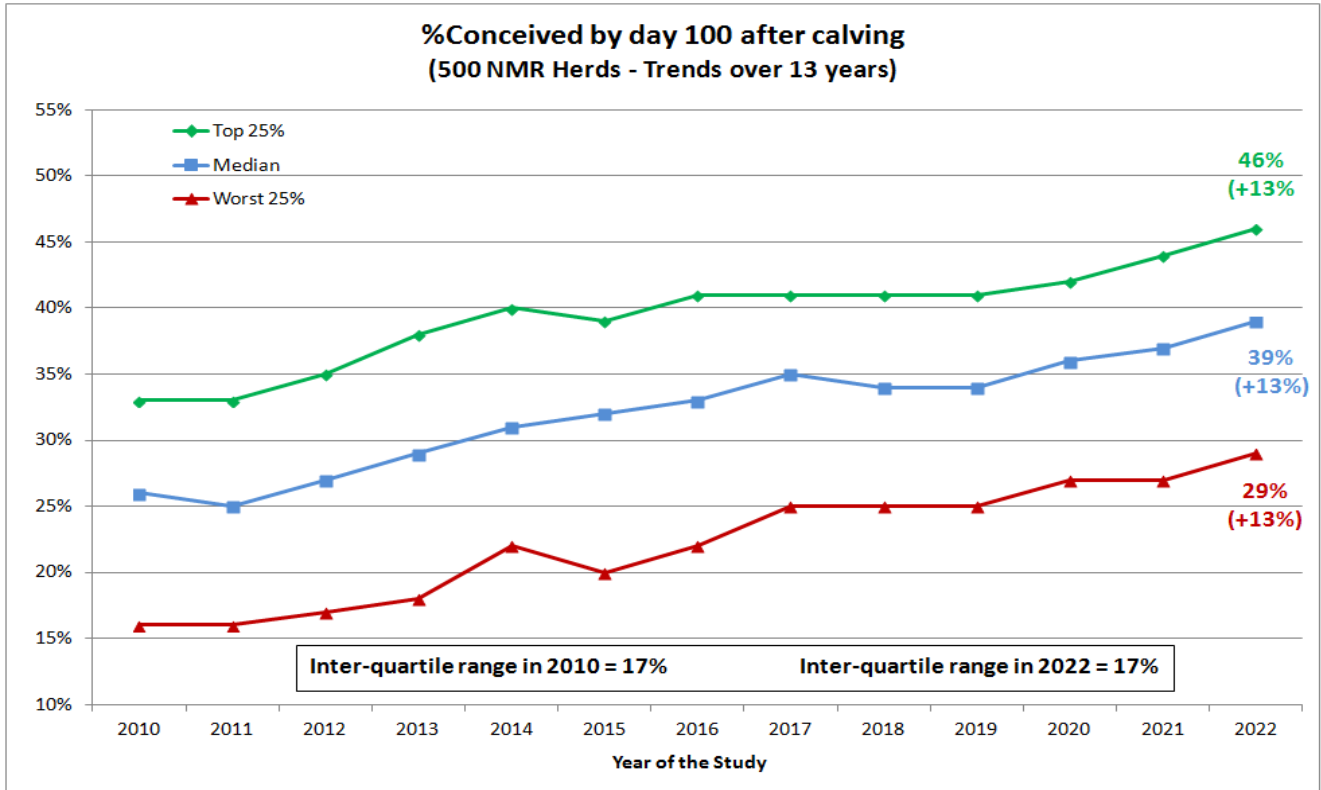


Figure 12. Percentage of all repeat services that are 18-24 days after the previous service (Heat detection)

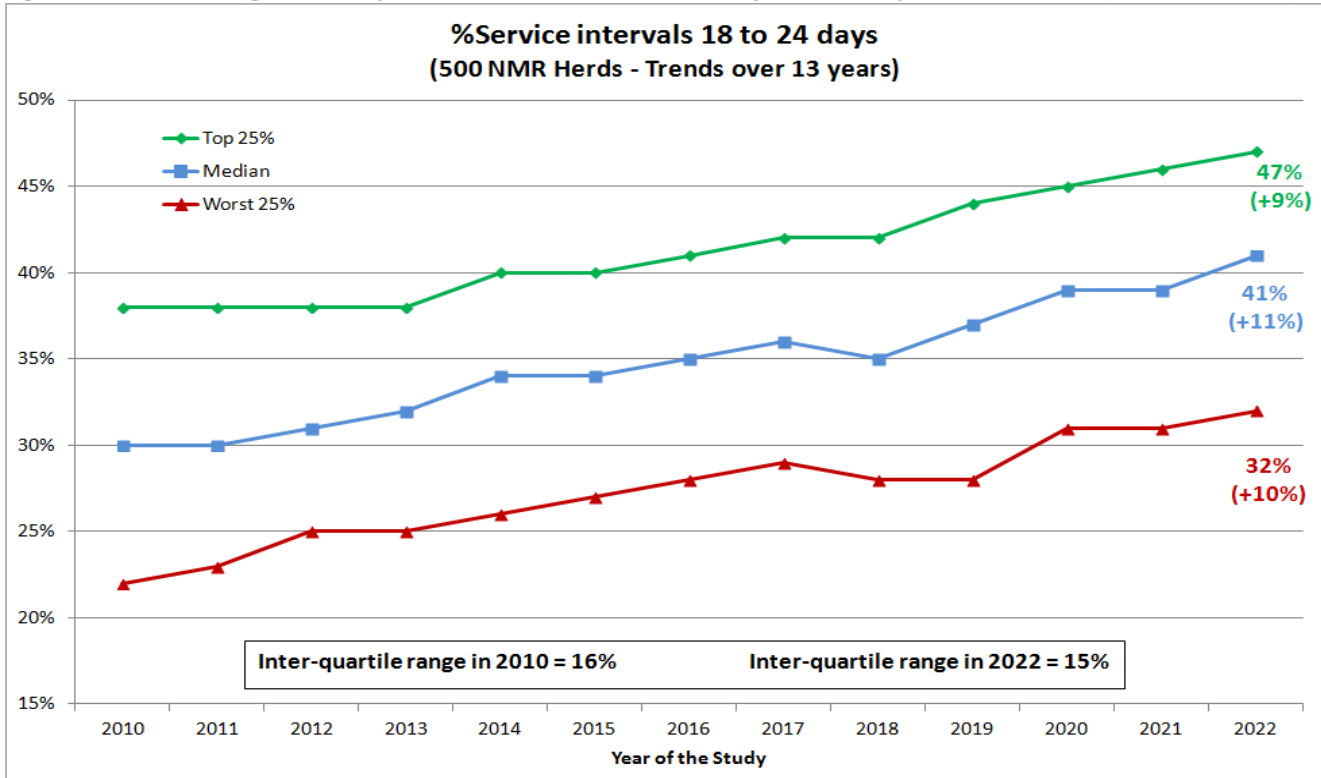


Figure 13. Percentage of all service resulting in a conception

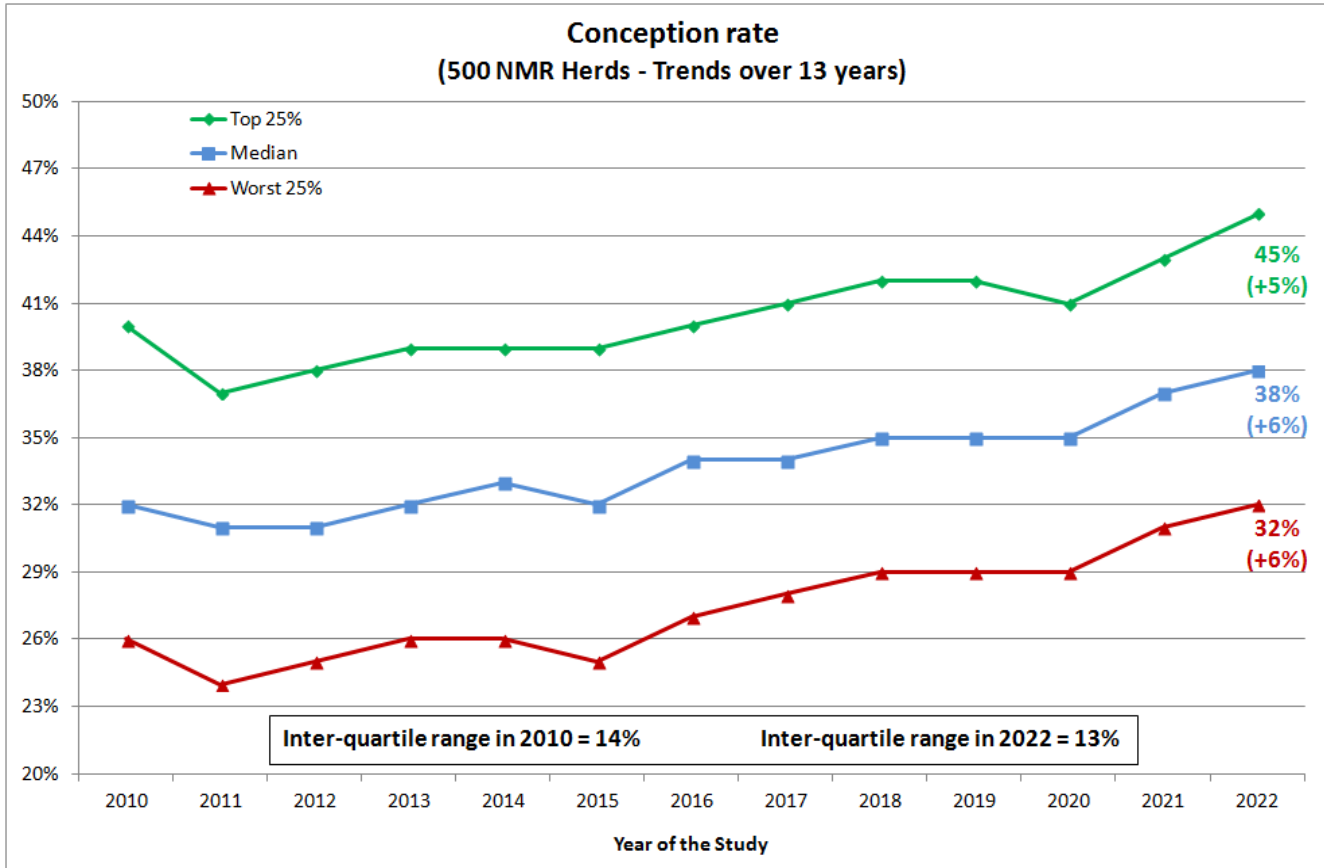


Figure 14. Submission rate

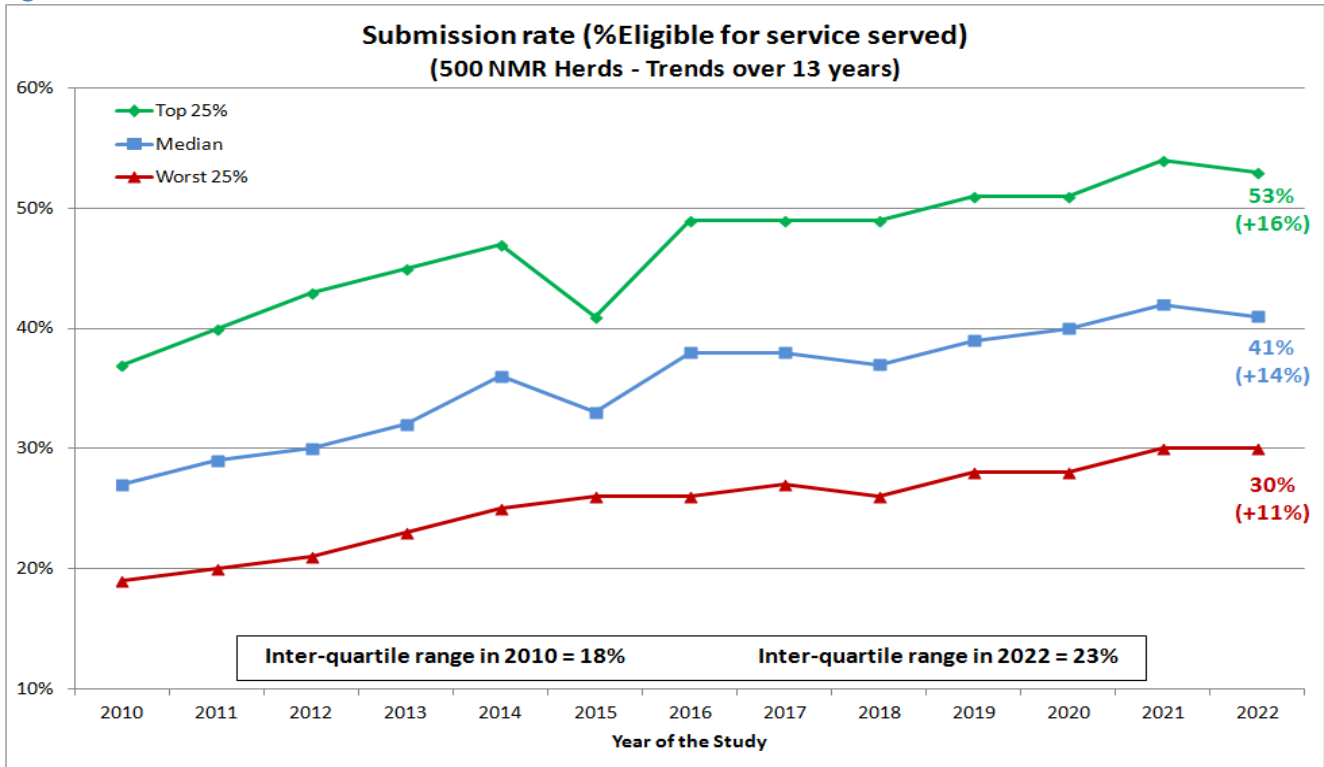


Figure 15. Pregnancy rate

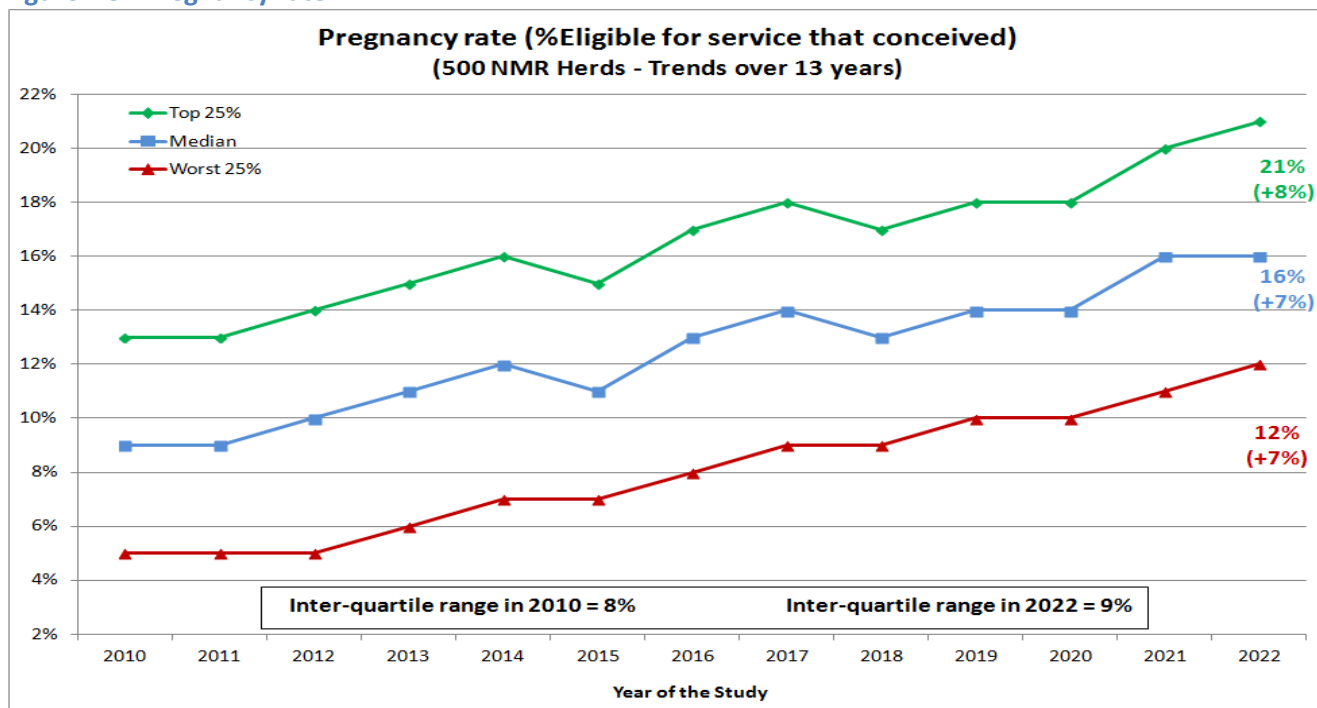
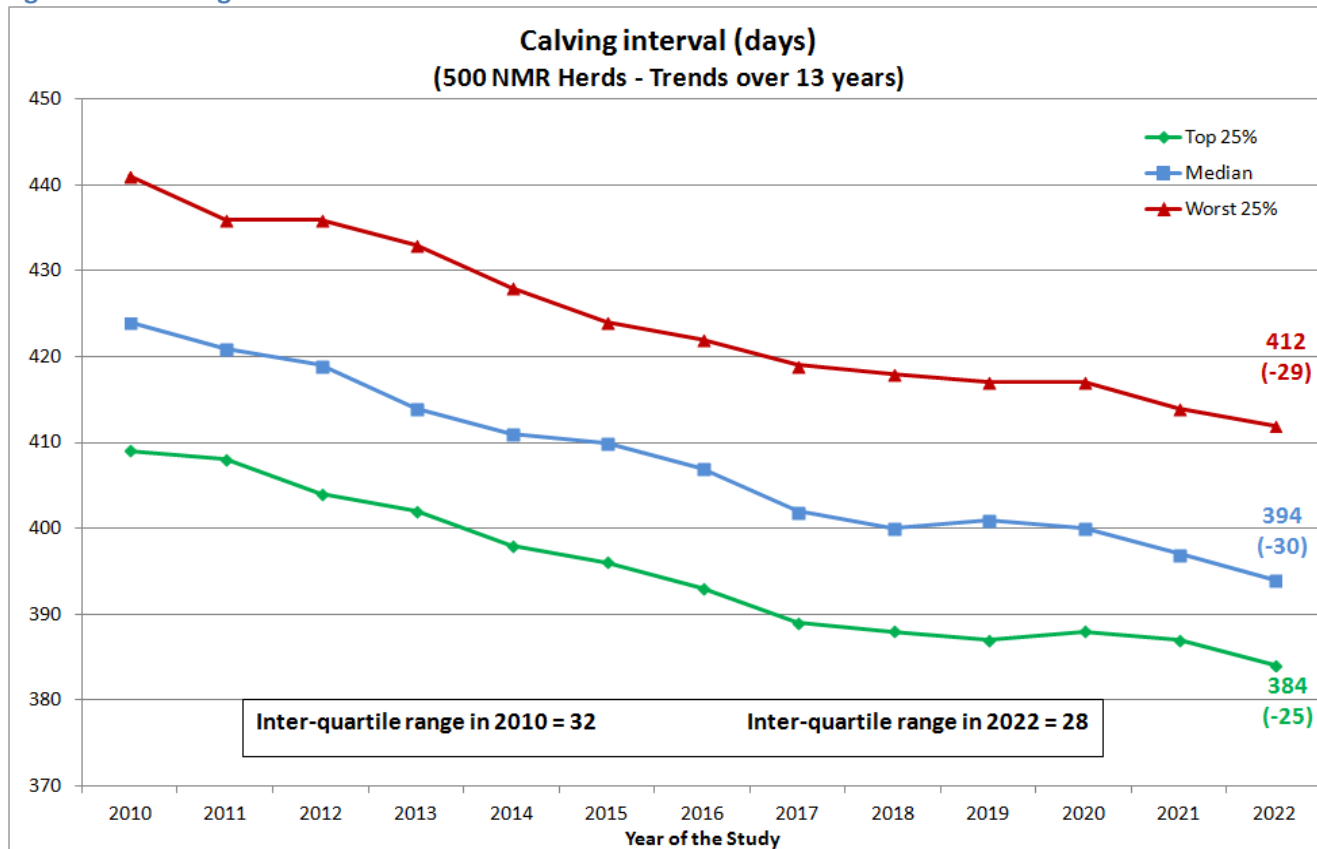


Figure 16. Calving interval



3.3 Trends in Milk Production Parameters over the last 13 years

Figure 17. Lifetime milk per cow / day (kg). This includes days between birth and first calving.

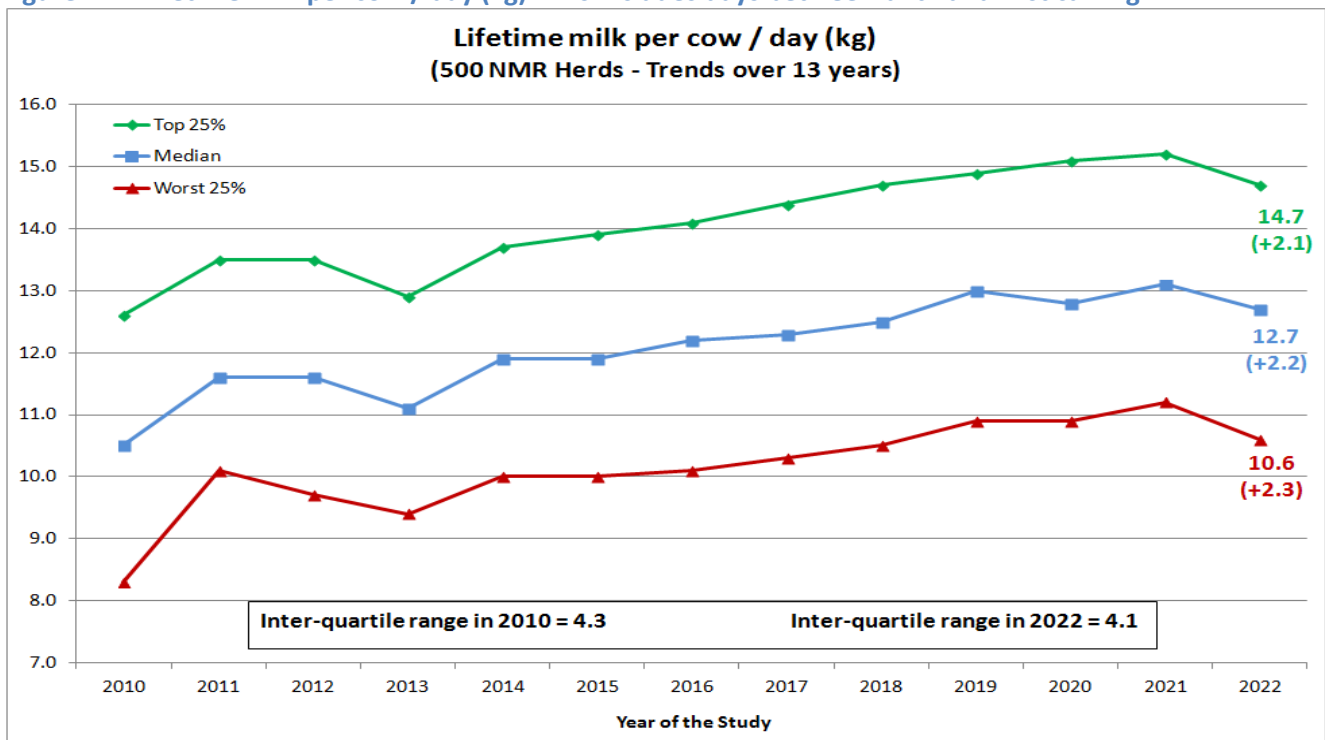
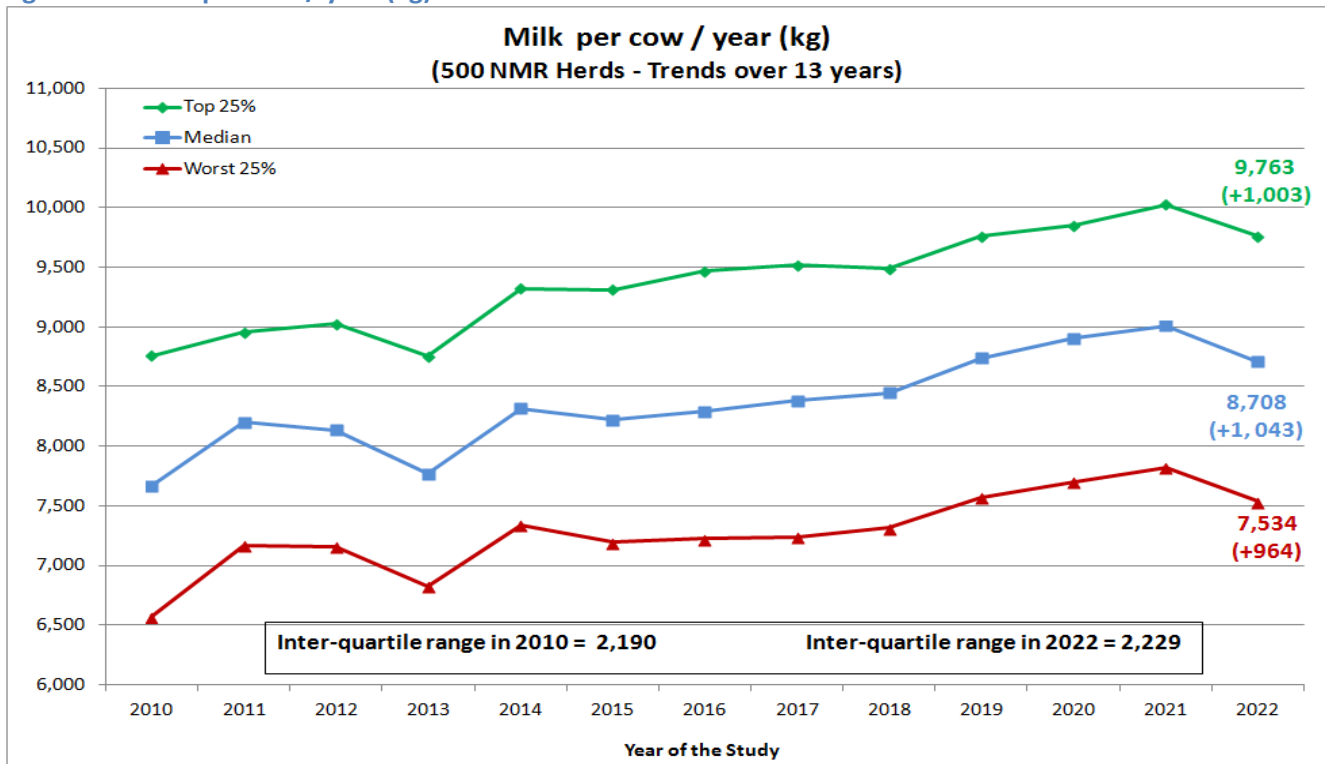


Figure 18. Milk per cow / year (kg)



3.4 Trends in Key SCC parameters (over last 13 years) & Mastitis rate (over last 7 years)

Figure 19. Herd Somatic cell Count

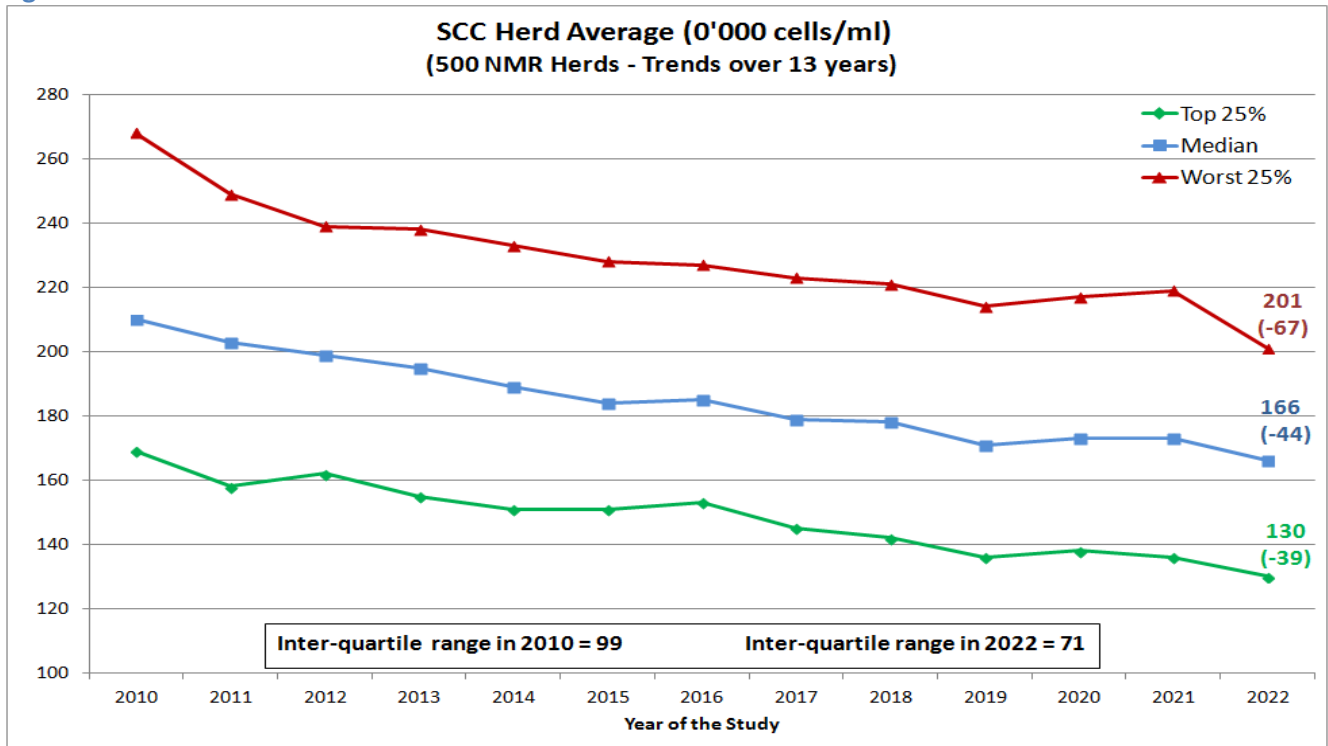


Figure 20. Percentage of milk samples originating from chronic (repeat) high SCC cows

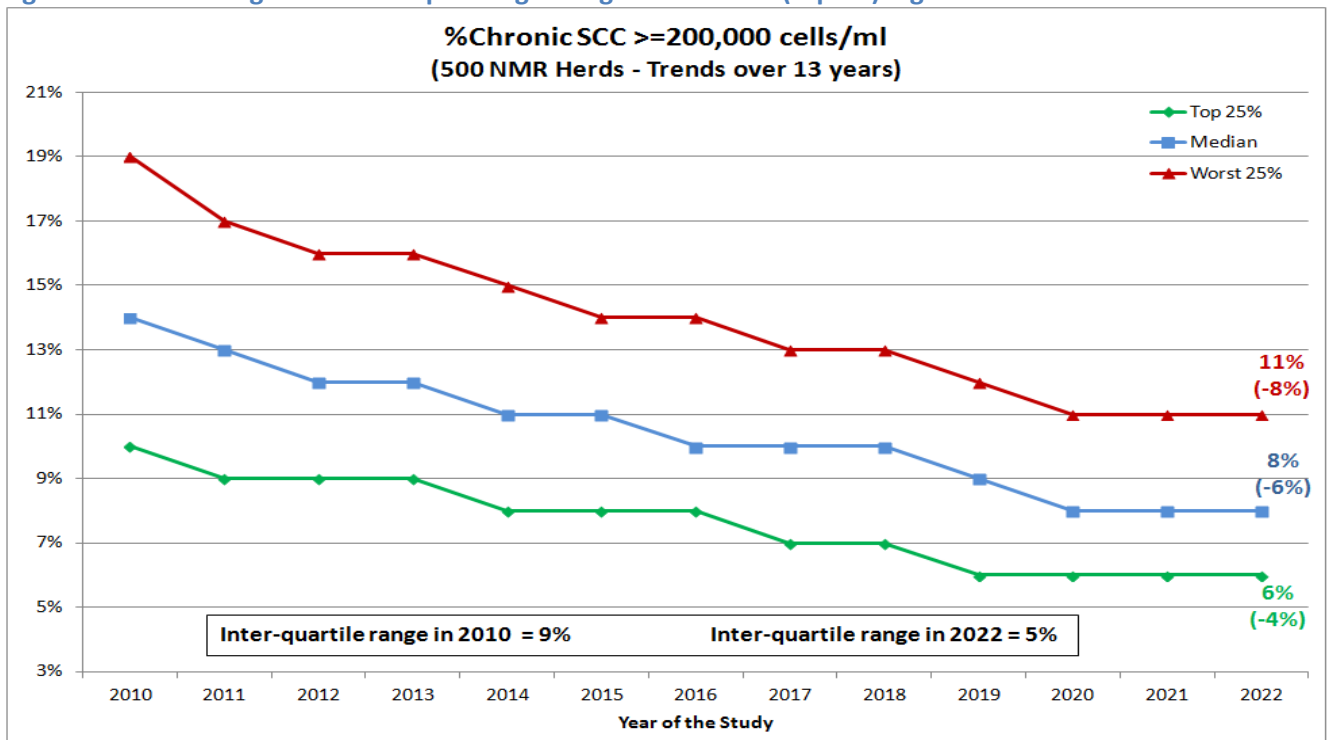


Figure 21. Percentage of cows dried-off with no high SCC in lactation

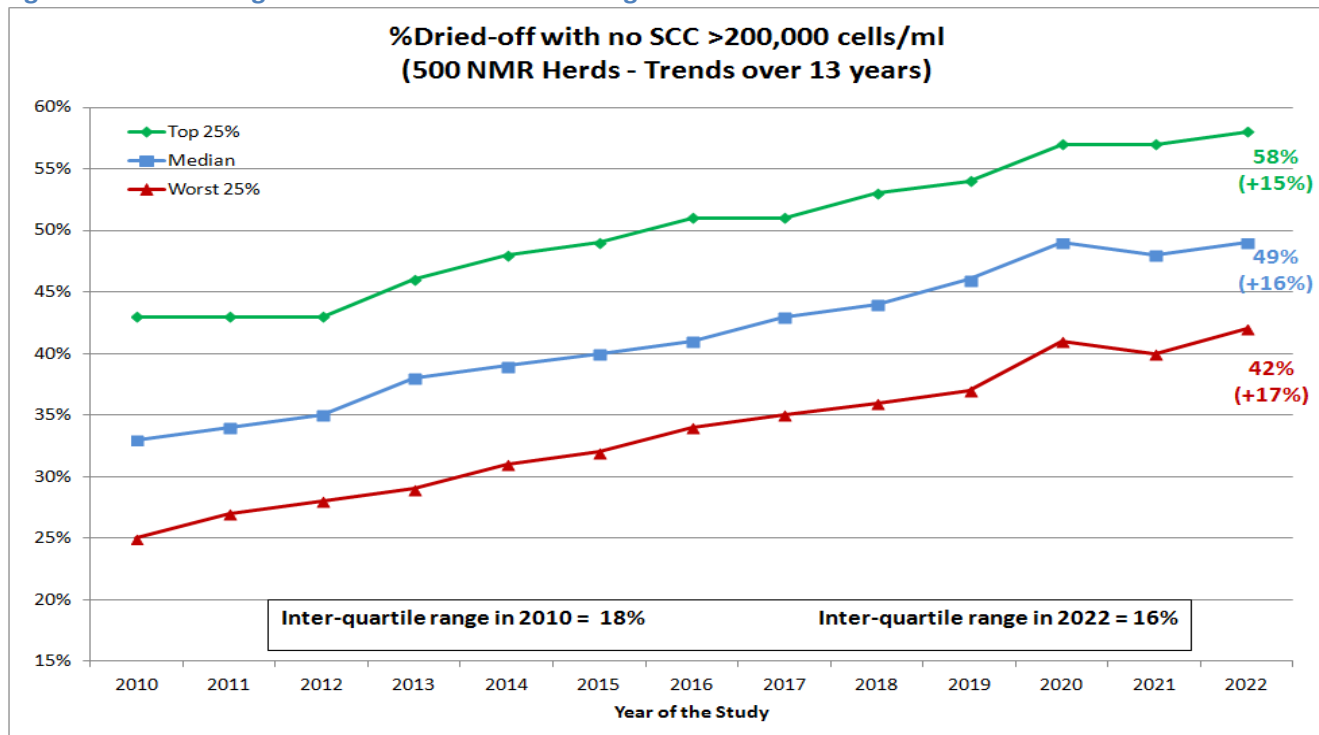


Figure 22(a). Mastitis rate (cases / 100 cows in milk / year) – mastitis groups of herds in last 7 years

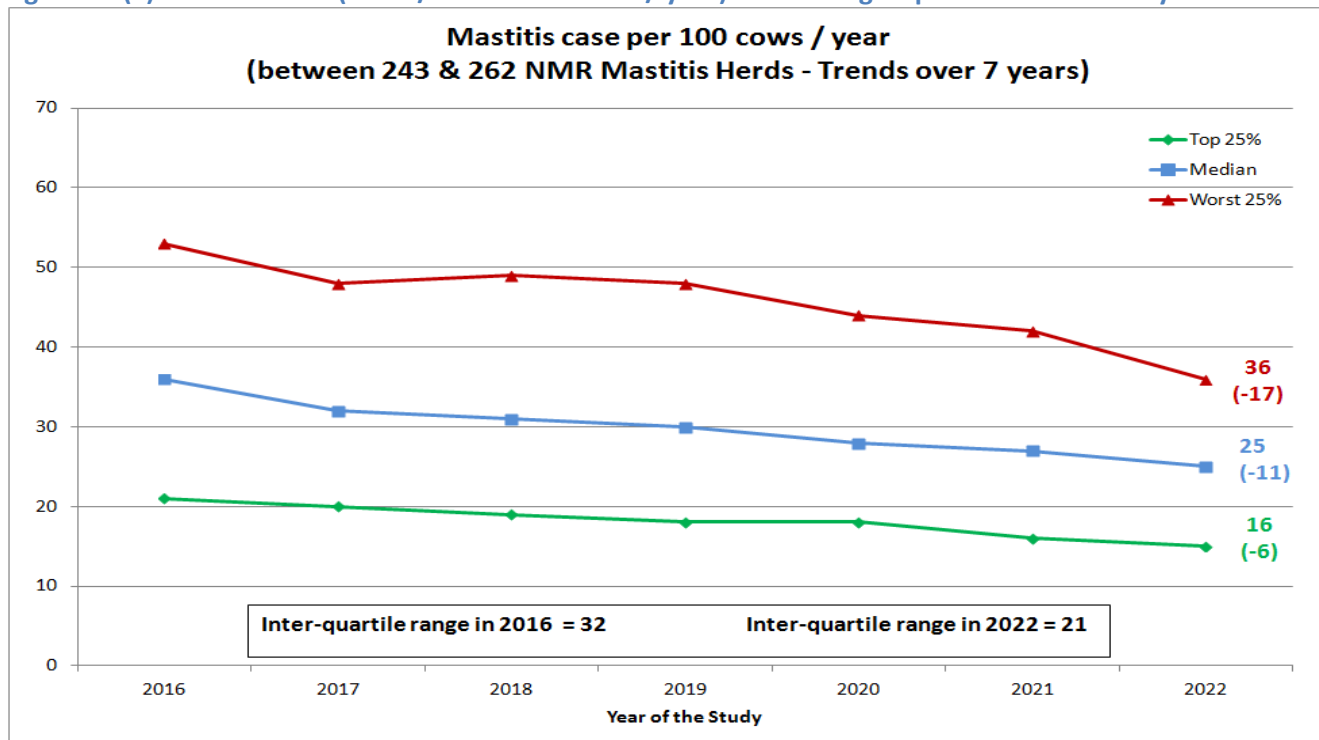
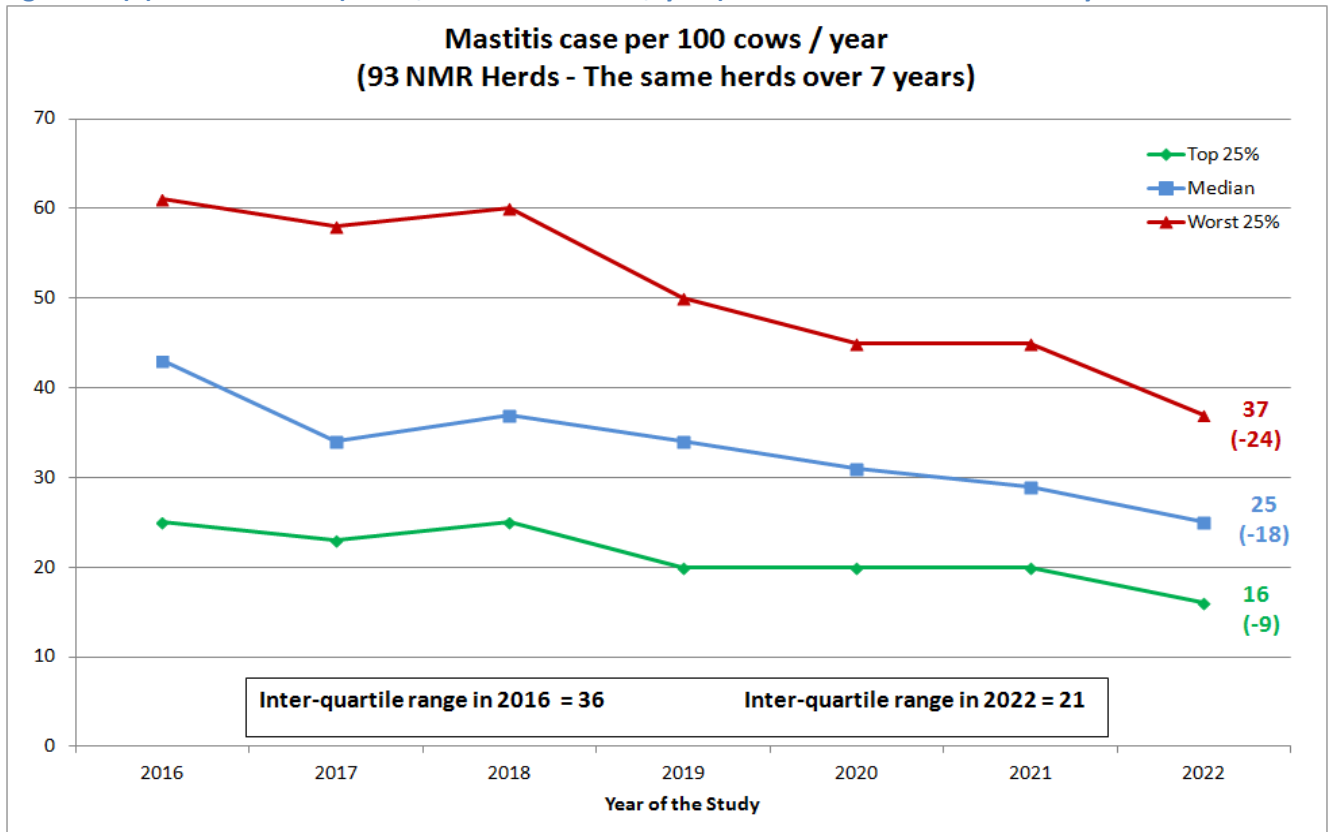


Figure 22(b). Mastitis rate (cases / 100 cows in milk / year) – the same herds over last 7 years



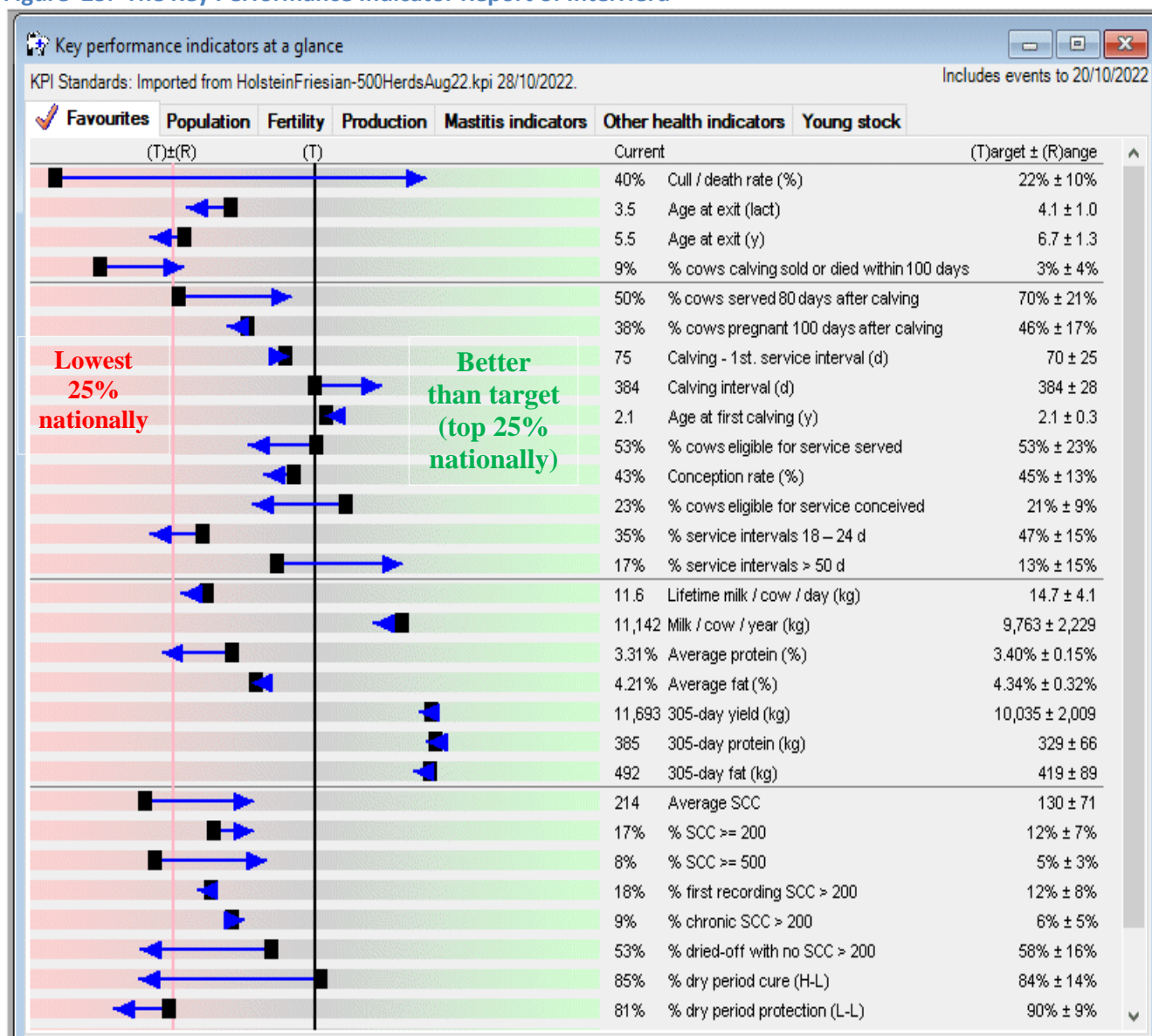
Section 4. The Practical Use of Key Performance Indicators By Farmers And Their Technical Advisers

The figures obtained from this study can be treated as “national standards” for UK 'black and white' dairy herds in 2022, with target values set at the level currently achieved or bettered on one in four of the 500 farms in the survey. A farmer can readily see where their herd would perform for each parameter relative to the 500 herds. This can be used to focus discussion on the causes and options/need for improvement.

The Key Performance Indicators Report in the InterHerd+ program provides an overview of performance for an individual herd. Parameters are calculated in an identical way so are directly comparable to the KPI values in the study. Comparing the performance of the herd with the results of the study highlights areas of strength and weakness in that herd’s performance (Figure 23).

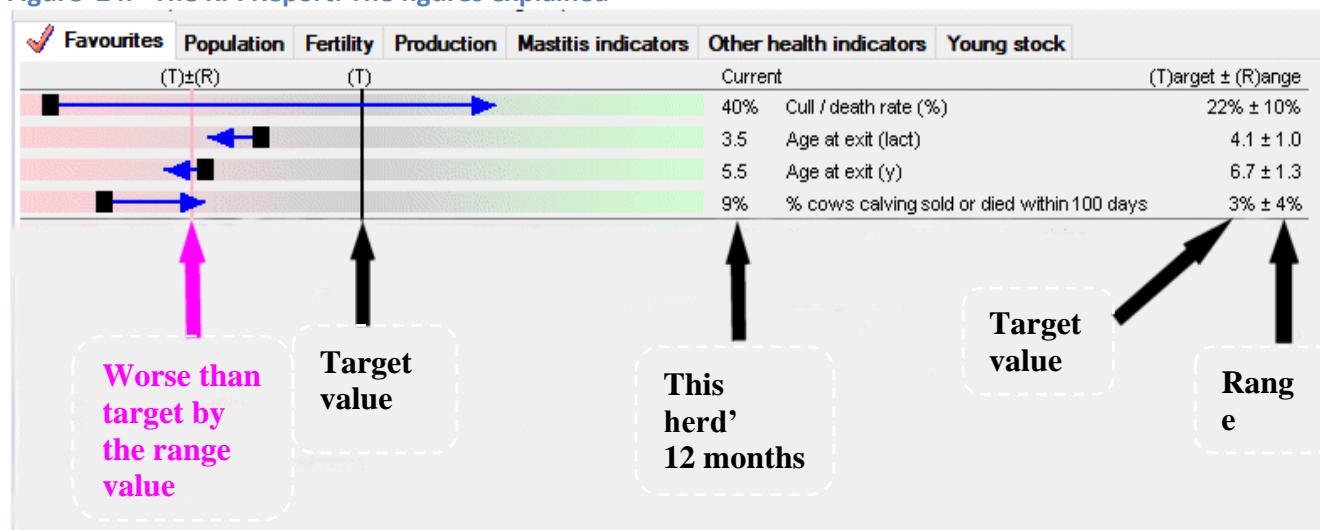
The combination of parameters relating to production, fertility and health, emphasizes the dynamic nature of dairy production and the need for high standards across all areas of herd management. Many herds are excellent in one area of production, fertility or health but seldom in all. There is always room for improvement in efficiency.

Figure 23. The Key Performance Indicator Report of InterHerd+



The meaning of the different lines and values against each key performance indicator are explained in Figure 24 below.

Figure 24. The KPI Report: The figures explained




The value displayed to the left of each parameter title represents the herd's performance over the last year. It is the rolling 12 month average for that parameter. In Figure 24 the herd had a cull/death rate averaging 40% over the previous 12 months.

To the right of each listed parameter is a **target** value and a **range** (corresponding to the values given in Tables 1(a) & 1(b)). In Figure 24 above the TARGET value for cull/death rate is 22% with a range of ±10%.

These values are also displayed graphically to the left of the parameter titles. The **target** value is represented by the **vertical black** line. The area to the right hand side is shaded green to denote a performance level that is **better** than the target value.

Left of the target line is shaded **red** denoting performance that is **worse** than the target value. The **vertical red** line represents the level that is "**worse than the target by the range value**" (so the performance of the poorer performing 25% of herds). In Figure 24 for culling rate, the red vertical line represents the target (22%) worse by the range (10%) so a culling rate of 32%.

The positions of the black square and blue arrow  show how the current herd is performing for each parameter relative to the specified target and range values. The arrow indicates any direction of change.

- The **black square** is the **12 month rolling average** value for that parameter. So it is the longer-term performance based on the last 12 months of data (the value displayed to the left of the parameter title).
- The **blue** arrow head is the **3 months rolling average** value for that parameter. In other words it is the short-term performance based on the last 3 months only. The line and arrow show the difference and direction of change between the 3 and 12 month average values. Beware that while this may indicate a significant change in herd performance, the blue line may also be influenced by seasonal factors in that 3 month period.

Using the target and range values to highlight a herd's strengths & weaknesses

Herd strengths: This study identifies the level achieved by the best 25% of the herds for each parameter. That value is then set as the "TARGET" for comparison with other herds. In Figure 25, any

KPI with a black square to the **right (green side) of the vertical black target line** is **“in the best 25%”** when compared to the 500 study herds. In Figure 25 below, the herd displayed has 7 parameters that are “better than target” so this herd would currently be in the top 25% of herds nationally for those parameters. This mainly includes 2 fertility parameters, 4 yield parameters, in addition to one SCC parameter.

Herd weaknesses: The **vertical red line** represents the performance achieved or bettered by 75% of the 500 herds (the target, worse by the range). Any parameter with a black square to the **left of the vertical red line** would be **“in the bottom 25%”** for that parameter when compared to the 500 study herds. There are 5 parameters highlighted in Figure 25, including culling rates and 3 SCC parameters, so this herd would currently appear in the bottom 25% of herds for those parameters.

Average performance levels: Parameters that fall between the vertical black and red lines are within the inter-quartile range (so the middle 50% of herds) when compared with the 500 study herds.

Figure 25. Highlighting the strengths and weaknesses of a dairy herd

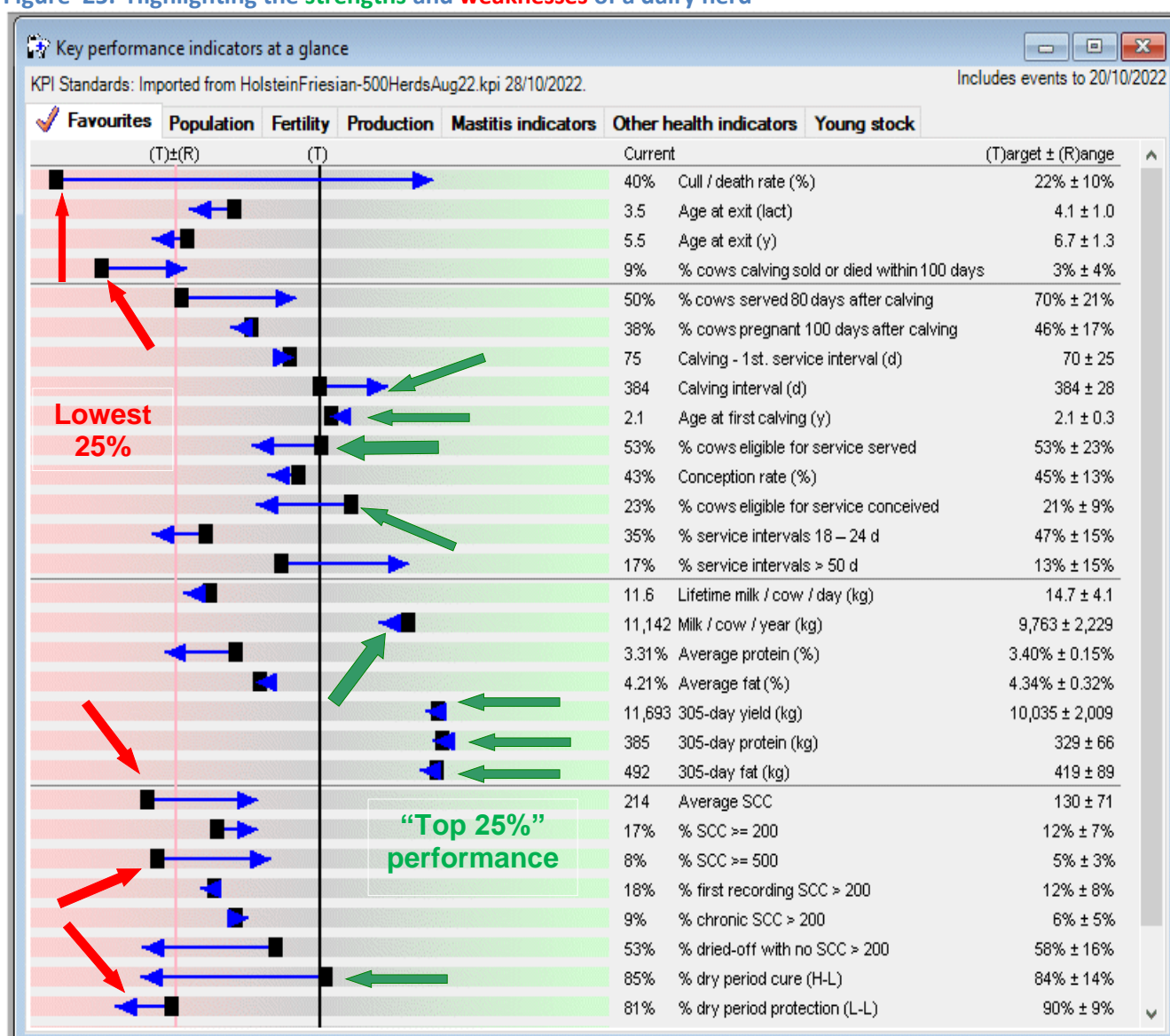


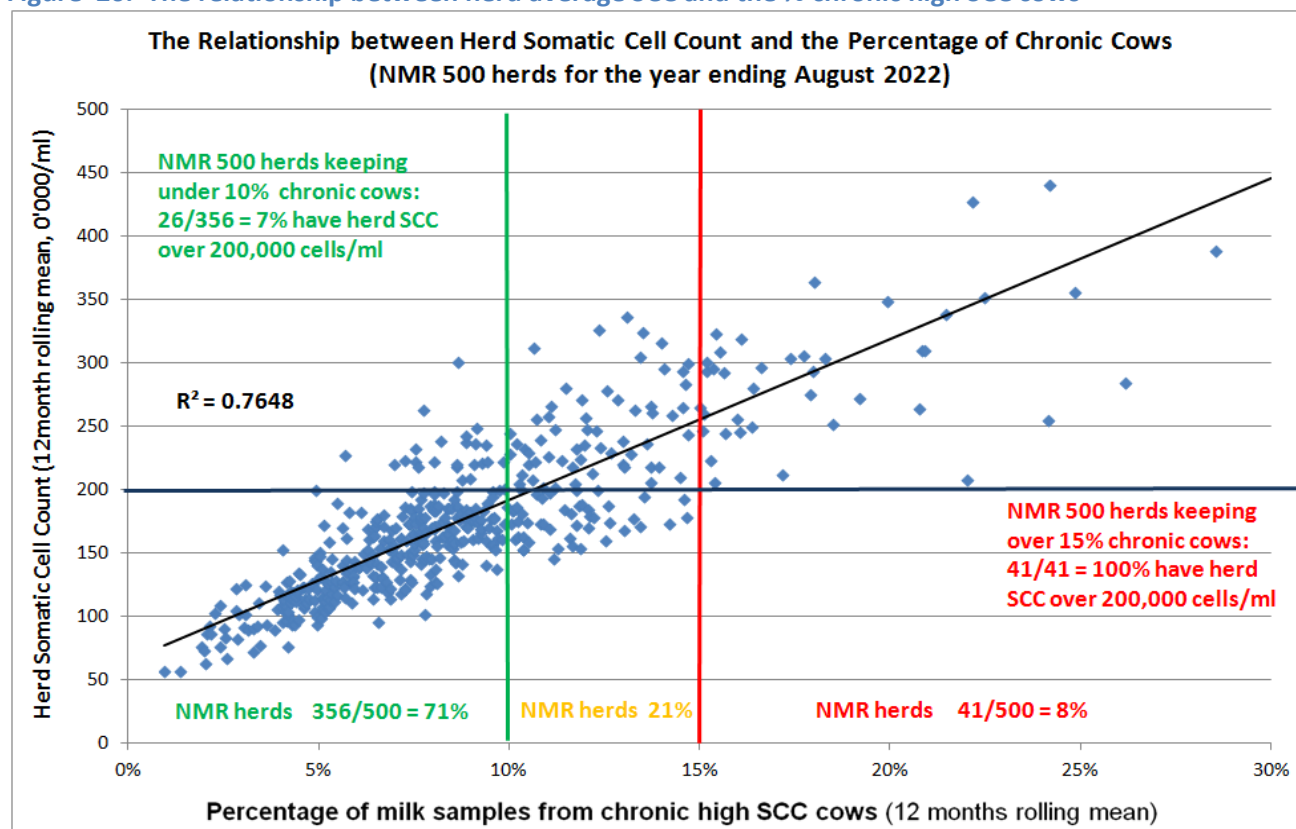
Figure 25 must be treated as a **DISCUSSION DOCUMENT**. The emphasis is on achieving an appropriate balance of performance in production, fertility and health. A parameter in the top 25% is not necessarily a good thing. The aim is to **stimulate informed discussion between farmers and their advisers** about **what** is happening and **WHY**.

Relationship between parameters: Herd SCC vs % chronic high SCC milk samples

The 500 herd studies also provide data to investigate correlations between different Key Performance Indicators which can provide simple messages for farmers and advisers. A good example of this is the strong correlation between the Herd SCC and the percentage of milk samples deriving from chronic high SCC cows (2nd/3rd/4th etc consecutive high SCC milk sample). Figure 26 shows the distribution of the 500 herds from the current study (year ending 31st August 2022).

Each blue square represents one of the 500 study herds. The very strong correlation ($R^2=0.765$) is clearly evident giving a very clear message. If you have a high level of chronic cows in your herd you are also very likely to have a high herd SCC with all the costs and penalties associated with that.

Figure 26. The relationship between herd average SCC and the % chronic high SCC cows



In addition to the correlation the graph shows that in herds where over 15% of the milk is from chronic cows the vast majority are penalised for having a high herd SCC. In 2022 there were 41 herds of this type and 100% of them had a high herd SCC (averaging greater than 200,000 cells/ml). In contrast, there were 356 herds with less than 10% chronic cows of which only 26 (7%) also had a high herd SCC.

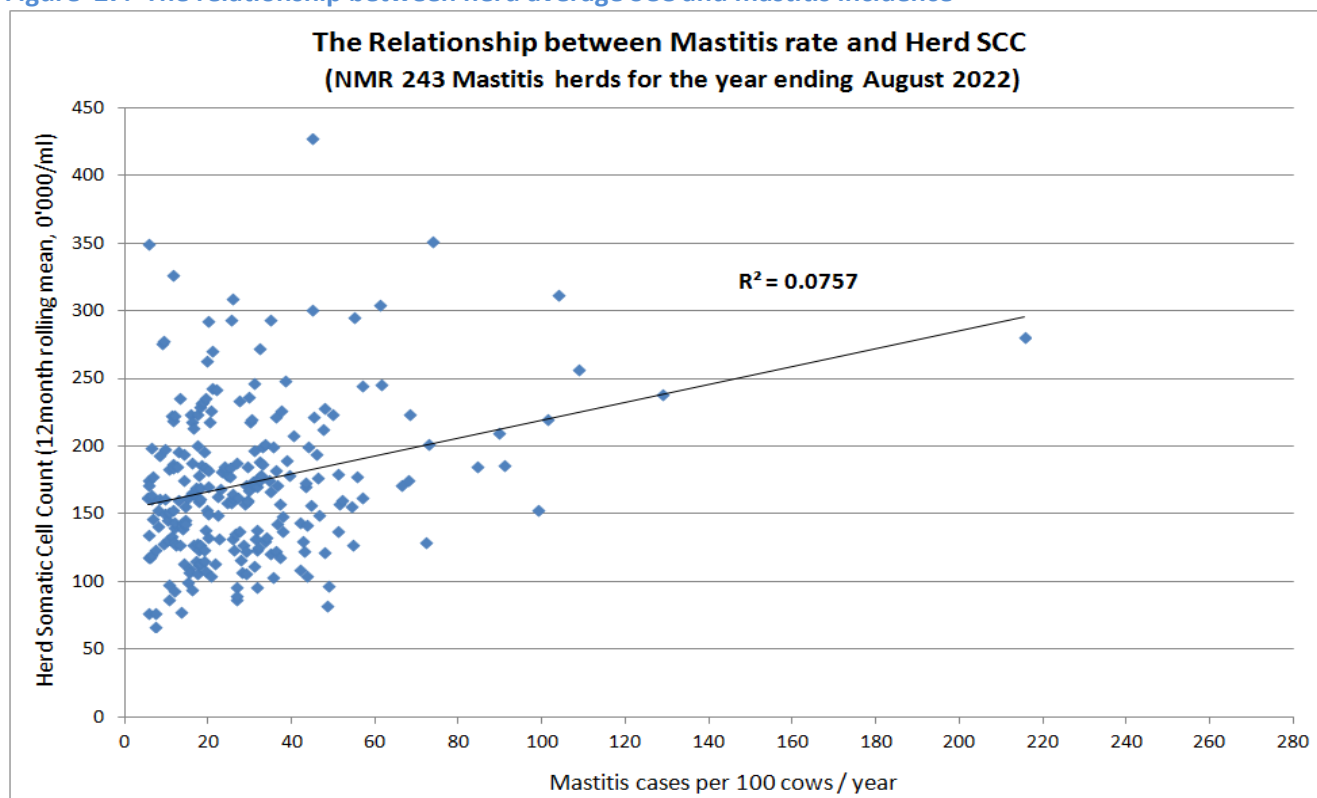
This strong correlation has been evident in all the 13 annual KPI studies. Table 3 shows the enormous gains that the UK dairy industry has made in tackling high herd SCCs. The 67% of the herds (336/500) in the most recent study that qualify as “Low levels of chronic cows” (less than 10% chronic cows), are a dramatic improvement on the 24% of herds in the original study in 2010. Over the same time interval the % of herds keeping high levels of chronic cows ($\geq 15\%$ of the herd) has dropped from 41% of herds in 2010 to just 10% in 2021.

Table 3. Percentage of herds with low (<10%) and high (≥15%) levels of chronic high SCC samples, in the KPI studies from 2010 to 2022

KPI study year	Low levels of chronic cows (<10% of milking cows)	High levels of chronic cows (≥15% of milking cows)
2010	24% of herds	41% of herds
2011	32% of herds	35% of herds
2012	34% of herds	30% of herds
2013	36% of herds	29% of herds
2014	42% of herds	24% of herds
2015	44% of herds	21% of herds
2016	51% of herds	18% of herds
2017	51% of herds	17% of herds
2018	56% of herds	12% of herds
2019	62% of herds	13% of herds
2020	65% of herds	10% of herds
2021	67% of herds	10% of herds
2022	71% of herds	8% of herds

In contrast to the strong correlation between herd SCC and the level of chronic cows, there is no clear correlation between the level of mastitis incidence and the herd SCC. Figure 27 shows the poor correlation observed in 2022. Similar poor correlation is observed in previous studies.

Figure 27. The relationship between herd average SCC and mastitis incidence



Appendix 1. Changes in Key Performance Indicators between 2010 and 2022 in herds included in every study over 13 years

Since the initial study in 2010, wherever possible the same herds are kept in the sample used each year. If necessary, herds with poorly recorded fertility data and herds no longer recording were replaced with randomly selected new herds. Within the sample of the 2022 study, there remain 113 herds (about 23%) that have been included in all the 13 studies (2010 to 2022).

As a check to confirm that replacement of some herds and retention of others has not introduced any unexpected bias in the sample, the table below shows the changes observed in KPIs over 13 years (2010 vs. 2022) for the ‘changing sample’ of 500 each year alongside the changes seen in the 113 herds common to all 13 years. The table below shows similar trends in the ‘common 113’ herds to the trends on the ‘whole 500’ herd samples. Overall, these results do not suggest that significant bias has been introduced by the year-on-year partial replacement of herds in the sample.

		500 herds groups		113 common herds	
		Median value		Median value	
Parameter	Year of the study	2010	2022	2010	2022
A. Culling rate		24%	26%	23%	27%
B. Culling / death rate in first 100 days of lactation		7%	5%	6%	5%
C(a). Age at exit (years)		6.6	6.0	6.7	6.0
C(b). Age at exit (days)		2393	2180	2448	2178
D. Age at exit by Lactations		3.9	3.6	4.0	3.6
E. Percentage Served by day 80		46%	60%	46%	57%
F. Percentage conceived 100 days after calving		26%	39%	27%	38%
G. Calving to 1 st service interval (days)		105	80	102	82
H. Calving interval (days)		424	394	423	395
I(a). Age at 1 st calving (years)		2.4	2.2	2.5	2.2
I(b). Age at 1 st calving (days)		893	799	909	808
J. Conception rate		32%	38%	32%	38%
K. Percentage service intervals at 18-24 days		30%	41%	32%	40%
L. Percentage service intervals >50 days		32%	19%	29%	19%
M. Percentage eligible for service that served		27%	41%	29%	41%
N. Percentage eligible for service that conceived		9%	16%	10%	17%
O. Lifetime milk / cow / day (kg)		10.5	12.7	10.9	12.2
P. Milk / cow / year (kg)		7,665	8,708	8,140	8,363
Q. Average Protein%		3.27%	3.33%	3.26%	3.32%
R. Average Fat%		3.96%	4.18%	3.94%	4.22%
V. Average SCC (*000 cells/ml)		210	166	189	162
W. Percentage SCC >=200,000 cells/ml		24%	16%	22%	16%
X. Percentage SCC >500,000 cells/ml		9%	7%	8%	6%
Y. Percentage 1st recording SCC >=200,000 cells/ml		20%	15%	18%	16%
Z. Percentage chronic SCC >=200,000 cells/ml		14%	8%	12%	8%
ZA. Percentage Dry period cure (High:Low)		74%	78%	76%	79%
ZB. Percentage Dry period protection (Low:Low)		84%	86%	85%	85%
ZC. Percentage Low SCC at end of previous lactation		60%	78%	65%	76%

Appendix 2. Key Performance Indicators definitions

In the following definitions the average population of cows is calculated using animal days. Every day that animal is present in the population at risk during the period of study is a 365th of an animal year. The total animal days is divided by 365 to give animal years, which equates to the average population at risk.

Parameter	Description
A. Culling rate	The number of cows dying or culled during the 12 month period expressed as a percentage of the average cow population for the same 12 month period.
B. Percentage culled / died 100 days after calving	The percentage of heifers/cows calving during the 12 month period that exit within 100 days after calving.
C. Age at exit (years)	The average age (in days) of cows culled/died in the analysis period, divided by 365.24
D. Age at exit by lactations	The average number of lactations completed by cows culled/died in the analysis period.
E. Percentage Served by day 80	The percentage of cows reaching the 80 th day after calving that have been served at least once.
F. Percentage conceived 100 days after calving	The percentage of cows reaching 100 days after calving that have conceived.
G. Calving to 1 st service interval (days)	The average days between calving and 1 st service for all cows served for the first time in a lactation during the analysis period.
H. Calving interval (days)	The interval between calvings, in days, for all re-calvings recorded in the analysis period.
I. Age at 1 st calving (years)	The age at first calving for all cows calving for the first time during the analysis period.
J. Conception rate	The number of conceptions as a percentage of the total number of services (services to cows culled are included) during the analysis period.
K. Percentage service intervals at 18-24 days (Heat detection)	The percentage of all service intervals for cows returning to service during the analysis period that are between 18 and 24 days (equating to one oestrous cycle after the previous service).
L. Percentage service intervals >50 days	The percentage of all service intervals for cows returning to service during the analysis period that are over 50 days.
M. Percentage of cows eligible for service that were served (Submission rate)	The percentage of cows that are eligible for service (42 days+ after calving and not barren or already pregnant) during the analysis period that are served per 21 day (oestrous cycle) period.
N. Percentage of cows eligible for service that conceived (Pregnancy rate)	The percentage of cows that are eligible for service (42 days+ after calving and not barren or already pregnant) during the analysis period that conceive per 21 day (oestrous cycle) period.
O. Lifetime milk / cow/day (kg)	The average of total milk yield divided by age in days (from birth to culling) for cows leaving the herd during the analysis period.
P. Milk / cow / year (kg)	The total milk produced per cow place in the year. The total milk divided by the average population of cows (both in milk and dry).
Q. Average protein%	The weighted average protein% of all milk recorded during the analysis period.
R. Average fat%	The weighted average fat% of all milk recorded during the analysis period.

Parameter	Description
S. 305 day yield (kg)	The average 305 day production for all cows reaching 305 days after calving during the analysis period.
T. 305 day protein (kg)	The average 305 day production of milk protein for all cows reaching 305 days after calving during the analysis period.
U. 305 day fat (kg)	The average 305 day production of milk fat for all cows reaching 305 days after calving during the analysis period.
V. Average SCC (‘000 cells/ml)	The weighted average somatic cell count of all milk recorded during the analysis period.
W. Percentage SCC \geq 200,000 cells/ml	The percentage of all recorded milk samples during the analysis period that had an individual SCC reading of 200,000 cells/ml or higher.
X. Percentage SCC \geq 500,000 cells/ml	The percentage of all recorded milk samples during the analysis period that had an individual SCC reading of 500,000 cells/ml or higher.
Y. Percentage 1st recording SCC \geq 200,000 cells/ml	The percentage of all cows starting new lactations that had a high SCC (\geq 200,000 cells/ml) reading at the first milk recording in the lactation.
Z. Percentage chronic SCC \geq 200,000 cells/ml	The percentage of all milk samples taken in the analysis period that originated from chronic SCC cows where the current and previous milk samples both had SCC levels of 200,000 cells/ml milk or greater.
ZA. Percentage Dry period cure (High:Low)	Of re-calving cows recorded starting a new lactation during the analysis period: the percentage of cows ending the previous lactation with a HIGH SCC (\geq 200,000 cells/ml) that started the new lactation with a LOW SCC ($<$ 200,000 cells/ml).
ZB. Percentage Dry period protection (Low:Low)	Of re-calving cows recorded starting a new lactation during the analysis period: the percentage of cows ending the previous lactation with a LOW SCC ($<$ 200,000 cells/ml) that also started the new lactation with a LOW SCC ($<$ 200,000 cells/ml).
ZC. Percentage Low at end of previous lactation (SCC $<$ 200,000 cells/ml)	Of re-calving cows recorded starting a new lactation during the analysis period: The percentage that had a LOW SCC ($<$ 200,000 cells/ml) at the last milk recording in the previous lactation.
ZD. Percentage New SCC \geq 200,000 cells/ml	The percentage of all recorded milk samples that were of the “New” SCC Category, namely the first HIGH SCC (\geq 200,000) in a lactation following one or more low SCC samples.
ZE. Percentage Dried-off with no SCC \geq 200,000 cells/ml	The percentage of cows completing a lactation without recording a high SCC (cows recording only LOW SCC samples ($<$ 200,000 cells/ml) in the previous lactation).
ZF. Threshold Index new high / new low	Of cows with consecutive milk records in the same lactation, the number of cows changing from Low SCC at the previous to High SCC at the next recording divided by the number of cows going from High SCC at the previous to Low SCC at the next recording.
ZG. Recovery percentage of new/first/repeat infections	Of HIGH SCC cows (\geq 200,000cells/ml) that at the previous recording were either low SCC or not yet in milk, the percentage that were LOW SCC ($<$ 200,000 cells/ml) at the following recording.
ZH. Recovery percentage of chronic infections	Of CHRONIC High SCC cows (High SCC cows that at the previous recording were also High SCC), the percentage of those milked that were LOW SCC ($<$ 200,000 cells/ml) at the following recording.

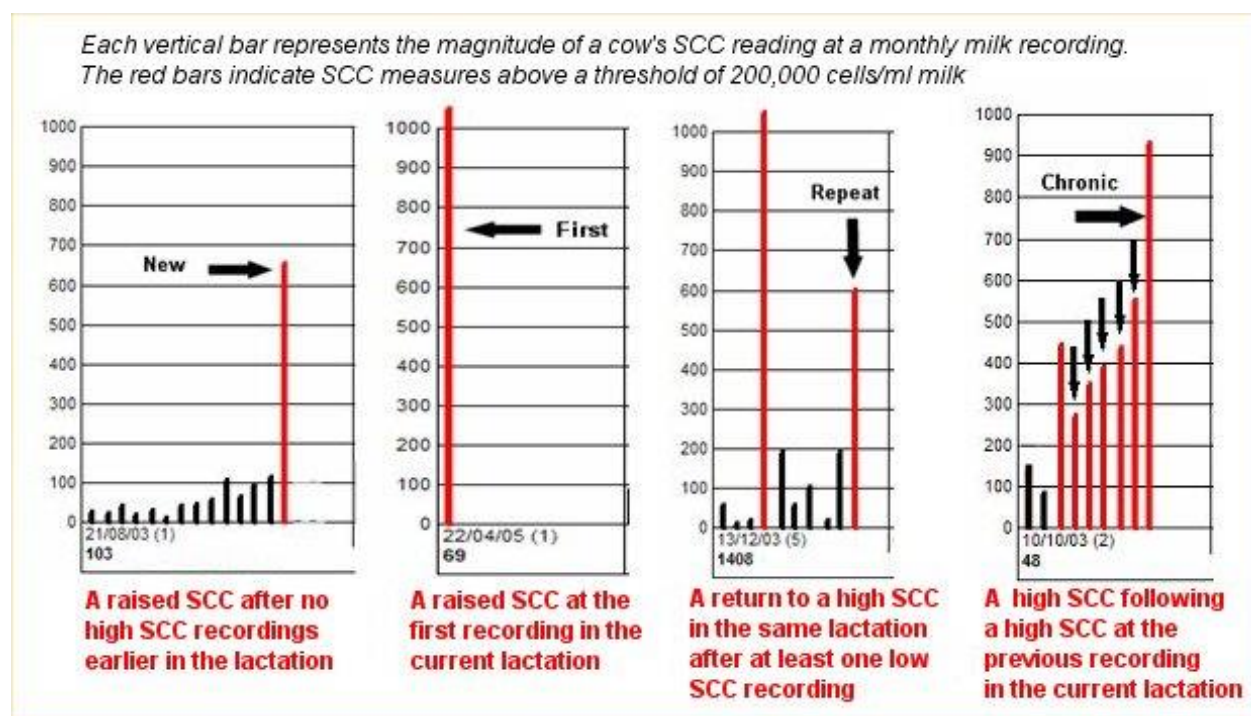
Parameter	Description
ZI. Percentage drying off with no mastitis cases	The percentage of cows completing a lactation without recording a mastitis case.
ZJ. Mastitis rate (cases/100 cows in milk per year)	The total cow cases of mastitis recorded divided by the average population of cows in milk, represented as a % (cases/100 cows in milk).
ZK. Index mastitis case by Day 30	The percentage of cows calving during the 12 month period that recorded a mastitis case by day 30 of the lactation.
ZL. Index mastitis rate after Day 30	The incidence rate of <i>index</i> mastitis cases in cows that have passed 30 days since calving.

Appendix 3. Herd Companion High SCC Categories

The web-based Herd Companion program (www.nmr.co.uk/Herd-companion) was introduced by NMR in 2003 primarily to support the use of milk recording data to control somatic cell counts (SCC) in dairy herds.

Herd Companion focuses more on the duration of a high SCC infection rather than the magnitude of an individual milk sample. Using a threshold of 200,000 cells/ml milk to indicate infection, the program aims to balance the ability of many cows to self-cure with the need to assist cows where infection is becoming established. While in the region of 50% of cows self-cure after an initial raised SCC this recovery rate falls to less than 20% once a cow has recorded a second high SCC. It is these persistent high SCC cows that require attention before they are damaged irretrievably by a sustained period of infection.

The development of Herd Companion led to the definition of four main categories of high cell count cow, as illustrated below. Each vertical bar represents the magnitude of the SCC at each milk recording in a lactation. Where the bar is black the SCC is below the threshold of 200,000 cells/ml milk. A red bar indicates a SCC level above the threshold.



NEW: The “New” category describes cows recording their first high SCC in the lactation, having recorded one or more low SCCs at earlier recording(s). An infection acquired in the lactation.

FIRST: The “First” category describes cows that are HIGH SCC at their First milk recording in the current lactation. This is an infection that may be related to the dry period.

REPEAT: The “Repeat” category describes a possible re-infection (or failure to cure). A cow that had high SCC recording(s) earlier in the current lactation recorded a LOW SCC in the previous month(s) but has returned to a High SCC at the latest recording.

Chronic: The “Chronic” category describes a cow that is High SCC at the latest recording AND was also High SCC at the PREVIOUS recording(s). So she was high SCC last time and failed to recover. In the example above the cow has 7 consecutive high SCC recordings so has been defined as Chronic for the last 6 months of consecutive high SCC recordings.