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 2016

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Section 1: Key Performance Indicators for the year ending 31/08/2016

Introduction

This is the seventh 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 2016. 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 36 parameters clearly showing the wide differences in performance, as well as huge potential for improvement, in commercial dairy herds. This includes 6 additional parameters (including mastitis rate/100 cows/year), over those described in the six previous studies (2010 to 2015). 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 leads on to *"Why is a parameter where it is? Which parameters could/should we 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 are sections on their practical use, using the InterHerd+ program and trends in a selection of the KPIs across all studies since 2010. A KPI template of 80 parameters for use in InterHerd+ is also available for users to update the KPI parameters to these values from 2016.

Parameter description

For 33 parameters described in this study, the performance level of each of the 500 herds (259 herds for the mastitis rate) is presented as a bar chart. The values are displayed from best to worst, in ascending or descending order depending on whether it is "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 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 represent 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 2015 study were maintained for the 2016 herds' sample. Herds with poor fertility data (inadequate recording of services and pregnancy diagnoses), as well as herds no longer recording, were replaced with herds selected using random numbers. In total 452 herds (about 90%) were in both the 2015 and 2016 studies.

Herd size for the 500 herds in the 2016 study ranged from 41 to 1029 cows, with a median value of 168 cows, as shown in Figure 1. In the sample 63% of herds were comprised of less than 200 cows, with 35 herds containing over 400 cows.

Figure 1. Herd size of the 500 herds in the 2016 study
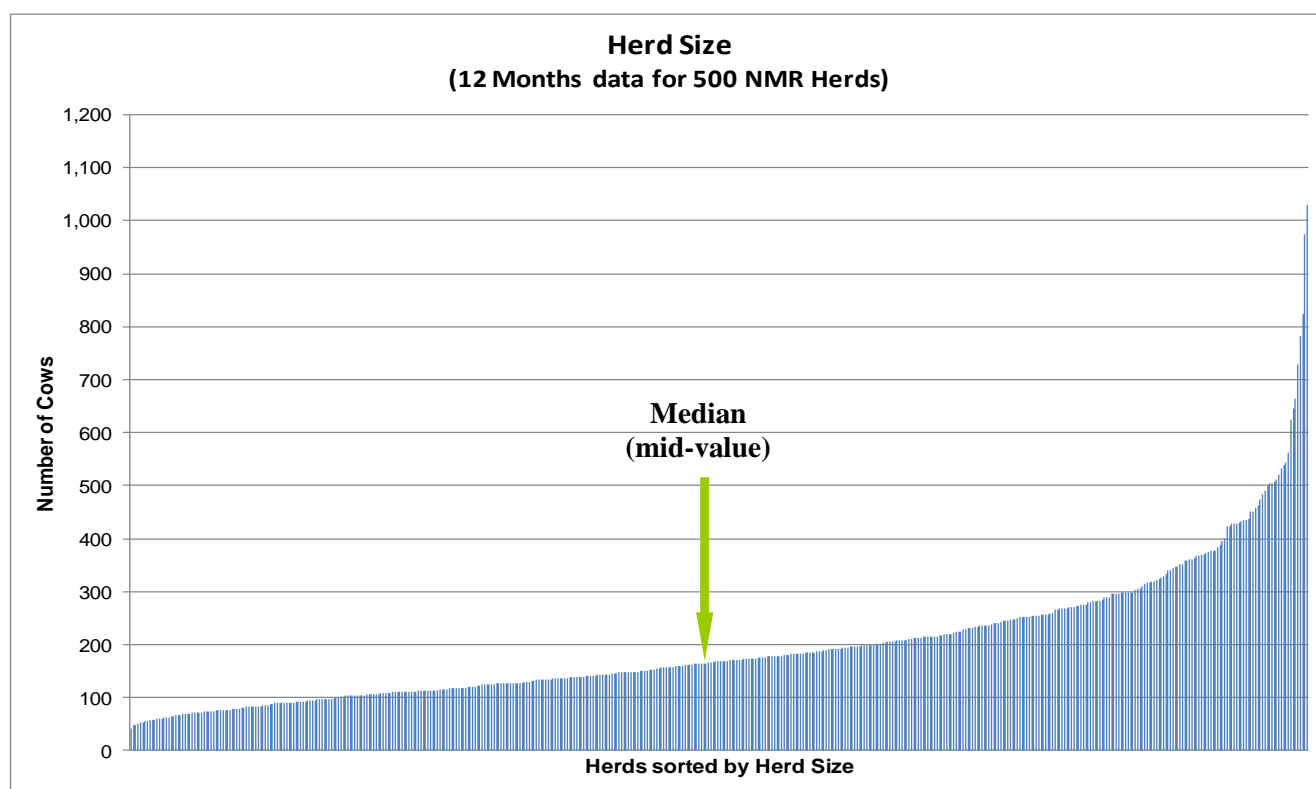
The parameters

To minimize the impact of short term seasonal changes, the key performance indicator values represent the 12 month rolling averages for each parameter. In other words, they represent the performance levels achieved by each herd for the 12 month period from 1st of September 2015 to 31st of August 2016.

The results of the study are summarized in Tables 1(a) & 1(b). For each parameter there are 4 values:

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. Half the herds do better and half do worse than the median 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% 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)**.

The origin of these values is described in Figure 2. Throughout this document the parameter value is displayed on the vertical Y axis with one bar for each of the study herds 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**
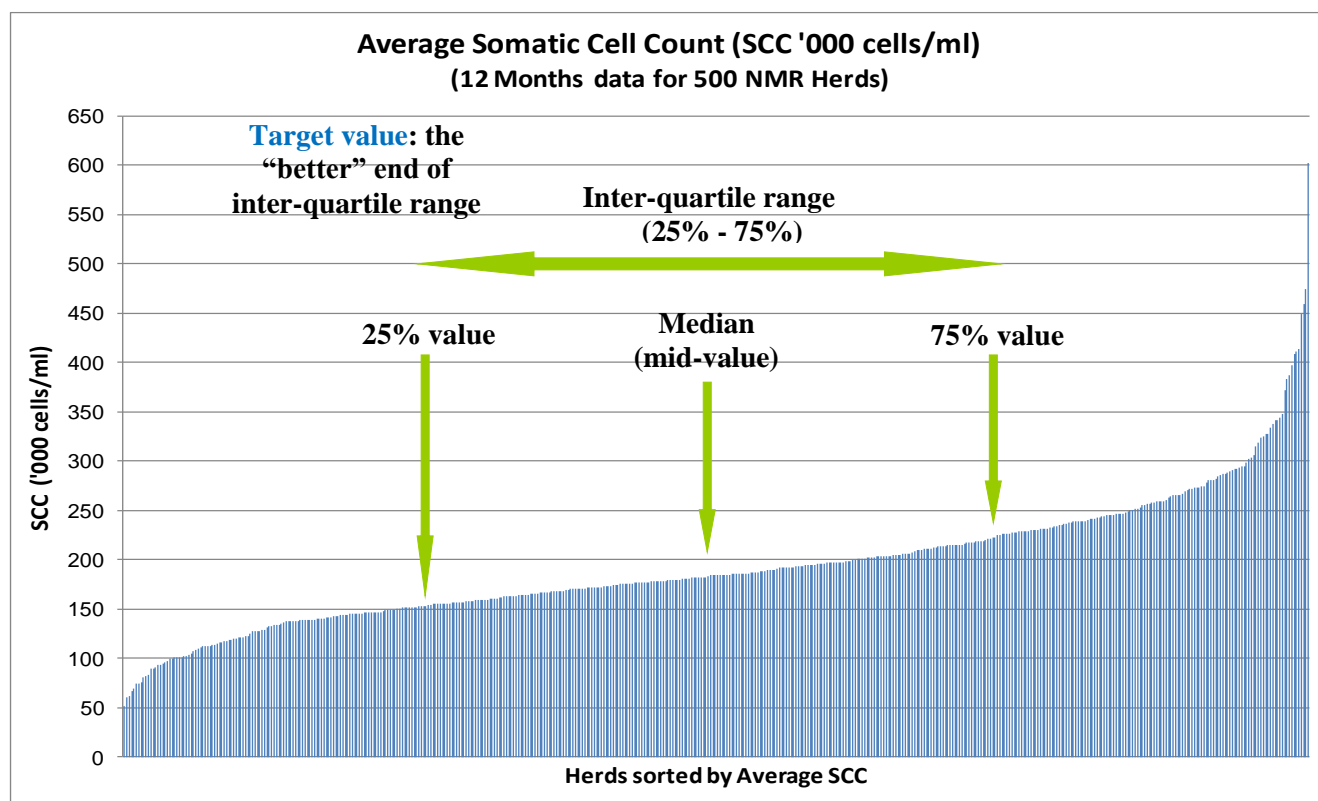
The definitions of each parameter are detailed in Appendix 1.

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/year). This is the first 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 over 50% of herds in 2016. For the purpose of this study any herd that recorded a minimum of 5 cases / 100 cows/ year was considered to record mastitis. In total 259 of the 500 herds (52%) qualified and the parameters are calculated based on these 259 herds.

2. **305 day milk/protein/fat yields:** In previous reports the 305 day yield parameter was calculated from all lactations, including lactations that were shorter than 305 days. In this, and future reports, 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 circumstances, when many cows have lactation lengths below 305 days, this can result in lactation yields smaller than the 305 day yields.

Section 2: KPI Results for the year ending 31/08/2016

Table 1(a)   Summary of Key Performance Indicators derived from analysis of 500 NMR milk recording herds for the year ending 31st August 2016 – Culling, fertility & milk parameters.

Parameter	Median (1)	1st – 3rd quartile (25% - 75%) (2)	Target (3)	Inter-quartile range (4)
A. Culling rate	27%	22% - 33%	22%	11%
B. Culling / death rate in first 100 days of lactation	5%	4% - 8%	4%	4%
C. Age at exit (years)	6.1	5.6 - 6.9	6.9	1.3
D. Age at exit by lactations	3.6	3.2 - 4.2	4.2	1.0
E. Percentage Served by day 80	56%	43% - 68%	68%	25%
F. Percentage conceived 100 days after calving	33%	22% - 41%	41%	19%
G. Calving to 1st service interval (days)	82	71 - 101	71	30
H. Calving interval (days)	407	393 - 422	393	29
I. Age at 1st calving (years)	2.3	2.2 - 2.5	2.2	0.3
J. Conception rate	34%	27% - 40%	40%	13%
K. Percentage service intervals at 18-24 days	35%	28% - 41%	41%	13%
L. Percentage service intervals >50 days	24%	16% - 33%	16%	17%
M. Percentage eligible for service that served	38%	26% - 49%	49%	23%
N. Percentage eligible for service that conceived	13%	8% - 17%	17%	9%
O. Lifetime milk / cow / day (kg)	12.2	10.1 - 14.1	14.1	4.0
P. Milk / cow / year (kg)	8,291	7,223 - 9,471	9,471	2,248
Q. Average protein%	3.26%	3.20% - 3.35%	3.35%	0.15%
R. Average fat%	4.03%	3.86% - 4.18%	4.18%	0.32%
S. 305-day milk yield (kg)	8,911	7,846 - 10,052	10,052	2,206
T. 305-day protein yield (kg)	287	259 - 325	325	66
U. 305-day fat yield (kg)	354	313 - 394	394	81

(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 by the "best" 25% of herds. So, depending on the variable, it is either the **first quartile (25% value) or third quartile (75% value)**.
(4) The inter-quartile range is the difference between the **first quartile (25% value) and third quartile (75% value)**.

Table 1(b)   Summary of Key Performance Indicators derived from analysis of 500 NMR milk recording herds for the year ending 31st August 2016 – Somatic Cell Count (SCC) and mastitis parameters

Parameter	Median (1)	1st – 3rd quartile (25% - 75%) (2)	Target (3)	Inter-quartile range (4)
V. Herd SCC ('000 cells/ml)	185	153 - 227	153	74
W. % milk samples with **High** SCC (*)	19%	16% - 24%	16%	8%
X. % milk samples with SCC >500,000 cells/ml	7%	6% - 10%	6%	4%
Y. % cows with **High** SCC at 1st recording in lactation (*)	17%	13% - 22%	13%	9%
Z. % **Chronic** milk samples (**)	10%	8% - 14%	8%	6%
ZA. Dry period cure (High:Low) (***)	75%	67% - 83%	83%	16%
ZB. Dry period protection (Low:Low) (***)	85%	80% - 90%	90%	10%
ZC. % Low at last recording of previous lactation (*)	69%	61% - 78%	78%	17%
ZD. % samples New SCC category (**)	7%	6% - 9%	6%	3%
ZE. % cows dried-off with no High SCC samples in the lactation (*)	41%	34% - 51%	51%	17%
ZF. Threshold Index new high / new low (****)	1.33	1.20 - 1.48	1.20	0.28
ZG. % of cows with New/First/Repeat sample that are Low SCC at next recording (**)	53%	48% - 58%	58%	10%
ZH. % of cows with Chronic sample that are low SCC at next recording (**)	18%	15% - 23%	23%	8%
ZI. Percentage drying off with no mastitis cases[+]	79%	71% - 87%	87%	16%
ZG. Mastitis rate (cases/100 cows/year)[+]	36	21 - 53	21	32
ZK. Cows with Index mastitis case by Day 30[+]	5%	3% - 8%	3%	5%
ZL. Index mastitis rate after Day 30[+]	22%	14% - 31%	14%	17%

(*) –   **HIGH** SCC is a milk sample with >=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): A cow that finishes a lactation with a HIGH SCC sample then starts the new lactation with a LOW SCC sample;
   Dry Period Cure (Low:Low): A cow that finishes a lactation with a LOW SCC sample then starts the new lactation also with a LOW SCC sample.
(****) The ratio of cows acquiring their index high SCC sample per High SCC cow returning to Low SCC

(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 by the "best" 25% of herds. So, depending on the variable, it is either the **first quartile (25% value) or third quartile (75% value)**.
(4)   The inter-quartile range is the difference between the **first quartile (25% value) and third quartile (75% value)**.

+ The mastitis parameters are derived from a group of 259 herds (within the 500 herds in the study) where mastitis rate >5 cases per 100 cows / year.
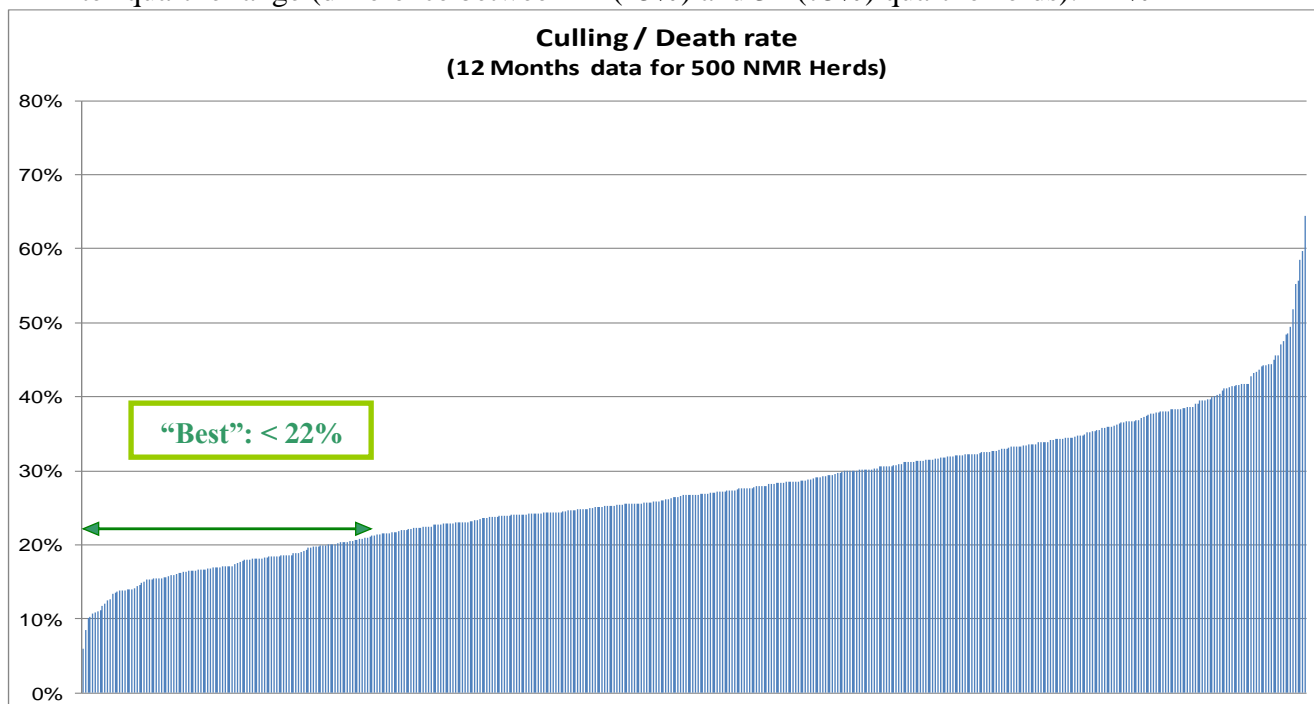
A. Culling/death rate: The % of cows that left the herd (culled/sold/died) in the last 12 months.
   Target (level achieved or surpassed by 25% of herds): 22%
   Median (level achieved by the middle herd): 27%
   75% level (level achieved or surpassed by 75% of herds): 33%
   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 11%

Culling / Death rate
**(12 Months data for 500 NMR Herds)**

"Best": < 22%

B. Culling / deaths in first 100 days of lactation: The culling % during the first 100 days of lactations during the last 12 months. A possible indicator of "involuntary culling"
   Target (level achieved or surpassed by 25% of herds): 4%
   Median (level achieved by the middle herd): 5%
   75% level (level achieved or surpassed by 75% of herds): 8%
   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 4%

Culling / Death rate within 100 days of Calving
(12 Months data for 500 NMR Herds)

"Best": < 4%
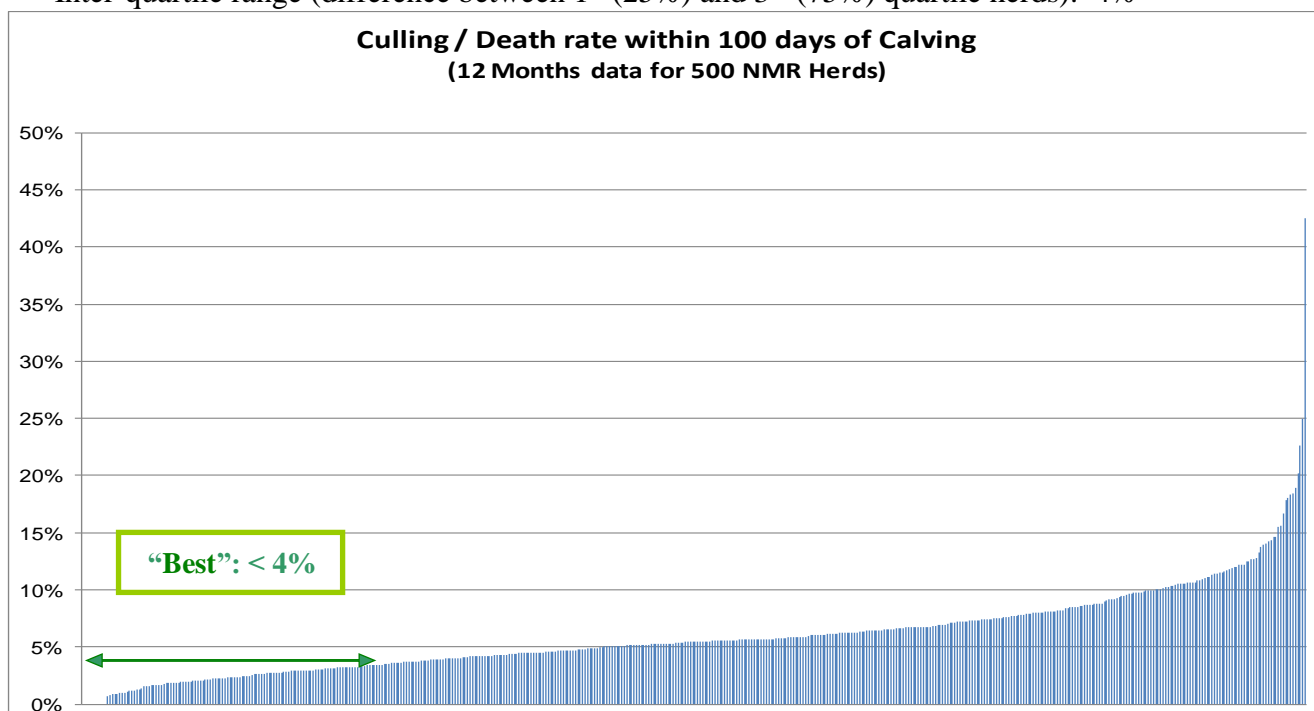
C. Average Age (in years) at exit: The average age of cows leaving the herd in the last 12 month at the time of exit. A potential measure of longevity.

Target (level achieved or surpassed by 25% of herds): 6.9 years
    Median (level achieved by the middle herd): 6.1 years
    75% level (level achieved or surpassed by 75% of herds): 5.6 years
    Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 1.3 years

Average Age at Exit (years)
**(12 Months data for 500 NMR Herds)**

"Best": >6.9 years
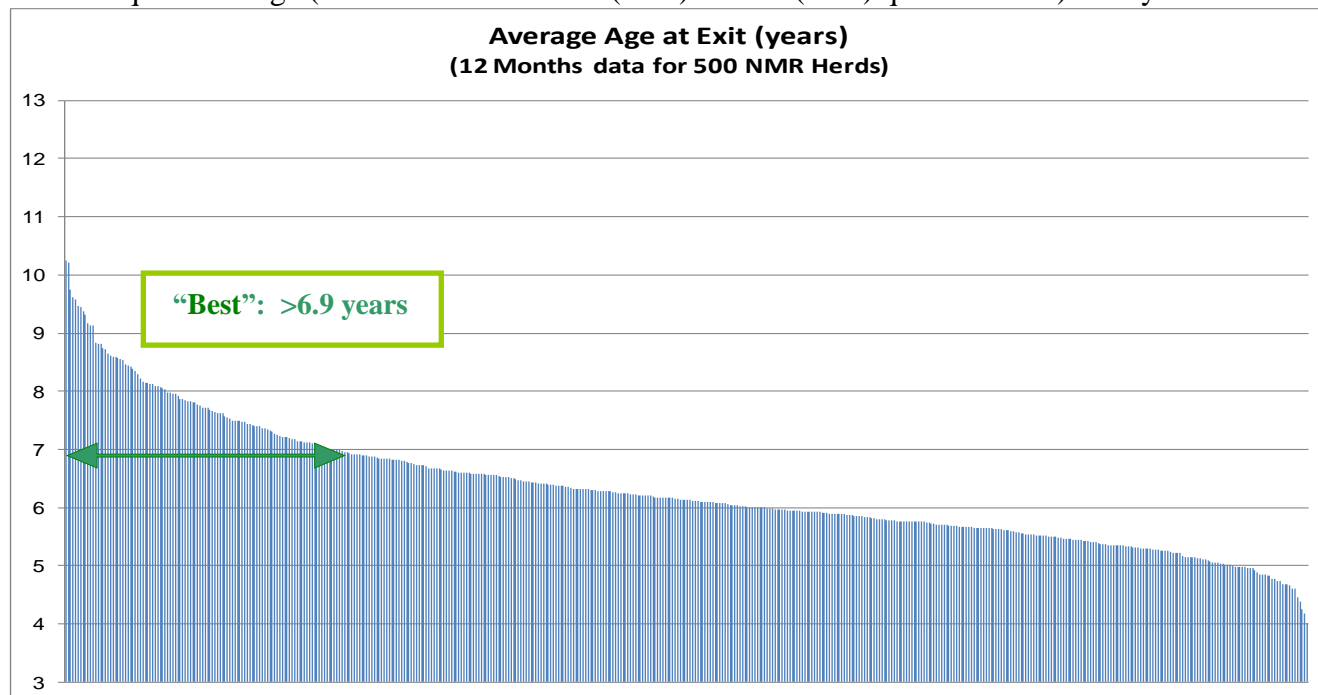
D. Average Age at exit by lactations: The average lactation number of cows leaving the herd in the last 12 months. A potential measure of longevity.

Target (level achieved or surpassed by 25% of herds): 4.2
    Median (level achieved by the middle herd): 3.6
    75% level (level achieved or surpassed by 75% of herds): 3.2
    Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 1.0

Average Age by Lactation No. at Exit
(12 Months data for 500 NMR Herds)
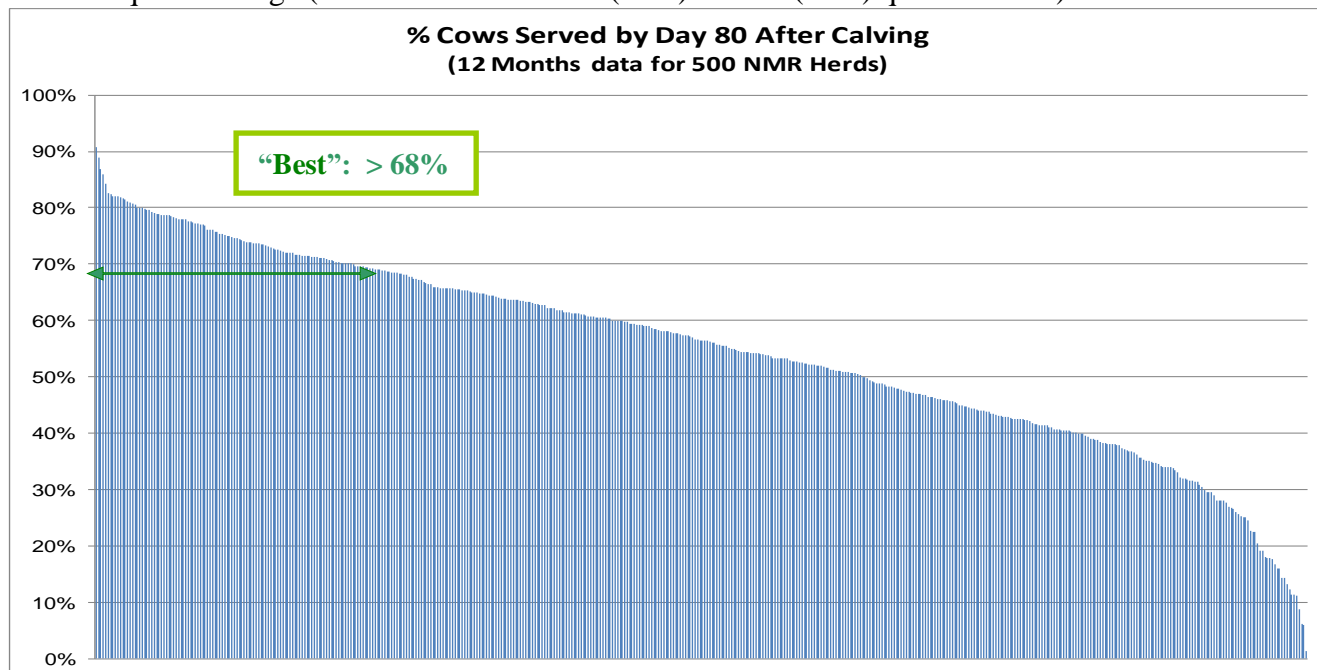
"Best": > 4.2 Lactations
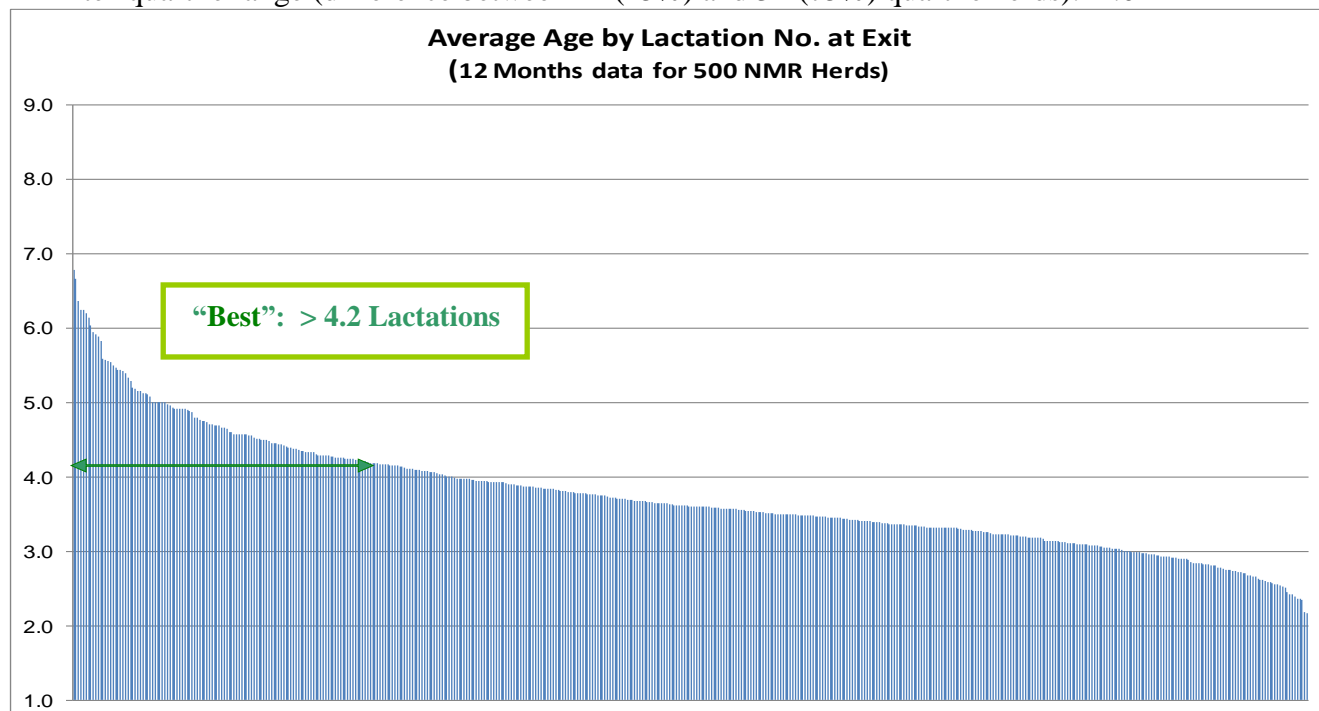
E. Served by day 80: The percentage of calving cows served at least once within 80 days of calving.

Target (level achieved or surpassed by 25% of herds): 68%

Median (level achieved by the middle herd): 56%

75% level (level achieved or surpassed by 75% of herds): 43%

Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 25%

% Cows Served by Day 80 After Calving
(12 Months data for 500 NMR Herds)

"Best": > 68%

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

Target (level achieved or surpassed by 25% of herds): 41%

Median (level achieved by the middle herd): 33%

75% level (level achieved or surpassed by 75% of herds): 22%

Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 19%

% Cows Pregnant by Day 100 After Calving
(12 Months data for 500 NMR Herds)

"Best": > 41%
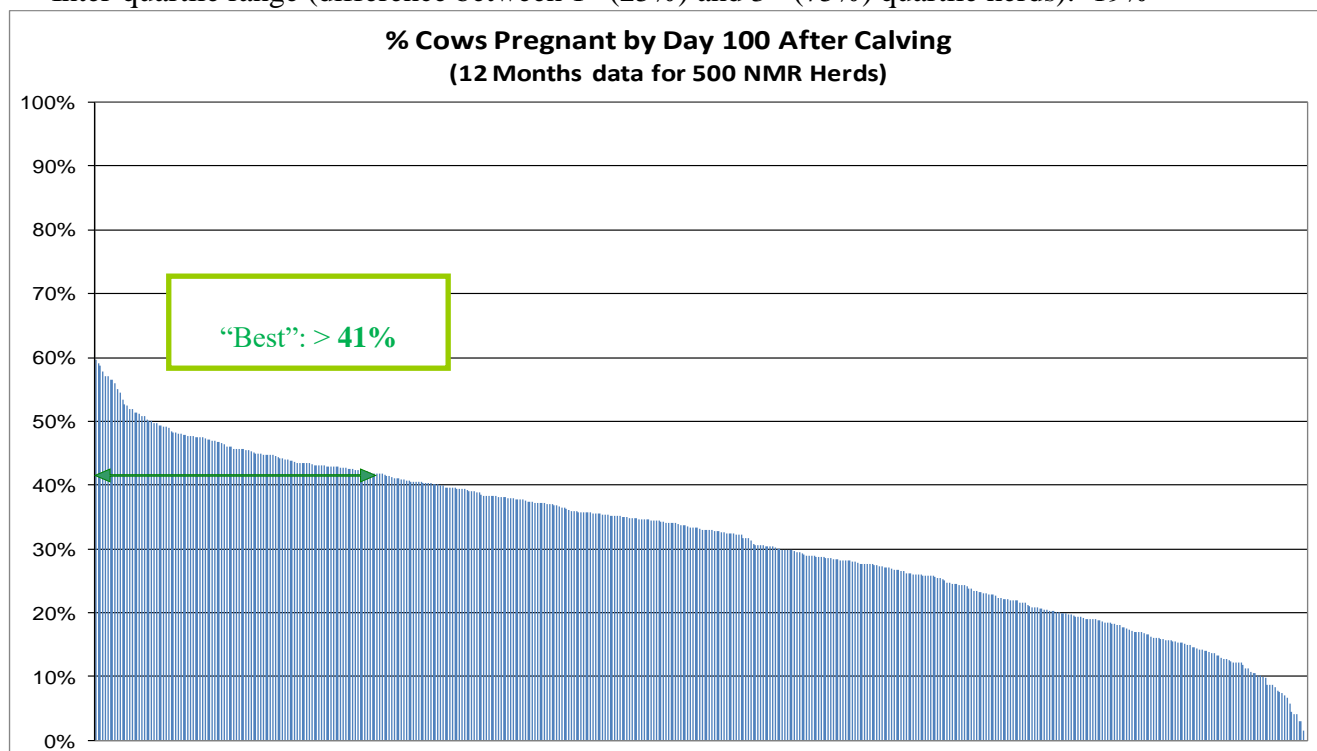
G. Calving to 1st service interval: The average interval between calving and 1st service (in days).
  Target (level achieved or surpassed by 25% of herds): 71 days
  Median (level achieved by the middle herd): 82 days
  75% level (level achieved or surpassed by 75% of herds): 101 days
  Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 30 days

Calving to First Service Interval (days)
**(12 Months data for 500 NMR Herds)**

"Best": < 71 days
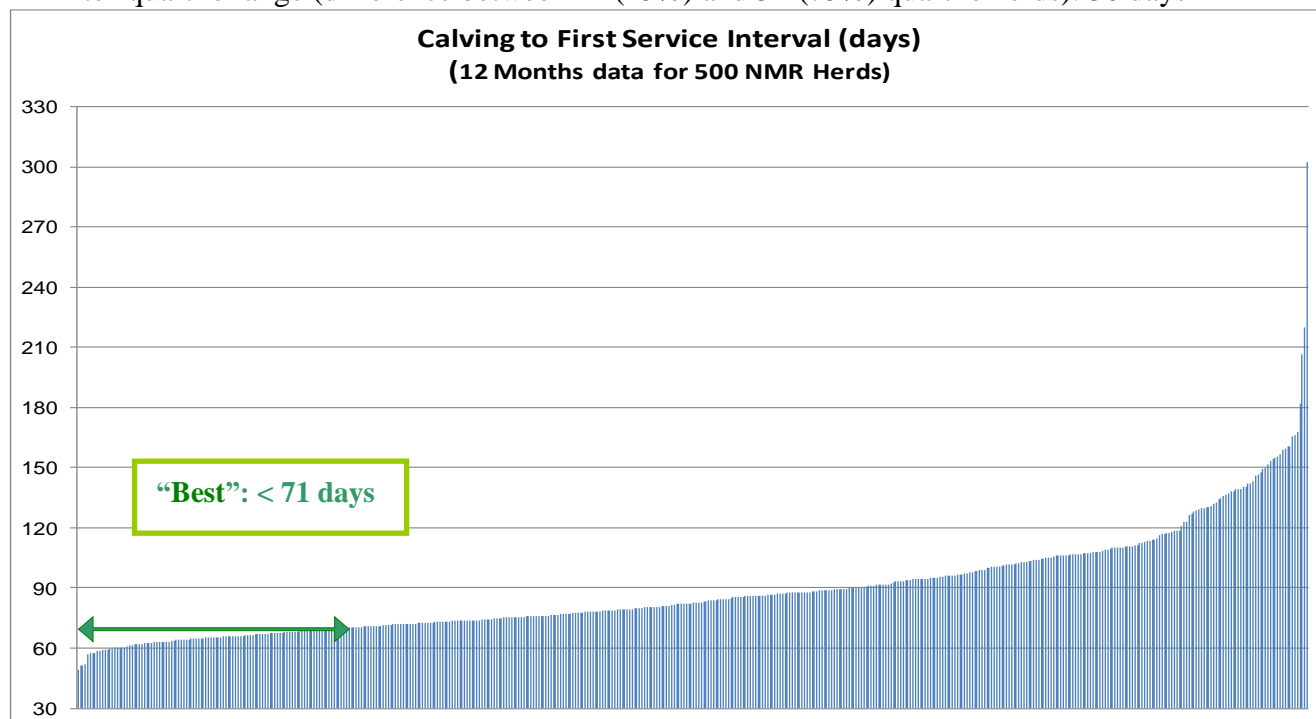
H. Calving interval: The average interval between consecutive calvings (in days).
  Target (level achieved or surpassed by 25% of herds): 393 days
  Median (level achieved by the middle herd): 407 days
  75% level (level achieved or surpassed by 75% of herds): 422 days
 Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 29 days

Calving Interval (days)
(12 Months data for 500 NMR Herds)

"Best": < 393 days

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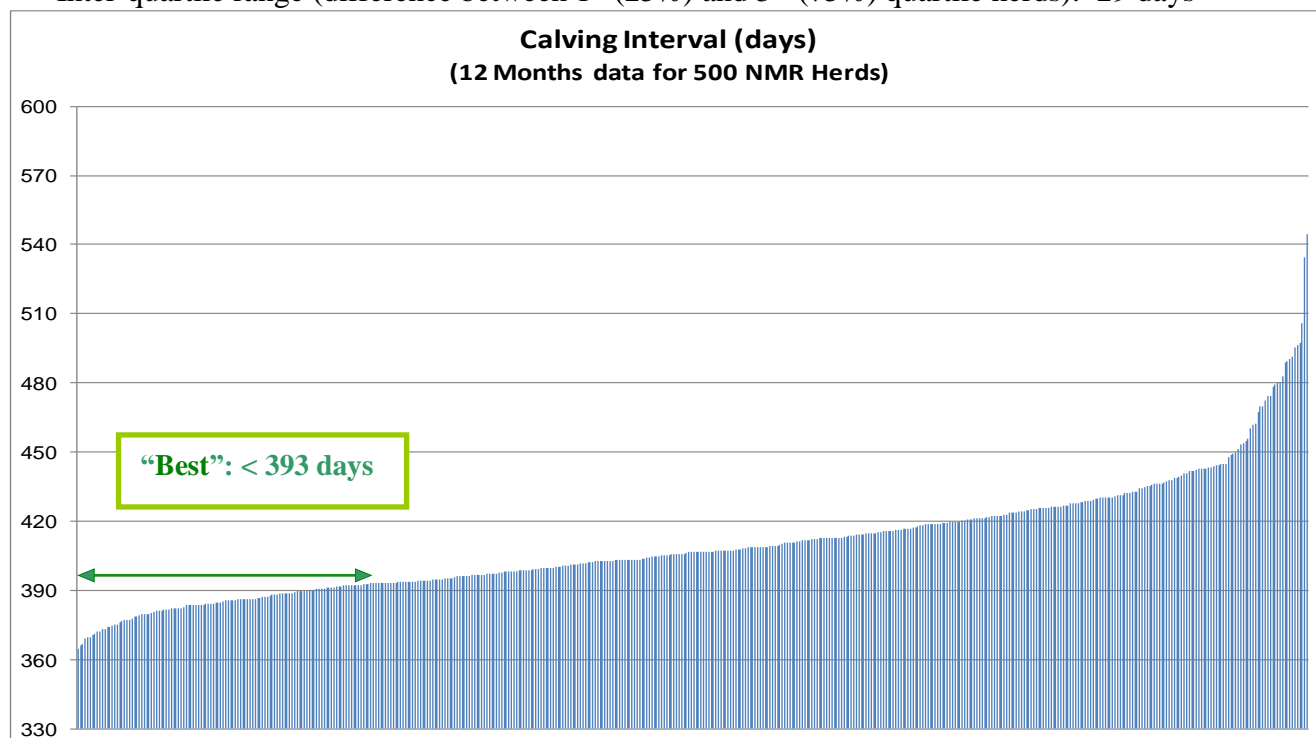
I. Age at 1st calving: The average age of heifers calving down (in years) over the last year.
Target (level achieved or surpassed by 25% of herds): 2.2 years
Median (level achieved by the middle herd): 2.3 years
75% level (level achieved or surpassed by 75% of herds): 2.5 years
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 0.3 years

Age at First Calving (years)
(12 Months data for 500 NMR Herds)

"Best": < 2.2 years
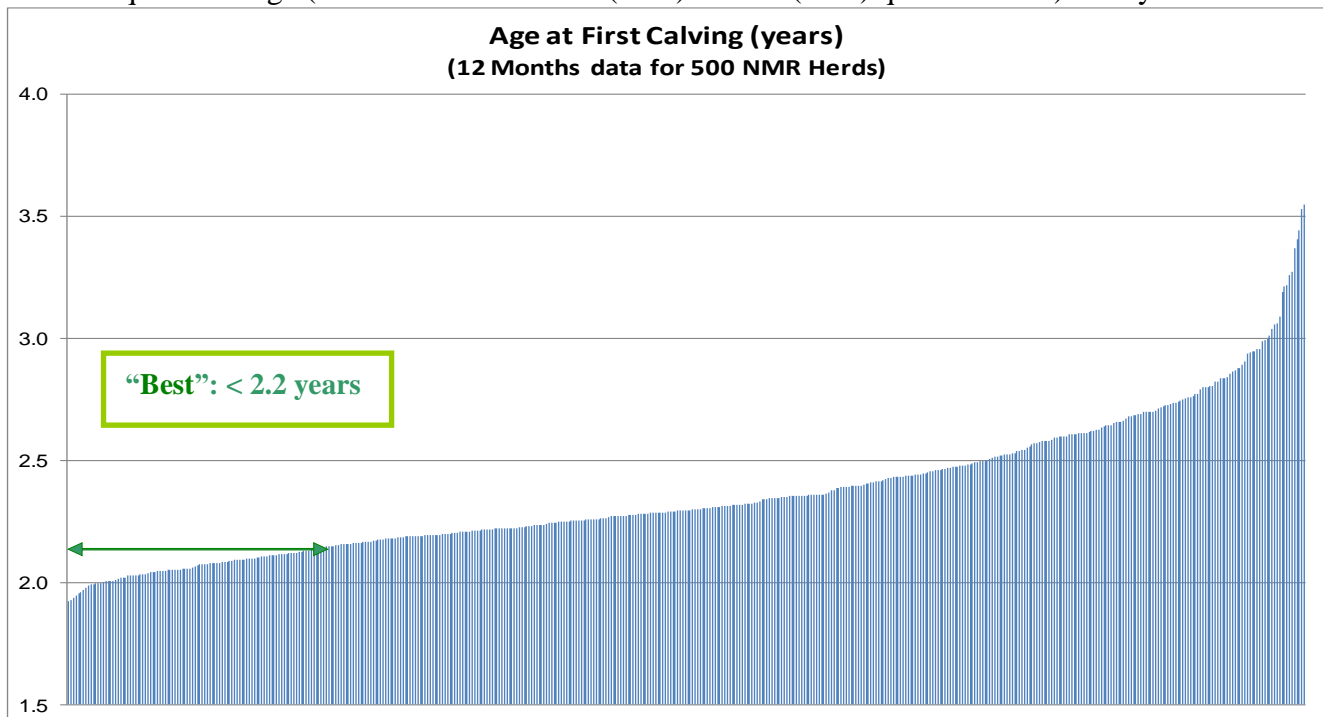
J. Conception rate: The average conception rate for all services in the last 12 months.
Target (level achieved or surpassed by 25% of herds): 40%
Median (level achieved by the middle herd): 34%
75% level (level achieved or surpassed by 75% of herds): 27%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 13%

Conception rate (%)
**(12 Months data for 500 NMR Herds)**

"Best": > 40%
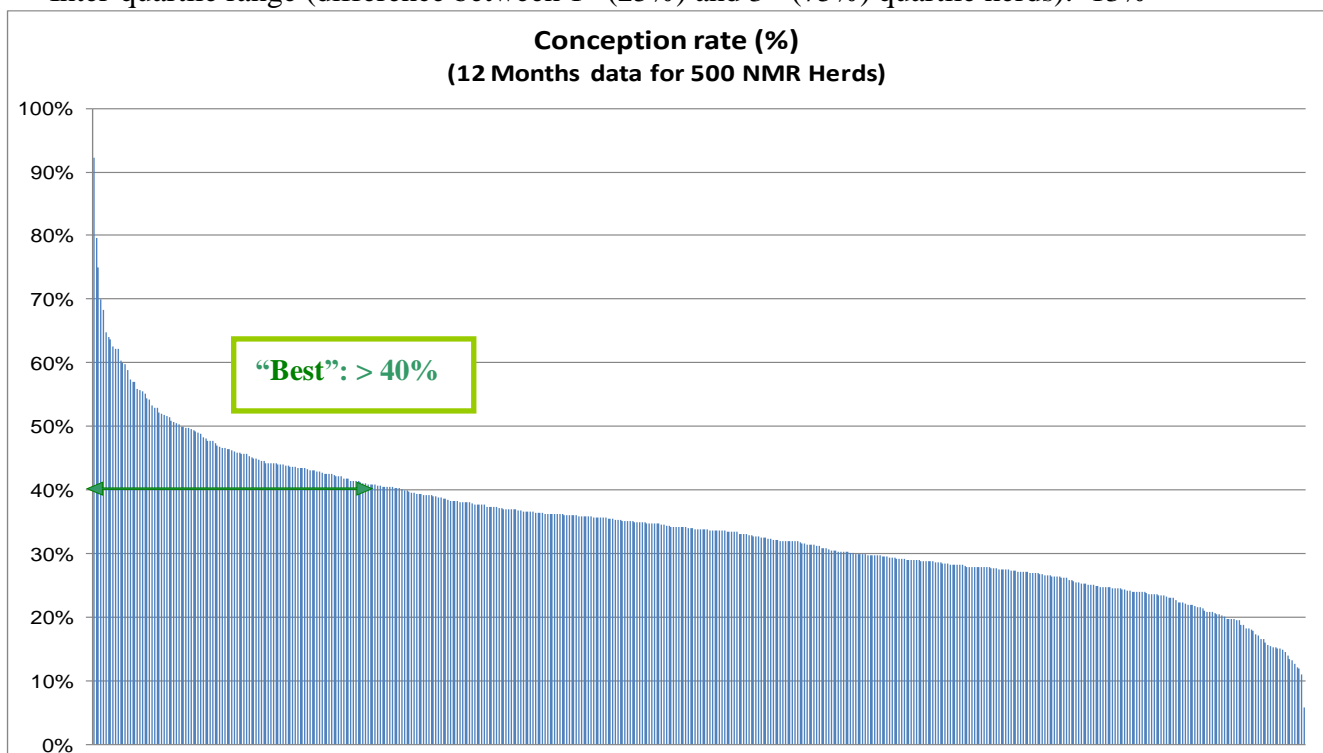
K. Percentage service intervals at 18-24 days: The % of all repeat services occurring 18-24 days (one oestrus cycle) after the previous service. A potential measure of heat detection efficiency.

Target (level achieved or surpassed by 25% of herds): 41%
Median (level achieved by the middle herd): 35%
75% level (level achieved or surpassed by 75% of herds): 28%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 13%

% Service Returns between 18 and 24 Days
**(12 Months data for 500 NMR Herds)**

"Best": > 41%
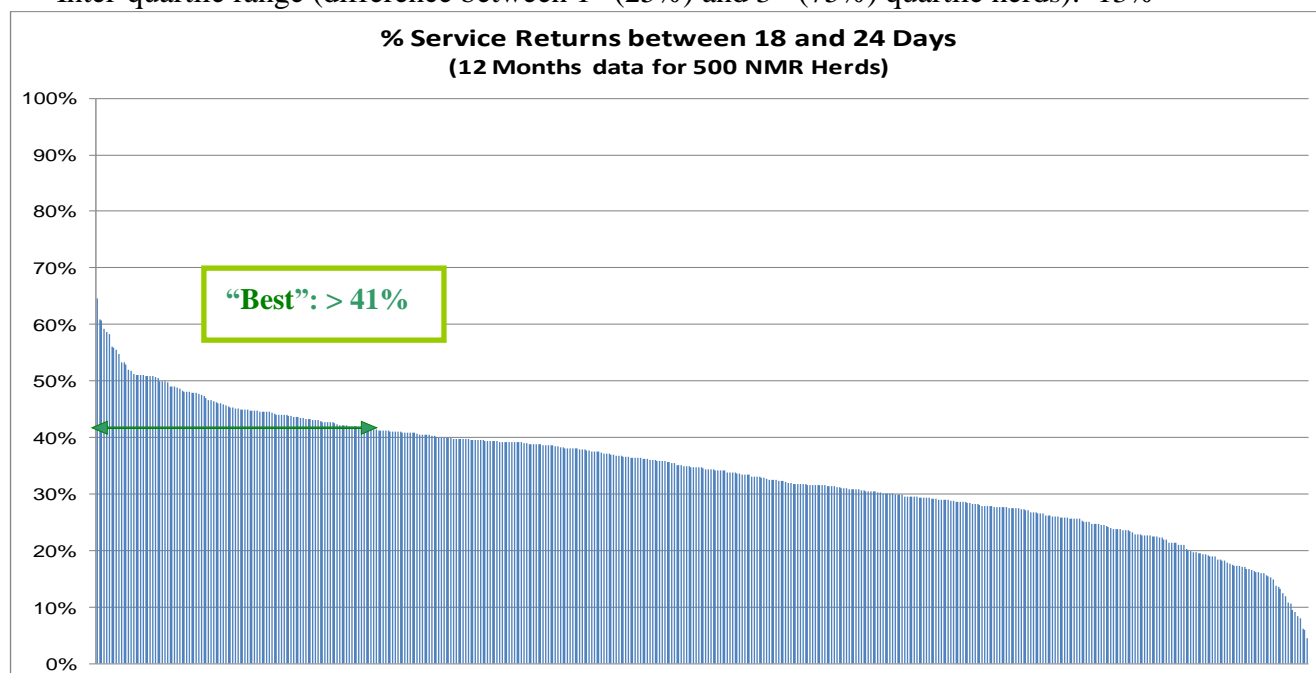
L. Percentage service intervals >50 days: The % of all repeat services with an interval of over 50 days since the previous service. A potential indicator of poor heat detection.

Target (level achieved or surpassed by 25% of herds): 16%
Median (level achieved by the middle herd): 24%
75% level (level achieved or surpassed by 75% of herds): 33%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 17%

% Service Returns at >50 Days
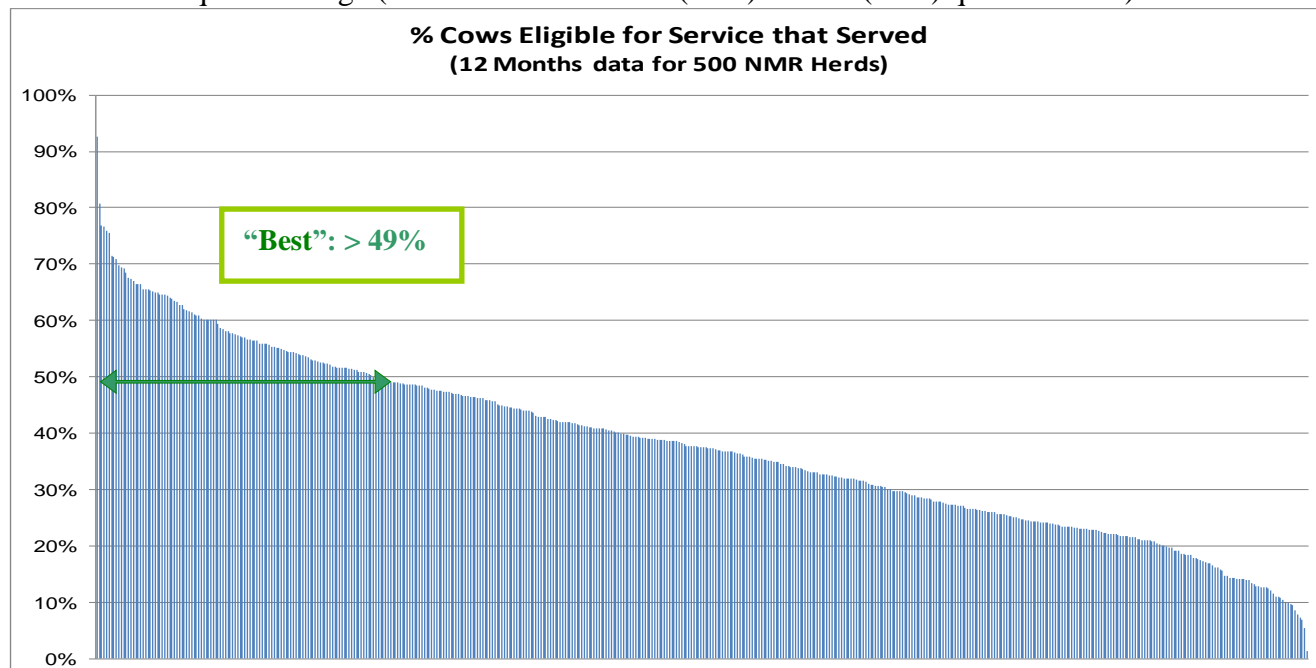**(12 Months data for 500 NMR Herds)**

"Best": < 16%

13
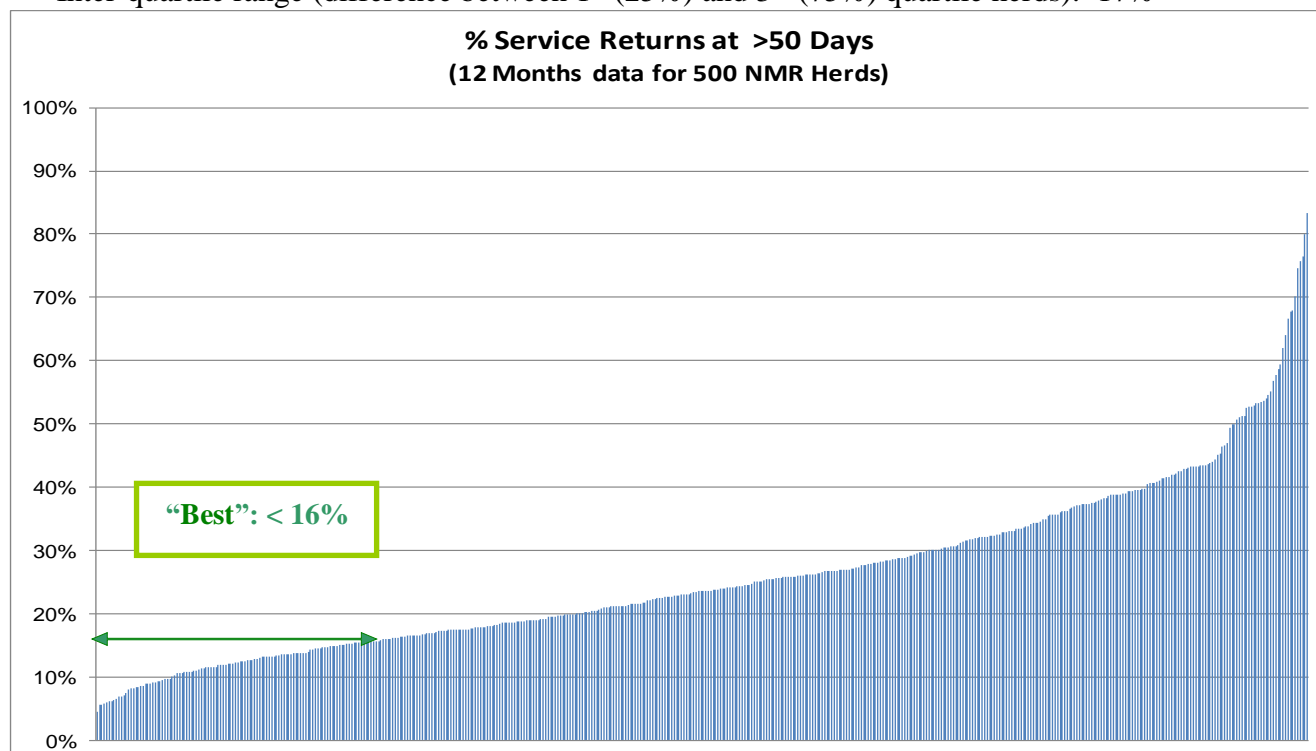
M. Percentage of cows eligible for service that were served: The percentage of cows eligible for service (>42 days calved, not barren, not pregnant) that were served.

Target (level achieved or surpassed by 25% of herds): 49%
Median (level achieved by the middle herd): 38%
75% level (level achieved or surpassed by 75% of herds): 26%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 23%

% Cows Eligible for Service that Served
(12 Months data for 500 NMR Herds)

"Best": > 49%

N. Percentage eligible for service that conceived: The percentage of cows eligible for service (>42 days calved, not barren, not pregnant) that conceived.

Target (level achieved or surpassed by 25% of herds): 17%
Median (level achieved by the middle herd): 13%
75% level (level achieved or surpassed by 75% of herds): 8%
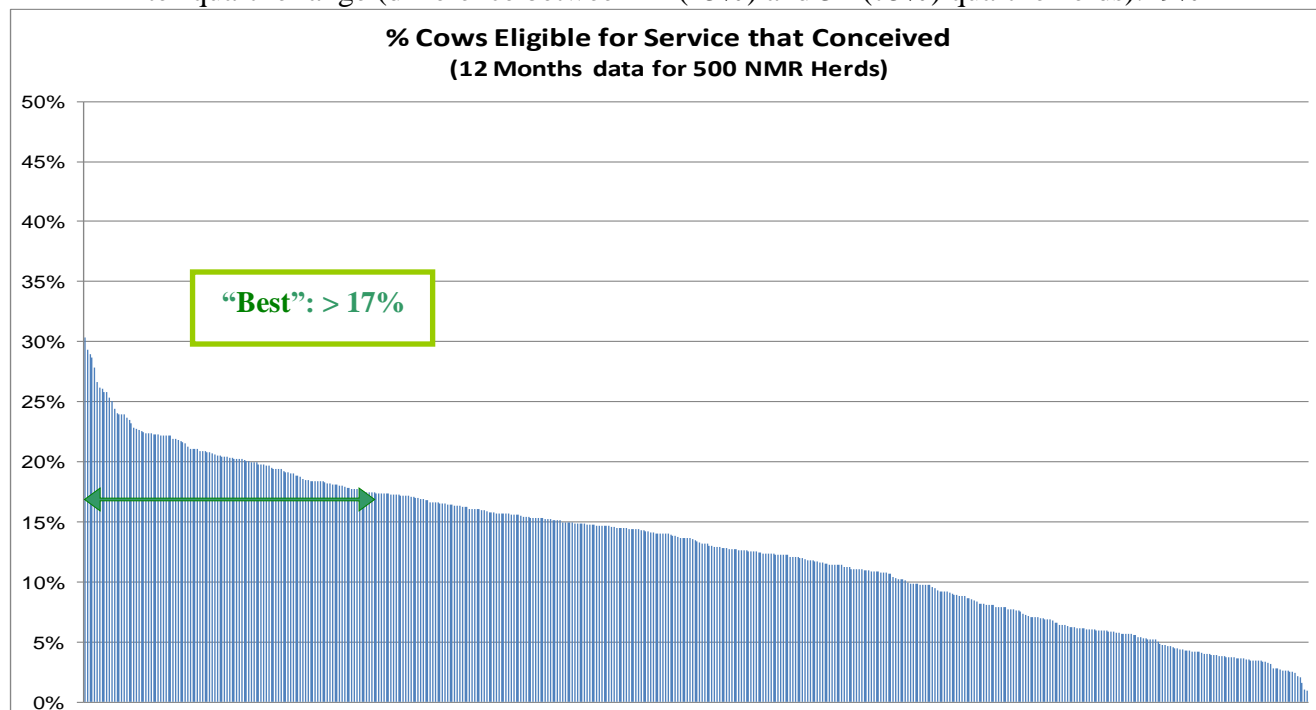Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 9%

% Cows Eligible for Service that Conceived
(12 Months data for 500 NMR Herds)

"Best": > 17%

14

O. Lifetime milk / cow / year (kg): The average daily milk yield of cows in their lifetime (including unproductive periods: time as a heifer, dry period).

Target (level achieved or surpassed by 25% of herds): 14.1 kg
Median (level achieved by the middle herd): 12.2 kg
75% level (level achieved or surpassed by 75% of herds): 10.1 kg
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 4.0 kg

Milk / Cow / Day of Life (kg)
(12 Months data for 500 NMR Herds)

"Best": > 14.1 kg
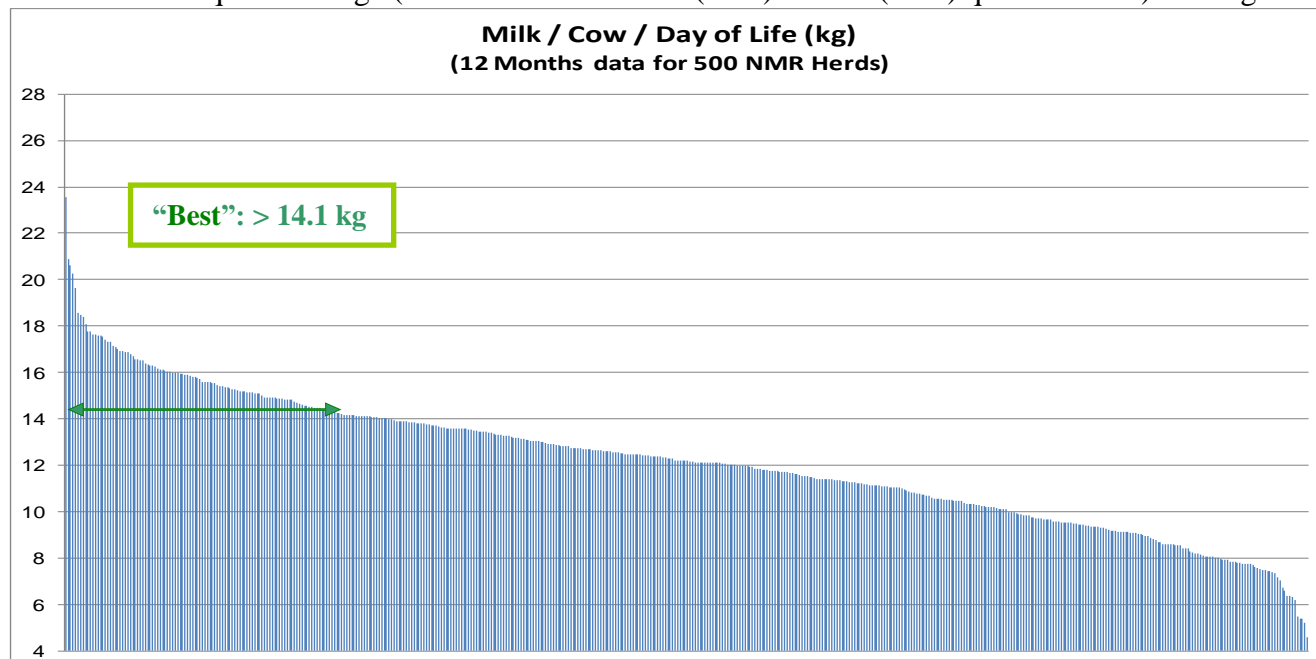
P. Milk / cow / year (kg): The average annual milk yield of all cows in the specified year. Total milk divided by the average cow population. A measure of milk yield per cow place in the herd.

Target (level achieved or surpassed by 25% of herds): 9,471 kg
Median (level achieved by the middle herd): 8,291 kg
75% level (level achieved or surpassed by 75% of herds): 7,223 kg
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 2,248

Milk / Cow / Year (kg)
(12 Months data for 500 NMR Herds)

"Best": > 9,471 kg

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Q. Average protein%: The average % protein of all milk samples taken over the year.
   Target (level achieved or surpassed by 25% of herds): 3.35%
   Median (level achieved by the middle herd): 3.26%
   75% level (level achieved or surpassed by 75% of herds): 3.20%
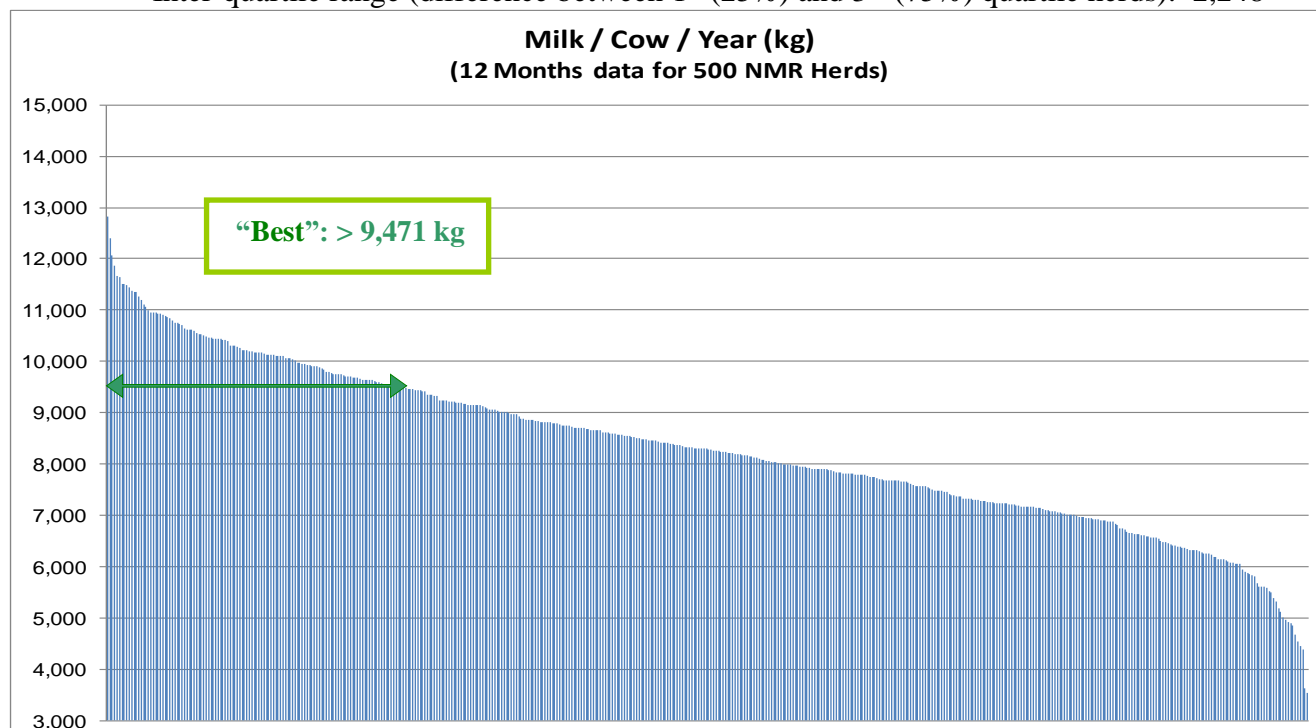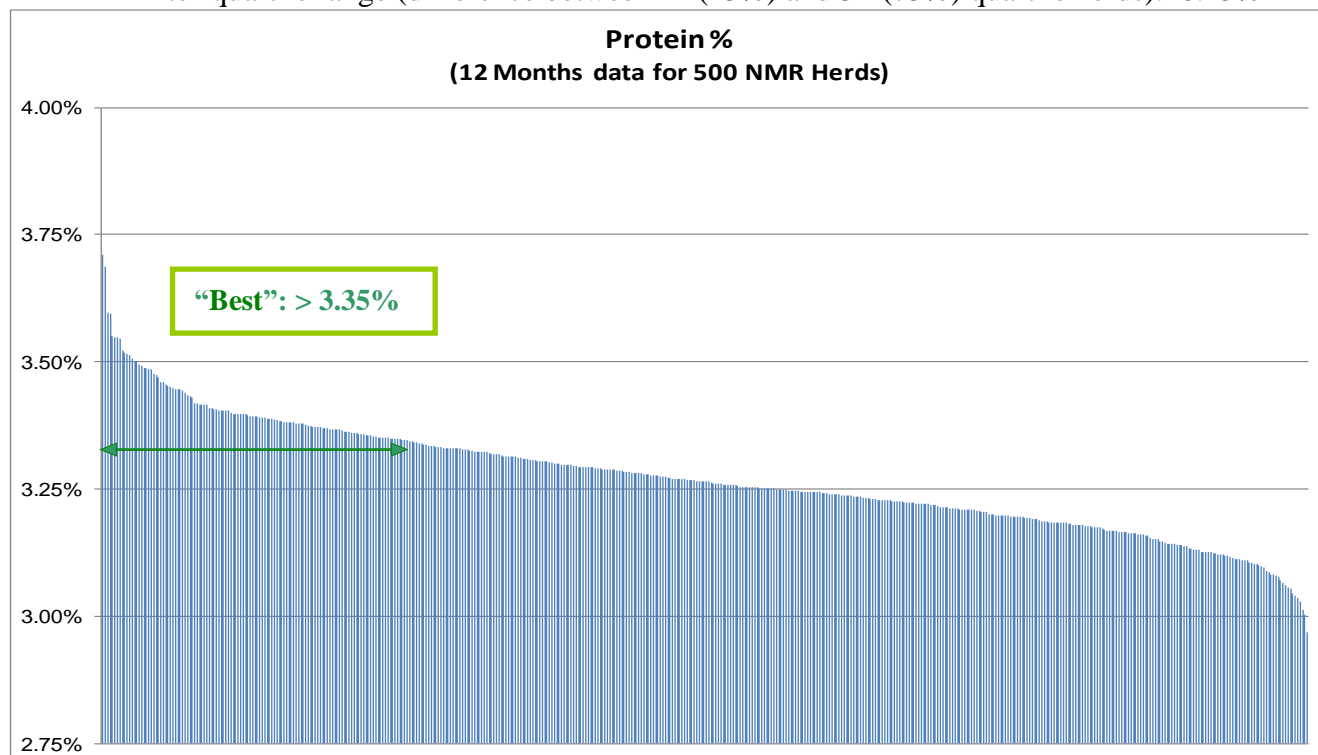   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 0.15%

Protein %
(12 Months data for 500 NMR Herds)

"Best": > 3.35%

R. Average fat%: The average % fat of all milk samples taken over the year.
   Target (level achieved or surpassed by 25% of herds): 4.18%
   Median (level achieved by the middle herd): 4.03%
   75% level (level achieved or surpassed by 75% of herds): 3.86%
   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 0.32%

Fat %
(12 Months data for 500 NMR Herds)

"Best": > 4.18%

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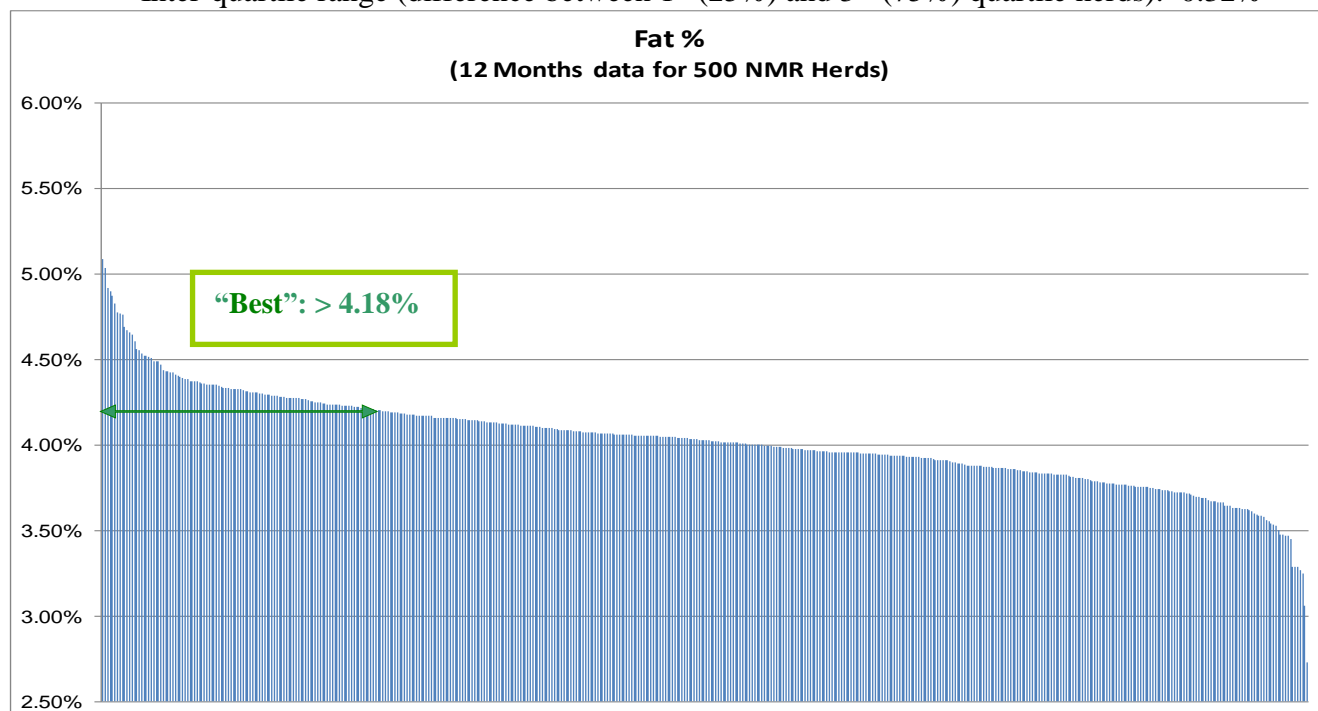
S. 305 day yield (kg): The average yield of cows by day 305 of the lactation.
   Target (level achieved or surpassed by 25% of herds): 10,052 kg
   Median (level achieved by the middle herd): 8,911 kg
   75% level (level achieved or surpassed by 75% of herds): 7,846 kg
   Inter-quartile range (difference between 1ˢᵗ (25%) and 3ʳᵈ (75%) quartile herds): 2,206 kg

305-Day Yield (kg)
(12 Months data for 500 NMR Herds)

"Best": > 10,052 kg

(bar chart: y-axis from 4,000 to 15,000 kg)

T. 305 day protein (kg): The average milk protein yield of cows by day 305 of the lactation.
   Target (level achieved or surpassed by 25% of herds): 325 kg
   Median (level achieved by the middle herd): 287 kg
   75% level (level achieved or surpassed by 75% of herds): 259 kg
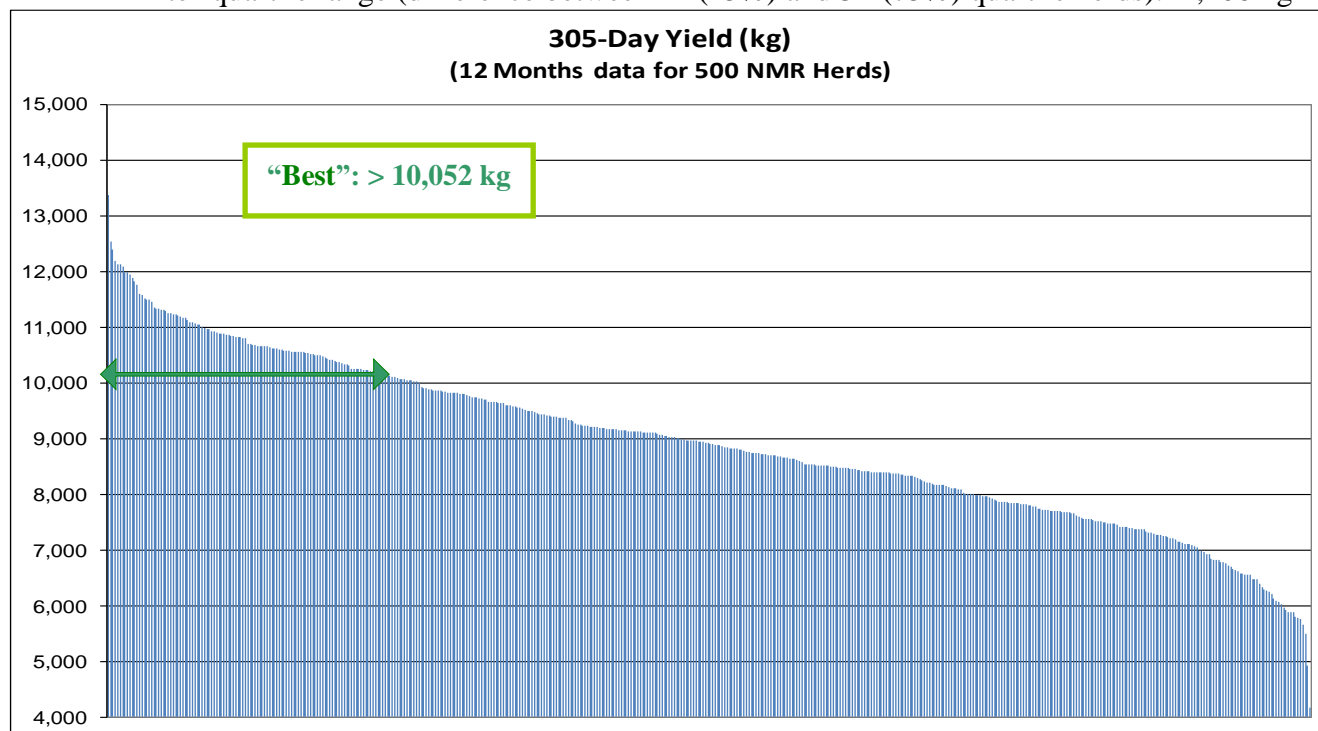   Inter-quartile range (difference between 1ˢᵗ (25%) and 3ʳᵈ (75%) quartile herds): 66 kg

305-day Protein (kg)
(12 Months data for 500 NMR Herds)

"Best": > 325 kg

(bar chart: y-axis from 100 to 450 kg)

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

Target (level achieved or surpassed by 25% of herds): 394 kg

Median (level achieved by the middle herd): 354 kg

75% level (level achieved or surpassed by 75% of herds): 313 kg

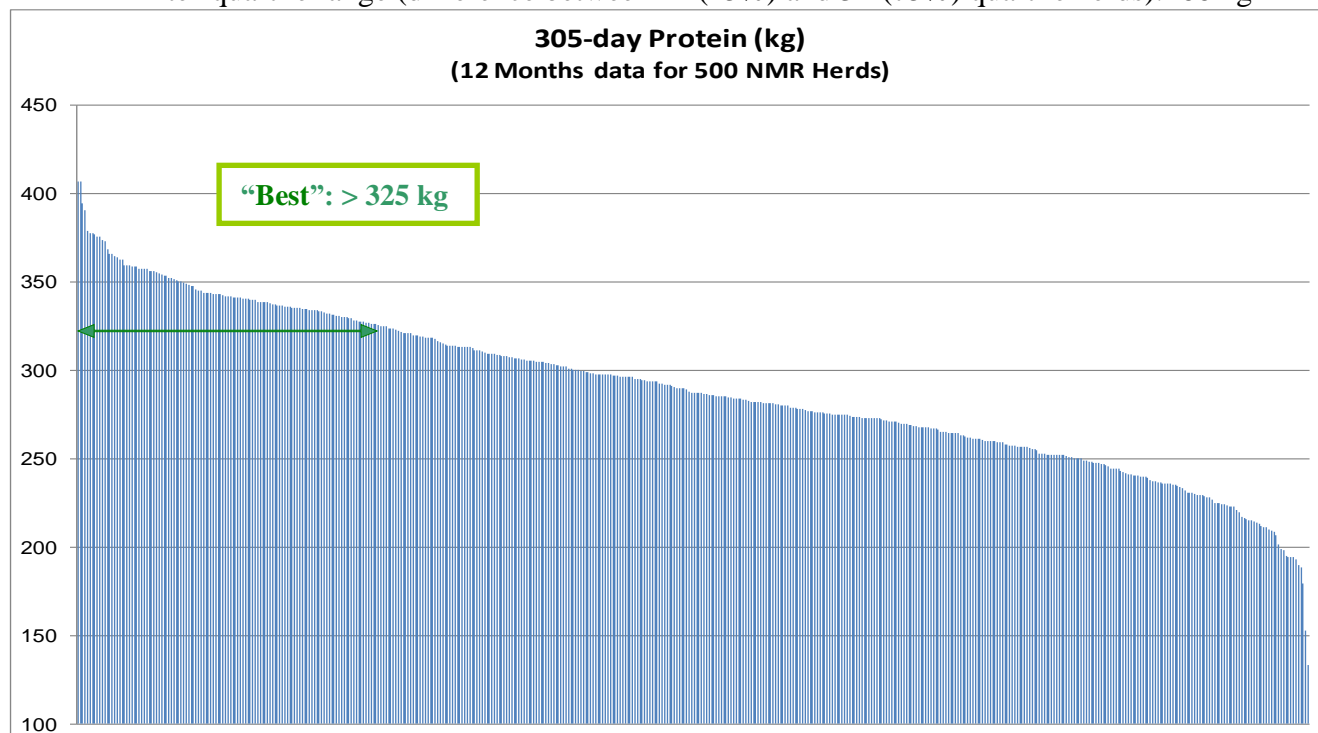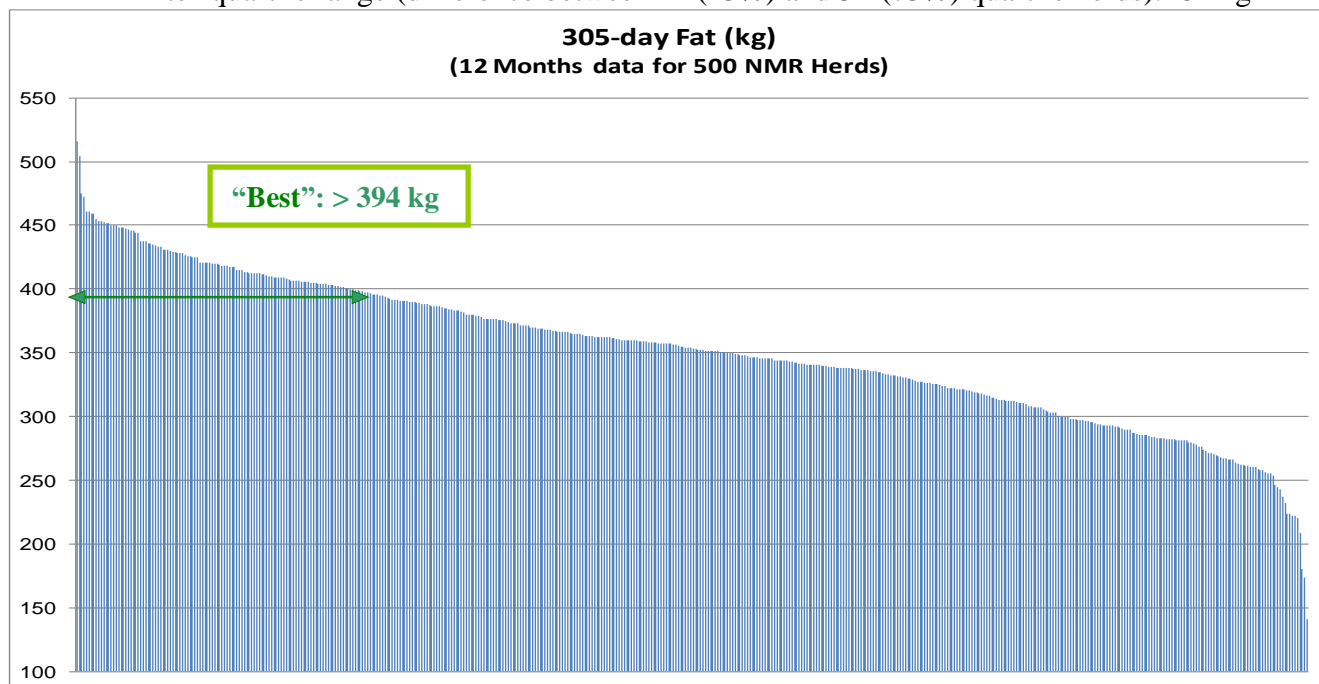Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 81 kg

305-day Fat (kg)
(12 Months data for 500 NMR Herds)

"Best": > 394 kg

V. Herd SCC ('000 cells/ml): The weighted average SCC of all milk samples taken in the last 12 months.

Target (level achieved or surpassed by 25% of herds): 153

Median (level achieved by the middle herd): 185

75% level (level achieved or surpassed by 75% of herds): 227

Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 74

Average Somatic Cell Count (SCC '000 cells/ml)
(12 Months data for 500 NMR Herds)

"Best": < 153

W. Percentage of milk samples with SCC >=200,000 cells/ml: The % of milk samples in the last 12 months with a SCC over 200,000 cells/ml milk. Indicates the size of any reservoir of infection.
   Target (level achieved or surpassed by 25% of herds): 16%
   Median (level achieved by the middle herd): 19%
   75% level (level achieved or surpassed by 75% of herds): 24%
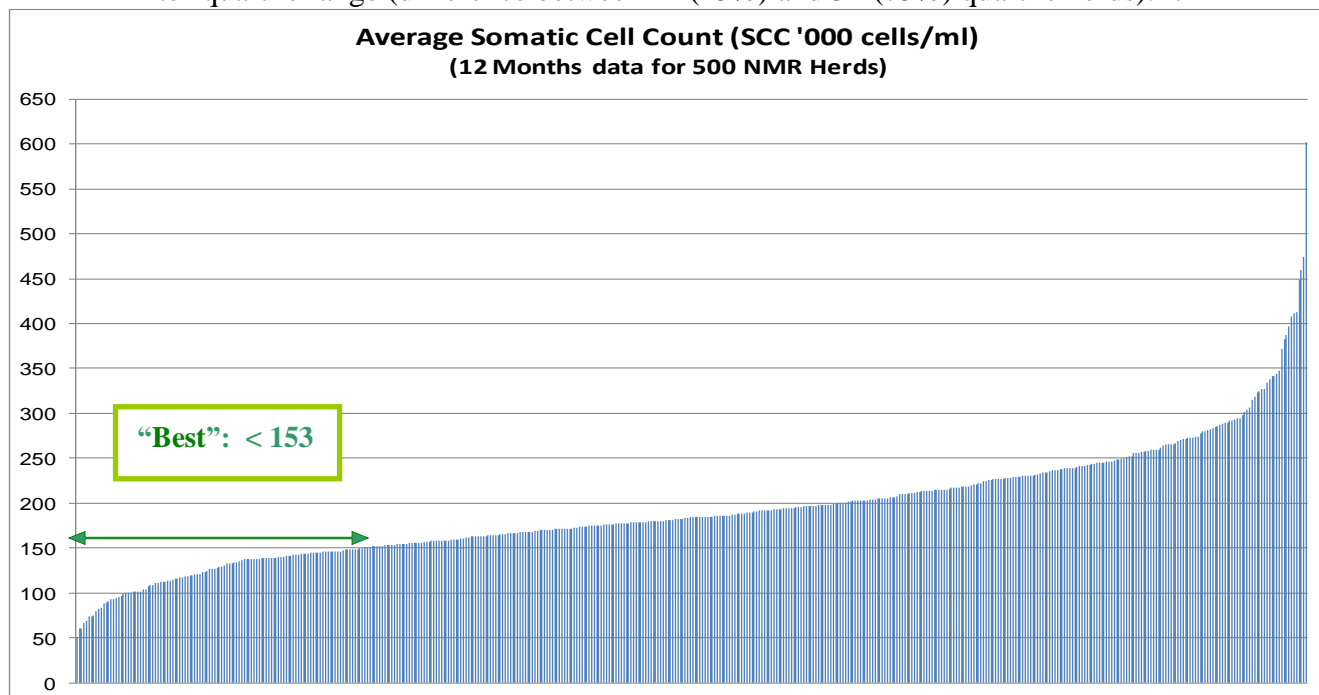   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 8%

% of Milk Samples with SCC >200,000 cells/ml
(12 Months data for 500 NMR Herds)

"Best": < 16%

X. Percentage of milk samples with SCC >500,000 cells/ml: The % of milk samples taken in the last 12 months with a SCC over 500,000 cells/ml of milk.
   Target (level achieved or surpassed by 25% of herds): 6%
   Median (level achieved by the middle herd): 7%
   75% level (level achieved or surpassed by 75% of herds): 10%
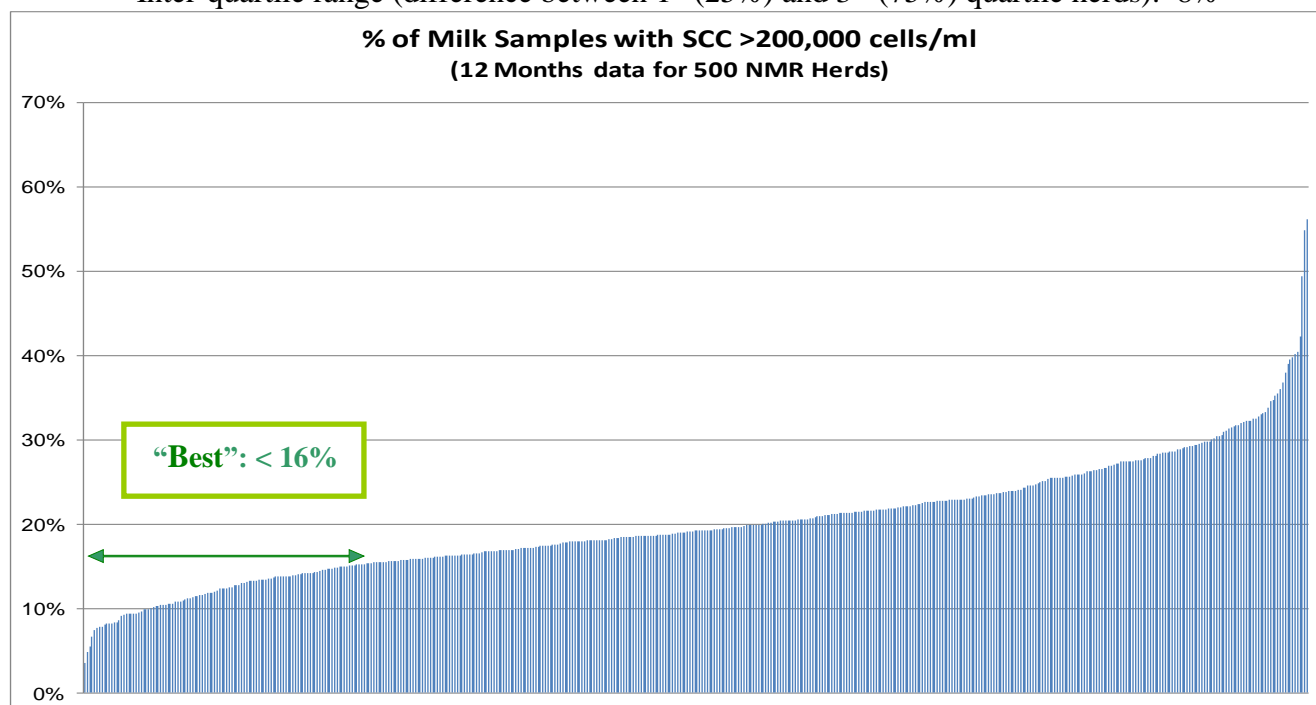   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 4%

% of Milk Samples with SCC >500,000 cells/ml
(12 Months data for 500 NMR Herds)

"Best": < 6%

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

Target (level achieved or surpassed by 25% of herds): 13%
Median (level achieved by the middle herd): 17%
75% level (level achieved or surpassed by 75% of herds): 22%
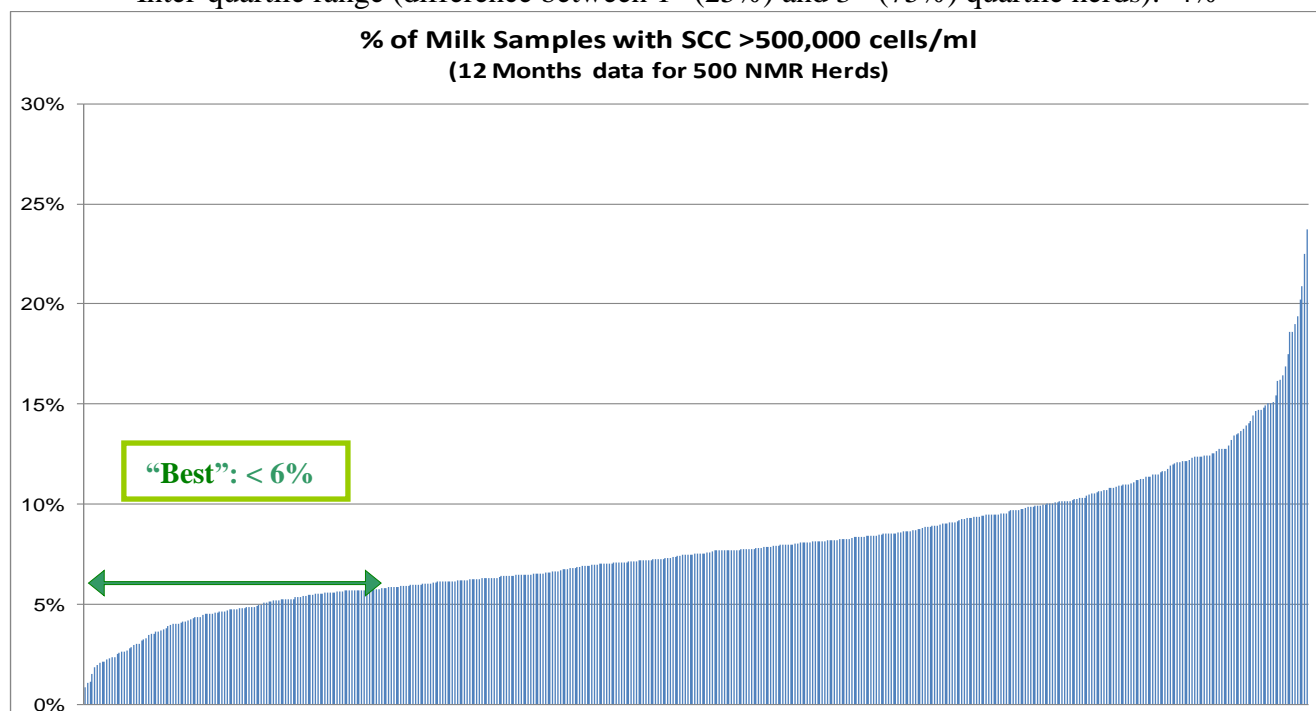Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 9%

% of Cows with high SCC (>200,000/ml) at First Recording in Lactation
(12 Months data for 500 NMR Herds)

"Best": < 13%

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

Target (level achieved or surpassed by 25% of herds): 8%
Median (level achieved by the middle herd): 10%
75% level (level achieved or surpassed by 75% of herds): 14%
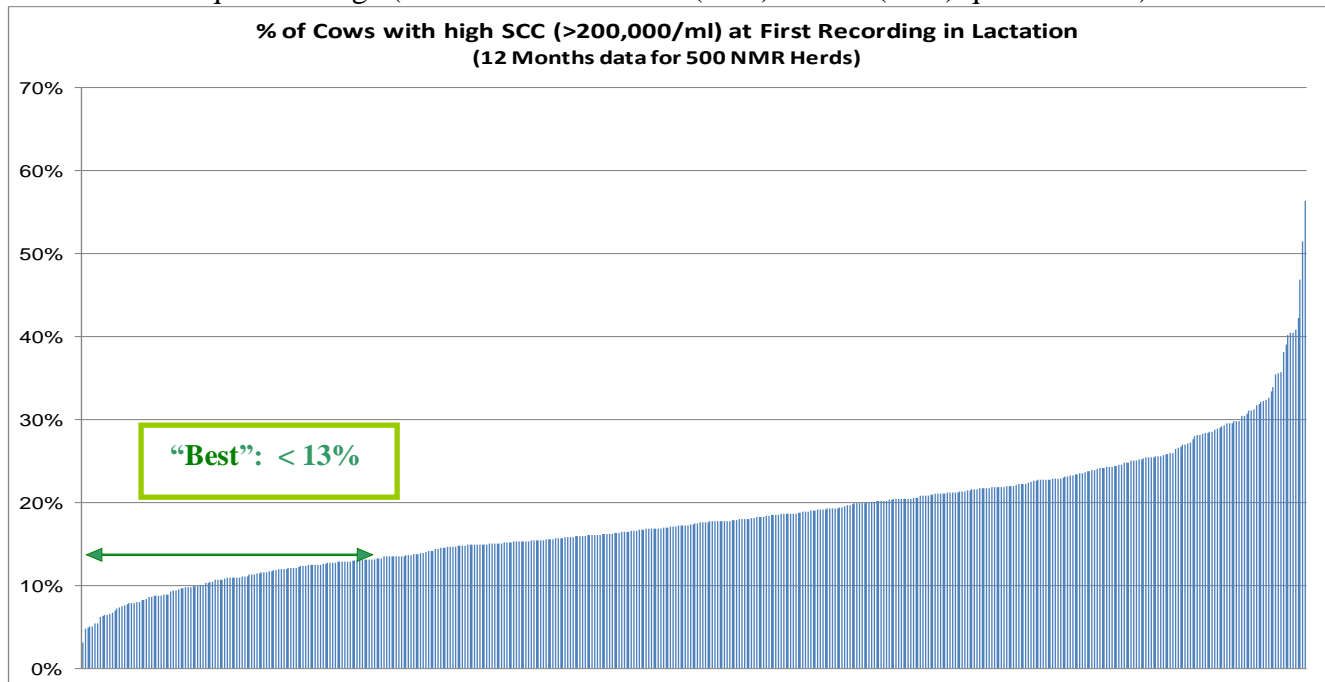Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 6%

% of Cows with Chronic Infections
(12 Months data for 500 NMR Herds)

"Best": < 8%

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

Target (level achieved or surpassed by 25% of herds): 83%
Median (level achieved by the middle herd): 75%
75% level (level achieved or surpassed by 75% of herds): 67%
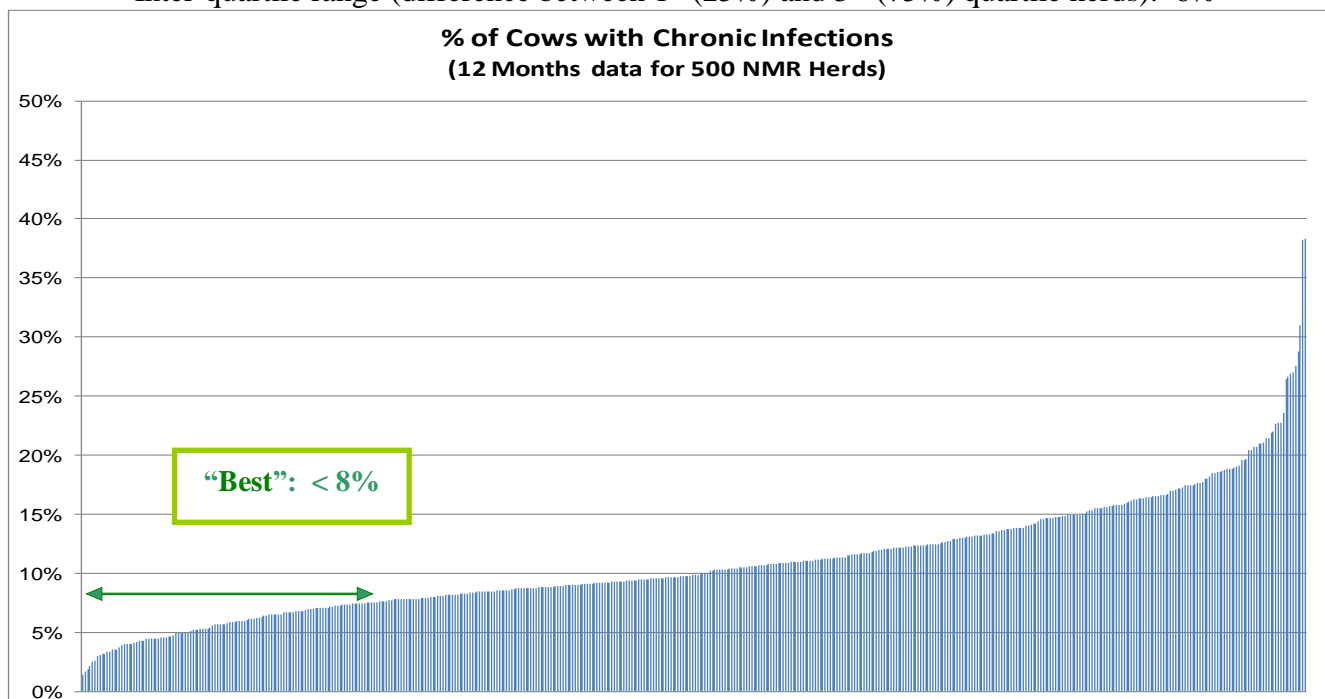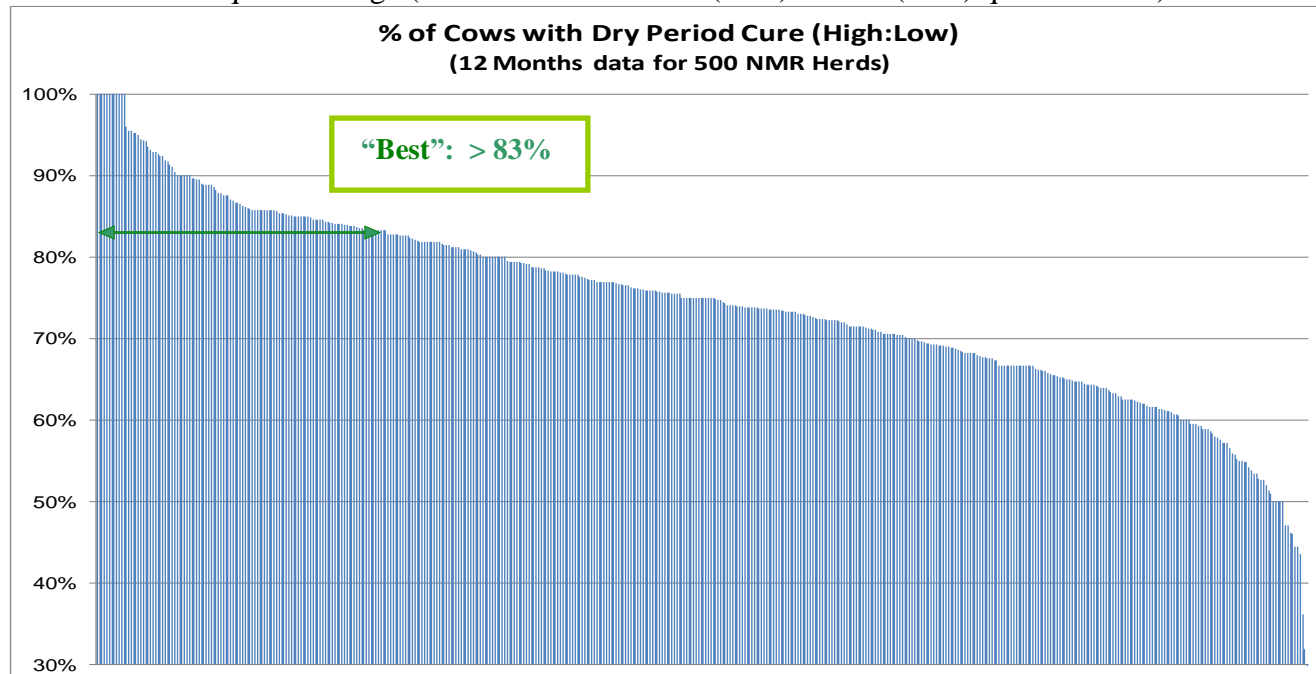Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 16%

% of Cows with Dry Period Cure (High:Low)
(12 Months data for 500 NMR Herds)

"Best": > 83%

ZB. Percentage 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 (level achieved or surpassed by 25% of herds): 90%
Median (level achieved by the middle herd): 85%
75% level (level achieved or surpassed by 75% of herds): 80%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 10%

% of Cows with Dry Period Protection (Low:Low)
(12 Months data for 500 NMR Herds)

"Best": > 90%

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

      Target (level achieved or surpassed by 25% of herds): 78%
      Median (level achieved by the middle herd): 69%
      75% level (level achieved or surpassed by 75% of herds): 61%
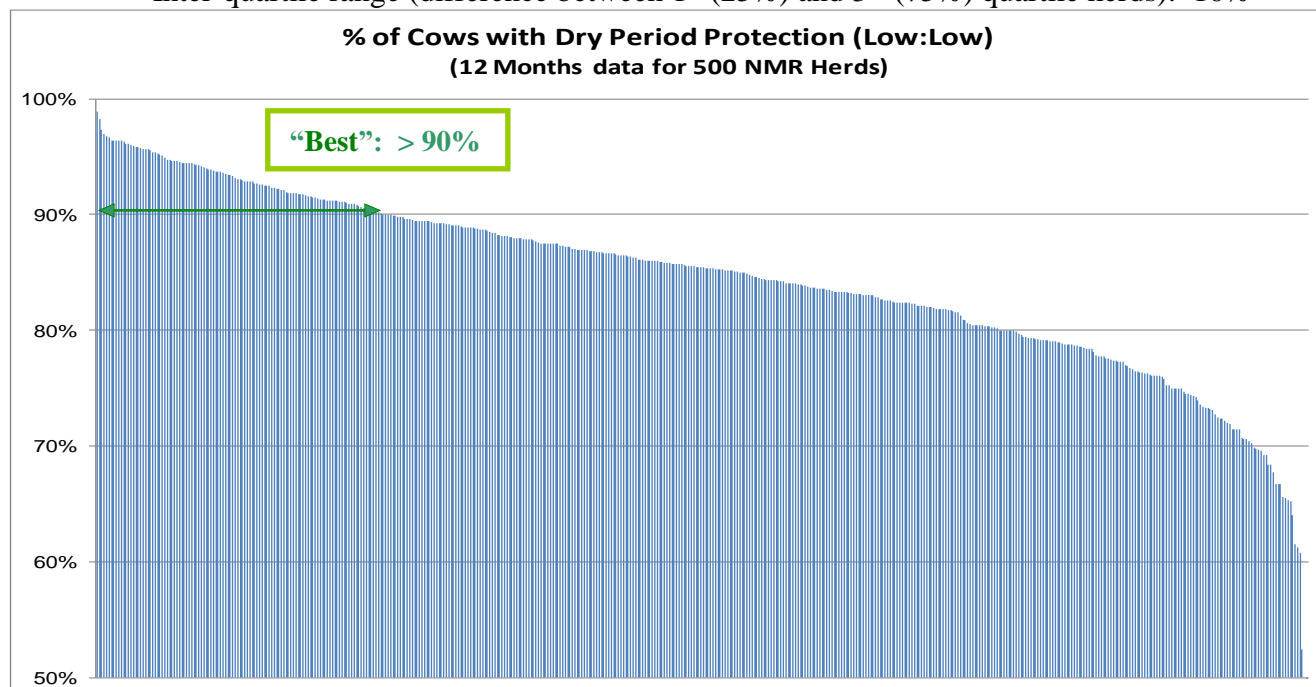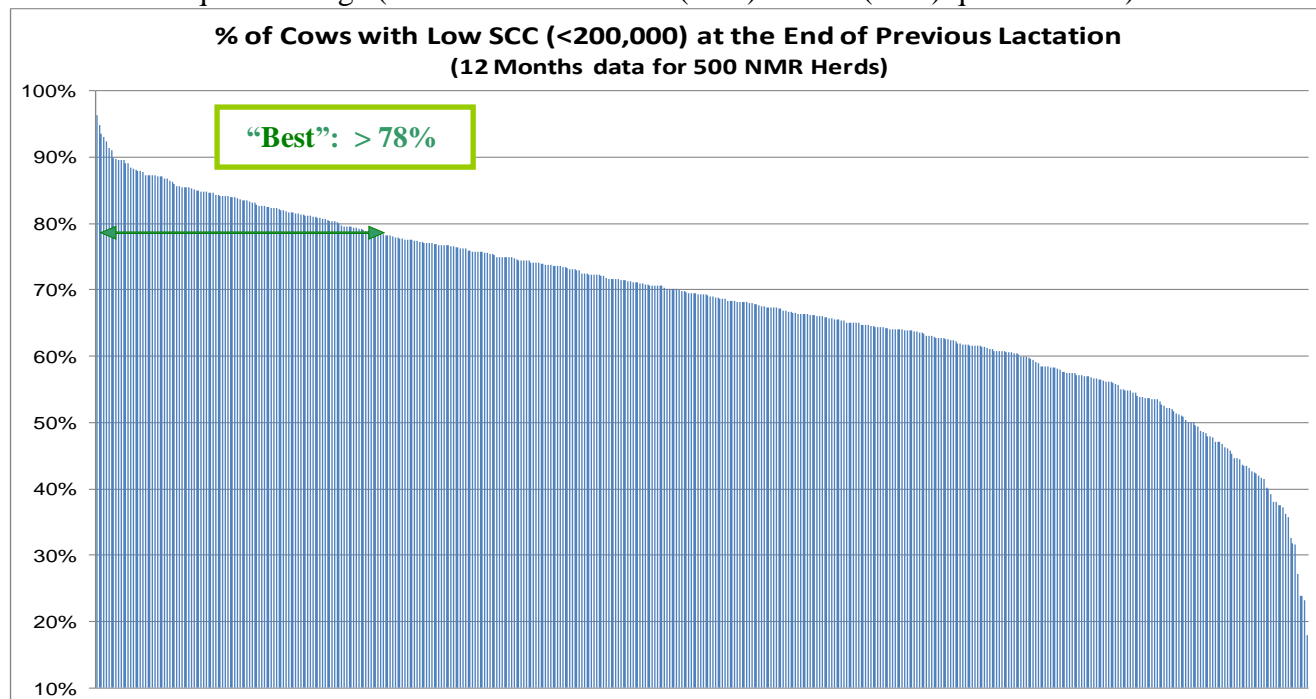   Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 17%

% of Cows with Low SCC (<200,000) at the End of Previous Lactation
(12 Months data for 500 NMR Herds)

"Best": > 78%

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

      Target (level achieved or surpassed by 25% of herds): 6%
      Median (level achieved by the middle herd): 7%
      75% level (level achieved or surpassed by 75% of herds): 9%
      Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 3%

% of New SCC > 200,000 cells/ml
(12 Months data for 500 NMR Herds)

"Best": <6%

ZE. Percentage Dried-off with no SCC >200,000 cells/ml: The percentage of cows recording only LOW SCC samples (<200,000 cells/ml) in completed lactations.

Target (level achieved or surpassed by 25% of herds): 51%

Median (level achieved by the middle herd): 41%

75% level (level achieved or surpassed by 75% of herds): 34%

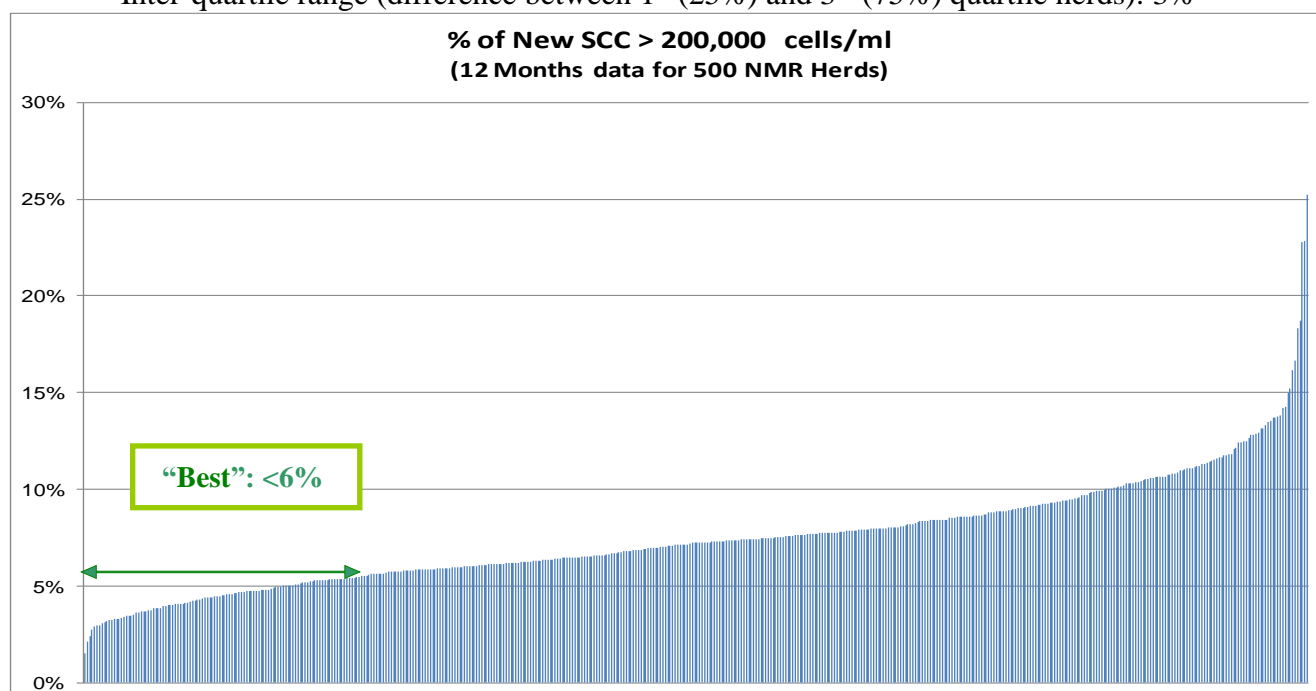Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 17%

% Cows dried off with No SCC > 200,000 cells/ml
(12 Months data for 500 NMR Herds)

"Best": >51%

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 (level achieved or surpassed by 25% of herds): 1.20

Median (level achieved by the middle herd): 1.33

75% level (level achieved or surpassed by 75% of herds): 1.48

Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 0.28
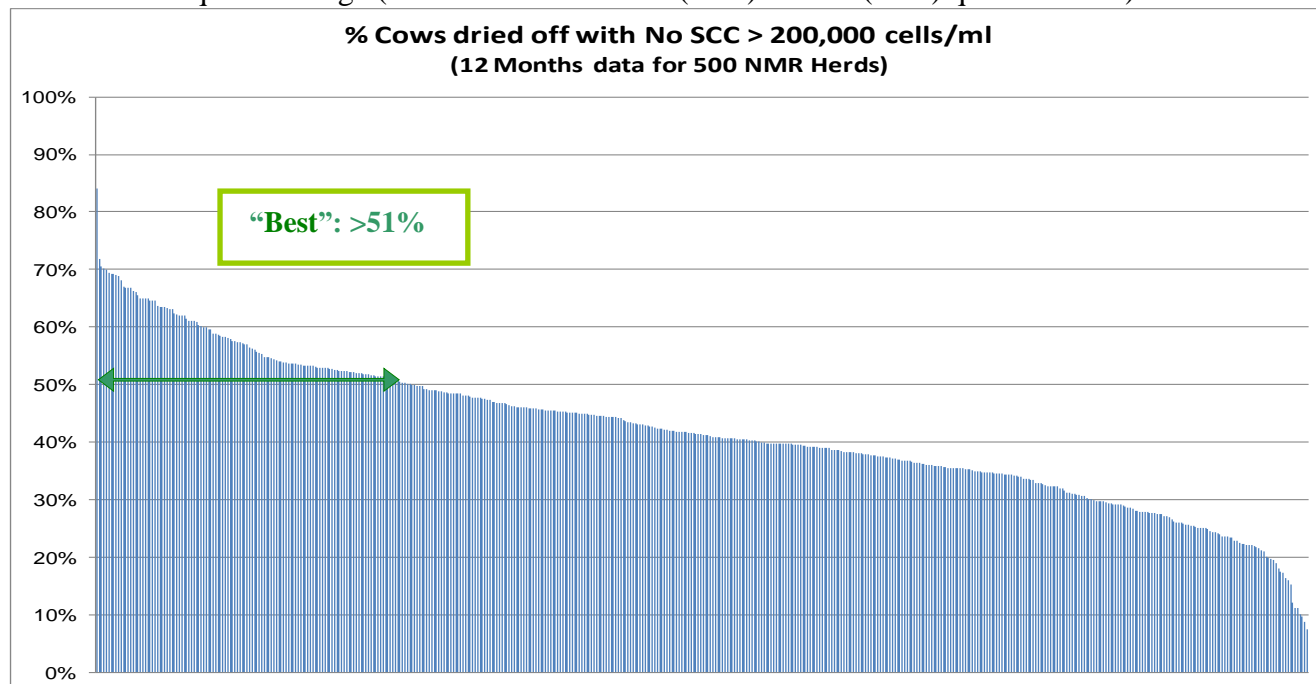
Threshold index new high / new low
(12 Months data for 500 NMR Herds)

"Best": <1.20

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ZG. Recovery percentage of New/First/Repeat infections: Of HIGH SCC cows (>=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.

Target (level achieved or surpassed by 25% of herds): 58%
Median (level achieved by the middle herd): 53%
75% level (level achieved or surpassed by 75% of herds): 48%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 10%
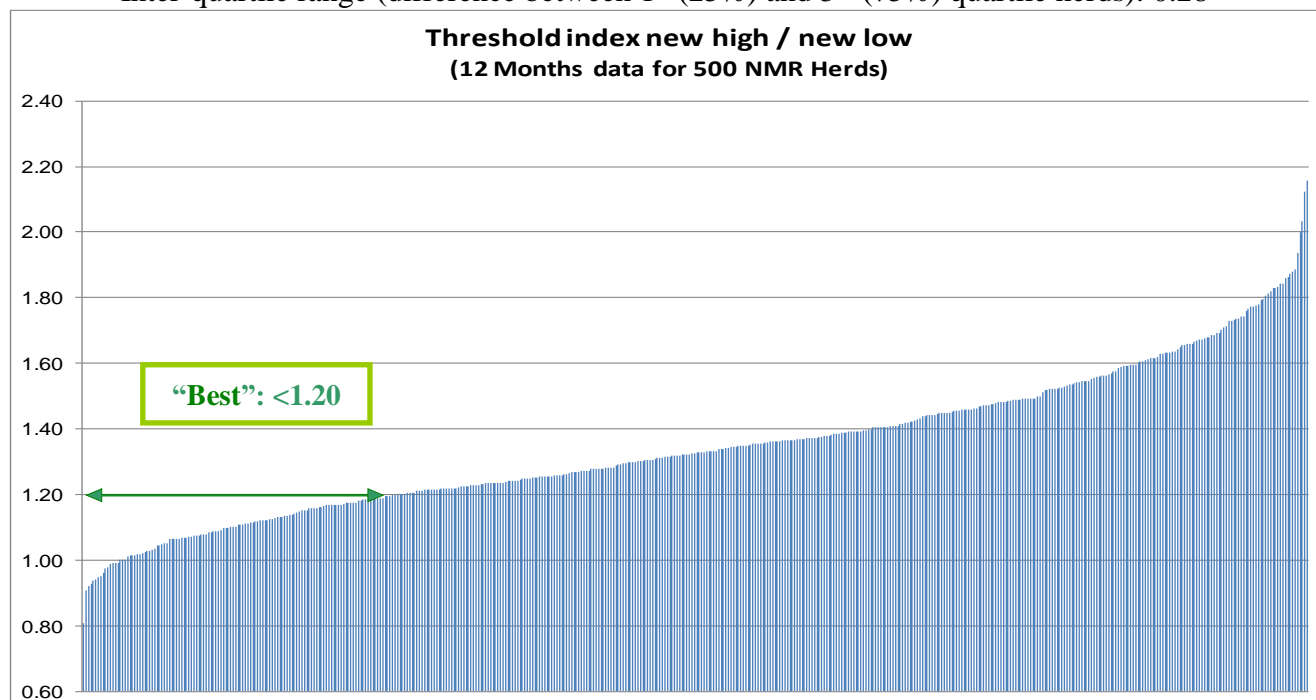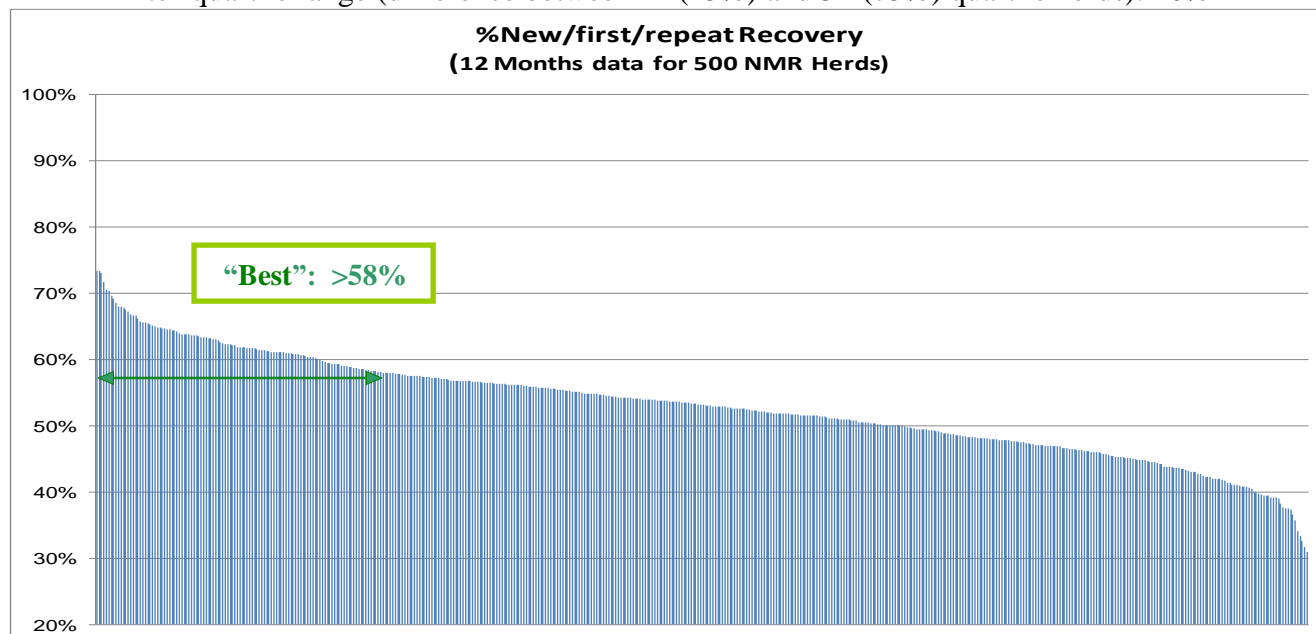

%New/first/repeat Recovery
(12 Months data for 500 NMR Herds)

"Best": >58%

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

Target (level achieved or surpassed by 25% of herds): 23%
Median (level achieved by the middle herd): 18%
75% level (level achieved or surpassed by 75% of herds): 15%
Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 8%

% Recovery from Chronic infections
(12 Months data for 500 NMR Herds)

"Best": >23%

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

Target (level achieved or surpassed by 25% of herds): 21

Median (level achieved by the middle herd): 36

75% level (level achieved or surpassed by 75% of herds): 53

Inter-quartile range (difference between 1st (25%) and 3rd (75%) quartile herds): 32

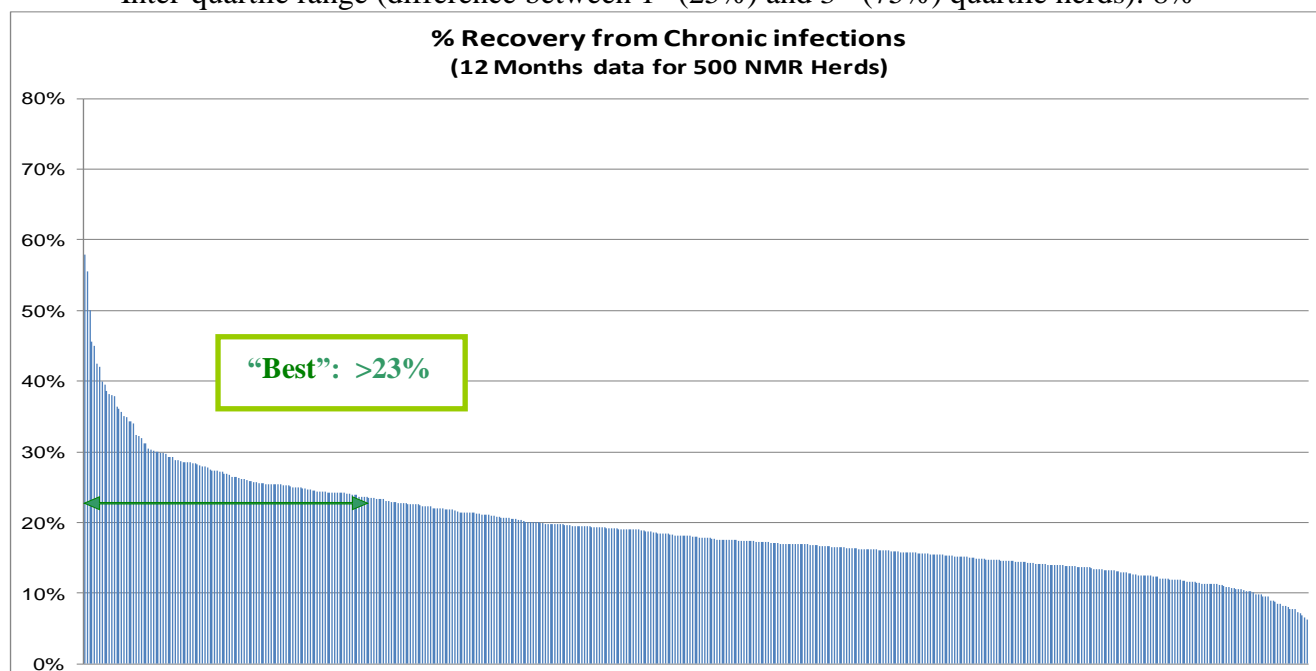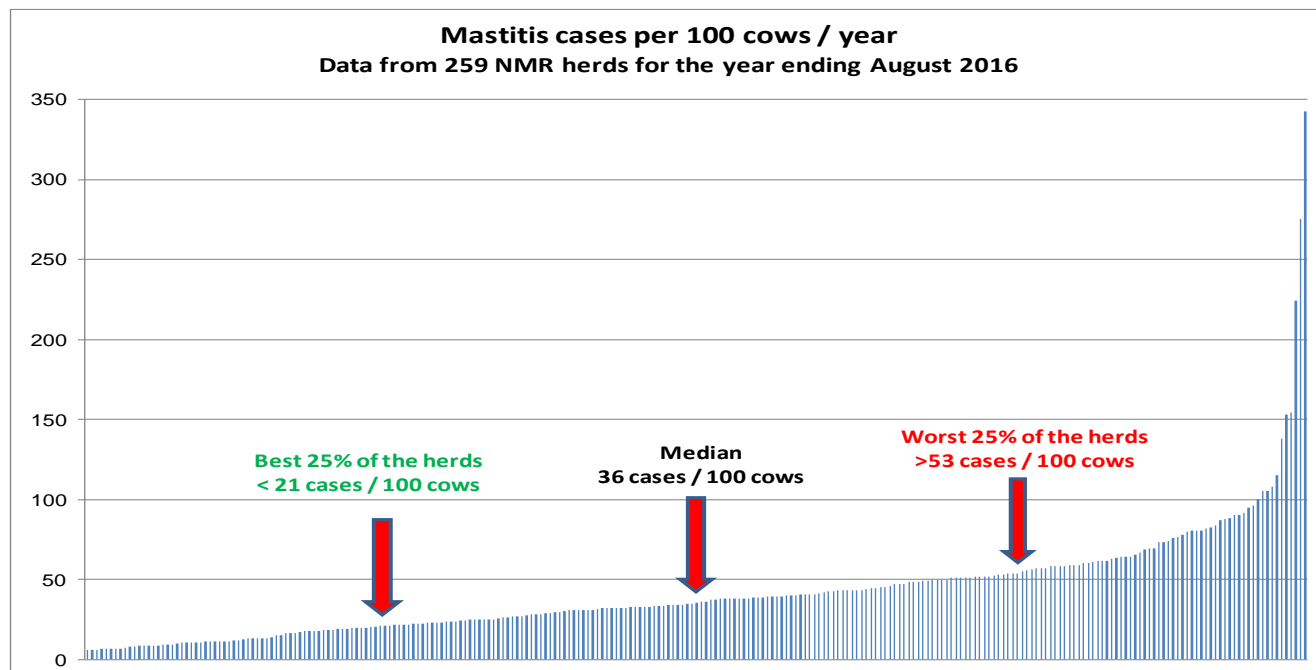**Mastitis cases per 100 cows / year**
Data from 259 NMR herds for the year ending August 2016

Best 25% of the herds
< 21 cases / 100 cows

Median
36 cases / 100 cows

Worst 25% of the herds
>53 cases / 100 cows

Section 3. 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 2016 with target values set at the level currently achieved on one in four UK dairy farms. A farmer can readily see where his/her herd would appear for each parameter and focus on discussion in to 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 herds 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 3).

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.

Figure 3. The Key Performance Indicator Report of InterHerd+
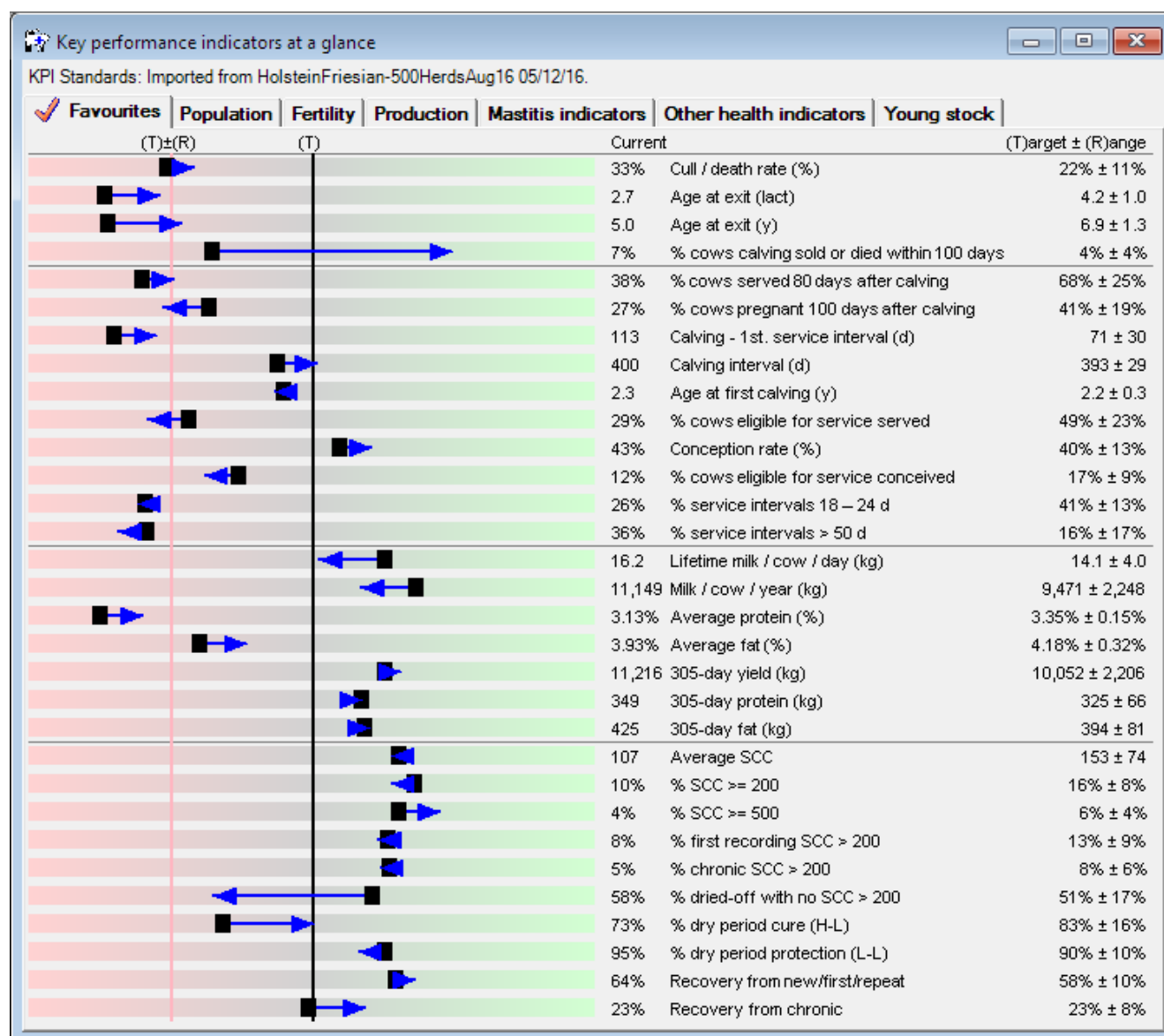
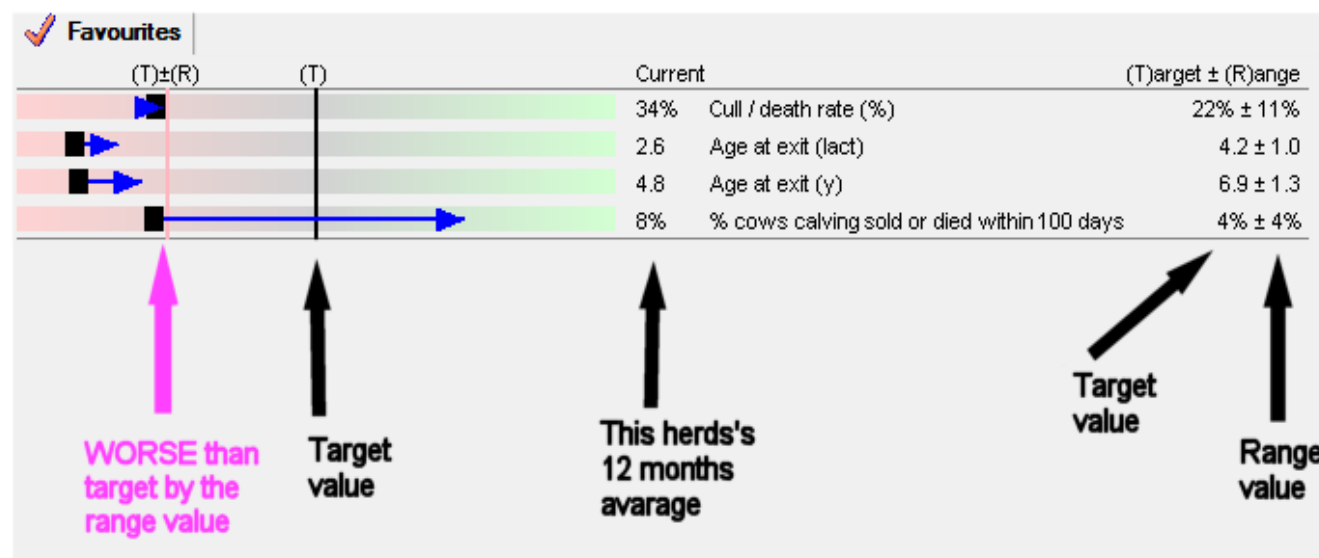The meaning of the different lines and values against each key performance indicator are explained in Figure 4.

Figure 4.   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 4 the herd had a cull/death rate averaging 34% 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 4 the TARGET value for cull/death rate is 22% with a range of ±11%.

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 4 for culling rate, the red vertical line represents the target (22%) worse by the range (11%) so a culling rate of 33%.

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 5, 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 5, the herd displayed has 14 parameters that are "better than target". This includes most milk yield and SCC parameters but only 1 fertility parameter (conception rate).

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 8 parameters highlighted in Figure 5, including 4 important fertility, culling and longevity parameters.

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

Figure 5. Highlighting the strengths and weaknesses of a dairy herd
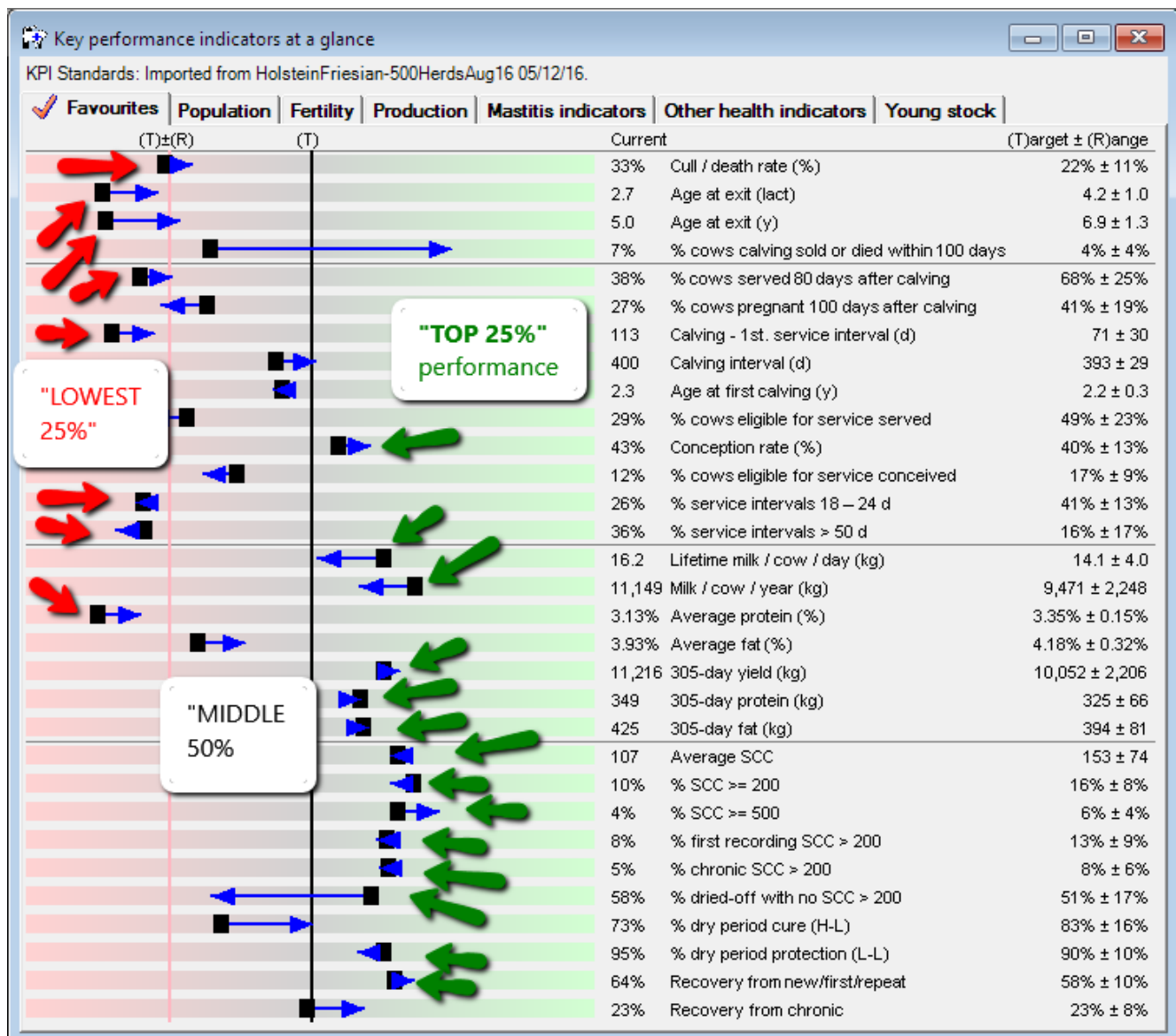

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Figure 5 must be treated as a **DISCUSSION DOCUMENT**. The emphasis is on achieving an appropriate balance of performance in production, fertility and health. A parameter in the bottom 25% is not necessarily a bad thing, the herd in Figure 5, for example, has low protein% values for milk but as it is a high yielding herd the 305-day yield of protein would put the herd in the top 25%. Conversely, a single parameter in the "top 25%" performance may expose weaknesses. In Figure 5 the herd has excellent conception rates but most of the other fertility parameters are "lowest 25%" performance levels with the cows served late and with poor heat detection.

The aim is to **stimulate informed discussion between farmers and their advisers** about **what** is happening **and WHY.**

Monitoring performance and improvement of groups of herds

Technical advisers and milk buyers are increasingly making use of the 500 herd graphs to monitor the status and improvement of their clients/members over time. Figure 6 shows the distribution of individual herd SCC of 32 client herds of a veterinary practice when superimposed on the SCC graph for the 500 herds. Each client herd is represented by a red vertical line. In this example it can be seen that 58% of the client herds were located in the bottom 50% of herds in the 500 herd national study. 11/33 (33%) were in the lowest national quartile.

Figure 6. Herd Somatic Cell Count of 33 client herds compared to the 500 herds study of 2013. Performance at the establishment of a veterinary practice farmer Discussion Group in March 2012
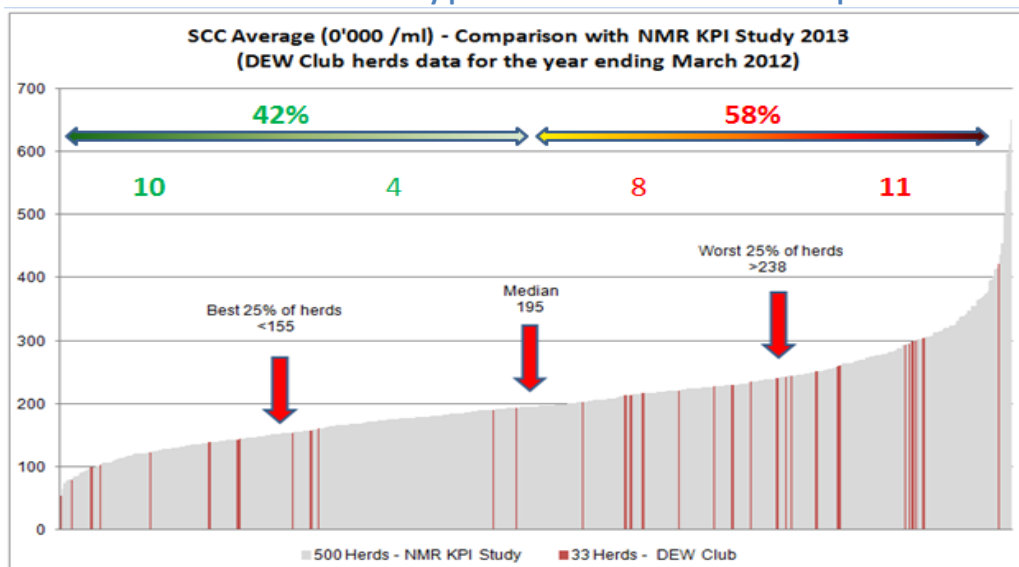
Repeating the exercise three years later (Figure 7) shows the significant progress the vet practice has made in controlling herd SCC. While there are still herds with high SCCs, there has been a marked overall improvement across the client base.

Figure 7. Herd Somatic Cell Count of 33 client herds compared to the 500 herds study of 2013. Performance two years after the establishment of the Discussion Group

Figure (top): SCC Average (0'000 /ml) - Comparison with NMR KPI Study 2013 (DEW Club herds data for the year ending March 2014)
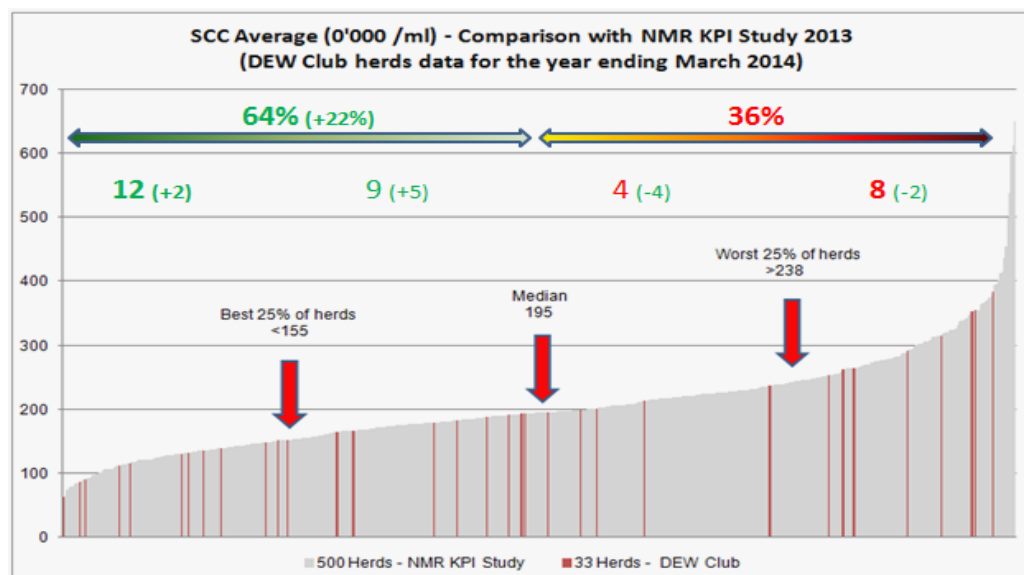
By comparing the performance level at the individual herd level, it is also easy to see which herds have made the most dramatic improvements:

Figure 8. Differences in Herd Somatic Cell Count of 33 client herds achieved over a 3 year period compared to the target levels of 500 herds study of 2015.
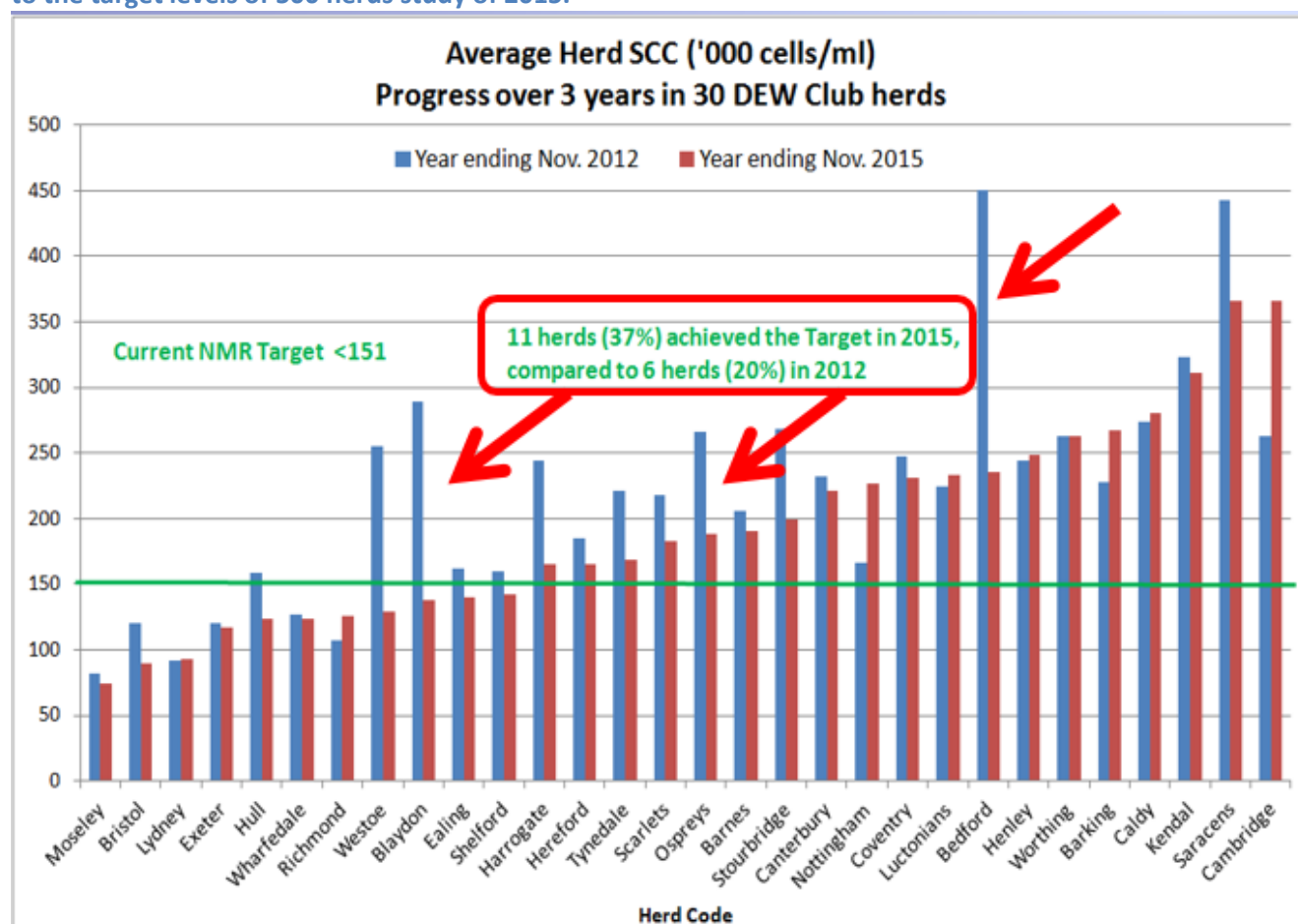
Section 4: Trends in Key Performance Indicators 2010 to 2016

The target and median figures from the current study are compared with the results from the first study for the year ending 30th September 2010. Table 2 below shows changes in the median and target (top 25% performance) values for each parameter over the five years period. The majority of parameters have improved (green) over the period with the exception of age & number of lactations at exit which show slight deterioration (red). There is no attempt at identifying any statistical significance in these changes.

Table 2. Comparison of median and target values derived from the study of 500 NMR recording herds in 2016 with the original study in 2010

Parameter	Median	Median		Target "Best 25%"	Target "Best 25%"
Year of the Study	*2010*	*2016*		*2010*	*2016*
A. Culling rate	24%	27%		18%	22%
B. Culling / death rate in first 100 days of lactation	7%	5%		4%	4%
C. Age at exit (years)	6.6	6.1		7.4	6.9
D. Age at exit by lactations	3.9	3.6		4.5	4.2
E. Percentage Served by day 80	46%	56%		59%	68%
F. Percentage conceived 100 days after calving	26%	33%		33%	41%
G. Calving to 1st service interval (days)	105	82		87	71
H. Calving interval (days)	424	407		409	393
I. Age at 1st calving (years)	2.4	2.3		2.3	2.2
J. Conception rate	32%	34%		40%	40%
K. Percentage service intervals at 18-24 days	30%	35%		38%	41%
L. Percentage service intervals >50 days	32%	24%		22%	16%
M. Percentage eligible for service that served	27%	38%		37%	49%
N. Percentage eligible for service that conceived	9%	13%		13%	17%
O. Lifetime milk / cow / day (kg)	10.5	12.2		12.6	14.1
P. Milk / cow / year (kg)	7,665	8,291		8,760	9,471
Q. Average protein%	3.27%	3.26%		3.33%	3.35%
R. Average fat%	3.96%	4.03%		4.12%	4.18%
V. Average SCC ('000 cells/ml)	210	185		169	153
W. Percentage SCC >=200,000 cells/ml	24%	19%		19%	16%
X. Percentage SCC >500,000 cells/ml	9%	7%		7%	6%
Y. Percentage 1st recording SCC >=200,000 cells/ml	20%	17%		15%	13%
Z. Percentage chronic SCC >=200,000 cells/ml	14%	10%		10%	8%
ZA. Percentage Dry period cure (High:Low)	74%	75%		80%	83%
ZB. Percentage Dry period protection (Low:Low)	84%	85%		89%	90%
ZC. Percentage Low at end of previous lactation (SCC<200,000 cells/ml)	60%	69%		70%	78%

Changes in the Key Fertility & SCC Parameters over the 7 annual KPI studies

The Figures below show the changes over the seven annual KPI studies (2010 to 2017) for a number of important parameters. The three lines represent the "better" quartile, median and "poorer" quartile values each year for each parameter.

Figure 8. Percentage of cows served by Day 80 after calving
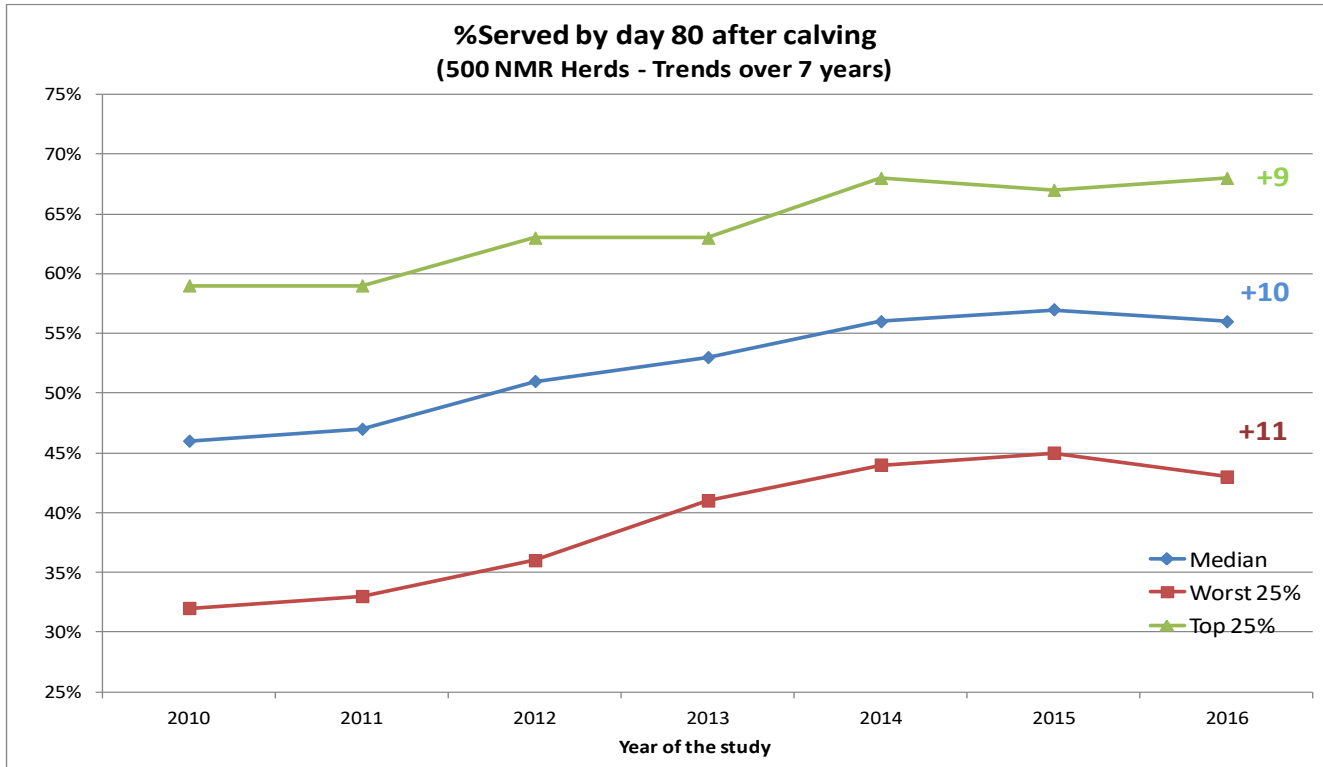
Figure 9. Percentage of cows pregnant (conceived) by Day 100 after calving

32
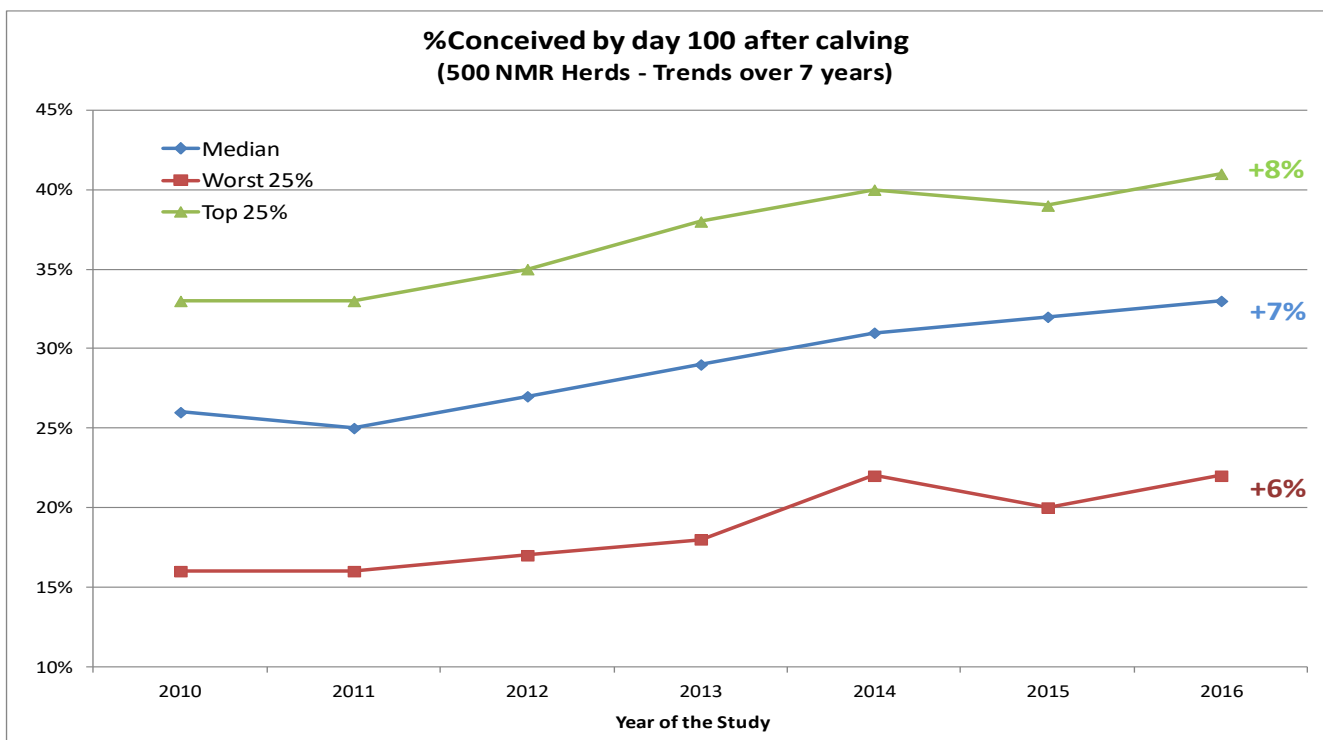
Figure 10. Percentage of all repeat services that are 18-24 days after the previous service

%Service intervals 18 to 24 days
(500 NMR Herds - Trends over 7 years)

+3%
+5%
+6%

Median
Worst 25%
Top 25%

Year of the Study
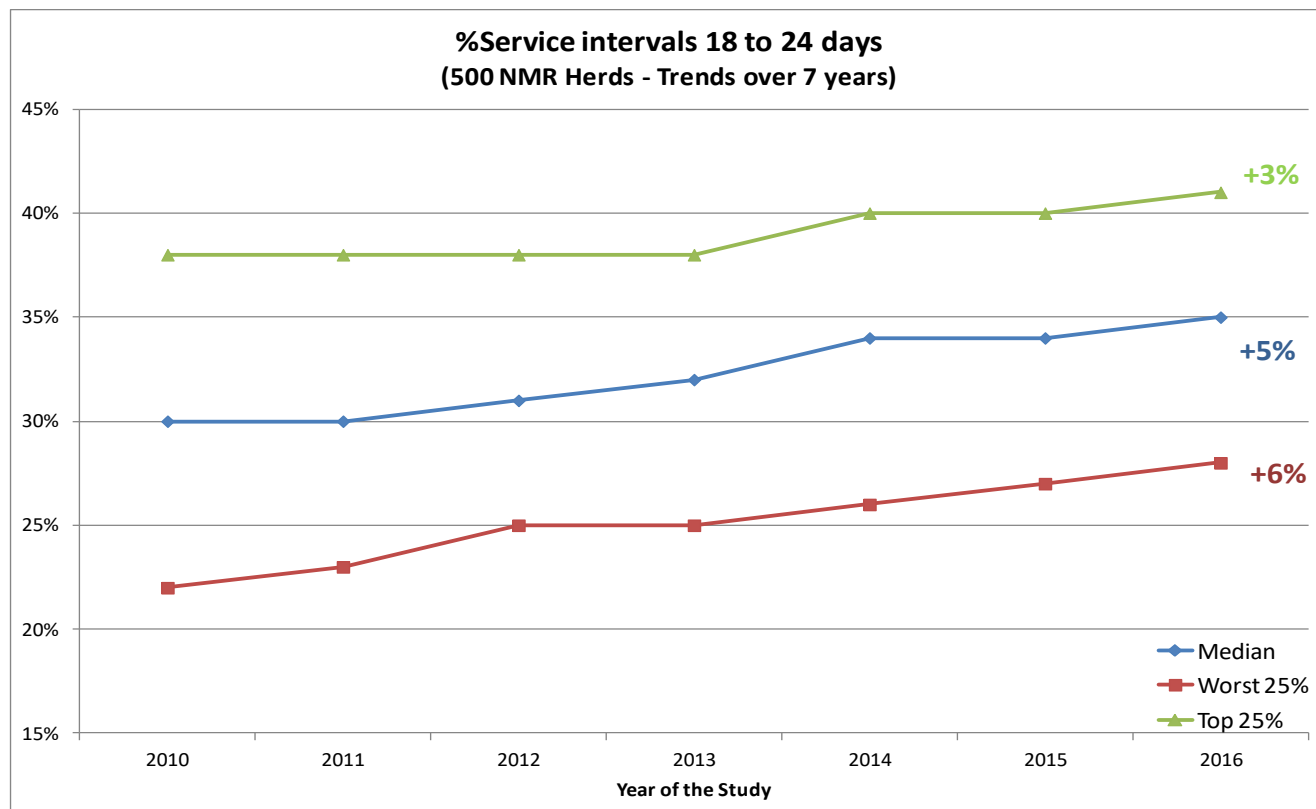
Figure 11. Percentage of all service resulting in a conception

Conception rate
(500 NMR Herds - Trends over 7 years)

Median
Worst 25%
Top 25%

+0%
+2%
+1%

Year of the Study

33
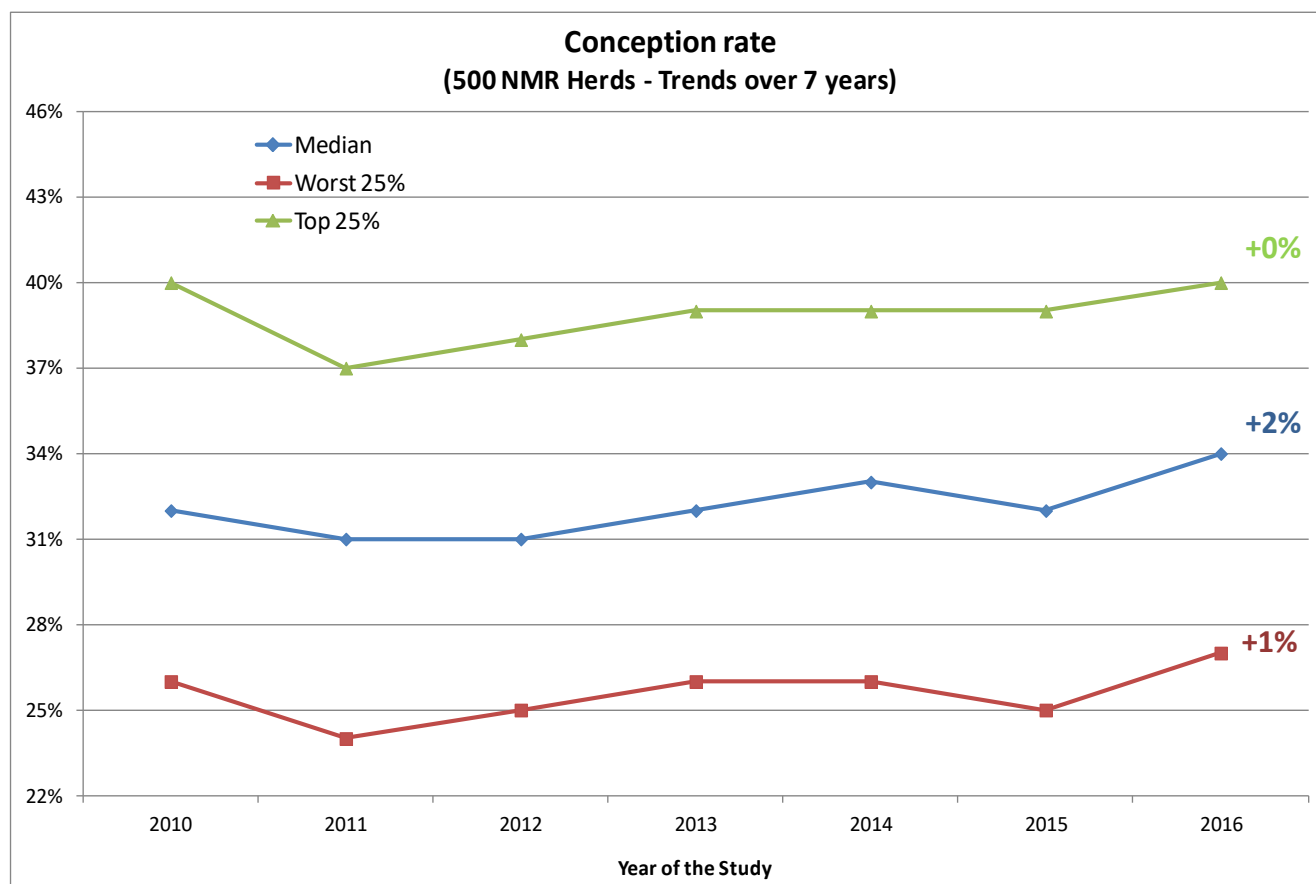
Figure 12. Herd Somatic cell Count

SCC Herd Average (0'000 cells/ml)
(500 NMR Herds - Trends over 7 years)

- Median
- Worst 25%
- Top 25%

-41
-25
-16

Year of the Study
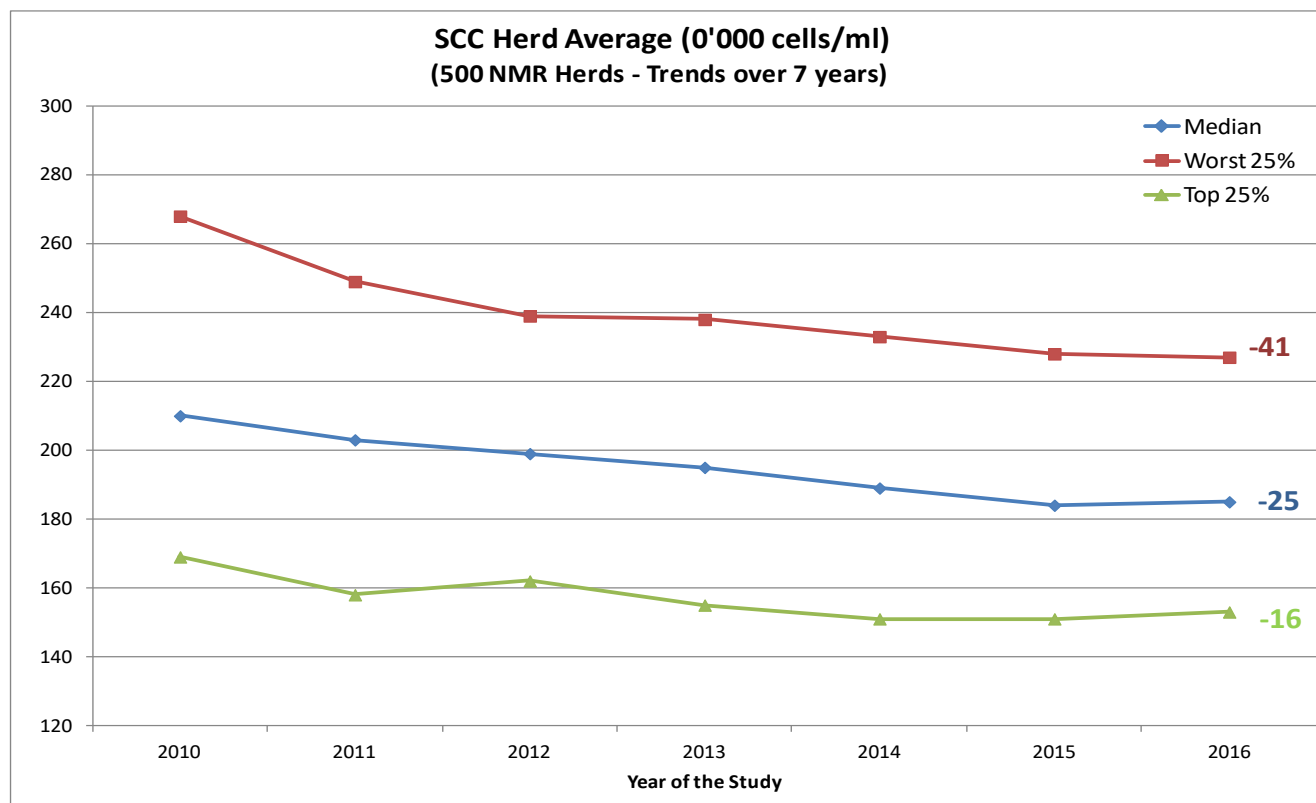
Figure 13. Percentage of milk samples originating from chronic (repeat) high SCC cows

%Chronic SCC >=200,000 cells/ml
(500 NMR Herds - Trends over 7 years)

- Median
- Worst 25%
- Top 25%

-5%
-4%
-2%

Year of the Study
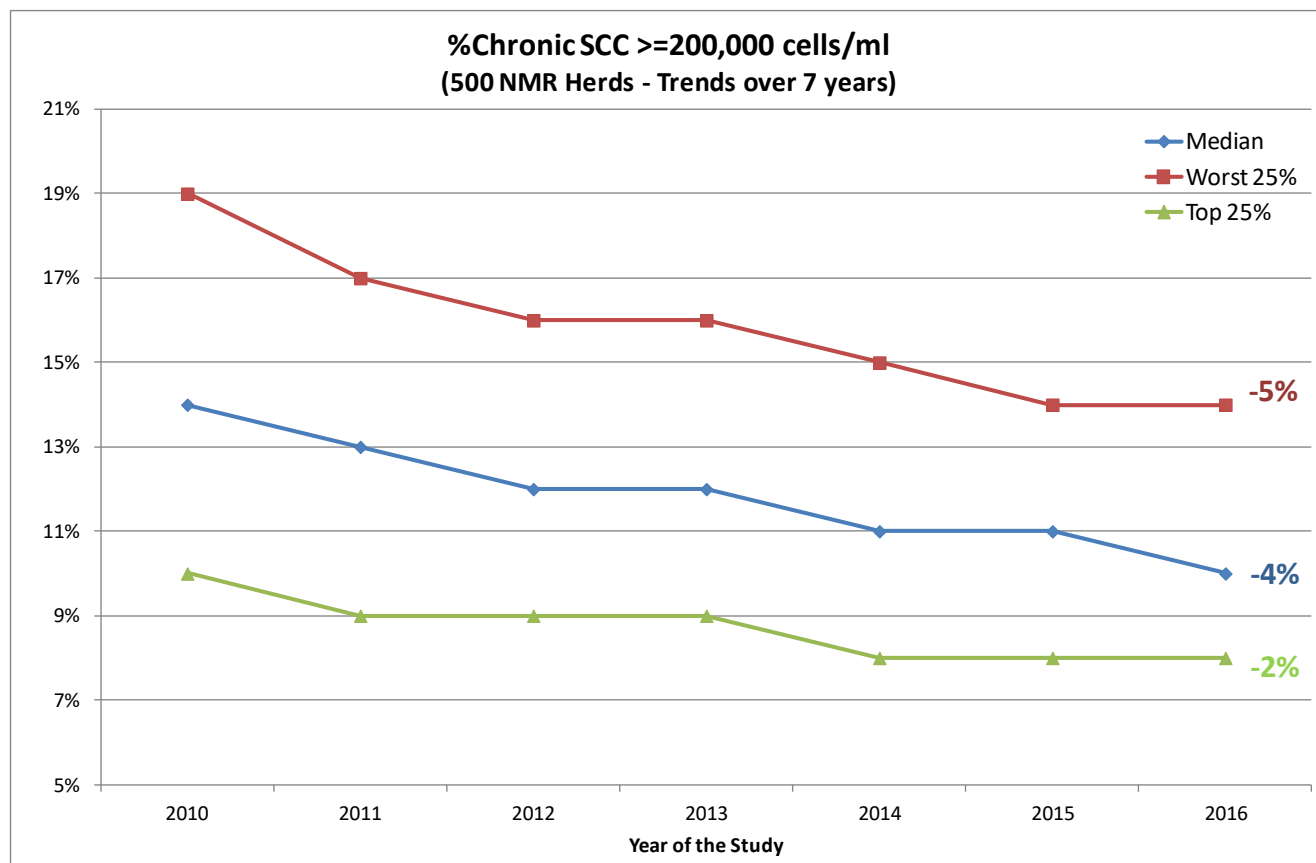
Appendix 1.   Key Performance Indicators definitions

The Key Performance Indicators are displayed as both 12 month and 3 month rolling averages.
In the following definitions the average population of cows is calculated using animal days. Every day that a cow is present and in the population at risk during the period of study is a 365th of an animal year. The total animal days is summed and divided by 365 to give animal years, or the average cow 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. Culling / death rate in first 100 days of lactation	The number of deaths/culls within 100 days of calving divided by the average cow population up to 100 days (aggregated total animal days up to 100 days after calving, divided by 365).
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 exist by lactations	The total number of lactations completed by cows culled/died in the analysis period, divided by the number of these culled/died cows.
E. Percentage Served by day 80	The percentage of cows reaching the 80th day after calving that have been served at least once on or by Day 80.
F. Percentage conceived 100 days after calving	The percentage of cows reaching 100 days after calving that have conceived on or by Day 100.
G. Calving to 1st service interval (days)	The average days between calving and 1st 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 1st 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	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 oestrus 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 eligible for service that served	The percentage of cows that are eligible for service (42 days+ after calving) during the analysis period that are served.
N. Percentage eligible for service that conceived	The percentage of cows that are eligible for service (42 days+ after calving) during the analysis period that conceived.
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 average protein% of all milk recorded during the analysis period.

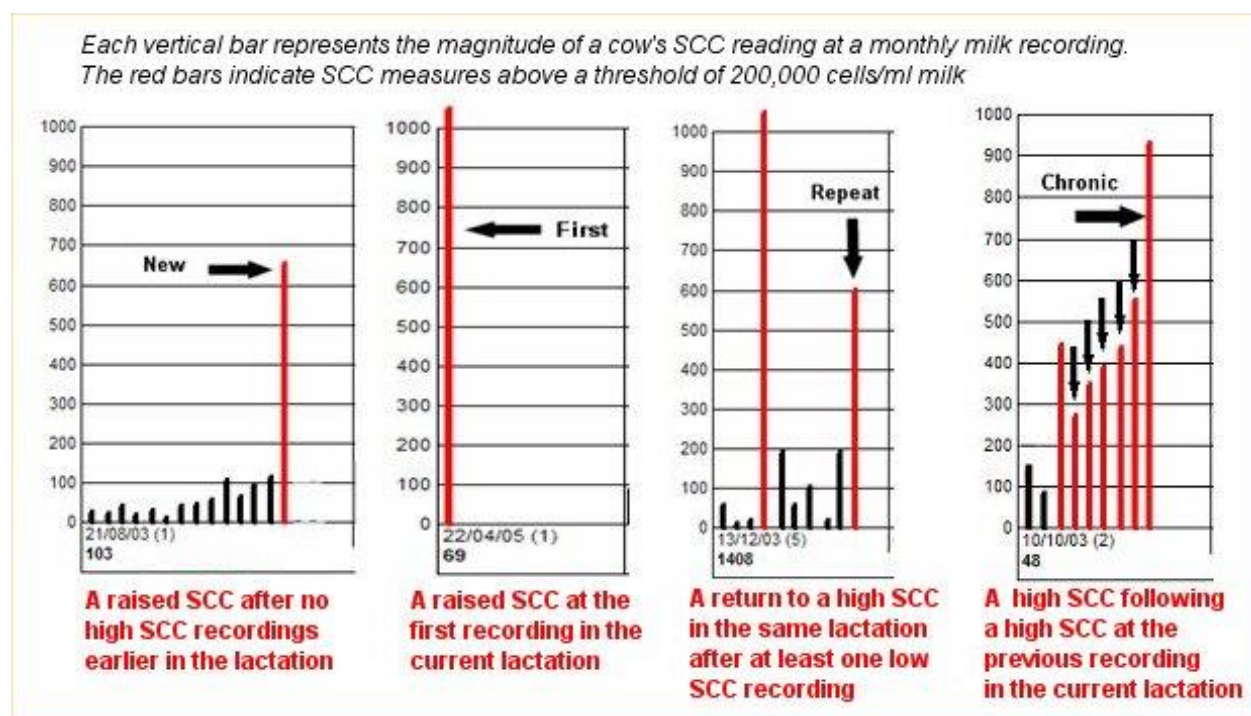| R. Average fat%	The average fat% of all milk recorded during the analysis period.
S. 305 day yield (kg)	The average production by Day 305 for all cows reaching 305 days after calving during the analysis period.
T. 305 day protein (kg)	The average production of milk protein by Day 305 for all cows reaching 305 days after calving during the analysis period.
U. 305 day fat (kg)	The average production of milk fat by Day 305 for all cows reaching 305 days after calving during the analysis period.
V. Average SCC ('000 cells/ml)	The average somatic cell count of all milk recorded during the analysis period.
W. Percentage SCC >=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 >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 >=200,000 cells/ml	The percentage of all cows starting new lactations that had a high SCC (>=200,000 cells/ml) reading at the first milk recording in the lactation.
Z. Percentage chronic SCC >=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 (>=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 >200,000 cells/ml	The percentage of all recorded milk samples that were of the New Herd Companion SCC Category(*), namely the first HIGH SCC (>=200,000) in a lactation following one or more low SCC samples.
ZE. Percentage Dried-off with no SCC >200,000 cells/ml	Of re-calving cows recorded starting a new lactation during the analysis period: The percentage of 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 (>=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.
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/year)	The total cow cases of mastitis recorded divided by the average population of cows, represented as a % (cases/100 cows).
ZK. Index mastitis case by Day 30	The percentage of calving cows that record a mastitis case by Day 30 of the lactation.
ZL. Index mastitis rate after Day 30	The rate of mastitis infection in cows that have not recorded a case of mastitis in the lactation and passed 30 days since calving.

Appendix 2.   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.

Each vertical bar represents the magnitude of a cow's SCC reading at a monthly milk recording. The red bars indicate SCC measures above a threshold of 200,000 cells/ml milk

New – A raised SCC after no high SCC recordings earlier in the lactation

First – A raised SCC at the first recording in the current lactation

Repeat – A return to a high SCC in the same lactation after at least one low SCC recording

Chronic – A high SCC following a high SCC at the previous recording in the current lactation

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.