THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Section 5 - ICAR Guidelines for Conformation Recording of Dairy Cattle, Beef Cattle, Dual Purpose Cattle and Dairy Goats

Section 5 - Conformation Recording
Version January, 2023

Network. Guidelines. Certification.

Table of Contents

Tables

Figures

Change Summary

Date of Change	Nature of Change
July 2017	Reformatted using new template.
July 2017	Table of contents added.
July 2017	Heading numbers and heading text edited for clarity and removal of redundant text.
August 2017	Stopped Track change sand accepted all previous changes.
August 2017	Moved the file to the new template (v2017_08_29).
August 2017	Heading edits to make shorter.
August 2017	Version updated to August 17.
October 2017	Hyperlinks have been corrected.
October 2017	At instigation of Conformation Working Group added two chapters to the guidelines: conformation recording for dual purpose cattle and recommendations for scoring defects in cattle. Minor changes to introduction to reflect these changes.
February 2018	On Saturday 10th February, changes approved at ICAR Assembly in Auckland, New Zealand.
May 2018	Fixed some inconsistencies as noted by Dorota Krencik by her email (23 May).
June 2018	Title amended to include dual purpose Cattle.
March 2022	Relationship between Conformation and Functional Traits for cattle added. Guidelines rewritten in more concise way. Standard trait definitions and relationship between conformation and functional traits moved to separate appendices.
January 2023	Guidelines on usage of data from AMS systems to derive udder conformation traits added.

1 Introduction

This document contains a description of conformation traits scored in dairy cattle breeds, dual purpose cattle, beef cattle breeds and dairy goats. For the four groups a separate trait list has been established. For the traits, trait definitions are given in wording and with drawings.

Besides giving trait definitions, recommendations are given on improvement and transparency of data collection and monitoring classifiers.

For the dairy, dual purpose and beef cattle breeds a recommendation on scoring conformation defects is given.

2 Linear and composite type traits

2.1 Linear Type Traits

Linear type traits are the basis of all modern type classification systems, and are the foundation of all systems for describing the animal. Linear classification is based on measurements of individual type traits instead of opinions. It describes the degree of trait not the desirability.

Advantages of linear scoring are:

a. Traits are scored individually.
b. Scores cover a biological range.
c. Variation within traits is identifiable.
d. Degree rather than desirability is recorded.

2.2 Standard Traits

The standard traits satisfy the following conditions:

a. Linear in a biological sense.
b. Single Trait.
c. Heritable.
d. Economic value, direct or indirect with reference to the breeding goal.
e. Possible to measure instead of score.
f. Variation within the population.
g. Each linear trait should describe a unique part of the animal which is not covered by a combination of the other linear traits.

2.3 Composite traits and general characteristics

2.3.1 Composite traits

a. Composite traits are groups of linear traits relating to one specific area.

b. The individual linear traits are weighted according to economic breeding objectives.

c. The main composite traits for dairy cattle are: frame including rump, dairy strength, mammary, feet/legs.

d. The main composite traits for dual purpose breeds are: frame, mammary, feet/legs and muscularity.

e. The main composite traits for beef breeds are: muscularity, type (breed standard), feet/legs, development and final score.

f. The main composite traits for dairy goats are: frame, udder, feet/legs and final score.

2.3.2 General characteristics

Type classification programs also include phenotype assessment. These are described as general characteristics or combined traits, which are not linear in a biological sense. A subjective score is given for the desirability of the animal according to the breeding goal.

- Female animals for dairy and dual purpose breeds are inspected, classified and assigned grades/scores ranging from 50-97 points.
- For beef breeds animals are inspected, classified and assigned grades/scores ranging from 60-99 points.
- Dairy goats are inspected, classified and assigned grades/scores ranging from 1-9 points.

The most common scale for mature cows (second or more lactations) in points are described in *Table 1*.

Table 1. Range of scores for general characteristics or combined traits for cattle of dairy, dual purpose and beef breeds and for dairy goats.

	Dairy and dual purpose breeds	**Beef breeds**	**Dairy goats**
Excellent	90 - 97	90 - 99	9
Very Good	85 - 89	85 - 89	7 - 8
Good Plus	80 - 84	80 - 84	4 - 6
Good	79 - 75	79 - 75	2 - 3
Fair/Poor/Insufficient	50 - 74	60 - 74	1

The awarding of classification grades varies in each country depending upon the breeding goals, and therefore classification scores must be considered in the context of the country of inspection.

The final class and score are derived from a breakdown of the main functional areas of the female:

- For dairy cattle: 1) Frame including Rump, 2) Dairy Strength, 3) Mammary System and 4) Legs/Feet.

- For dual purpose cattle: 1) Frame, 2) Mammary System, 3) Feet & Legs and 4) Muscularity.
- For beef breeds: 1) Muscularity, 2) Type (breed standard), 3) Legs/Feet and 4) Development.
- For dairy goats: 1) Frame, 2) Udder and 3) Legs/Feet.

For the quality of data for beef breeds it is important to score the traits for categories of similar age or sex. For example:

- Calves at weaning (5-10 months).
- Heifers: 6 months before calving.
- Cows: between first and second calving.

For the quality of data of dairy goats it is important to score the traits for categories of similar age or sex.

The weighting of the component breakdown scores should meet the breeding goals in the Country of inspection.

- It is recommended that for first lactating cows of dairy and dual purpose breeds the range of scores used is 70 - 90 points. The average score is always in the middle of the maximum and minimum a first lactating cow can be awarded.
- For beef breeds it is recommended that for animals the range of scores used is 60 - 99 points. In the case of the range 60 - 99, the population average should be close to 80.

For dairy goats it is recommended that for animals the range of scores used is 1 - 9 points. The average score is always in the middle of the maximum score and the minimum score the group (for example population within a country) can be awarded. In the case of the range 1 - 9, the population average should be close to 5.

3 Genetic evaluation of dairy and dual purpose animals

3.1 Type Inspection System - Genetic Evaluation

a. Breeding values for bulls and cows to be based on the classification of cows in the first lactation scored in a herd evaluation system.

b. In a herd evaluation system all first lactating cows, which have not be previously evaluated, must be scored during the visit of the classifier

c. Additional classifications to obtain a bull proof may only be possible if completed by the same organisation and daughters are sampled randomly with sufficient number of herd mates (contemporaries) scored during the same visit. A minimum of 5 first lactating cows, which qualify for genetic evaluation, are inspected at the same visit

3.2 Evaluation Model

a. Modern BLUP evaluation techniques should be used to obtain accurate unbiased evaluations.

b. Data should be corrected for influencing factors such as age, stage of lactation and season by the model. Classifiers should not make adjustments during scoring.

c. Corrections for variation between classifiers are required to avoid heterogeneity of variance.

d. Herd mates are defined as the contemporaries of the evaluated heifers in the same lactation, scored during the same visit by the same classifier.

3.3 Publication of Information

a. Publish bull-proofs around an average of 0 and a genetic standard deviation of 1.0.

b. Proofs of widespread bulls should be published as bar graphs covering the range between +3 and -3 standard deviations.

c. Or: Mean of 100 & the standard deviation in the base population where this standard deviation is adjusted to the situation the proofs of cows have a reliability of 100%.

d. The base of sire and cow evaluation should follow the definition of the production proofs, given by Interbull. This includes a stepwise fixed base that should be renewed every five years. The base is defined by cows born 5 years previously.

4 Conformation recording of dairy cattle

The ICAR multi dairy breed conformation recording recommendation integrates with the World Holstein-Friesian Federation guidelines on the international harmonization of linear type assessment, trait definition, evaluation standards and publication of type proofs for bulls.

This document contains a list of approved standard traits, which is a list of traits which should be scored by all organisations in the same way to improve further harmonisation on international level, also on Interbull level. The data collected within these recommended standards qualifies for MACE evaluation by Interbull.

Further the document contains a list of 5 traits which are commonly used by organisations in the dairy and dual-purpose breeds world-wide. This list of common standard traits is added to improve harmonisation of these traits too.

Besides giving trait definitions on standard traits, recommendations are given on improvement and transparency of data collection and monitoring classifiers.

The list with standard traits and the standard trait definition for Dairy Cattle can be found in Appendix 1.

5 Conformation Recording of dual purpose Cattle

This document contains a list of approved standard traits, which is a list of traits which should be scored by all organisations in the same way to improve further harmonisation on international level, also on Interbull level. The data collected within these recommended standards qualifies for MACE evaluation by Interbull.

Further the document contains a list of 5 traits which are commonly used by organisations in the dairy and dual-purpose breeds world-wide. This list of common standard traits is added to improve harmonisation of these traits too.

Besides giving trait definitions on standard traits, recommendations are given on improvement and transparency of data collection and monitoring classifiers.

The standard trait definition for Dual Purpose Cattle can be found in Appendix 2.

6 Conformation recording of beef cattle

The ICAR multi beef breed conformation recording recommendation describes a set of conformation traits which currently are used in several countries in several breed. The traits are defined in such a way that they are not breed specific.

This document contains a list of standard traits, which is a list of traits which could be scored by all organisations in the same way to improve further harmonisation on international level.

The list with standard traits and the standard trait definition for Beef Cattle can be found in Appendix 3.

7 Conformation recording of dairy goats

The ICAR multi dairy goat breed conformation recording recommendation describes a set of conformation traits which currently are used in several countries in several breed. The traits are defined in such a way that they are not breed specific.

This document contains a list of standard traits, which is a list of traits which could be scored by all organisations in the same way to improve further harmonisation on international level.

The list with standard traits and the standard trait definition for dairy goats can be found in Appendix 4.

8 Improving data quality and monitoring classifiers

8.1 Introduction

When collecting data on animal performances on a routine basis it is important to do this in a consistent and transparent way. In this way quality of data can be guaranteed and for everybody it is clear how it is done. This is also important for scoring animals for conformation traits, which is normally done by classifiers, specially trained doing this job.

This chapter describes the improvement of quality and transparency of data collection for conformation traits.

8.2 Practical aspects of type classification system

One organisation should be in charge of classifications within each evaluating system.

There should be a head-classifier in charge of training and supervising other classifiers within the evaluating system to achieve and maintain a uniform level of classification. Additionally the exchange of information between head-classifiers from different systems/countries is recommended.

Individual full time professionals should complete classification. Classifiers should be independent of commercial interest in AI-bulls/studs.

Classifiers must record the trait as observed without adjustment e.g. Age, stage of lactation, sire or management system.

The working information provided for the classifier should make no reference to the pedigree or performance of the animal.

Classifiers should always rotate classification areas (herds and regions) to ensure a good data connection between regions and to minimise the sequential scoring of animals by the same classifier. This way of working reduces this risk of classifier times regional genetics interaction or classifier times herd interaction.

An advisory group can be installed with expertise in the field of conformation classification, statistics, breeding, training people, in order to monitor and advise on the improvement to the classification system.

All factors accounting for any non-genetic variance should be recorded when a herd is visited, e.g. classifier's identification, date/time of scoring, management group, housing system, flooring, nutritional status. This makes it possible to find possible interactions between the environmental factors and the trait scored.

Types of housing can be free stall, tie stall, mixture (stall plus outside).

Types of floors can be concrete, cement with groves, slats, sand, rubber, straw, pasture.

8.3 Training and monitoring of classifiers

The monitoring and performance evaluation of classifiers is an important part of the standardisation of the ICAR international type program.

Objectives

Improve accuracy of data collection, within country all classifiers should:

1. Apply the same trait definition.
2. Apply the same mean.
3. Apply the same spread of scores.

Tools for objective 1:

a. National group training sessions.

b. Statistical monitoring of individual classifiers performance with reference to mean, spread and normal distribution of scores.

c. Compute the correlation between the scores of one classifier and the group by using bivariate analysis. This shows the quality of harmonisation of trait definition between classifiers.

d. Improve the genetic correlation for linear traits between countries (Interbull evaluation)

e. Apply the same trait definition in all countries.

Tools for objective 2:

a. International training of head classifiers.

b. International group training sessions.

c. Audit system.

If a country decides to change the definition of a trait, it is recommended not to use previous scores or use only as a correlated trait in the national genetic evaluation system.

8.3.1 National group training sessions

One way of improving harmonisation of scoring by classifiers is having regular training sessions with a group of classifiers.

There are many ways to accomplish trait harmonisation through training sessions. Normally a training session consists of scoring a group of animals and the scores of individual classifier are compared with the scores of the other classifiers and/or head classifier.

Attention points are:

a. Use a group of animals for training session which is representative for the population classifiers have to score during their herd visits.

b. Deviations of individual scores are discussed and it is made clear which is the correct score for a certain trait on an animal.

c. Scores of each classifier are analysed per trait using some analysis tools:

  - Compute the mean and standard deviation of the deviations of the scores on animals per trait, per classifier. The deviation is the difference between the score and the average group score for a trait, for an animal. This gives insight in the scoring of individual classifier: always above or below the mean, more variation in scoring a trait than the group/head classifier. (with a test it can be shown if the differences found are significant).

- Compute the spread of the deviation of scores given by classifier per trait. This gives insight in how consistent a classifier is scoring a trait. (with a test it can be shown if the differences found are significant).

d. Instead of scoring a group of animals once, the animals can be scored twice by the classifiers, for example in the morning and in the afternoon. Based on these scores (approximately 20) the repeatability per classifier per trait can be computed.

8.3.2 Statistical monitoring of individual classifiers

The scores of a classifier from a certain period in time can be analysed. A period can be 12 or 6 months, for example.

From these scores the mean and standard deviation can be computed. The mean should be close to (maxscore-minscore)/2, and the standard deviation should be near (maxscore-minscore+1)/6, where minscore is the lowest score on the scale and maxscore is the highest score on the scale. For example: scoring a trait on a scale of 1-9, a mean is expected of 5 and a standard deviation of 1.5.

Another option is to compute the correlation between the scores of one classifier and the scores of rest of the group by using bivariate genetic analysis. This shows the quality of harmonisation of trait definition between classifiers (Veerkamp, R. F., C. L. M. Gerritsen, E. P. C. Koenen, A. Hamoen and G. de Jong. 2002. Evaluation of classifiers that score linear type traits and body condition score using common sires. JDS 85:976-983).

For this analysis, two data sets are created, one with scores of one classifier and the other with scores of all other classifiers from a certain period, for example 12 months. Both data sets can be analysed in a bivariate analysis, estimating different (genetic) parameters. The analysis can be carried out for each trait and for each classifier. From the bivariate analyses the following parameters can be derived:

a. Heritability: the heritability estimated within each classifier can be used as criteria for the repeatability of scores within classifiers, albeit the optimum value is not unity but depends on the true heritability of each trait.
b. Genetic correlation: the genetic correlation between two data sets can be used as a measure of the repeatability between classifiers, where a genetic correlation of one between classifiers is expected.
c. Genetic standard deviation.
d. Phenotypic standard deviation (= square root of genetic variance and error variance).

For the evaluation of each trait for each classifier the diagram in Figure 1 can be used.

Evaluation obviously starts with the mean score for each classifier, i.e., the mean should be close to the trait standard (5 for linear traits and 80 for descriptive traits). Secondly, the genetic standard deviation should not be lower than the average.

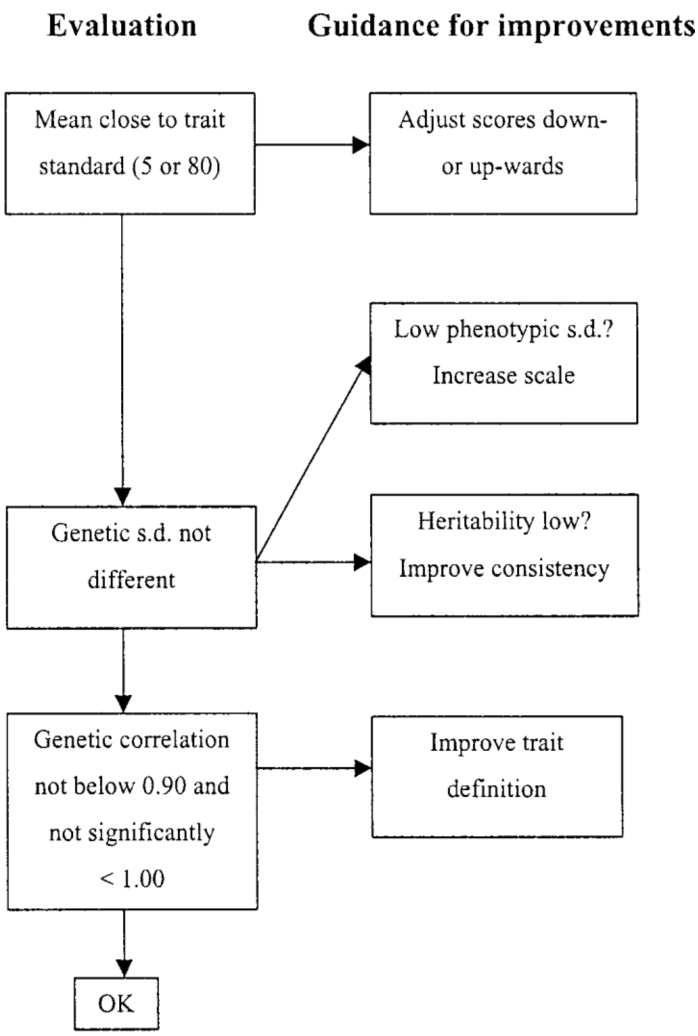

Figure 1. Scheme for evaluation trait by classifier using genetic parameters.

If the genetic standard deviation is lower, this could be due to the scale used (measured by the phenotypic standard deviation), due to poor within classifier repeatability (a low heritability) or both. If the low genetic standard deviation goes together with a low phenotypic spread, the advice is the classifier should use the scale in a better way, use more the extreme scores. If the genetic spread goes together with a low heritability, then the classifier should score the trait more consistently, apply the same definition.

If the genetic correlation is too low the classifier is likely to score a trait different than other classifiers.

All the parameters from the system can be tested using the standard error on the parameters estimated. Every classifier can be tested against the average of the parameters of all classifiers for a certain trait. A classifier with a few scores may deviate a bit more from the average of the group, therefore taking the standard error into account in a statistical test is more fair.

8.4 Auditing a classification system

The Classification system applied can be further improved by using an audit system where experts familiar with the conformation classification in other countries or organisations, examine the situation in your organisation or country.

An important issue is that information is exchanged between people responsible for the classification system.

Different options to audit are:

a. By using international workshops, in which information can be informally exchanged regarding how classifiers are trained and conduct their daily work
b. By inviting classifiers and/or a head classifier from another country or organisation to participate in or lead group training sessions
c. By having a group of experts visit an organisation responsible for classification, conduct a survey on methods and procedures, report their findings and makes suggestions for improvements.

9 Recommendation on scoring conformation defects in cattle

9.1 Introduction

In many conformation systems for cattle defects are scored when scoring animals for linear traits and general characteristics. Most of the time defects are used to determine the score for general characteristics.

This chapter describes characteristics of defects for dairy, dual purpose and beef cattle and contains a list of proposed defects which could be used. They are considered to be important for one of the breed types (dairy, dual purpose and/or beef) and could be considered by countries or organizations, that do not score them up to now. If a country or organization has already a list of defects, they could consider to reduce the list according to the ICAR list

9.2 Description of defect

Defects are not there to describe the whole variation in the population, but only a problematic trait (e.g. side leak) or a trait with a high enough frequency in the population.

The number of defects scored should be kept as low as possible as more defects means also more labor.

The easiest way to score conformation defects in a digital system is when a cow is scored for a group of the linear traits (frame, dairy strength, mammary system, legs/feet), the classifier is requested by the system if there are any defects within this particular group.

A conformation defect could be scored when it has the following characteristics:

a. heritable
b. not rare
c. is problematic for functionality
d. is clearly described and visible
e. should be scored as 0/1/2 (as soon as there is more variation and the frequency in population is considerable, one could/should consider to score this trait as a linear trait (scale 1-9)
f. is used to come up with a score for a general characteristic

Defects have no value to be scored when it is not used in determining general characteristics or when it is not used in a genetic evaluation.

The advantages of scoring defects are:

a. get overview what the status of a specific defect is in the population
b. could be used for determining the score for general characteristics

c. could be used to present figures per bull

Disadvantage of scoring defects:

a. difficult to harmonize classifiers as definitions are not always clear and for training sessions it is very hard to find a group of cows representing all defects.

Defects can be scored with 0 (not present), 1 (slightly present) or 2 (pronounced defect). More practical is that classifier score defects only when they are present, 1 (slightly present) or 2 (pronounced defect).

9.3 Approved standard defects

The list with approved conformation defects is chosen such that they satisfy the characteristics mentioned in 9.2.

Per defect a definition is given in *Table 2* and it is indicated in which type of breed the defect can have added value.

Table 2. List of defects in cattle.

Defect	Definition	Used in type of breed		
		Dairy	Dual purpose	Beef
Open shoulder	A significant gap between the tip of the shoulder and the side of the body		X	
Weak crops	The part of the animal behind the shoulder (just below the chine) is a lot narrower than the shoulder	X	X	
High tail	Evaluated by considering the tailhead in relation to the pins viewed from the rear. It could be considered as a defect when tailhead is at least 9 cm over the pins.	X	X	X
Advanced anus	Anus is ahead of pin bone. Tendency for the anus and vagina to be pulled forward.	X		
Toes out front	Animal walks with a slight amount of toeing out. Maybe due to a twisting knee or to a lack of heart.	X	X	
Crampy	Unnatural or irregular contraction of muscles of the rear legs.	X		
Thurls too far back	Ratio of distance of thurl position to rump bone and thurl position to pin bone ratio is larger than 4:1 (80%-20%)	X		
Blind quarter	Quarter never given milk.	X		
Webbed teats	An extra teat is attached to functional teat.	X		
Side leak	Little functional hole on the side of the teat.	X	X	
Extra functional teats	Extra teats which produce milk.	X		

10 Relationship between conformation and functional traits for dairy and dual purpose cattle

10.1 General considerations on the use of conformation data for longevity

Conformation appraisal of cattle was introduced with the goal of comparing animals with breed standards (true type model). An additional goal of conformation recording was to be a simple predictor of production potential and longevity.

Since these times, many new traits have been recorded and evaluated for dairy and dual-purpose cattle regarding health and longevity. These traits have been supplemental to conformation recording and have even replaced them for certain purposes.

However, conformation recording is still an efficient way to assess many cows during a relatively short period of time and requires less commitment and time from the dairy producer to collect the data.

The usefulness of this data for the prediction of health and longevity should be considered in the setting up of a conformation recording system.

In Appendix 5, the relationship between some of the ICAR standard conformation linear traits for dairy and dual-purpose cattle and health and longevity is described in detail. This information can be used to show farmers how the conformation scores can help him to breed a kind of cow which is able to perform the best in the herd.

11 Guidelines on usage of data from AMS systems to derive udder conformation traits

11.1 Introduction

To collect information on quality of conformation of udders, the udders of dairy cows are scored by professional classifiers. In the ICAR guidelines several linear udder conformation traits are defined for Dairy Cattle (Appendix 1) and Dual Purpose Cattle (Appendix 2).

High genetic correlations have been reported in literature between linear scored traits and the same traits based on data from automatic milking systems (AMS) (Byskov et al., 2012; Poppe et al, 2019). The advantage of using data from AMS is that information is collected continuously during the whole lactation and also over lactations. In a regular classification system a cow is scored only once during her life, at one moment in the first lactation. Further the collection of data via an AMS system is cost effective.

11.2 Description of AMS data about udder traits

In AMS information is stored about the positions of teats to be able to attach the milk cups in a short time. The storage or information of the teat positions can be different across manufacturers, but at the end the positions of all four teats are determined by an AMS and are stored.

Based on teat positions, five different udder traits can be derived. Each milking record contained Cartesian coordinates (x, y, z) of each of the 4 teats, indicating the 3-dimensional location of the teat tips. The z-coordinate is a measure of the distance from the teat tip to the floor, the y-coordinate is a measure of the position of the teat on the axis parallel to the long side of the robot, and the x-coordinate is a measure of the position of the teat on the axis perpendicular to the long side of the robot. The Cartesian teat coordinates in the AMS data set can be used to calculate the udder conformation traits: rear teat distance (RTD), front teat distance (FTD), udder depth (UD), distance between front and rear teats (DRF) and udder balance (UB, the difference in depth between front and rear udder). A specification of the udder conformation traits and equations for calculation are given in Table 3.

The trait rear teat distance is similar to rear teat placement, and front teat distance is similar to the trait front teat placement. Rear teat placement, front teat placement and udder depth are currently in the ICAR list of conformation traits for dairy and dual purpose cattle.

Table 3. Calculation of udder conformation traits based on teat positions measured by AMS.

Udder trait	Description	Calculation[1]
UD	Average distance of teat ends to the floor in mm	$(Z_{lf} + Z_{rf} + Z_{lr} + Z_{rr})/4$
FTD	Distance between left and right front teat ends in mm	$X_{lf} - X_{rf}$
RTD	Distance between left and right rear teat ends in mm	$X_{lr} - X_{rr}$
UB	Average difference in distance to the floor between the front and rear teat ends in mm	$(Z_{lr} + Z_{rr})/2 - (Z_{lf} + Z_{rf})/2$
DRF	Average distance between the front and rear teat ends in mm	$(Y_{lf} + Y_{rr})/2 - (Y_{lf} + Y_{rf})/2$

[1] Z = Z-coordinate, Y = Y-coordinate, X = X-coordinate, lf = left front, rf = right front, lr = left rear, rr = right rear.

11.3 Edits screening AMS data

When AMS data is used for analysis, checks need to be applied. Recommended edits are:

1. Milking is not a failure or not refused;
2. Milk yield is larger than 0 kg;
3. Teat positions are known;
4. Measures of z-coordinates (distance teat - floor) larger than 0 mm;
5. Distances between left front and rear or right front and rear larger than 0 mm;
6. Distance between left and right rear teats larger than -30 mm[1];
7. Distance between left and right front teats larger than 0 mm;
8. Observation deviates less than 4 standard deviations from the expected observation of an animal;
9. At least 5 hours interval with previous milking;
10. Measurements are available on all four teats. So, data of cows with less than four milking quarters has to be removed.

[1] A negative distance is possible in case of crossing teats. The distance depends on the order of attaching the cups, if for example the left teat is stored as left teat or as right teat.

Fields required using information form AMS:

a. Animal id;
b. Herd id;
c. Date and time of miking;
d. x, y, z coordinates;
e. Milk yield;

f. Information on success of milking.

11.4 Analysis of data in genetic evaluation

From the AMS, information of every separate milking more than 700 measurements are made available during a lactation. To analyze the data in genetic evaluations several options are possible:

- Usage of all measurements.
- Usage of every x^{th} measurement.
- Usage of average of n-measurements (e.g. 10) or of a certain period (e.g. week).

11.5 Considerations

- Determined teat positions are actually the position of teat ends. In case trait udder depth is derived from teat positions, one also should or could consider teat length to get a more exact measure of udder depth. This correction only is possible in case the AMS system is also determining teat length.
- Further it should be noticed that stature of the cow affects the distance from floor to udder (z coordinate). It also should be noticed that scoring udder depth by classifiers, udder depth is scored in relation to the hock (as reference point). This also results in the situation that udder depth scored by classifiers is also affected by stature.
- When using udder depth data from AMS for genetic evaluation one always should check the genetic correlation between udder depth scored by classifiers and udder depth based on AMS data. A way to improve the genetic correlation is to add the breeding value for stature and teat length as extra effects to the model for udder depth based on AMS data.
- In the future, data from AMS might also become available from udder traits like teat length, teat direction or teat thickness.

11.6 Literature

Byskov, K., L. H. Buch, and G. P. Aamand. 2012. Possibilities of implementing measures from automatic milking systems in routine evaluations of udder conformation and milking speed. Interbull Bull. 46:28–32.

Poppe, M., H.A. Mulder, B.J. Ducro, and G. de Jong, 2019. Genetic analysis of udder conformation traits derived from automatic milking system recording in dairy cows. J. Dairy Sci. 102:1386–1396.