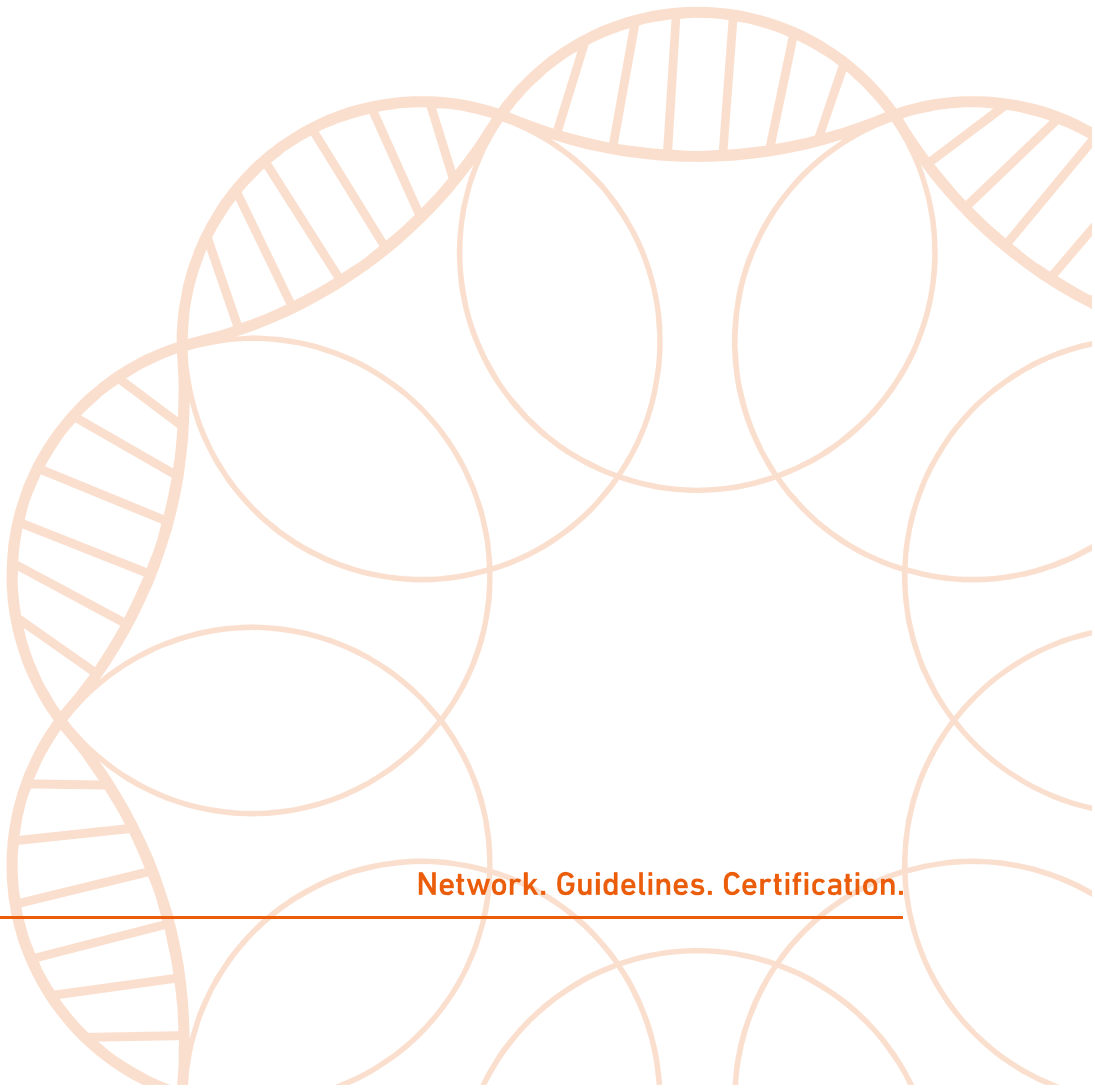
THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Section 7- Guidelines for Calving Traits in Bovine

Section 7 – Bovine Functional Traits

Version May, 2022



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Change Summary

Date of Change	Nature of Change
August 2017	Reformatted using new template.
August 2017	Table of contents added.
August 2017	Heading numbers and heading text edited for clarity and removal of redundant text.
August 2017	Insert links to ICAR website for Claw Health Atlas and Disease Codes.
August 2017	Insert table and equation captions. Insert Table and Equation index into Table of Contents.
August 2017	Fixed bulleted lists; fixed et al as italics and minor changes.
August 2017	Stopped Track changes and accept all previous changes otherwise there was no valid pagination.
August 2017	Added two Sections female fertility in dairy cattle and udder health (Section 7.2 and 7.3). Add index of figures to Table of Contents. V17.05.
August 2017	Added figure and header on page 64.
August 2017	Accepted all changes. V17.06.
August 2017	Stopped Track change sand accepted all previous changes.
August 2017	Moved the file to the new template (v2017_08_29).
August 2017	Correct heading error on page 72 and some other minor edits.
October 2017	Hyperlinks have been corrected.
April 2018	Minor corrections proposed by Dorota Krencik.
April 2018	The “Table of content” for the Figures has been updated as indicated by Dorota Krencik.
January 2018	Claw Health chapter (4) added.
May 2018	Claw Health chapter (4) replaced with new version. Edits marked with track changes. All changes accepted to facilitate final edits and cross referencing.

June 2018	Minor corrections as suggested by Noureddine Charfeddine and Christa Egger-Danner.
July 2018	Draft approved by ICAR Board on 24th July.
August 2018	File name added to improve version control. Draft finalised for distribution to General Assembly for approval.
October 2018	Accepted all previous changes and stopped tracking; paginated according to the template. Published on ICAR website.
April 2019	Lameness chapter (5) added.
October 2019	Lameness chapter 5 updated by FT-WG.
January 2020	Edits made by the FT-WG. Submitted to ICAR Board for approval.
February 2020	Photos added to table 26.
March 2020	Corrections by Anne-Marie Christen (CA) and by Johann Kofler.
April 2020	Corrections by Dorota Krencik as indicated in her email (31-March 2020).
May 2022	Adding chapter of Calving traits to guidelines.

1 Calving traits in Dairy Cattle

1.1 Introduction

The purpose of these ICAR guidelines for recording of calving performance traits in dairy cattle is to give recommendations on recording, data validation and use of information in herd management, documentation of animal welfare, benchmarking, and genetic evaluations. For beef breeds please see Section 3 of the ICAR guidelines for Beef Cattle Recording.

1.2 Definitions and terminology

The main calving traits are stillbirth and calving ease. Other relevant traits are calf size and gestation length. All these traits have both direct and maternal aspects.

Stillbirth is one of the major issues related to the calving. Figures suggested that the frequency has increased in dairy herds, although the reasons are still not clear (Mee, 2020). Stillbirth is defined as a calving in which the calf is born dead or dies during the first 24 hours after parturition. Other terms like calf livability, perinatal survival, or calf mortality (alive or dead) are also used in addition or instead of stillbirth. In this document we use stillbirth.

Calf mortality may be classified as abortion if it is stillborn before 260 days of gestation, and as stillbirth if it is after 260 days of gestation (Mee, 2020). Calf mortality later than 24 hours after parturition and mortality of young stock will not be considered further in this guideline.

Calving ease is defined as how easy or difficult the calving was. In this document we use calving ease, other terms such as calving difficulty and dystocia are used for similar traits.

Gestation length is the number of days between conception date (usually the last insemination date) and the calving date. Average dairy cattle gestation length is +/- 280 days.

Calf size at birth (or calf birth weight). Often assessed as a subjective score. Calf size is associated with calving ease, stillbirth, and calf mortality. For Holstein the average calf is about 40 kg with a standard deviation of 4 to 5 kg.

1.3 Data recording

Registration of calving traits should be done for all calvings within all herds. Calving information is usually recorded by the dairy farmer. In some countries severe cases of dystocia may be recorded via veterinary treatments and be available from health recording system.

1.3.1 Recording of calving traits

The most important traits to record are: Calving ease and stillbirth.

Also recommended: Gestation length and calf size.

1.3.1.1 Important information for calving traits recording

In general, the following information should be ensured for calving traits:

a. Herd ID
b. Cow ID
c. Parity/lactation number
d. Calving date
e. ID of calf/calves[1]
f. Sex of calf/calves[2]
g. Number of calves born at calving (twin information)
h. Sire ID
i. Sire breed
j. Calf from embryo? (Yes/No); if Yes, specify if from Ovum pick up (OPU)

1.3.1.2 Other relevant information for calving traits recording

The following may be useful information related to calving traits:

a. Detailed information related to embryo transfer process (see: Section 6 of the ICAR guidelines for recording AI and ET and reporting fertility.
b. Calf size
c. Insemination dates are needed for calculation of gestation length
d. Pelvic area or rump width and rump angle
e. Information on sexed semen

[1] ID of calf. From identification & registration perspective all live animals should be identified within 48 hours, but regulations regarding calves born dead may differ between countries. A "dummy" ID needs to be assigned to stillborn calves that have not been assigned an official ID.

[2] Sex of calf should always be recorded, as it has a strong influence on calving ease and the importance of including this in the evaluation model increases when sexed semen is used. This also includes the sex of stillborn calves.

1.3.1.3 Calving Ease scoring scale

The calving ease score should describe how easy or difficult the calving was. The optimum would be to distinguish between the following situations:

a. Unassisted unobserved calving (if farmer not present)
b. Unassisted observed calving (no assistance needed)
c. Easy pull: calving which really needed some manual assistance
d. Hard pull: some mechanical assistance required
e. Difficult calving: vet assistance required.
f. Caesarean section
g. Embryotomy

All details may not always be relevant or needed. We recommend that calving ease should be scored in 4 classes. The classes should be well defined and allow easy determination of the class to help keeping accurate records.

a. **Easy, unassisted:** calving without any assistance (also if unobserved/farmer not present)
b. **Easy pull:** calving which really needed some manual assistance
c. **Difficult calving/Hard pull**: some mechanical assistance required, with or without veterinarian aid
d. **Caesarean section/embryotomy**

We recommend that caesarean section and embryotomy be recorded in a separate category, such that these records can easily be omitted when data are used for genetic evaluation.

Other scaling systems exist, and the level of detail needed may vary between breeds and depend on the purpose of data use.

1.3.1.4 Stillbirth scoring scale

Stillbirth is defined as a calving in which the calf is born dead or dies during the first 24 hours after parturition. We recommend scoring stillbirth using two classes:

a. Alive
b. Dead at birth or dead within the first 24 hours

Some countries record stillbirth using 3 categories: 1. Alive, 2=Dead at birth, 3=Alive at birth but dead within the first 24 hours.

Calves alive at birth and passing the 24-hour threshold alive must be identified and recorded as such. Therefore, a calf born without information on calf identification and live status should not be assumed to be alive calf.

1.3.1.5 Recording gestation length

Gestation length is computed from insemination date and calving date (number of days).

1.3.1.6 Recording calf size

Calf size at birth is often assessed as a subjective score, e.g. small, medium, large. A more accurate alternative would be calf birth weight.

1.3.2 Documentation and data flow

The farmer/dairy producer used to fill in the birth registration for each new born and delivered it to DHI /milk recording organisation. Information related to how the calving took place and on the status of liveability of each calf, was until recently filled in the same form but as optional information, in most countries.

Nowadays, all information related to the calving is becoming more and more relevant, mainly for use in genetic evaluations. As soon as possible after each delivery, calving ease score should be set by the farmer and reported in connection with new born animal id registration, mainly through digital solutions, to assure a complete and an accurate data recording. Digital applications, widely used for animal registration, allowed by different drop-down-menu options recording all information about calving, such as the number of calves born, the sex of each new calf, the size of each new calf and its liveability. For herds without access to digital solutions, information could be recorded by DHI/milk recording technicians or by filling all the information in the traditional registration form and sent it to the correspondent registration organisation within each country.

1.4 Data validation

The main issues related with calving traits data recording are:

- Potential under-reporting of dystocia cases: That may result in herds with very low frequency of some calving ease classes.
- Potential misinterpretation of the scale: the differentiation between scores 1 and 2 may not always be well understood. That is why farmers should take into consideration the cow's needs rather than what they did. For herds with more frequent assisted calving than unassisted calving, scores definition should be discussed with the farmer.

The data validation process has to ensure the usefulness of this information for each purpose and avoid loss of information.

Data validation is generally done in two steps called data verification and data editing.

1.4.1 Data verification

Basic checks on format and completeness, at the incorporation of data.

For example, Plausibility of ID: animal-ID, herd-ID, calving ease score. Reasonableness of dates: date of insemination, date of calving.

Checking the correctness of data depend on the purpose of use and on the information source.

1.4.2 Data editing

Data editing should include a clear protocol that describes how to validate the quality of the data from each farm. For calving ease, a check on the distribution of classes is needed. If a herd has a high percentage of records in a single class, the calving ease records from that herd period should be checked with the farmer, and depending on the data uses, they might be omitted.

To define the required period, we should bear in mind that we need to define a minimum number of calving. Depending on the use of the data a minimum frequency could be required.

For genetic evaluation the following edits should be considered:

- If frequency of a single class of calving ease is very low (Less than 1%) it should be combined with the neighbouring class or increased the period. If classes are combined

due to the number of cases, data should continuously be carefully monitored. The limits here should follow local circumstances.
- Exclude records of multiple births.
- How to handle calving records resulting from embryo transfer (ET) is a question.
    - Exclude all ET records.
    - Modelling ET correctly: direct and maternal effects - dam of embryo and cow carrying the calf (recipient cow), pedigree and pe effects
    - Include method for ET.
- Breed of sire of calf. How to handle beef on dairy
    - Exclude if sire or maternal grandsire of calf is unknown or of another breed.

One solution to these issues is to edit the data used for genetic evaluation and exclude calving records resulting from embryo transfer, records from multiple births (twins), and if sire or maternal grandsire of calf is unknown or of another breed.

For herd management and benchmarking the following edits should be considered:

Data recorded about calving are valuable for herd management and decision-making process. For this use data should be as complete as possible and only records that are completely not consistent with other sources of information such as milk recording data, should be removed.

For benchmarking use, the most important check should be made on the representativeness of the reference group at which belong each record.

1.5 Use of data

Routinely recorded calving performance is valuable information that can be used in herd management, documentation of animal welfare, benchmarking and for genetic evaluations.

1.5.1 Genetic evaluation

1.5.1.1 Model

Ideally, the categorical traits of stillbirth and calving ease should be analyzed using a multivariate threshold model with direct and maternal effects (e.g. Heringstad et al 2007; Cole et al., 2007). However, linear models may often be the model of choice for routine genetic evaluation as they are fast, easy to implement, and in most cases gives a very similar ranking of animals as more advanced models. Eaglen et al. (2012) compared models for calving traits and concluded that multi-trait models had an advantage over univariate models and that extended sire models (i.e. sire maternal grandsire model) are more practical and robust than animal models.

The models used for genetic evaluation must include both direct and maternal effects for all calving traits. Direct effects are the calf's genetic potential for being born easily and alive, while maternal effects are the cow's genetic potential for easy calving and liveborn calves

1.5.1.2 Traits and trait definitions

Precorrection for heterogenous variance may be needed. EuroGenomics (2022) suggest that if a linear model approach is chosen, should approximation to normal distribution using e.g. Snell scores be used (Snell, 1964).

Calving ease is recorded as an ordered categorical trait. How many classes to be used in genetic evaluation is a question. If the frequency is low than 1% in any classes, it may be needed to combine with neighbouring class. However, if the frequency of any class is higher than 90%, the

data of the herd-period of time should be eliminated when the aim is estimating breeding values.

In some countries (USA for example) calving ease is defined as calving difficulty expressed as percentage of births of bull calves that are difficult in primiparous heifers and in adult cows.

Calf size and gestation length are examples of genetically correlated traits that may be useful indicator traits to include in a multivariate model together with stillbirth and calving ease.

If multiple parities are included in the genetic evaluation we recommend that first and later parities are treated as genetically correlated trait. Genetic correlations far from 1 suggest that first and later lactation should not be assumed to be the same trait across parities.

1.5.1.3 Effects to consider

Effects to consider in the model for genetic evaluation of calving traits, in addition to the standard effects such as the cow's age, contemporary group, and parity, are the sex of calf(s) and the number of calves born (twin information). Calves coming from embryo transfer must be modelled correctly, as a direct effect is coming from the pedigree of the dam that provided the embryo, while the maternal effect (genetic and potentially permanent environment) is coming from the pedigree of the dam that carries the calf.

Consider whether interaction terms to correct for environmental time trends are needed, such as Herd-Year-Age or Herd-Year-Month of calving.

1.5.1.4 Proofs published

The traits delivered to INTERBULL are only first parity calving traits. It would be an improvement if INTERBULL would allow sending BV predicted for multiple lactations. The traits considered are direct and maternal calving ease and direct and maternal stillbirth. For details related to national genetic evaluations of calving traits see: https://interbull.org/ib/geforms

Calving ease direct: It indicates the influence of the sire on calving ease.

Maternal calving ease: It indicates how easily a sire's daughter will calve compared to the daughters of other sires.

Breeding values for gestation length and calf size could be useful for herd management purposes.

1.5.1.5 Genetic parameters

Heritability. The heritabilities of calving performance traits are in general low. The range of heritabilities used for first parity calving traits in national genetic evaluations by countries that deliver calving traits to Interbull are in

Table 1 (From: https://interbull.org/ib/geforms), and details are given in Appendix 1: heritability of calving traits used in national genetic evaluations.

Table 1. Range of heritabilities of calving traits used in national genetic evaluations.

	Calving Ease		Stillbirth	
	Direct	**Maternal**	**Direct**	**Maternal**
Linear model	0.021 – 0.24	0.023 – 0.158	0.002 – 0.04	0.010 – 0.086
Threshold model	0.056 – 0.08	0.027 - 0.067	0.03 - 0.059	0.058 - 0.066

Genetic correlations. In routine genetic evaluations are the genetic correlation between direct and maternal calving traits often assumed to be zero (https://interbull.org/ib/geforms). Heringstad et al (2007) estimated strong genetic correlations between direct stillbirth and direct calving difficulty (0.79), and between maternal stillbirth and maternal calving difficulty (0.62) for Norwegian Red cows, whereas all genetic correlations between direct and maternal effects within or between traits were close to zero, suggesting that bulls should be evaluated both as sire of calf (direct effect) and sire of the cow (maternal effect).

1.5.2 Herd management use

Information on calving traits are useful in herd management. Farmers try to consider an endless list of best practices and recommended standards to ensure a good preparation for calving. Nevertheless, there is no clear evidence of their effectiveness. On the other hand, it is known that herd management to reduce dystocia cases should start with heifers' development.

The best way to know if something is going wrong around calving within a specific farm is by using calving ease scores and monitoring the situation over different periods of time. Reducing the number of dystocia cases will improve cow- as well as calf health and animal welfare. Examples on measures that can improve calving performance:

- Make breeding plans to avoid difficult calvings. Consider the bulls breeding value for calving ease and calf size (direct effect, sire of calf) when choosing which bulls to use for each cow. Avoid using bulls that gives large calves to heifers/small cows and to cows that had difficult calving in the past (e.g. GENEX, 2022).
- Breeding values for gestation length (direct effect, sire of calf) can be used to predict expected calving date more accurately and thereby be an useful herd management tool.
- Use information on calving performance when making culling decisions for the herd.

Unfortunately, evidence-based best management practices for animals around calving are largely unknown, with several knowledge gaps still existing on the subject. Further investigations on the effect of management practices, on the effect of environmental conditions on calving time, and on cow-calving behaviours are needed to understand better calving process and help farmers with more information about how to improve dairy cow's management around calving period. Meanwhile, analysing, throughout seasons/years of calving, the easy-calving-score frequencies to detect any issues and check all risk factors to find out their grounds.

1.5.3 Animal welfare use

Ensuring a high animal welfare on dairy industry may rely on many factors, which could be related to herd management, farm facilities and animal abilities. The objective way to assess animal welfare should be related to animal performances. Calving performance traits, considered as health or reproductive aspects by animal welfare expert, are ones of the

important performances taken account by animal welfare protocol assessments. Routinely recorded herd data, such as records on stillbirths and dystocia, can be used for documentation of animal welfare status (Haskell et al. 2019; OIE, 2020).

1.6 Acknowledgements

We are grateful to EuroGenomics, who shared their knowledge and experience, and gave access to their document "Golden Standard for calving traits (https://www.eurogenomics.com/golden-standards.html), which aim at harmonization of traits within the EuroGenomics collaboration.

1.7 References

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1.8 Appendix 1: heritability of calving traits used in national genetic evaluations.

Table 2. Heritability of calving traits used in national genetic evaluations by countries that deliver calving traits to Interbull (from: https://interbull.org/ib/geforms, accessed March 2022).

Country	Breed[1]	Model[2]	Calving Ease		Stillbirth	
			Direct	Maternal	Direct	Maternal
Australia	HOL	MT AM	0.07			
Belgium	HOL	ST AM	0.077	0.023		
Canada	HOL, BWS, GUE	MT AM	0.036	0.125	0.0055	0.071
	AYR	MT AM	0.048	0.086	0.004	0.06
	JER	MT AM	0.021	0.158	0.0018	0.0712
Denmark, Finland, Sweden	HOL	MT AM	0.08	0.06	0.04	0.035
	RDC	MT AM	0.06	0.04	0.035	0.02
France	HOL	THR	0.056	0.032	0.03	0.066
	BSW	THR	0.074	0.043	0.059	0.058
Germany, Austria, Luxemburg	HOL	MT AM	0.048	0.039	0.027	0.054
Austria, Germany	BSW	MT AM	0.057	0.065	0.013	0.010
Austria, Germany, Czech Republic	FL	MT AM	0.066	0.105	0.012	0.011
GBR	HOL	S-MGS	0.068	0.044		
Hungary	HOL	MT AM	0.24	0.156		
Ireland	HOL, RDC	AM	0.09			
Israel	HOL	MT AM	0.06	0.03	0.03	0.014
Italia	HOL	THR	0.08	0.036		
Netherlands	All	MT AM	0.068	0.048	0.038	0.086
New Zeeland	All	MT AM	0.045			
Norway	RDC	MT AM	0.068	0.048	0.011	0.011
Poland	HOL	MT AM	0.048	0.039	0.027	0.054

Country	Breed[1]	Model[2]	Calving Ease		Stillbirth	
			Direct	Maternal	Direct	Maternal
Slovakia	HOL	THR, S-MGS	0.072	0.067		
Spain	HOL	THR, S-MGS	0.072	0.027		
Switzerland	HOL	MT, S-MGS	0.053	0.041	0.007	0.02
USA	HOL	THR, S-MGS	0.072	0.053	0.03	0.065

[1]Breed: HOL=Holstein, RDC=Red Dairy Cattle, AYR=Ayrshire, JER=Jersey; FL=Fleckvieh.

[2]MT=multi-trait model, AM=animal model, S-MGS=Sire maternal grandsire, THR=Threshold model.