Body Conditions Scoring: a first proposal for recommendations for recording and use for herd management, genetic improvement and welfare assessment

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Abstract

Body Condition Scoring (BCS) is a widely used and subjective method of assessing the amount of metabolizable energy stored in fat and muscles in live animals. It provides a rapid indication of levels of body fat reserves, e.g., which are crucial in early lactation to buffer cows against negative energy balance as they prioritize energy towards milk production. However, the rapid mobilization of body fat reserves at early-lactation, but also over-condition at late-lactation or dry period can lead to fertility and health issues. Therefore, regular monitoring of BCS is essential for maintaining optimal body condition, health, and productivity in dairy herds. This paper proposes first ideas for standardized ICAR guidelines for BCS recording, emphasizing its applications in herd management, genetic improvement, and welfare assessment. We highlight the diversity of BCS scales used in the different BCS systems and suggest approaches to overcome challenges in comparing responses across different systems. The contributions to ICAR guidelines reported here are a direct continuation of the ICAR-IDF webinar on "Recording and evaluation of BCS and its relationship with health and welfare" and the work done by the "Joint Expert Advisory Group for BCS Guidelines" organized by the ICAR Functional Traits Working Group.

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Introduction

Body Condition Scoring (BCS) is considered today an essential tool for evaluating the health and metabolic status of dairy cows by estimating their body fat reserves, particularly during early lactation. BCS is widely accepted as the most practical method for assessing body fat content, mobilization and changes in energy reserves in dairy cattle (Bewley *et al.*, 2008). By estimating their status, it assesses the pivotal role that fat plays in buffering cows against negative energy balance while they partition energy primarily toward milk production. This rapid mobilization of fat reserves but also being over conditioned may lead to reproductive and health problems, including fertility issues as cows, that are either too thin or too fat, are prone to these disorders (Garnsworthy, 2006). Optimal body condition is important and requires frequent monitoring of BCS which can be used to detect and to correct problems and improve the health, welfare,

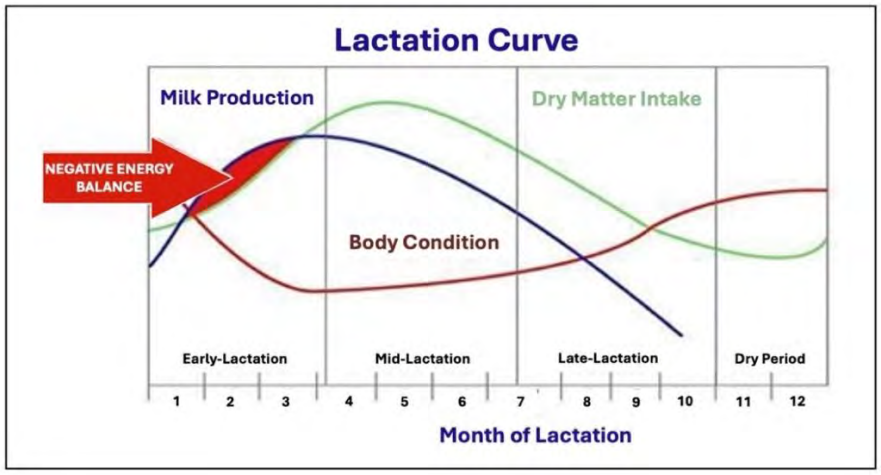

Figure 1. Lactation curves comparing milk production, intake and body condition showing reaction of body condition in early and potential over condition at the end of lactation.

fertility and productivity of dairy cows and herds (Domecq *et al.*, 1997; Roche *et al.*, 2007). Figure 1 shows the lactation curves comparing milk production, intake and body condition.

The practice of visual and tactile appraisal of BCS began in the 1970s, with one of the earliest developments by Jefferies (1961) of a BCS system for ewes and has evolved into various numerical systems with multiple scales, depending on the country, organization, and intended purpose. While some scales focus on welfare assessment and are simple, others are more detailed to optimize feeding strategies by detecting early changes in body condition. Despite these advancements, different scoring systems can cause confusion when comparing targets and results across farms and programs. Moreover, while automated BCS recording is becoming more common, it remains challenging to achieve the same accuracy as manual palpation in dairy cattle. This contribution to ICAR guidelines is a direct continuation of the ICAR-IDF webinar on “Recording and evaluation of BCS and its relationship with health and welfare” and the work done by the “Joint Expert Advisory Group for BCS Guidelines” organized by the FT-WG. In the following document we will call BCS system the use of a given BCS scale in a specific context (e.g., group of animals scores, frequency of scoring, use of scores).

Defining Body Condition Score (BCS)

BCS as an indicator of fat content

There were no simple measures of a cow’s energy reserves or condition prior to 1970s (Stockdale, 2001). Because cows of a given weight might be tall and thin, short and fat, or both, body weight (BW) alone was not a reliable measure of body reserves. Energy storage in cows with comparable body weights differed by as much as 40%, according to Andrew *et al.* (1994) and Gibb *et al.* (1992), demonstrating the unreliability of using BW as the only indicator of body condition. Furthermore, because increased feed intake coincides with tissue mobilization during early lactation, reductions in body tissue weight may be masked by increased gut fill, meaning that increases in BW may not correspond to changes in adipose and lean tissue weight. A strong positive correlation ($r^2 = 0.86$) between BCS and the proportion of physically dissected fat in Friesian cows as reported by Wright and Russel in 1984 has been used as visual or

tactile (palpation) appraisal of cow condition or BCS. This provides a good assessment of body fat reserves, ignoring, or minimizing the influence of frame size and intestinal contents (Wright and Russel, 1984). This traditional subjective appraisal has been rationalized into various numerical BCS systems using many different scales. This diversity in scales is based on the purpose of recording BCS and different scales employed in different circumstances by different countries or organizations (i.e., BCS Systems).

BCS scales and their diversity

In contrast to some other traits with very precise definitions, there are wide variety of scales that have been used to measure body condition. This variety of scales is also based on the purpose of recording the BCS and on different scales used in different circumstances by different countries or organizations, resulting in different BCS systems.

BCS scales across countries

A large variety of BCS scales exist today. Some are reported in Table 1. It is important to notice that the number of classes available to the assessors is the important feature allowing fine scoring, not the numerical boundaries. Jefferies (1961) initially developed a BCS system for ewes which involved palpation of backbone and lumber processes, feeling the sharpness, and covering of the bones. He developed a scale from 0 to 5 (here after called 0-5 scale), where 0 was extremely thin, i.e. no longer viable, and 5 was extreme obese. His technique was adapted for scoring beef cattle by Lowman et al. (1973) which involved palpation of the lumbar vertebrae and around tail head. Table 1 give some other relevant reference methods. Subsequently a similar system with 0-5 (11 classes) was proposed by Mulvany (1977) in the UK but introduced adjustment factors if the scores in the tailhead and the loin areas differed. In Australia, an 1-8 system (15 classes) of scoring dairy cows was developed by Earle et al. (1977) and a similar 1-10 system (19 classes) developed in New Zealand (Roche et al., 2004). Both scoring systems used photographs of individual cattle to define condition scores. Body condition scoring of dairy cows in the US is generally performed according to the scale 1-5 (Wildman et al., 1982). This method, like those used in the UK, involves palpating cows to access the amount of tissue under the skin. As for many scales different variants were proposed. Ferguson et al. (1994) also used a 1-5 scale but 0.25 interval leading to 17 classes. Body condition score being an optimal intermediate trait, and, in all scales, lower values indicate a leaner body conditioning in cows, whereas higher values indicate greater obesity level. Several scales used in various countries are summarized in Table 1.

Table 1. Various BCS scales used in different countries along with the method of assessment.

Country	Scale	Interval (classes)	Method	References
United Kingdom, Ireland	0 to 5	0.5 (11)	Palpation	Mulvany (1977),
New Zealand	1 to 10	0.5 (19)	Palpation	Roche et al. (2004)
Australia	1 to 8	0.5 (15)	Visual	Earle et al. (1977)
United States	1 to 5	1 (5) 0.25	Palpation/Visual	Wildman et al. (1982)
	1 to 5	(17)	Palpation/Visual	Ferguson et al. (1994)

Diversity in BCS scoring systems

Developments of various BCS scoring system were based on circumstances and purposes such as breeding, herd management, and welfare. Within each system factors like granularity of scoring (i.e., scale and intervals used), population evaluated, timing, and frequency various within different systems. Recent advancements in technology-assisted or even technology-driven BCS systems are also leading to other BCS systems. This leads to challenges as this variation among systems can lead to confusion when comparing and difficulty exists in interpreting the literature. Especially putting together data across different herds and different BCS systems and can require transformations of scales.

Using Body Condition Score (BCS)

Description of some commonly used scoring system

BCS system associated to linear scoring and genetic evaluations (1-9 scoring scale)

Currently in many countries BCS is scored in routine once in first lactation inside the linear scoring system used for genetic evaluation for conformation. Therefore, a 1-9 scoring scale (9 classes) is taken as a linear scale although BCS is not a true linear trait. The covering of fat over the tail head and rump is taken as the reference point and is scored as described in Figure 2. For the score ranging from 1-6, the accessor has to look at the loin, while the tail implant is important with the higher scores (7-9).

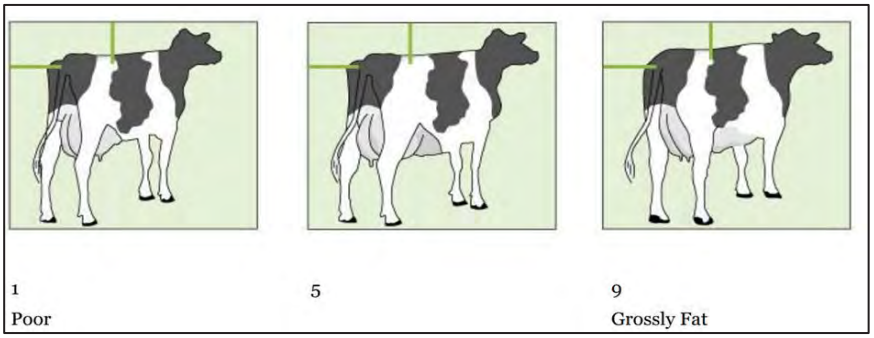

Figure 2. 1-9 BCS scale (adapted from ICAR).

BCS based on a 1-5 scoring scale

Detailed information describing the way the 1-5 scoring scale with 0.25 intervals (17 classes) are assigned are given by Edmonson *et al. (1989).* In Figure 3, the major elements for assigning the 5 major steps are given as an example.

How to assess BCS

Manual assessment

Manual assessment of BCS involves palpating key body regions (e.g., ribs, spine, hips) to estimate fat and muscle reserves. Figure 4 shows the anatomical features associated with body condition scoring. This method remains reliable but is subject to assessor variability. Consistency in training assessors is crucial to reduce this variability.

Digital tools

Automated BCS recording using digital technologies, such as 3D imaging systems, is becoming more widespread. These tools offer a more objective and consistent assessment of BCS, minimizing human error. However, technological limitations still

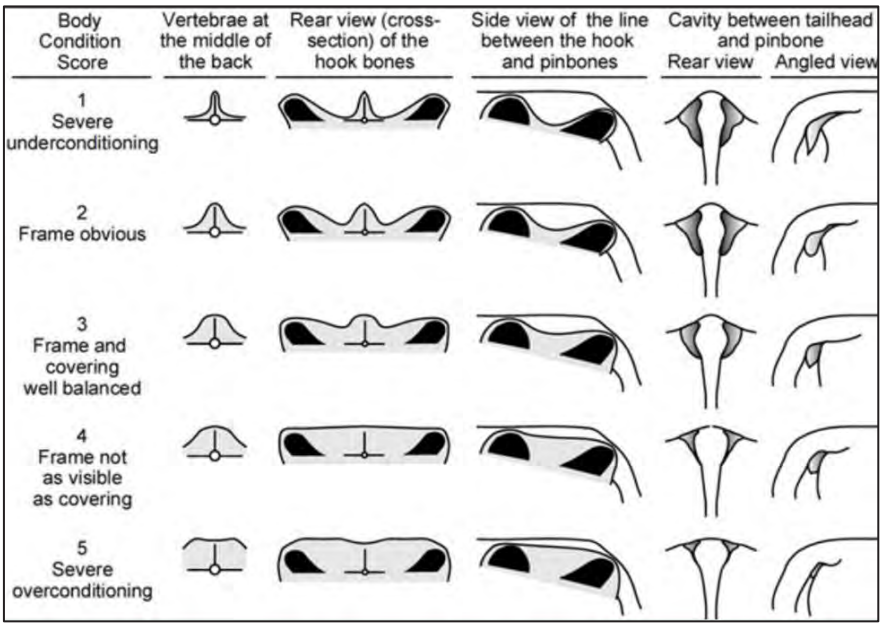

Figure 3. Example of an 1-5 BCS scale chart (Modified from Edmonson et al., 1989).

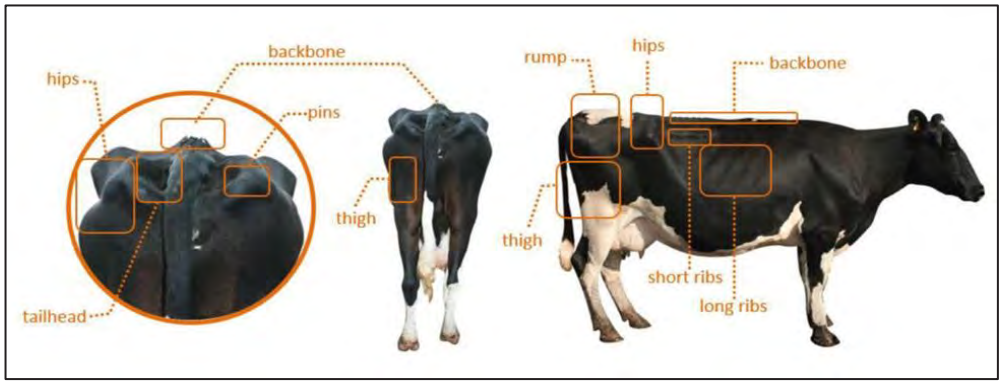

Figure 4. Anatomical features associated with body condition scoring in cattle. (Huang et al., 2019).

make it challenging to achieve full accuracy, particularly when compared with manual palpation. Three levels were identified and can be recommended:

1. Use of digital tools to document and do easy recording of visual assessments.
2. Technology-assisted assessments: Human assessors are still doing the scoring but devices providing support to the manual assessment replacing the human eyes. These tools should be easy to use, resilient to environmental disturbance, and allow easy identification of animals and data transfer.
3. Technology-driven assessments: These are purely automatic sensor-based technology driven assessment that should be more reliable, allowing more frequent

on-farm BCS assessment. Technologies are diverse, generally digital images of the rear aspect of the cow based or 3D body condition scoring using fixed position optimized camera systems.

Recommendations for use of BCS scales

Conversion between BCS scales

Mathematical conversion

Although Garnsworthy (2006) and others highlighted the common practice of BCS systems to assess similar body parts and to establish links between scores and levels of adiposity, there are concerns about the reliability of simple mathematical conversions between different scales. These might not be accurate because scales may use the range of conditions not linearly (Garnsworthy, 2006). Therefore, we recommend only using these equations with caution, and only when no other information is available. As example here are the proposed transformations towards a 1-5 scale:

- 1-4 scale: BCS x 4/3 – 1/3
- 0-5 scale: BCS x 4/5 + 1
- 1-8 scale: BCS x 4/7 + 3/7
- 1-9 scale: BCS / 2 + 1/2
- 1-10 scale: BCS x 4/8 + 5/9

Conversion based on simultaneous scoring

An alternative way to develop conversion equation was presented by Roche *et al.* (2004). In their method simultaneous scoring is required (Figure 5). Still enough variability at the extremes is needed and local scales may be adapted to local populations (e.g., breeds) making conversion more difficult.

Conversion based on distributions of scores

Under the hypothesis that all scales describe the same underlying trait, the adiposity of animals in a given population, the distribution of attributed scores using each scale

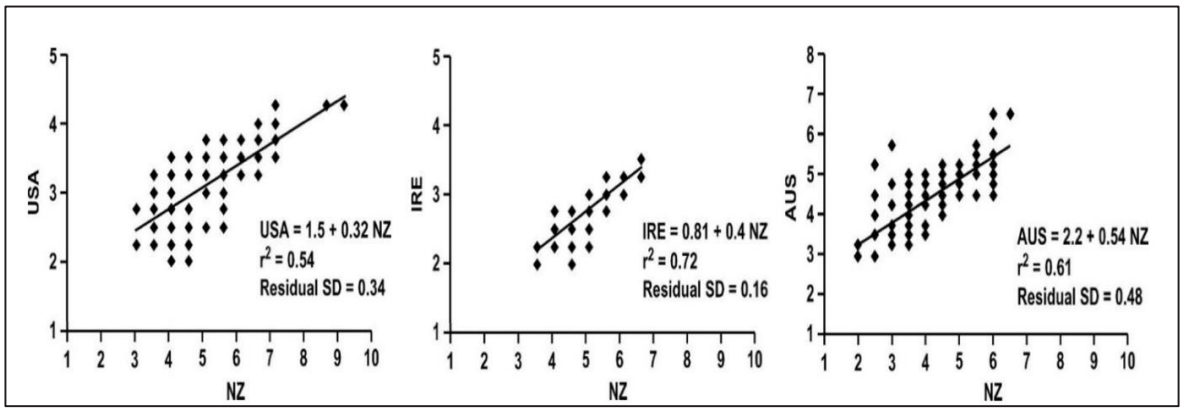

Figure 5. Conversion equations based on simultaneous scoring in the USA, IRE and AUS of local cows using local and NZ scales (Roche et al., 2004).

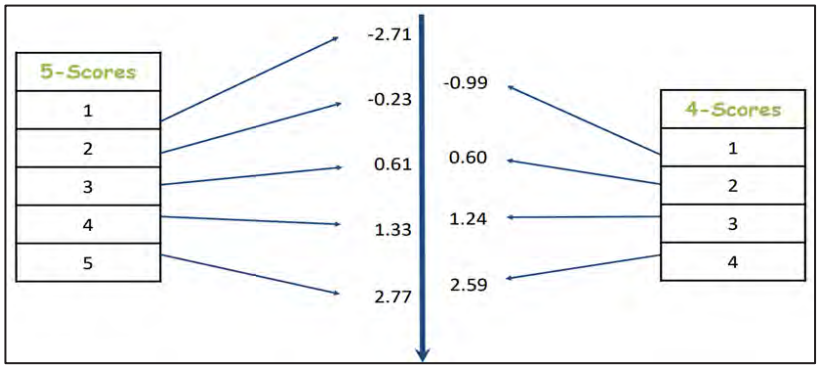

Figure 6. Matching scores taken on 5- and 4-class scales using Snell Scores (Snell, 1964).

can be mapped a posteriori to this underlying normal distribution (i.e., z-scores which are the standardized distances from the zero of a normal distribution) using appropriate methods (e.g., Snell Scores). Figure 6 shows how a posteriori 5-class respectively 4 -class score scales can be mapped to a common scale or even common classes. In this example scores 1 and 2 of the 5-class match approximately to 1 of the 4-class scale, as do 3 to 2, 4 to 3 and 5 to 4. The z-scores can obviously also be used directly as a common measure of adiposity.

Under the hypothesis that both scoring scales are used on animals representing the same population with large enough sample sizes this method does not require simultaneous scoring.

Recommendations for herd management

BCS plays a vital role in managing dairy herds, allowing farmers to adjust feeding strategies and monitor metabolic health. Frequent BCS assessments help identify cows that are either losing or gaining condition too quickly, which may indicate underlying health or nutritional issues. In general, five BCS classes are usually sufficient to capture significant BCS variability, but can be increased for specific purposes (e.g., feeding optimization, early detection of health problems) or reduced for welfare assessments aiming only to detect the general status of the cows (too thin – normal – too fat) (Table 2).

Table 2. Various BCS scales proposed for specific purposes

Purpose	BCS Scale	Frequency	Remarks
Feeding advice	5 classes	Frequent and longitudinal	Identification of cows with BCS change indication potential health problems and optimization of feeding
Detection of metabolic disturbance	5 classes	Before and after calving and at least 2 time before peak of lactation (~50 DIM)	Enables BCS change in the herd
Welfare assessment	3 classes		Detect general status of cows (thin-normal-fat)

Table 3. Timing of BCS assessments.

Moment	Recommended frequency
Pre-calving:	Conduct BCS evaluations approximately 3 weeks before calving to ensure optimal condition.
Early-lactation:	Closely monitor BCS during the peak of lactation to detect metabolic imbalances early.
Dry off period:	Assess BCS 7-8 weeks before calving to adjust feeding as needed

Table 3 outlines the recommended frequency for BCS assessment depending on key stages in the cow's lactation cycle:

With an optimal recording scheme could be (in bold recommended): Dry off, Pre-calving, Calving, Early lactation/Pre-service, 1st Service, Pregnancy Check, and Late lactation.

It should be noted that a representative random stratified sample of cows representing all lactations should be measured at least at the beginning (pre-service), at the end of the lactation (drying-off), and before calving to ensures effective assessment. In herds at risk of transition cow issues, more frequent recording of all at-risk cows is required.

Recommendations for individual cow management

In individual cow management, BCS can be used as a troubleshooting tool to adjust feeding programs or identify health concerns. For example, cows that drop below a certain BCS threshold may require increased energy intake, while those with higher-than-recommended scores might benefit from a restricted diet. These measures are essential for improving not only productivity but also fertility, feed efficiency, and overall wellbeing in dairy herds.

Detection of extreme BCS animals is required for individual cow management, therefore finer scales than only 5 classes and repeated recordings to enable detection of body condition changes are recommended.

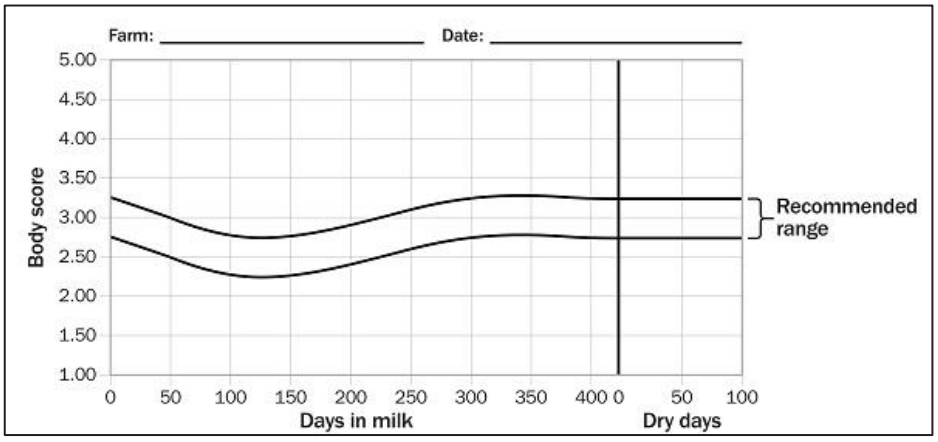

Figure 6. BCS chart used in Ontario, Canada. (https://www.ontario.ca/page/body-condition-scoring-dairy-cattle).

We recommend developing optimal BCS lactation curves based on breeds and management system. Figure 6 shows the chart developed in Ontario, Canada, that allows farmers to plot individual cows on this chart according to stage of lactation. This optimal BCS lactation curves can be used to profile a herd at one point time or to monitor changes over a lactation for an individual cow.

Recommendations for genetic evaluation

BCS is recognized as an intermediate optimum trait in genetic selection. Incorporating BCS data into genetic evaluations enhances breeding programs, particularly for selecting cows with a more favorable balance between milk production and metabolic health. The use of BCS as auxiliary trait is common in many genetic evaluation systems (e.g., for fertility). Regular, accurate BCS data collection allows for better herd selection and ultimately contributes to long-term herd sustainability. Current practice is organized in parallel to linear scoring which involves in most systems recording BCS once in a lifetime done during 1st lactation using the same 1-9 scale as for linear scores.

Our recommendations are that for genetic evaluation BCS should be recorded on all cows on a frequent basis throughout the cow's life with at least a 5-class scale. Obtaining repeated records of BCS can also be useful for the derivation of novel traits such as resilience and resource allocation. Weakness of single recording on a cow level can be partially compensated by appropriate modeling of BCS changes on a sire level through its progeny. Even if this single measurement does not capture the BCS variation throughout the cow's lactation, on the level of the offspring of a sire we recommend the use of random regression models to assess the heritable changes observed in the progeny of a given sire.

Recommendations for welfare monitoring

As explained previously, current practice in welfare monitoring BCS systems is the use of a 3-class scale which is sufficient in this context. Because assessment is only conducted once at a specific point in time, a critical element is sampling a representative group of animals, including recording of relevant elements to ascertain this (e.g., parity, lactation stage).

As for other BCS systems, to maximize synergies, for example with herd and individual cow management, and breeding, it would be beneficial if all animals were assessed even in a welfare monitoring. This would also allow the detection of individuals with specific welfare issues.

Important considerations

Additional data to be recorded

In addition to the recorded BCS, also to allow further use the following information is recommended to record: unique Animal ID, Herd ID, breed, date of recording, assessor-ID, BCS Scoring System (linked to a comprehensive description of the system), days to / from calving in relevant parity and parity number.

Training of the accessor

An important element is the training of accessors. First, they need to have a clear understanding of and training on the BCS Scoring System. Standard Operating Procedures (SOP) along with a scoring chart and ensuring comprehensive and regular training on utilizing these resources effectively need to be developed. Frequent harmonization between assessors is needed. Best practice is that different assessors score the same farm(s) and grouping of data across different farms is done e.g. the data is used for benchmarking. Finally frequent evaluation of inter- and intra-assessors' repeatability is important especially for use in research studies.

Benchmarking and use for herd management

For herd management information on individual cows could be of less importance. But to effectively benchmark, manage herds, and genetically evaluate animals, it is crucial to centralize the collected information into a database. Benchmarking enables comparisons among farms and the identification of areas for improvement. However, for meaningful comparisons between herds, factors such as assessment frequency, lactation stage, and recording must be considered and therefore recorded (see point "Additional data to be recorded"). Furthermore, the data should be representative of the population and the distribution of BCS is more relevant rather than just means.

Conclusion

Body Condition Scoring is a key method for assessing the health and wellbeing of dairy cows, providing a practical measure for managing herd nutrition, productivity, and welfare. Standardizing BCS scales and recording methods is crucial to improve data consistency across regions and systems. While technological advancements, such as automated scoring, offer promise, manual assessments remain important. Regular BCS monitoring, along with harmonized guidelines for recording, will support better decision-making in herd management, genetic selection, and welfare assessment. Here we presented the first proposal draft of guidelines for the scoring of body condition in dairy cattle. This should lead to comprehensive guideline aiming at standardizing BCS methods and includes considerations and recommendations for improved BCS recording in the context of a herd management, animal welfare, and genetic evaluation maximizing also synergies between BCS systems.

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