The 3G Consumer-Based Beef Eating-Quality Prediction Framework

The Meat Standards Australia (MSA) system demonstrated that beef eating quality can be predicted using carcass characteristics, processing information and consumer sensory assessments.
A central principle is that eating quality should be predicted for specific combinations of muscle or commercial cut, ageing period and cooking method rather than assigning a single quality score to an entire carcass. Predictions are calibrated against sensory assessments by untrained consumers representative of the beef-eating population. The Global Guaranteed Grading (3G) framework was developed based on this approach.

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Eating quality is a major determinant of consumer satisfaction and repeat purchases of beef. However, despite its commercial importance, it remains insufficiently controlled across the European beef supply chain.

Beef eating quality varies considerably due to multiple factors, including animal genetics, on-farm management, slaughter conditions, carcass chilling, ageing, cutting and cooking practices. Consequently, consumers may experience inconsistent quality, and the price of beef does not necessarily reflect its tenderness or overall eating quality.

Building on the MSA approach, the Global Guaranteed Grading (3G) framework was developed for European conditions and calibrated using the International Meat Research 3G Foundation DATAbank.

In INTAQT, consumer sensory evaluations followed the 3G methodology, including the carcass measurements needed to predict the eating quality of all cuts, as not all samples could be tasted in sensory tests. This factsheet presents a recent study (Neveu et al., submitted) testing whether EUROP fat class and chronological age could replace rib fat depth and ossification score.

Fig 1: Grading of carcasses in the chiller by human graders accredited by the International Meat Research 3G Foundation

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The study describes the European DATAbank and evaluates the suitability of the available carcass information for implementing the 3G prediction framework commercially.

The DATAbank brings together results from research projects conducted in several European countries, including the INTAQT project, using standardised protocols. Its principal strength is the traceability linking individual animals and carcasses to cuts, samples and individual consumer sensory scores. Standardised cut identification, cooking protocols and sensory assessment procedures make it possible to combine data collected by different research teams and over years.

Consumer assessments followed the 3G beef eating-quality protocol recommended by UNECE (United Nations Economic Commission for Europe) since 2018. Untrained consumers evaluated tenderness, juiciness, flavour liking and overall liking. These responses were combined into a single consumer meat quality score (MQ4 = 0.3 tenderness + 0.1 juiciness + 0.3 flavour liking + 0.3 overall liking), with weightings derived from more than 100,000 consumer ratings.

Fig 2. Carcass grading according to the UNECE Beef Eating Quality protocols

This study first described the geographical and experimental coverage of the dataset. Then, the study investigated how carcass characteristics influence eating quality across different cuts. This matters because a carcass measurement may have a substantial effect on one cut but a much smaller effect on another.
The analysis therefore assessed whether the effects of ossification (which is related to physiological age) and rib fat depth (related to fatness) should be modelled separately for each cut, as required by the 3G framework.

The objective of this study was to identify the potential additional measurements and practical adjustments needed to deploy the 3G consumer-based beef quality prediction framework in European abattoirs without changing existing classification systems or processing practices.
For instance, we examined relationships between routinely available carcass characteristics (e.g. age and EUROP fat class) and the specific measurements required by the 3G model (ossification score and subcutaneous rib fat depth).

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A major finding was that EUROP fat class cannot reliably replace direct measurement of rib fat depth. Fat class explained approximately 30–43% of the variation in measured rib fat depth. This limitation has practical consequences: a classification system designed to describe overall fat cover cannot accurately identify carcasses meeting a specific rib fat depth threshold.

The effects of carcass characteristics on eating quality were also strongly dependent on the cut considered. Rib fat depth, marbling and ossification did not have uniform effects across cuts. Their importance could be underestimated or obscured if a single common relationship were assumed for all beef cuts. This finding supports the cut-specific architecture of the 3G framework.

Finally, hanging method and ageing period were identified as the largest determinants of eating quality in the analysis. Importantly, these factors are already managed by abattoirs and processors and do not require additional carcass measurements. Among the carcass characteristics assessed, marbling was particularly valuable and could be measured at locations compatible with existing European cutting practices.

Fig 3. Visual observation of the carcass vertebrae to assess ossification score, an indicator of physiological age.

The analysed dataset comprised 12,553 beef samples from 2,446 carcasses, collected through 43 research projects in seven countries: Poland, Northern Ireland, Ireland, France, Wales, Italy and Spain. It covered 28 cuts and four cooking methods, although the number of samples and the diversity of cuts differed substantially between countries.

Another important finding concerned physiological maturity. Although chronological age is known for European cattle through mandatory identification systems, it explained only about 1% of the variation in ossification score among commercial cattle and therefore cannot replace ossification as an input to the 3G model. The two indicators are nevertheless complementary: ossification is most discriminating in younger animals, whereas in mature cattle, where ossification reaches its maximum, age may provide additional information. This is particularly relevant in countries such as France, where beef from older animals is consumed.

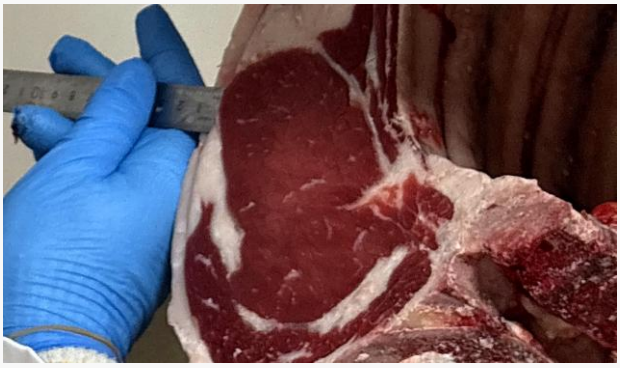

Fig 4. Measurement of rib fat depth.

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The results indicate that the 3G framework can be applied to the European beef industry largely in its existing form. However, commercial implementation requires a small, clearly defined set of additional carcass assessments rather than a complete redesign of current classification systems.

First, ossification must be measured because chronological age does not provide sufficient information about physiological maturity. Second, marbling should be assessed because it contributes to eating-quality prediction and can be measured at sites accessible under existing European cutting practices.

Rib fat depth presents a more complex challenge. EUROP fat class does not provide sufficiently accurate estimates. Furthermore, the rib location used for measurement may not be exposed during conventional commercial cutting practices in Europe. Direct measurement, potentially supported by calibrated imaging systems, may therefore be necessary when predictions are used to support a quality guarantee to consumers.

Fig. 5. Assessment of marbling by a human grader with a grid or using a portable camera

The 3G framework offers a practical route towards more consistent, predictable and consumer-oriented beef quality. By linking standardised carcass and processing information with sensory responses from consumers, it shifts quality assessment beyond traditional carcass classification towards the eating experience of the final product.

Processors can improve eating-quality consistency through management of hanging methods, chilling conditions and ageing periods. For consumers, more reliable predictions could reduce quality variability, increase satisfaction and encourage repeat purchases. For producers and processors, the framework could support improved quality management.

The approach could also improve communication throughout the supply chain by providing a common basis for describing eating quality across cuts and systems.

Overall, the study demonstrates that consumer-based beef eating-quality prediction is feasible for European commercial application.

Key reference: Neveu et al (2026)

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