MEAT & LIVESTOCK AUSTRALIA

APPENDIX C:

THE BEEF LANGUAGE AND EXPORT MARKET ACCESS

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OVERVIEW

The achievement and maintenance of export market access for beef is ultimately dependent on meeting the differing requirements of importing country authorities. These official requirements include:

- Meeting animal health conditions (e.g. that the exporting country is free of specified animal diseases able to be transmitted via beef);
- That the beef/beef product meets food safety standards (e.g. that it has passed veterinary ante- and post-mortem inspections);
- That each consignment of beef/beef product is accompanied by official certification in a format accepted by the importing country authorities; and
- That an accurate trade description is applied to the product and is reflected in the official certification accompanying the export consignment.

Failure to comply with any of these official importing country requirements places continued market access at risk and has, increasingly, seen major exporting countries introduce a quality-assured systems approach to assist in demonstrating on-going compliance with these key measures. Under these quality systems approaches, there has been a trend for governments in beef exporting countries to maintain their direct involvement in systems delivering food safety outcomes and to enforce trade description outcomes through verification of industry and third party quality systems. In particular, Australian authorities officially recognise the AUS-MEAT product description language and associated accreditation and verification controls.

The current situation relating to product description controls is in marked contrast to that prevailing before the 1980s in Australia. Under the then regulations for export meat, provisions existed for the appointment of official graders and quality standards were specified under Schedules to the regulations. These included quality descriptors for beef, such as “first”, “second”, “third” and “manufacturing” types. In general, markets required beef to be graded and labelled as to its quality type. However, since the 1960s, market needs began to rapidly change with the emergence of the US market for boneless manufacturing beef and the lessening importance of the UK market for carcase beef. As the US Meat Import Law required imported meat consignments to be inspected at import to establish not only compliance with health and hygiene requirements, but also with US labelling requirements, much beef was described in clear as “boneless” or “bone-in” with further descriptors in code (as agreed by industry organisations). This approach avoided the need for import inspectors to verify cut or other product descriptors as true to label, but left industry to resolve product claims with or without recourse to independent arbitration.

The beef language currently used in the Australian meat industry thus reflects its long and successful history in serving a large number of export markets and may be said to be characterised by an approach which allows the accurate and verifiable description of product to a level of detail required by a customer, be that detail minimal or exacting.

Clearly, the challenge for a future beef language is one of accommodating evolving consumer-driven demands for accurately described product (including product attributes of an increasingly diverse nature), while facilitating value adding as product moves through the supply chain. A particular challenge for the language will be to retain the ability for it to simultaneously operate in either a more or less regulated environment. These and other drivers will be further discussed in this paper.

IMPORTING COUNTRY REQUIREMENTS FOR BEEF DESCRIPTION

Understanding the range of current requirements of importing countries for describing beef is important in gauging the acceptability to particular importing country authorities of any significant changes to the Australian beef language.

In general, Australia's exports of beef fall into two broad categories, namely: a) packaged ready for consumer sale; and b) beef intended for further processing prior to its sale to consumers. In the first case, the importer is essentially a distributor of finished product and needs to ensure that the product is accurately labelled in accordance with applicable national (and, possibly sub-national) laws. The importer may elect, if required, to directly seek label approvals from national (and/or sub-national authorities) or require the beef exporter to obtain such approvals. Labels need to use the language or languages required for the importing country concerned.

In the second case, the importer and/or exporter need to ensure the packaging of the beef for further processing is labelled so as to comply with the requirements of the importing country. As with the first case, the accuracy of labelling may or may not be directly verified during the import clearance process, but is likely to be checked against product descriptions entered on official health certificates accompanying the consignment. The importer also needs to supply such additional information about the product as may be required by the further processor. This additional information may be in the form of official health or other certification issued by exporting country authorities, certificates issued by third parties ("Halal" or "Organic" certifying bodies), declarations/certificates issued by the packer/exporter of the consignment, or laboratory certificates of analysis relating to the product. Additionally, it is not unusual for a supply contract between an exporter and an importer to contain detailed specifications (cut type, weight range, fat cover, chemical lean) which are verified by the importer and, if out of specification, may result in a commercial claim. The information conveyed by these various means for each consignment provides a basis for accurately labelling beef products derived from the consignment.

The general experience of Australian beef exporters is that product accurately described using the basic and/or alternative categories under the AUS-MEAT language can access the majority of export markets. The basic categories of bovine meat, utilising dentition (as an indicator of age) and sex (in the case of entire males), are "veal", "beef", and "bull". Dentition and sex (including presence or absence of secondary sexual characteristics) is used by the AUS-MEAT Language to describe some 11 alternative categories of "beef" and some 3 alternative categories of "bull".

For some export markets (e.g. Canada), it has been necessary to enter into formal processes (i.e. letters of agreement, memoranda of understanding) at a government-to-government level to obtain recognition of the equivalence of the AUS-MEAT Language and/or the basic categories of beef, as defined under Australia's export meat legislation, to the legislated provisions of the importing country. In the majority of cases, it is apparent through custom and practice that bovine meat when described in accordance with the basic and alternative categories of the current Australian beef language enjoys recognition as meeting importing country product description requirements. This circumstance prevails despite the existence of different beef carcase categorisation systems (e.g. where ossification and not dentition is used as a determinant of carcase age) in some importing countries and, in the majority of cases, in the absence of formal equivalence agreements on a government-to-government basis.

Despite the AUS-MEAT Language for bovine meat enjoying broad acceptance across export markets, there remain a few markets (e.g. Chile) which require carcase categories to be determined by government-appointed or accredited graders and for carcase categories and derived cuts to strictly accord with their legislated requirements.

In the case of Chile, a government-to-government Memorandum of Understanding has been finalised which recognises the equivalence of the AUS-MEAT Language and the official Australian government accreditation and oversight of AUS-MEAT arrangements for provision of carcase classification services on behalf of government. A number of other countries (or country groupings) recognise that Australia's legally-based recognition of the AUS-MEAT Language and the formal arrangements for the auditing and general oversight of AUS-MEAT Limited as equivalent to the direct provision by the Australian Government of an official carcase classification system.

Such recognition provides Australian beef exporters with considerable flexibility in securing access to markets requiring an official carcase classification system. It follows that to contemplate changing existing AUS-MEAT oversight arrangements would not be without risk to currently enjoyed levels of export market access. Additionally, the existing arrangements would assist in managing the possible future introduction of stricter, consumer-driven oversight requirements by importing country authorities.

A further area of exception to the generally favourable level of acceptance of Australian approaches to beef product description by importing countries, relates to special requirements for imports of specified categories of beef to certain markets. A contemporary example is provided by exports of "high quality" beef to the European Union (EU). In order to supply this category of product under the EU quota, Australian authorities needed to secure formal recognition of a specially designed grain-fed beef specification together with detailed oversight and certification arrangements.

A number of other markets are sensitive to labelled claims for "organic beef", "bio-dynamic beef" or similar descriptors and require that an equivalence determination is reached as prior condition for market access. For some markets, government-to-government certification attesting to official oversight of the preparation of the "organic beef" is required. Likewise, claims about livestock feeding regimes made on labels (e.g. "lot fed", "grass fed", "grain fed") need to meet agreed standards, often under approved arrangements of oversight. In some cases standards need to be agreed on a government-to-government basis, while in other cases prior label approval must be obtained from the relevant importing country authority. Consignments of these products may need to be accompanied by specified official certification or by declarations made by the exporter/packer.

As beef marketing becomes more competitive and responsive to consumer demands, it is likely that many more types of labelling claims (also described as "product raising" claims by the marketing sector) about the attributes of beef will enter into use. Such claims can be expected to extend to methods of cattle husbandry (including their perceived animal welfare benefits and, in some instances, their perceived human nutritional/health benefits) and to meeting environmental standards during cattle raising and/or processing into beef. Other examples of raising claims for beef in current useage include geographic indicators of origin (e.g. "King Island Beef") and breed of origin (e.g. "Angus Beef"). As with certain other labelling claims governments, driven by a need to meet consumer expectations, can be expected to require that labelled information not be misleading and for claims to be verifiable. These circumstances will, in turn, lead to the need for the development of underpinning standards and the possible referencing of such standards by statute.

It follows that the beef language of the future will be facilitating of not only the communication of traditional categories of bovine meat through the supply chain to the consumer, but also of more novel product claims such as those relating to cattle husbandry, human nutrition, and environmental care. While there are clear drivers for the Australian beef language to evolve in response to changing consumer expectations and in order to help assure Australia's continued export beef competitiveness, it is also evident that significant change in describing the basic categories of bovine meat cannot occur without some risk of loss of access to sensitive export markets. Any significant change to either the basic categories and the associated AUS-MEAT Language (and associated legislative and oversight arrangements) would necessitate a transparent consultative process, both domestically and overseas. In particular, change would require that a well-argued and scientifically supported case be successfully made out with sensitive export markets.

ROLE OF INTERNATIONAL STANDARDS AND THE WORLD TRADE ORGANISATION (WTO)

A number of international standard organisations elaborate standards and guidelines which have relevance to trade in meat and meat products. The Australian Government and meat industry have a long history of actively contributing to the work of these organisations, and have done so with a view to ensuring international standards and guidelines to accommodate Australian conditions, industry practices and regulatory approaches.

The work of the joint World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) Codex Alimentarius Commission (often referred to as the "Codex") has considerable relevance to Australia's export meat industry (and food industries more generally). The following Codex Committees elaborate standards and guidelines of direct relevance to the meat industry:-

- Codex Committee on Food Hygiene
- Codex Committee on Food Labelling
- Codex Committee on Food Import and Export Inspection and Certification
- Codex Committee on Meat Hygiene (presently adjourned)
- Codex Committee on Fats and Oils.

Additionally, the Codex Alimentarius Commission (CAC) from time to time convenes Task Forces to address topical issues. A relevant example is provided by the Task Force on Animal Feeding, which was convened in response to animal feed risks to food safety.

The International Standards finalised by the Codex are scientifically based and enjoy WTO recognition. The work of the Codex Committee on Food Labelling provides principles and guidance for the labelling of food being traded and thereby assists in the interpretation of Codex commodity standards, including those relating to fresh and processed meat. Codex labelling standards have a direct bearing on the way beef may be described when moving in international trade and therefore on the acceptance and use of the Australian beef language, including product claims it might convey.

The international standards work of the World Organisation for Animal Health (the OIE) is also scientifically based, with OIE standards enjoying formal WTO recognition. The OIE work on animal production food safety has a strong focus on zoonotic diseases and is conducted in close collaboration with the WHO, FAO and the CAC in order to help afford a harmonised approach to standards development. Current OIE standards, apart from veterinary certification requirements, have only limited application to beef description and labelling areas.

The work of a number of other international standards bodies is of direct relevance to meat moving in international trade, and is also closely monitored by Australian government and industry. However, unlike standards elaborated by the CAC and OIE, the products of these bodies do not enjoy formal WTO recognition. Some relevant bodies include:-

- The International Standards Organisation (ISO)
- The United Nations Economic Commission for Europe (UNECE)
- Global Standards One (GS1) International.

Some of the work of the above groups relates to food safety, quality assurance and environmental standards and/or has application to supply chain management. In particular, the UNECE Standard for Bovine Meat Carcases and Cuts defines quality descriptors for bovine meat. The Standard defines a product code allowing all relevant product information to be combined in 20 digits.

The code is compatible with the GS1 International supply chain system of unique identification codes and electronic communication (e.g. bar codes). Similar code articulation has been achieved for the AUS-MEAT Language codes through collaboration with GS1 Australia.

It is notable that the UNECE Standard for Bovine Meat Carcases and Cuts closely harmonises with the current AUS-MEAT Language. Such an outcome was not accidental and clearly demonstrates the benefits deriving from AUS-MEAT investment of time and expertise, and that of the Australian meat industry more broadly, in the development of this international standard.

International standards and guidelines, including those relating to the description and labelling of beef and beef products, are intended to facilitate the conduct of international trade. Likewise, the work of the WTO is intended to promote trade in goods and services by providing a rules-based approach aimed at avoiding arbitrary or unjustified barriers to trade. Australia is a WTO Member as are many, but not all, of the countries to which it exports beef. WTO membership confers rights and obligations and provides a mechanism for arbitration and settlement of trade disputes.

While the WTO clearly recognises the legitimate need for Members to restrict imports in order to protect human, animal and plant health and the environment and in order to ensure the quality and safety of goods, it has two binding agreements in place to help ensure measures of these types do not constitute unnecessary barriers to trade. The relevant WTO Agreements are the Technical Barriers to Trade (TBT) Agreement and the Sanitary Phyto-sanitary (SPS) Agreement.

The SPS Agreement recognises the right of Members to an appropriate level of health protection, while seeking to ensure that SPS measures do not represent unnecessary, arbitrary, scientifically unjustified, or disguised restrictions on international trade. Key provisions of the SPS Agreement include the need to conduct a scientific risk assessment if a SPS measure is not based on an International Standard and to recognise the equivalence of alternative sanitary measures where the exporting party can demonstrate the same level of health protection is achieved.

The TBT Agreement specifically excludes measures covered by the SPS Agreement and seeks to avoid unnecessary obstacles to trade, while protecting Members' legitimate interests. Its key principles include encouraging harmonisation of TBT measures through adoption of international standards, non-discrimination in the adoption and application of measures, requiring measures to be least trade restrictive and promotion of transparency through notification of measures.

In terms of food, labelling requirements dealing with nutrition claims, quality and packaging regulations are not considered to be SPS measures and hence are normally subject to the TBT Agreement. However, labelling requirements dealing with food safety are considered to be SPS measures.

SPS measures must be based on scientific principles, while TBT measures may address a range of legitimate objectives. As a result of this difference, the principle of equivalence only applies to SPS measures as these must be based on a scientifically justified appropriate level of protection, so allowing objective comparison of alternative measures. However, TBT measures must pass a least trade restrictive test, meaning that approaches that are capable of meeting the legitimate objective for the TBT measure should not be unreasonably excluded. This latter interpretation has not been tested under WTO arbitration, unlike a number of SPS Agreement principles.

The WTO framework of agreements, including associated dispute settlement procedures, may be viewed as facilitating orderly, rules-based trade between Member countries. The principles set down in the SPS and TBT Agreements are often used bilaterally by trading partners in resolving concerns about conditions for market access, so avoiding the need for recourse to formal WTO dispute resolution processes.

OTHER PRODUCT QUALITY STANDARDS

As noted above, a number of international standards of relevance to quality standards for beef and beef products, and in relation to their labelling, currently exist. These are supplemented by a range of country-specific legislated requirements for describing and labelling meat, with some provisions of a sub-national nature. Additionally, a range of accreditation schemes, either oversighted by government or third parties, are used to allow the description of special attributes of beef and beef products.

The existing Australian beef language allows a purchaser to reliably specify the type of beef required by reference to such product attributes as age, sex, fat depth, meat colour, fat colour, cut type and trim. The purchaser can therefore be said to have specified meat of a certain quality range and which, therefore, is more likely to be fit for its intended use and provides greater confidence in the price able to be paid for the purchase (i.e. valuing the purchase has been facilitated).

A range of other beef quality descriptor systems are directed at influencing the purchasing decisions of consumers and, by conveying information about the quality attributes concerned, may further assist the product supply chain to value livestock at points of sale and purchase. These schemes often assign fanciful names to product categories (e.g. “natural beef”) which are promoted to consumers as possessing certain quality attributes and appear on labels at point of retail sale. Increasingly, raising claims of this type are required under consumer law to be underpinned by verifiable standards. Interestingly, some official grading systems also employ subjective nomenclature to different grades of product (e.g. “Prime”, “Choice”) and promote consumer awareness of these terms.

The legislation of importing countries with official meat grading systems is often framed in a way which requires graders to be officially appointed (often after completing prescribed training courses) and for carcases, sides or quarters to be presented for grading within a defined timeframe following slaughter. Additionally, there may be cattle breed and/or feeding requirements in order for carcases to be assigned to particular grades. The combination of these importing country requirements often results in imported beef being channelled into the lesser value market segments for ungraded product or being assigned a default grade. These market arrangements are long standing and, as a result of custom and practice and despite not being tested under WTO dispute resolution procedures, may be regarded as legitimate measures under the TBT Agreement.

One newer approach to describing beef quality attributes is that of specifying eating quality outcomes for the consumer, especially in terms of tenderness. This approach may operate without the need to employ many of the descriptors used in current beef languages while still allowing value to be assigned at various points in the beef supply chain when ownership changes. Standards for describing eating quality outcomes may enjoy direct legislative cover (e.g. as under the US Meat Tenderness Marketing Claim Standards , Anon n.d.)) or be trade mark protected (whereby users of the trademark are licensed and must agree to meet defined standards and are subject to audit).

There are currently no eating quality outcome international standards for beef, with only a few countries with defined schema/standards in place. In Australia, the trade mark protected Meat Standards Australia (MSA) beef grading system is used to predict eating quality outcomes by grade, cooking method and ageing requirement in order to guarantee the tenderness of beef for consumers. The MSA system is quality assured to international standards (i.e. it is ISO 9000 Series compliant) and is recognised under US Department of Agriculture (USDA) statutes as a Process Verified Program (USDA n.d.). This recognition allows MSA graded beef to be marketed in the US with packaging displaying the USDA “process verified” logo. Such importing country recognition of a quality assured grading system in Australia might represent an important precedent, especially under the circumstance where there are no internationally-agreed approaches/standards for tenderness description of beef.

Industry-guaranteed quality standards have an increasingly important role in underpinning export market access. It is possible for an industry sector (e.g. the “grass fed” sector) to formulate a quality standard and a system for its verification. Such an approach allows consumer confidence to be developed for product marketed as meeting the industry standard and, in some circumstances, for importing country authorities to approve imports of the class of product concerned. In some cases it may be necessary for the industry scheme to use independent third party auditors and for its satisfactory operation to be verified from time to time by the importing country authority concerned. It will be important for the beef language of the future to be able to accommodate a whole range of product descriptions arising from industry quality standards.

The area of purchaser quality standards is of increasing importance to the meat industry. Essentially, purchasers may and do develop “private standards” and require suppliers to demonstrate their compliance with the standard through maintaining auditable quality systems. These private standards may cover diverse areas, including animal husbandry practices, animal welfare, traceability, environmental stewardship, food safety and occupational health and safety. Alternatively, the “private standard” could specify compliance with a standard managed by another party (e.g. an animal welfare organisation or environmental group). With the continued growth in the use of private standards, and the attendant increase in record keeping and audit costs, there is likely to be demand for more holistic industry standards which address the more common elements of the range of these private standards.

Thus, for example, the cattle producer sector could develop a single industry standard addressing on-farm animal welfare, animal husbandry, food safety and environmental care aspects. Such developments would likely be accompanied by a need for the beef language of the future to be able to describe, through the food chain, product which complied with recognised industry sector quality standards. It is of interest to note that AUS-QUAL (the auditing arm of AUS-MEAT Limited) has been able to promote some harmonisation of private standards, especially in the area of allowing a single audit to address the verification requirements of several private standards. Indeed, greater investment in replacing and/or harmonising existing private standards is likely to be justified.

REFERENCES

Anon (n.d.) http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateN, accessed 20/01/2015).

USDA (n.d.) United States Department of Agriculture. Agricultural Marketing Service. Process Verified Program (http://www.ams.usda.gov/AMSv1.0/processverified, accessed 20/01/2015).

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MEAT & LIVESTOCK AUSTRALIA

APPENDIX C:

THE CONSUMER AND MEALS LANGUAGE

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SUMMARY

Buying a beef meal is the point at which language comes face to face with the consumer. Research undertaken around the world over the last 25 years shows that information which enhances consumer confidence and bridges the gap between expectation and experience has a major impact on repeat purchasing.

In the 1980's the Australian Beef Industry took steps to formally describe beef products with the introduction of the AUS-MEAT language and the Handbook of Australian Meat (HAM). The language used objective measures drawn from industry best practice to classify beef carcasses based on physical characteristics establishing a global trading platform used extensively within the processing and wholesale sectors of the beef industry.

In the nineties, driven by the Meat Industry Strategic Plan (MISP) which had 'guaranteeing the eating quality of beef and lamb' as one of its six imperatives, the Australian industry took a strategic decision to focus more on the consumer. It brought together consumer research, market research and scientific research to lay out the basis for a voluntary 'national product quality description scheme'. The key requirements were that it 'must be consumer driven, involve standards that could not be compromised, be simple to communicate and be continually monitored and improved to ensure accurate application of standards against consumer sensory responses'.

An eating quality assured system provided a way to empower consumers and overcome their expressed lack of confidence by offering a guaranteed outcome. It also offered a way for the industry to move away from a commodity driven culture to an industry that could be more aligned with the expectations of consumers in the new century.

The resulting meat eating quality predictive model was a powerful new technology and firmly established Australia as the global leader in guaranteeing eating quality outcomes for beef consumers .

A position which is still maintained although Europe and America are re-positioning their research focus following many years of dealing with the consequences of BSE and other food safety issues.

The advent of this new technology based on the merging of meat science principals and consumer sensory behaviour provided a further opportunity for the industry to extend the meat language, in this case to include objective descriptions of beef meal outcomes.

Use of this interactive prediction model technology (Meat Standards Australia) has underpinned an expansion of company brands by providing a means to position brand attributes based on differentiated outcomes for the consumer. This has opened up many avenues for innovation throughout the value chain. It has also provided a strong and consistent basis on which to build brand equity and on-farm premiums for cattle identified as delivering required quality outcomes.

Further brand differentiation has developed around the use of 'raising claims' and provenance stories. Grassfed, organic, grain-fed, natural, hormone free, Wagyu, Angus, Hereford along with regional descriptions all appear in domestic and international marketplaces.

In addition new products based around muscle seaming and targeted at specific cooking styles are becoming commonplace allowing further brand and product differentiation.

While branding is developing as the industry response to changing consumer requirements, the speed of smartphone technology change and its effect on consumer behaviour – through access anywhere, anytime, to multiple retail channels, product information, personalised offers and social media – is placing an urgent need on the industry to provide consumers with credible product information from any point in the supply chain.

Research shows that while price is an important element in a consumer's purchasing decision other attributes play a significant part in a consumer's judgement about value when purchasing beef products.

Beef language can play a role in this process by making available both eating quality and provenance information in a more streamlined way allowing simplified carcass sorting, boning and packaging to support branded product offers for different market segments.

Further it can assist in providing a flow of information up and down the supply chain – from consumer to conception to consumer – carrying market signals of benefit to each sector of the value chain.

This paper explores: the future world of the consumer and how rapidly changing technology is placing them in an unprecedented position of power; pertinent megatrends; research regarding consumer purchasing behaviour and demand and value determinants; overseas language trends and implications for the language chain.

KEY OBSERVATIONS

1. The consumer as the sole source of industry revenue is a critical point in the supply chain and central to the purpose of any beef language. Language should empower the ultimate consumer by relaying critical descriptors which will assist them to make a value judgement about the beef meal being purchased.

2. The concept of value is central to a consumer's buying decision and as such is often misunderstood. Value represents the outcome, or at the point of purchase the expected outcome, judged against the price being asked. While eating quality is central to the value equation it includes many other factors of varying importance to different consumers based around the provenance and integrity of the product.

3. The Australian beef language currently holds 'language' descriptors related to the predicted meal outcome of 39 different beef muscles by three quality bands and multiple cooking methods when graded using the MSA Eating Quality Prediction Model.

   These 'descriptors' form a consumer product matrix and can influence two areas in particular which are critical to consumer demand for beef now and into the future;

   a) Quality – Consumers make value judgements when purchasing beef and information around 'quality' is a highly important 'cue' into their decision making. As these descriptors predict the sensory outcome of their purchase the consumer's 'actual' eating experience will be more closely aligned with the 'expected experience', encouraging repeat purchase.

   b) Market-specific information - Consumers and markets are becoming increasingly diverse driving a need for more targeted and personalised communications.

4. Research shows that the variation within individual cuts greatly exceeds the difference between them. This together with cooking method interactions leads to cut description by itself being a poor indicator of the actual eating experience for the consumer. Product inconsistency erodes consumer confidence. As an alternative to cut descriptions a simple and accurate indication of the meal outcome based on the consumer product matrix could be used to underpin individual product descriptions. The cut name is displaced and the consumer reference becomes the cooking or 'meal style' – for example Grill, Roast, Stir Fry, Casserole, Shabu Shabu, Yakiniku.

5. Given the consumer's increasing desire for information about how their food was produced it is important that the industry has a unified approach towards how claims are verified and communicated. It may be advantageous for verification outcomes to be in line with international best practice and globally recognised.

6. With over 70.3% of our beef being exported it is important that our international consumers have access to language descriptors which are meaningful to their purchasing decisions. The emerging global middle class will increasingly demand high quality product and it could be beneficial to the industry to undertake consumer sensory research in key markets matched to the cooking styles of that market, using the predictive

ability of MSA technology to produce product matrices more closely aligned to the needs of global markets and market segments.

7. Australia currently is the only country to have developed a formal system to deliver an eating quality guarantee at a meal level – however other countries are increasingly moving into this space. While this is positive for the overall perception of beef worldwide it does signal a need for a more collaborative approach to ensure that language descriptions of quality are recognisable globally.

8. Transparency within the supply chain is being increasingly demanded by consumers. This cannot be achieved under its current adversarial style but will require genuine co-operation and openness between each of the sectors to achieve this.

   A fully collaborative supply chain linked to the latest technology can reward efforts to increase the value of the product at each stage of the chain.

   Improved transparency may be expected to drive greater efficiencies as each stage of the chain responds to signals directly from the consumer of their product.

9. To facilitate an open supply chain closely linked to the consumer and able to communicate in a unified way a determined effort will be required to increase knowledge and understanding between sectors. Industry bodies may need to consider appropriate programmes to facilitate this along the lines of the original AUS-Meat Feedback workshops.

THE CONSUMER

AUSTRALIA

In a report entitled 'Environmental Future Scan – MegaTrends to 2030: Mega trends for the red meat processing industry,' (McKinna *et al*, 2012) Australia is described as a genuine multicultural community, with an aging population, a changing ethnic mix and four generational cohorts who represent market segments with quite different product and shopping expectations – Gen Z, Gen Y, Gen X and Baby Boomers.

They are described as follows:

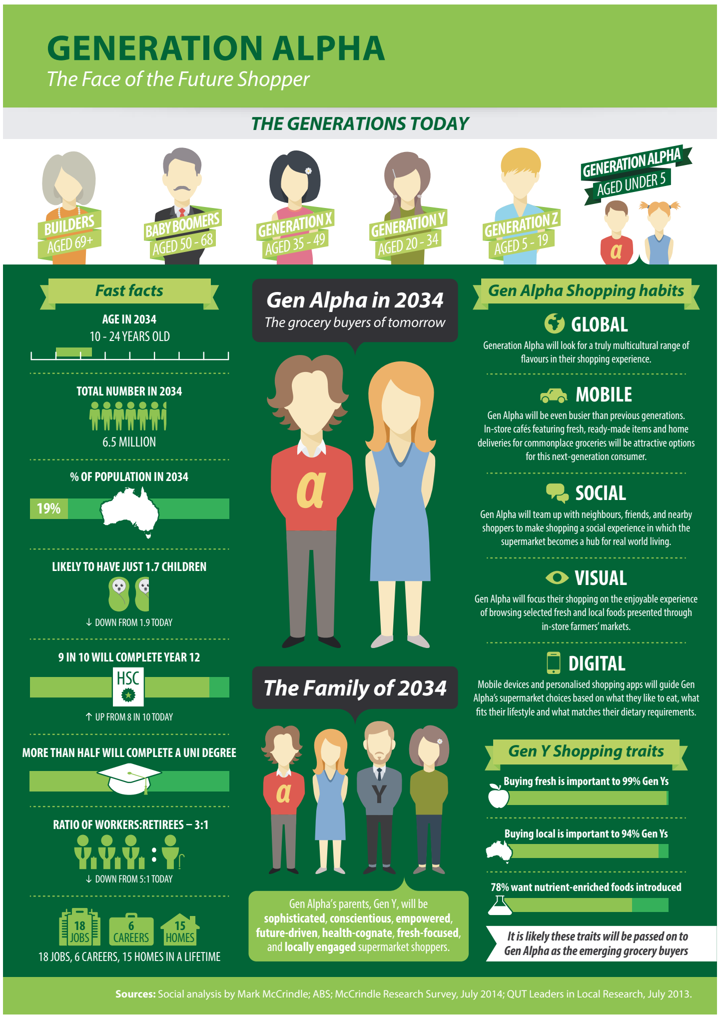
Gen Z
Born after 1994
- Tech savvy
- Treated as adults by their parents from the day they were born.
- Less active than previous generations.
- Opinionated consumers at an early age.

Gen Y
Born after 1976–1993
- Have grown up with the internet
- Have grown up in a period of proserity.
- 20% still live at home.
- Conservative values.
- Self-absorbed and impatient.
- Idealistic, ethical and principled.

Gen X
Born after 1961–1975
- Educated, wordly, socially and environmentally aware.
- Time poor.
- 20% still live at home.
- Have percentage of females still in the workforce.
- Highly stressed – juggling busy lives.

Baby Boomers
Born after 1945–1961
- Living longer, better and more active lifestyles.
- Staying in workforce longer.
- Growing old disgracefully.
- Conservative values.

The traditional household structure is changing with households with two parents with children rapidly disappearing - 20% of households are single person homes and 22% consist of single parents. *When making food choices* – 'Consumers are seeking a balance between convenience, nutrition, enjoyment and authenticity'; and in regard to our *social values and lifestyle* – 'Australians want to know where their food comes from and the story behind it (particularly Gen X and Gen Y)'; there is an increased awareness of animal welfare issues; and an increasing use of social networking/ media. This is creating new forms of social relationships – with respondents in the Sensis 2011 social media report showing that a significant number of respondents not only used social networking sites for catching up with friends but also to 'follow particular brands or businesses and to research products and services' (McKinna *et al.* 2012).



As part of their Trolley Trends series, a Woolworths commissioned report in 2014 entitled 'The Future of Fresh – Transforming the Fresh Food Landscape over the next 20 years' - the buying, eating and shopping habits of consumers past, present and in the future were examined. It outlines how technology will be an integral part of the shopping experience in the future and how it is changing the way we 'source information… what we eat, how we eat and where we experience shopping'.

They describe – Generation Alpha – the shoppers of 2034 – and kindergarten children of today. For them, shopping will be a 'hybrid of online shopping through mobile devices and personalised shopping apps, and real world fresh food shopping in-store'.

As part of a trend towards 'a "back-to-basics' approach to fresh produce' where food is organic, local, fresh, and delivered daily' with an increasing focus on convenience, provenance and health, the supermarket will become 'the epicentre of modern communities, shifting from a necessity to a lifestyle destination'.

In 2034 'the term 'value' will come to mean much more than just price – incorporating important lifestyle, ethical and well-being elements in its definition'.

Increasingly, behaviour will reflect a shopper's values, beliefs, lifestyle choices and inter-connectedness with friends and family.

'56% (of Australian consumers) are spending more time reading labels, ingredient lists, and scanning for additives than 3-5 yrs ago'.

Along with this growing importance of health considerations is 'social health – the value Australians place on communities, growers, local farmers and the environment'.

Inherent in these trends is the desire for facts about the products they buy and 'in an age of information saturation, reputable messages from credible sources will be at the forefront in shaping consumer choices'.

UNITED STATES

More recently American Research through the Beef Checkoff programme has focussed on the 'Millenials' (a group born between 1980 and 2000), and regarded as an important target market for the beef industry. The research report, 'Why Millennials Matter: A research overview' excerpted from a Winter 2012 'Beef Issues Quarterly' article by W. Neuman and the 2012 Millennial Parents Study Executive Summary written by R.McCarty and W. Neuman outlines how 92% of this group eat beef and offers the following insights:

- 'Millenials' are less likely to cut out foods they enjoy to cut costs; when they are confident the results will be worth the expense they are happy to spend on premium items.
- 'Millenials' lack of knowledge about beef cuts is a major barrier to buying beef. To overcome this they tend to purchase the same few cuts they are familiar with. They are however receptive to information on how to shop for and prepare beef. They are also driving retailers to provide information on beef's nutrition and production systems (animal welfare and environmental impacts).
- Convenience is their highest priority – being time poor this generation favours ready-to-eat meals and easy beef recipes that take 20 minutes to cook.
- 'Millenials' favour meals that are casual and simple to prepare while looking for recipes with new cuisines and flavours.
- 'Millenials' are eager to access information and more than any other consumer segment use social media for tips about preparing beef. They look for authentic in person interactions at the meat case and rely heavily on online resources.

In addition, this report highlights the following: 'more than 50%…are disappointed with the results when they cook burgers and steaks…with 61% saying they get a poor experience on beef flavour and 62% say tenderness is an issue'.

THE INTERNATIONAL CONSUMER

As over 70% of our beef is exported, consumers in international markets are a vital part of our industry.

The demographics of our world are changing faster than ever, creating new consumption patterns

A large emerging global middle class of sophisticated shoppers is creating diverse markets and increasingly requiring quality goods and discretionary items beyond their basic necessities.

This will provide market opportunities to supply products that are highly differentiated. It will also require changes to the way supply chains currently operate to suit evolving purchasing behaviour moving from being commodity driven to supplying more value added, highly differentiated products.

For most consumers, price and value for money are most important when purchasing food, however consumers of premium quality are increasingly seeking other product attributes around quality, provenance, safety and healthiness.

MEGATRENDS

An important part of ensuring our beef language is relevant into the future is to understand what the major influences will be on our societies into the near future. Major forecasting and foresight studies provide many insights into Megatrends. In their report entitled 'Global Megatrends that will change the way we live' CSIRO (Hajikowicz *et al* 2014) highlight the following megatrends:

- 'Virtually Here' – explores a world of increased connectivity and our immersion in a more virtual world in which 'digital media is allowing people to form new connections and selectively access trusted information tailored to meet their needs through multiple channels…' and 'in addition to connecting people, the digital world is building new connections between institutions and gadgets...'

- 'Great Expectations' – a megatrend which explores the rising demand for 'services and experiences over products.... and the expectation that people have for personalised services to meet their unique wants while being delivered en masse'. 'People's expectations in coming decades will be 'great' because income growth will give people increased discretionary expenditure and a budget to buy experiences. Expectations will be great because the on-demand and instant service offerings we currently have will expand and be taken for granted…because people will expect a highly tailored product or service to anticipate needs and wants *they may not even know they have*… because consumers are increasingly seeking moral and other 'feel good' outcomes…and expectations for improved social relationships and human interaction in an online world…'.

- Other megatrends highlighted in this report cover 'More from less', 'Going, Going…Gone, 'The Silk Highway' and 'Forever Young'.

Anon (2014) The 17th Annual Global CEO's Survey - 'Fit for the Future: Capitalising on Glbal Trends' PWC, describes how in the digital economy 'increasingly connected consumers want to shop anytime, anywhere' and how innovation 'is critical and it requires getting close to customers'. Increasingly in our digitalised world through use of our smartphones and embracing of social media we are registering a picture of ourselves, our tastes and shopping patterns. This has led to an explosion of data which with increasingly sophisticated computing technology is being 'captured' and stored. This combination of 'Big Data' and 'Cloud Computing' will profoundly change the consumer marketplace providing businesses with the opportunity to customise different offerings to different consumers in real-time.

Retail success in the new digital age is illustrated by trends in China as outlined in Anon (2013) PWC – 'A new era in buying – Retailing in China's digital Age'. China Digital Byte series. Excerpts from this include:

- Driven by the most rapidly growing consumer market in the world a retailers future success ' will be defined by their approach to e-commerce and digital in an omni-channel China market'…'multi-channel shopping is gradually becoming the social norm as Chinese consumers price-match, product search, research and decide whether to make in-store or online purchases…this is omni-channel retailing in practice...'.

- Further, the use of the mobile wallet not only will revolutionise payment systems but is also about 'providing holistic, value added services to deliver the personalised shopping experience'.

- While E-Commerce is in its early stages, mobile engagement is the key to unlocking the personalised shopping experience.

- Further, they expect the sophisticated Chinese consumer to quickly move to outcome-based commerce where the transaction is not just about the purchase of goods but also an outcome. This is outlined by the move by Nike to a health based outcome, Nike+.

Further insights come from the following excerpts from Anon (2012) Retailing 2020 – Winning in a Polarised World (www.PWC.com/us/en/retail-consumer/publications/assets/pwc-retailing-2020.pdf):

- A future world of retailing described as a 'world without walls' in which more retail sales are expected to come from non-store based shopping. Signficantly they note that technology is not just driving changes to the shopper and retail environment it is also requiring a *value chain without walls*. Tracking technologies like RFID and other innovations on hand held devices can seamlessly provide shoppers with the opportunity to understand everything from product origon to brand legitimacy'. This change will require greater transparency in the retail supply chain.

- In 2020 retail brands will still be crucial but will be less standard and more tailored to the specific customer.

- Due to polarisation of the retail landscape and increasing consumer connectivity backed by 'Big Data' (large and complex sets of data from multiple sources), a retailer's communication will need to be shopper specific to build brand loyalty. Greater visibility in the transparency of retail brands will require premium brands to become more transparent and authoritative as retailers leverage them to build their equity.

- Value will become more personalised as retailers maintain a more private, specifically tailored conversation with each customer about pricing and products in line with that customer's preferences.

- Leading retailers in 2020 will be classified by those who have the best conversational marketing skills – good at listening to their to their shopper's needs and projecting an authoritative, secure image.

- The ablity to accumulate data – from within store and external sources – enabling the telling of the right story at the right time will distinguish the better retailers as will competency in total value chain management.

- Consumers will expect and demand an element of trust and reciprocity in their relationships with retailers. Information regarding the conditions under which products are produced, procured, its adherence to social responsibility standards etc. will be required. This will be part of an information exchange as retailers will have a view into their shoppers through information generated from their transactions.

The following excerpts from the report above in a section on 'Key trends that will affect the US Consumer landscape in 2020' – PWC note the following trends as significant:

- Consumer driven supply chains

- By 2020…made possible by the convergence of physical retail formats, digital services and eCommerce, retailers will increasingly deliver to their consumers a seamless brand experience online, in-store and across multi-channel media, both consistently and continuously.

- Consumer-driven transparency of everything – the shopper of 2020 will have ever expanding tools to 'see' into the inner workings of retailers, manufacturer and distributors across the entire supply chain. Whereas today they are focussed on corporate social responsibility and transparency of product quality (eg 'certified organic') tomorrow's shoppers will be more attuned to full transparency up and down the entire supply chain – including raw ingredients, fair trade, the environmental impact of all ingredients, packaging, transport and storage processes.

  This transparency means examination, documenting and continuously tracking supplier relationships, product sourcing and even third party labour practices – by 2020 they believe any efforts to limit this transparency will receive harsh backlash from consumers via the viral nature of social media and other online communications.

- The concept of 'mass customisation' challenges manufacturers and retailers to seamlessly integrate customisation related processes with existing consumer driven personalisation tools; eg offering menu options in a restaurant to match dietary needs or a touch driven display to build a salad.

- Real Brand Value – Seeking out the Truth. Consumers will increasingly have the tools to access information from multiple sources. By 2020 to be pro-active and 'manage' information - brand management will require new skills, tools and communication methods and to be both more nimble and innovative than is typical of today.

- 'Green retailing' in 2020 – The consumer of 2020 is envisaged as curious and diligent about tracking retailers and their suppliers. In turn retailers will increase their risk management capabilities. It is envisaged that 'green retailing' will most likely be provided by easily accessible 'scorecards' bought to the attention of shoppers as they make a retail location choice using their smartphones.

- Consumer-centric retailing - The consumer of 2020 will be a moving target, responding to fads, trends and information faster than in the past. While retailers will try to move at the same speed PWC believe their best strategy will be to get as close to the consumer as possible.

- Shopping will trend away from large stock-up shopping to more targeted, time-efficient, needs based trips from stores that are easier and faster to access.

- Leading retailers in 2020 will most likely be known as the fastest 'data translators' as they adapt their system architecture to aggregate real-time consumer information. The best retailers will become sought after partners as they add value to trading partners by re-distributing this information.

- Retail brands in 2020 will have three key attributes:
  - Consistency – in an increasingly fragmented world it is important that shoppers have the same impression of what the retailer stands for
  - Intensity – only retailers with a passionate following can meaningfully influence shopper behaviour
  - Accuracy – 'the transparency of everything' will require retailers to be truthful to the image they portray.

- Retail conversations with customers – in 2020 the core competency will be integrating and acting upon what the shoppers' passions and interests are not just with what the shopper bought and how to get them to buy more.

- The successful 2020 retailer will build a true omni-channel operation allowing customers to interface though any channel of their preference on a 24/7 basis, anywhere at any time.

'In the future, products will be tracked and recorded throughout the entire supply chain from commodity source through manufacturing and quality assurance and into shoppers' homes…As RFID technology becomes more prevalent, its use will influence everything from supply chain management to retail checkout/payment'.

As smartphones become more effortless and enmeshed in our lives and their functionality increases 'effective leverage of smart devices, specifically prompting users to engage at retail…will become an everyday reality for the retail industry of 2020'.

In this context of perpetual connectivity a fundamental re-shaping of the '4Ps' of retail marketing are envisaged with:

- Product – merchandising being more interactive for the shopper at the shelf

- Packaging – will actively show products in use or communicate directly to smart devices

- Price will be more dynamic and tailored to each individual

- Promotions will be triggered by the shopper's physical presence, personalised and tailored to each shopper.

Social media is a powerful enabler for engaging the consumer and by 2020 it is expected the next generation of social media will force merchandising and marketing into 'group activity' both on-line and in-store (e.g. 'likes' associated with products at the shelf level in stores) meaning we could expect shelf tags with ratings that change as shoppers review and purchase and/or usage suggestions derived from social media groups providing product information at the store.

With regard to shopper behaviour – this report highlights the following as significant drivers of change, income disparities, generational differences and the polarised value centric, premium-seeking shopper.

Technology is enabling the premium shopper to be frugal in certain circumstances while at the same time seek premium products they care deeply about. Consumers will ‘be able to more clearly define and find specific products to meet their needs ... and shoppers will pay a premium for products or services that reflect their values’ or for products that have a specific outcome. This ‘new premium’ is defined by three core attributes:

- Transparency – access to information allowing shoppers to know what a brand stands for. This visibility in turn becomes important for brands positioning themselves as authentic.
- Preservation – while shoppers are increasingly concerned about preserving the world under the banner of health and wellness they will spend increasing amounts on themselves.
- Purpose – it is expected that shoppers will continue to make decisions based on a broader sense of social responsibility with consumers becoming even more engaged by a greater range of larger social responsibility issues by 2020.

With specific regard to the Australian beef industry, McKinna *et al* (2012) in their report, ‘Environmental Future Scan: MegaTrends to 2030’ highlight the following:

Retailing dynamics – supermarkets are driving the social accountability agenda; the private label is making a renaissance and proprietary brands of red meat are growing; while supermarkets still dominate – new shopping channels are emerging and increasing in popularity (e.g. central markets, farmer’s markets, gourmet supermarkets and fresh food stores, home delivery and on-line and direct markets (particularly for red meat); and butcher shops are evolving more into meals solutions stores.

In a discussion on the evolution of MSA the report highlights that – ‘MSA is now the universal quality framework for red meat’ and 'relative to the FMCG sector, the meat industry is still unsophisticated in marketing and not using it to its full potential'.

The report further highlights that product development in beef is lagging behind the rest of the food industry. 'New products are required to meet the changing and differing needs of consumers and foodservice with opportunities provided by our growing ethnic populations, new cooking techniques and changing cuisine styles particularly in the use of secondary cuts'.

Further, 'the red meat industry will need to continue to develop its animal welfare programmes and stay ahead of the wave of societal expectations; monitor and develop responses to other social agendae, including environmental sustainability, food miles and workplace conditions and understand and participate in rapidly evolving social media technologies'.

CONSUMER PURCHASING BEHAVIOUR

HOW DO CONSUMERS PERCEIVE QUALITY?

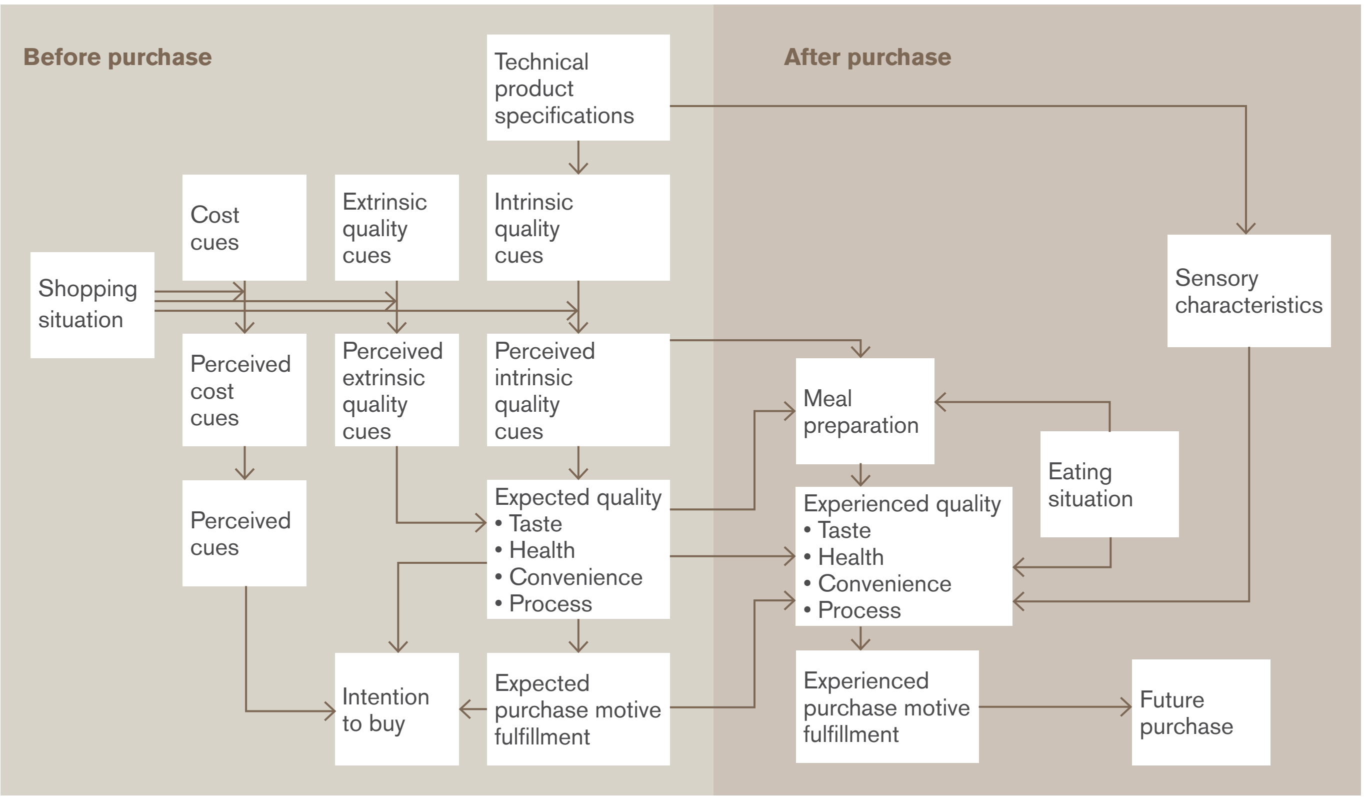
'The relationship between quality expectation and quality experience (before and after purchase) is commonly believed to determine product satisfaction, and consequently the probability of purchasing the product again' (Grunert *et al*. 2004) – Consumer Perception of meat quality and implications for product development in the meat sector – a review.

When buying a product a consumer develops an expectation about quality in order to make a choice. This expectation is based on '*intrinsic*' cues – which cover the physical characteristics of the product (e.g. its appearance, colour, fatness, marbling) and '*extrinsic*' cues covering all the other aspects of the product, (e.g. brand name, labelling, price, where it is sold, packaging, raising claims etc.).

The trade-off between 'expected quality and expected fulfilment' against any negative consequences (mostly monetary) determines the intention to buy. After the purchase, the consumer will have a quality experience, which often deviates from expected quality. This is especially true when it is based on quality cues with a low degree of predictive power (Grunert et al. 2004).

They proposed a Total Food Quality Model (Grunert *et al*. 2004) to integrate a number of approaches to analysing consumer quality perceptions and decision making. This distinguished between influences at the point of purchase and of the actual experience after purchase, how they relate and influence repeat purchases. This is summarised in the following diagram.

Figure 1: The total food quality model (Grunert et al. 2004)



How consumers form quality expectations is described in a study undertaken by Grunert, K.G. (1997). What's in a steak? A cross cultural study of the quality perception of beef. Food Quality and Preference, 8, 157-174. He reported that when evaluating beef the most important quality dimensions were sensory qualities - taste, tenderness, juiciness - freshness, leanness, healthiness and nutrition. However consumers showed a high degree of uncertainty in forming quality expectations about fresh meat. *The cues they used to form these expectations were in most instances the exact reverse of what they supposed.*

In summary they concluded that 'quality expectations are based on a small number of key cues which are probably not very predictive with regard to the quality actually experienced during consumption'… and 'given the uncertainty consumers seem to exhibit in the formation of quality expectations about fresh meat, one may expect that consumers would welcome additional information at the point of purchase which could help them in making choices'.

In regard to quality expectations and the actual quality experience a distinction must be drawn between those qualities that can be experienced during eating ('experience qualities') and those that can't ('credence qualities'). 'Credence qualities' (such as healthiness) can be readily understood whereas consumers have limited ability to predict 'experience qualities'.

Key points from this research are:

- That consumers have considerable difficulty in forming quality expectations in a way that will help them predict a quality experience'.
- The relationships between the physical characteristics of the product and the expected and experienced quality is weak at best.
- 'We expect that those quality dimensions that are accessible to the senses – taste, tenderness, juiciness – carry more weight in the quality 'experience phase' than those which are not, like healthiness and nutrition' whereas this distinction is not as strong in the purchasing phase.
- The relationship between expected and experienced meat quality is limited. 'The lacking ability of consumers to predict their own quality experience after purchase is partly due to the misinterpretation of certain intrinsic quality cues, especially intramuscular fat, and due to the paucity of extrinsic cues'. This also aligns with earlier research conducted by Australian Meat Standards where visual expectations relating to marbling and external fat thickness were compared to the ratings given by the same consumers after consumption in a blind taste test (Polkinghorne, 2010).
- The results indicate that fresh meat is largely still sold as a commodity with consumers basing their quality evaluations most on the appearance of the product in the absence of other meaningful cues.
- Consumers misjudge the eating quality when looking at the meat.
- Improving the eating quality of meat at a producer level is counter-productive unless the consumer has a way of identifying this in the shop.
- New ways are required to signal quality to the consumer if product differentiation is to succeed.
- Brands are the major quality signal that allows consumers to learn from their experience.
- Branding will require changes in the organisation of the value chain to deliver both the meat and the information and require closer co-operation between sectors in the supply chain.
- A consumer study using a branded product showed 'branding could play a major role in the marketing of differentiated meat products. Consumers are receptive to the brand signal and use it in the formation of quality expectations. This goes for all consumers, but the use of the brand signal is…especially strong for consumers with less experience in the product category'.

Differentiation by eating quality, health and convenience

'As for eating quality, the results indicate that a constant reliable quality, signalled by a branded product, is a market opportunity. It would require a reduction in the variability of eating quality…..points to vertical differentiation where different levels of eating quality can distinguished (like premium quality as compared to a standard quality)'.

Due to diversity of consumer preferences and behaviour, 'consumer oriented product development…will therefore typically require a segment-specific approach' (Grunert & Vali, 2001).

Differentiation by process characteristics

Consumer concern about the way food is produced has increased substantially in most European countries and as process related qualities are mostly 'credence' characteristics the consumer has no way of evaluating the promised qualities. This highlights the importance of trust when signalling these cues.

Grunert & Anderson (2000) clearly showed the pitfalls of positioning a product on process characteristics which had little impact on the consumer's experience as the quality actually 'experienced' fell short of expectations.

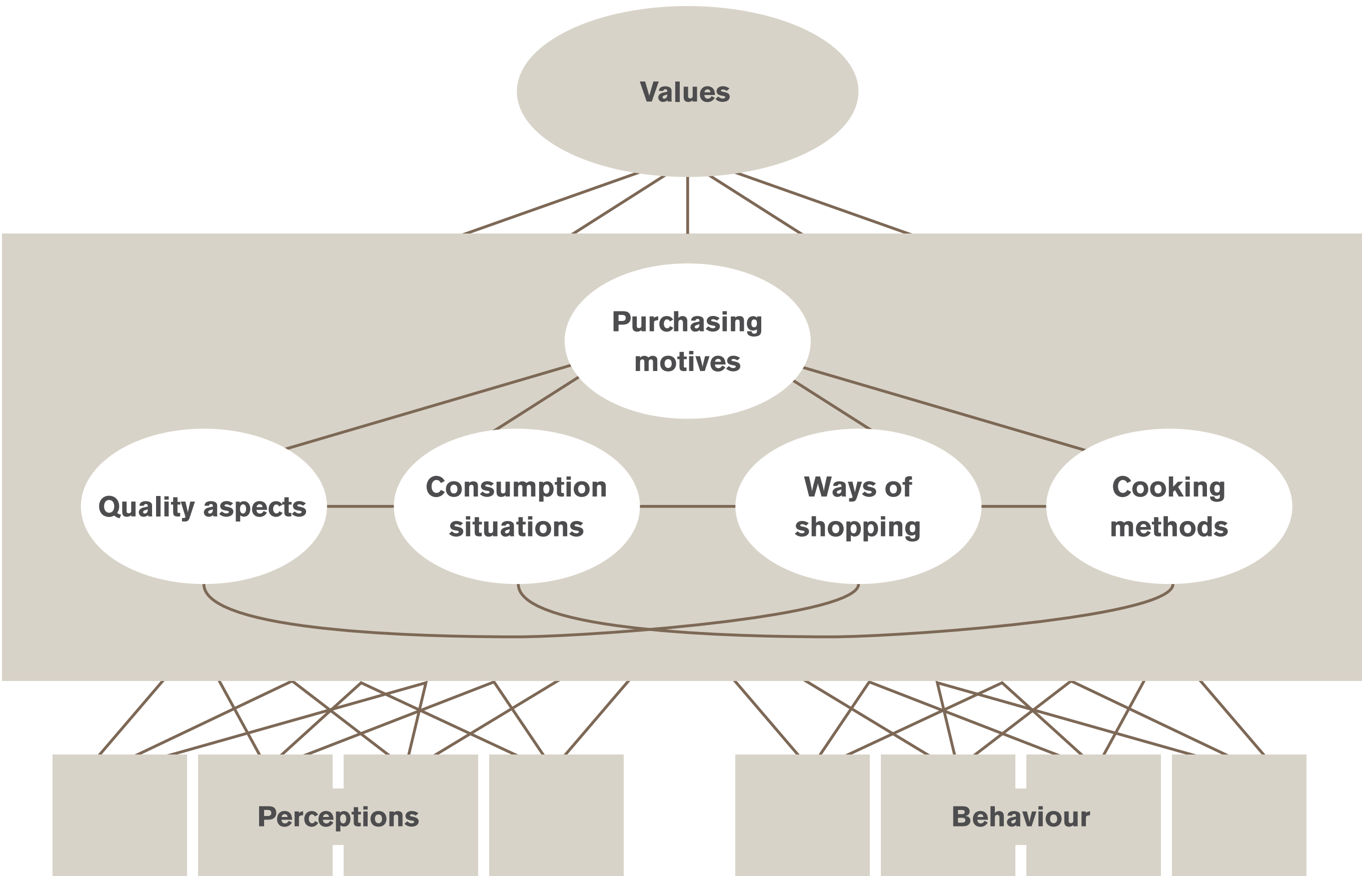
In conclusion he states that *'consumers have difficulty in evaluating meat quality, resulting in uncertainty and dissatisfaction'*. Ample opportunity exists for development of differentiated products in terms of eating quality, health effects, added convenience and desirable process characteristics' and this should be consumer led from conception to final launch into the marketplace.

EXTRINSIC CUES

The importance of '*extrinsic*' cues to consumers and how to evaluate them in terms of their relevance to meat language is outlined in – 'Future Trends and Consumer Lifestyles with Regard to Meat Consumption' by Klaus G. Grunert (2006).

The concept of a food-related lifestyle model as depicted below in *Figure 2* has been widely used in food research (Brunso & Grunert, 1998: Grunert, Brunso, Bredahl, & Bech, 2001).

Figure 2: The food-related lifestyle model (Grunert K.G. 2006).



Lifestyle is defined here as the intermediate level of a hierarchical cognitive system – at the top are abstract personal values such as self-direction or tradition, on the bottom level are product perceptions that are specific to a situation for example, the perception of a range of meat products in a shop.

The five elements of a food related lifestyle – purchasing motives, ways of shopping, quality, cooking and consumption situations – are the intervening cognitive structures that link situation specific product perceptions on the bottom to increasingly abstract cognitive categories and finally, to personal values at the top.

Values are commonly assumed to be quite stable and change slowly over time whereas our perception of the environment for example is highly variable and situation specific. Lifestyle changes reflect our attempts to maintain a balance between our own value system and changes in the environment.

Using this model four trends that are relevant for meat production, processing, marketing and consumption were identified:

- The increasing importance of extrinsic cues as consumers attach more importance to healthiness and process characteristics and the desire for 'stories' attached to the product. This can only be effective in supporting brands and increasing consumption if a) the information is available and b) it comes from a credible source.

- Consumers make decisions and scan product packs extremely fast.

- Convenience is a major trend in food and goes beyond eating ready-made meals and eating out. 'Convenience can cover any savings of time, physical energy or mental energy that occurs during one or more of the phases of the home food production chain: deciding what to eat, purchasing, preparation and cleaning up'. (Darian and Cohen (1995)). There is no simple relationship between time scarcity and demand for convenience products.

  Moreover it is expected that different types of consumers will demand different types of convenience products even though they are all under the same amount of stress or time constraints and demand for convenience can be high in lifestyle segments as different as 'adventurous' and the 'extremely uninvolved' (de Boer *et al*, 2004; Ryan, Cowen, McCarthy, & O'Sullivan 2002).

  To date the meat industry has responded mostly in the ready meal category targeted mainly at the uninvolved rather than at the food-loving consumer segments whose natural preference would be for meal component types of products.

- With regard to ongoing discussion within the meat industry as to how much concern there is for animals and the environment numerous studies show that some consumers have concerns and people's awareness has been heightened by various meat scandals. It is also widely held that the attitudes expressed by the consumers may not be strongly related to their purchasing behaviour. *'The less we know, and the more what we know is based on indirect sources, the less these attitudes will affect our behaviour'.*

  For example while consumers have lots of concerns about animal production they freely admit that there was no or little link between the negative image of production methods and their purchase behaviour (Holm & Mohl 2000, Ngapo *et al*, 2004). So while people do have attitudes towards meat production it is more likely expressed in a range of behaviours that are not related to being a consumer, but in the role of the person as a citizen.

- He adds that the biggest trend of all in meat production is the movement from bulk to differentiated, value added products as food chains increase capacity to exploit the fact that consumer preferences differ amongst consumer segments.

CONSUMER PERCEPTIONS OF VALUE, PRICE AND DEMAND

Value, price and demand are interrelated factors but often misunderstood and inappropriately used.

'Consumer demand for beef is one of the most important and widely discussed, yet poorly understood, concepts affecting the beef and cattle industry. Difficulty in understanding demand originates from fundamental misunderstandings of demand, but also arises because of the complexity of consumer beef demand determinants.

Yet, because of the importance of beef demand for industry prosperity, it is imperative that the beef industry recognise what drives consumer demand, what expectations are for the future, and assess the industry's ability to adjust practices to target evolving consumer preferences or to influence important demand determinants' (Schroeder *et.al.* 2013).

'Demand' is the volume of specified product that will be sold at a particular price with 'value' representing the outcome delivered (or at the point of purchase the outcome expected) for the price.

Price is a result of the product being traded and the volume available. Therefore, while price will affect volume and demand for a constant product offer, improvements to the product offer will provide an increased price at a constant demand volume (or increase volume at a constant price).

While price is important in beef marketing at all levels the critical factor for industry prosperity is demand. "From a consumer perspective, beef is valued relative to competing protein sources including chicken, pork and fish' (Schroeder *et.al.* 2013).

Improvements to the product's credentials consequently deserve industry focus as these alone will drive price and associated demand levels by improving the value of beef relative to competitors. Provision of clear unambiguous description is an essential and fundamental prerequisite to improved demand.

DEMAND DETERMINANTS

Many factors contribute to beef value and interact with price to determine demand. As discussed in multiple Australian and international studies these include: product performance and meal satisfaction, food safety, convenience, health and nutritional, environmental, sustainability and welfare concerns, raising claims including organic, grass and grain fed plus hormones or GMO use, breed and processing claims including Wagyu, Angus, Hereford, aged, dry aged, and social aspects including country or region, artisan or small producer claims.

The relative importance and related price/demand sensitivity for each factor varies both between and within markets. These relativities are affected by experience and cultural aspects. Food safety may be top of mind in a country such as China where recent food safety breaches received strong attention or in Japan due to radiation concerns post the tsunami event but be less overtly considered in Australia where food safety is assumed and effectively just a background cost of doing business. In this situation it is unlikely to drive any price premium whereas it may be an important demand driver in a market where safety has been compromised.

Food safety also provides an interesting insight into consumer trust and the relationship between such trust and purchasing behaviour. While Western Europe can be regarded as a mature food market where food safety is expected as a base regulatory requirement, the finding of BSE in cattle herds and more recently horse meat substitution for beef massively affected demand across the market as a whole but was highly differentiated for individual retailers.

A number of premium British retailers with well-developed and closed supply chains experienced little if any drop in demand reflecting consumer trust in their brands and integrity in contrast to others who suffered extreme demand reduction, resulting in dramatically reduced volume even at lower prices. Trust proved to be the key factor with a perceived safety risk not negotiable at any price.

The relative importance of individual demand drivers may also vary at the individual consumer level depending on occasion or circumstance as illustrated by Professor David Hughes description of 'foodies and fuelies'. He proposes that the same person may be both, seeking only a quick 'hunger buster' for a rushed workday lunch with little to no regard for supporting attributes, the 'fuelie', while becoming a 'foodie' vitally interested in supreme quality, organic and raising claims when purchasing at a farmers market for a weekend dinner party.

An MLA study conducted in Japan that sought to define population segments that might be targeted by specific beef marketing also concluded that the 'segment' was more strongly related to a meal occasion than to a population group. People from most population demographics desire beef of different qualities for different occasions be it for a celebration, wedding or birthday to a quick meal while travelling or a quick workday lunch.

A similar range between and within countries is exhibited with animal welfare. While animal rights and welfare receive constant publicity and attention in the United Kingdom they rate extremely low in countries such as Spain although both are EU nations. While welfare is also being constantly raised through activists in Australian and USA media the actual current impact on demand may not be commensurate.

USA research indicates that *'despite all the attention, these factors are not currently important aggregate demand shifters*'. A caution is advanced however that such issues have the potential to quickly become major issues if ignored by industry but reacted to by government. The Australian live shipping experience illustrates this observation.

While the relative importance of individual demand drivers varies with country and within the population a constant in all markets is the satisfaction provided as a cooked meal.

A visual analogy might be that of a series of balls with eating quality/cooked meal satisfaction the basketball in most circumstances and the other issues varying in size by market or from time to time from marble to golf ball to tennis ball or bowling ball.

Figure 3: Value is enhanced by supporting attributes

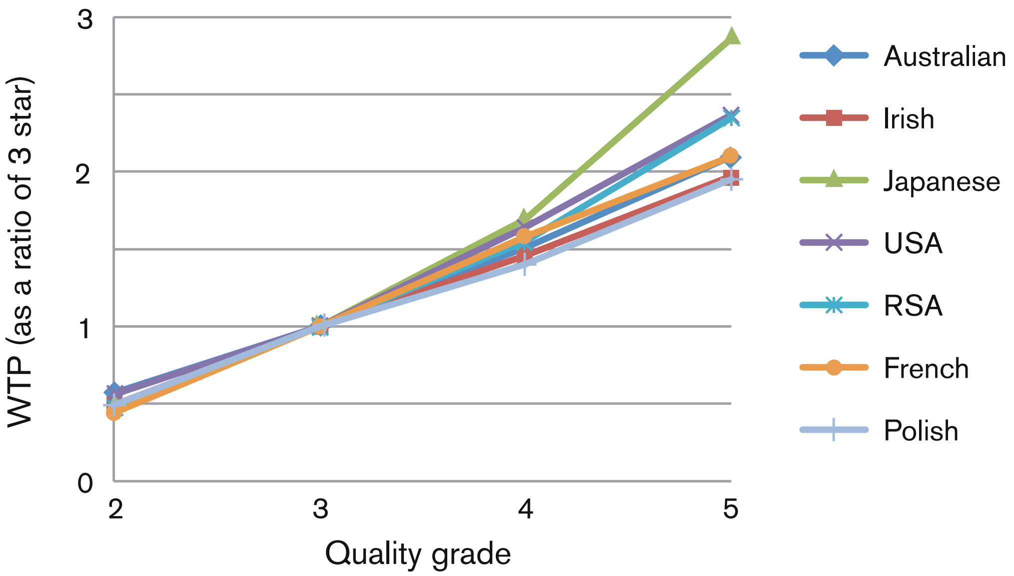
Relative importance varies by market and occassion – some become mandatory as a cost of doing business

While peer-reviewed data regarding individual demand components is difficult to find there is very solid evidence regarding price and eating quality relationships across multiple markets.

The predominant Australian evidence comes from MSA research where willingness to pay (WTP) data has been collected for close to 10 years in conjunction with all consumer testing activity. Direct MSA testing has included studies with USA, Japanese, Irish, South African, French and Australian consumers further augmented by others utilising common protocols in New Zealand, USA, France and Poland.

Lyford *et al* (2010) present results to 2010 comparing USA, Japanese, Irish and Australian consumers. More recent work continues to find equivalent response in New Zealand, USA, French and Polish consumer studies involving in excess of 15,000 additional consumers. A summary of WTP results is provided in *Figure 4*.

Figure 4: Willingness to pay (WTP) for unsatisfactory (2*) and better than everyday (4*), and premium (5*) expressed as a ratio of good every day (3*) value



The results clearly show a consistent consumer response that assigns a 50% price discount to beef of unsatisfactory versus good everyday quality (3*), a 50% premium to beef rated better than everyday (4*) relative to 3* and from a 200% to 300% premium for that rated premium (5*).

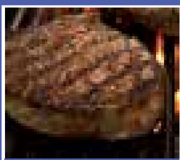
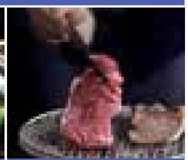
This delivers an extremely strong message, with its strength emphasised by the fact that it was obtained from consumers immediately after consuming 7 beef samples that included a wide quality range. Results for grilled, roasted and stewed product exhibit similar relativities further supporting the validity and importance of eating quality to a consumer's overall value assessment.

It appears unlikely that other demand drivers are associated with value changes of equivalent magnitude other than in the case of crisis where a failure may trigger dramatic consumption and demand decline. This supports the need for any beef language to provide a clear and accurate indication of the expected outcome from use of the product.

EATING QUALITY LANGUAGE AND COMMUNICATION

In line with research outlined above it would appear important that language provide the consumer with a clear and unambiguous description of an expected outcome. To the maximum extent possible it should deliver certainty within a narrow expectation range. The essence of such a system is provided by the generalised matrix shown in *Figure 5.*

Figure 5. An example of the cut x cook matrix that could be used at retail

Occasion		MEAL STYLE					
							
		Grill	Roast	Slow Cook	Stir Fry	Shabu Shabu	Yakiniku
Everyday	3★	$	$	$	$	$	$
Special	4★	$ x 1.5	$ x 1.5	$ x 1.5	$ x 1.5	$ x 1.5	$ x 1.5
Very special	5★	$ x 2	$ x 2	$ x 2	$ x 2	$ x 2	$ x 2

Within this matrix a simple purchase decision begins with an occasion, relates to an eating quality (EQ) level and from there to the desired cooking style. The $ outcome represents either but ideally both the price point demanded by the supplier and the demand point for a consumer on that occasion. Multiple descriptions or formats may be conceived to relay the essential message as presented from standard language approaches via MSA grade or by individual company brands which by extension could also include a restaurant name and reputation.

Further embellishment with other demand drivers may well be associated with this message but, importantly, should not confuse the core description. Value is also driven by the certainty of the implied result. There is minimum consumer uncertainty when purchasing a carton of low fat milk; the value as judged post consumption will align with the perceived value at purchase.

CURRENT RETAIL AND FOOD SERVICE LANGUAGE APPLICATION FOR EATING QUALITY

Australian and international communication at the point of sale is currently strongly focussed on cut. Despite this focus, or perhaps due to poor experience from attempting to use this framework, consumers are confused by cut names which, as illustrated by USA studies, they find lengthy, confusing and even unappealing (anon Uniform Retail Meat Identity Standards (URMIS) 2015). The traditional assumption appears to be that the cut can imply the final cooked result. While this is true to an extent highly significant variation is evident within cuts and within cuts from a common breed, common age group or common days ageing.

The degree of variation is illustrated by Table 1 which presents consumer results, as MQ4 scores, for cuts tested within the Australian MSA AUSBlue database. It can be seen that within each of the cooking methods shown there is a huge range of MQ4 for every cut with a majority of grills exceeding a 70 MQ4 point (within a 1 to 100 point scale) range as an example. The standard deviations further indicate that a considerable range is the norm rather than an isolated exception.

Table 1: The range in MQ4 scores for cuts cooked as grills, roast and stews along with a mean MQ4 score sand the number of samples tested (R Polkinghorne, unpublished data)

		GRILL						ROAST						STEW					
CUT	MSA Code	min	max	range	sd	mean	*n*	min	max	range	sd	mean	*n*	min	max	range	sd	mean	*n*
Bolar blade	BLD096	20	90	**70**	11	56	1044	25	82	**57**	10	60	345	28	81	**53**	10	55	277
Chuck eye	CHK074	21	84	**63**	15	54	43	19	79	**60**	12	56	65	50	87	**37**	10	70	18
Chuck	CHK078	14	89	**75**	15	59	440	24	84	**60**	12	56	217	34	88	**54**	11	62	180
Chuck tender	CTR085							20	76	**56**	15	51	29	25	75	**50**	12	54	33
Cube roll	CUB045	22	92	**70**	13	60	1150	23	89	**66**	11	65	612						
Spinalis	CUB081	24	94	**70**	8.5	78	297	53	86	**33**	8.4	71	19						
Eye round	EYE075	15	81	**66**	11	45	698	19	85	**66**	12	52	666	11	76	**65**	11	45	255
Knuckle eye	KNU066	17	87	**70**	12	55	573	20	87	**67**	11	62	427	9	73	**64**	13	43	262
Knuckle cover	KNU099	20	70	**50**	11	46	227	15	75	**60**	13	47	90	20	64	**44**	11	45	84
Outside flat	OUT005	11	84	**73**	13	43	1381	10	82	**72**	14	45	1152	9	82	**73**	14	47	438
Oyster blade	OYS036	22	94	**72**	11	70	1398	23	88	**65**	10	63	126						
Rump cap	RMP005	27	95	**68**	13	65	349	36	95	**59**	13	67	47						
Tri tip	RMP087	60	90	**30**	8.2	77	29	40	79	**39**	10	59	42						
Rostbiff	RMP131	18	85	**67**	12	54	2067	27	88	**61**	11	62	594	33	62	**29**	6.4	45	30
Rump eye	RMP231	18	90	**72**	12	57	1187	36	88	**52**	10	66	330						
Striploin	STR045	8	95	**87**	14	56	18328	18	90	**72**	13	58	1208	25	79	**54**	13	50	156
Tenderloin	TDR062	31	95	**64**	9.1	77	1704	38	95	**57**	8.1	75	593						
Topside	TOP073	14	94	**80**	12	44	1197	11	88	**77**	13	48	1173	10	85	**75**	13	42	501

These results indicate that a description system based solely on cut is likely to reinforce any consumer misapprehension that they are responsible for not 'knowing their cuts'.

While cut and cooking method remain important criteria within the MSA prediction model they are extensively modified by other interactions including tropical breed %, HGP status, marbling, ossification, sex, carcase weight and ageing. It is not possible, and should not be assumed, that the customer and in particular the final consumer be responsible for calculating the net effect of cut, cook and a myriad of other contributing factors.

'Less is more' in regard to clarity and is pertinent when considering the requirements of a contemporary beef language.

The problem of consumer confusion in regard to cut names has been recognised by prior research and has stimulated efforts across countries to develop more consumer friendly and genuinely helpful language. Very current examples include the reviewed USA URMIS, which is still cut based but seeks to simplify and standardise names and align them with usage advice, and a new French system about to be introduced which utilises a star system in conjunction with cooking style (but still including the cut name) to classify and simplify purchasing.

Australia currently enjoys a significant technical advantage in the MSA system which goes well beyond carcase grading and loosely associated cut and cook advice to deliver a credible prediction of consumer eating quality results for individual cooked meals. While impressive as the global leader there are however substantial knowledge gaps in documenting sensory response in further important global markets and in evaluation of novel cooking methods within these markets. The base technology is recognised in other countries to a greater or lesser extent at research and commercial level. Research and commercial groups in France, Poland, Ireland, Northern Ireland and New Zealand have all conducted consumer research utilising MSA protocols and are progressing in developing grading prediction models.

A recent United Nations Economic Commission for Europe (UNECE) working party established a rapporteur group, led by Poland, to consider common standards for carcase appraisal and consumer testing together with examining potential data pooling to facilitate development of international consumer standards. This initiative could greatly benefit the Australian industry both in expanding the ability to predict consumer response to a broader range of cattle and meal types at low cost to Australia and, critically, in establishing a common standard and related consumer language to facilitate global trade.

To date the MSA technical knowledge has only been exploited at a fraction of capacity with the vast majority of MSA backed brands or identified retail and wholesale product purely described as “MSA”. This base description removes product predicted to fail but includes potential MQ4 outcomes from 46 to 100 points, a substantial and unacceptably large range. This base MSA appellation has also been typically applied as an addition to base conventional description. At wholesale and export level this in general includes carton labelling based primarily on cut name and AUS-MEAT category and at retail predominantly as an addition to cut names.

The grading data however provides an as yet underutilised tool to simplify labelling and description and present a clear meals based outcome in contrast to existing practise. Trends in this direction are evident within some retail offers and new company branding initiatives and need to be facilitated where possible by beef language including legislative or framework changes where these restrict or complicate more advanced application.

LANGUAGE FOR DESCRIBING OTHER COMPONENTS OF PRODUCT VALUE

THE EUROPEAN EXPERIENCE

The BSE crisis in Europe caused a major shift in awareness by consumers – as expressed in the Common Agricultural Policy (CAP) review 'there are growing public concerns about both the way in which food is produced and the way in which agriculture is supported'. The project states ‘European consumers desire more environmentally friendly, higher quality and safer food production’. Policy emphasis is now directly focussed on the consumer.

As a result European retailers have had to become more conscious of product sourcing which has required structural changes and increased integration in the supply chain to allow traceability and verification of brands.

EU enacted food laws have a strong emphasis on process controls from paddock to plate to provide safety, quality and transparency to the consumer. Their mandatory labelling system’s purpose is to ensure full traceability of beef sold back to the animal or group of animals from which it came.

In addition voluntary programmes also emerged. Unlike Australia, where voluntary schemes have focussed on the final product and improving eating quality outcomes for the consumer, these schemes primarily focus on providing robust assurance schemes championing food safety and provenance.

The Northern Ireland Beef & Lamb Farm Quality Assurance Scheme (NIBL FQAS) is about farm quality. It has eight main elements in the Product Standard (Animal husbandry, animal health, animal nutrition, animal traceability, housing and handling, transport, environmental care, farm procedures) with 85 codes of practice. Its purpose is to assure the consumer of the quality of production methods, that care for animals is practiced, the farm environment is of a high quality and that the food sold under their logo will be safe and wholesome. An independent certification body verifies that producers are adhering to the standards of the scheme.

Underpinning the Quality Meat Scotland (QMS) brand is a Beef Eating Quality Summary of Good Practice with four critical control points (CCP's) – animal input, animal management, early post mortem (processing) and aging. This brand also features Scotch Beef with Protected Geographical Indication (PGI) status which ensures the cattle were born, reared and processed in Scotland.

In England the EBLEX Quality Standard Mark Scheme (QSM) for beef developed to address the additional consumer concerns about eating quality, such as succulence and tenderness. The standard contains guarantees of food safety, animal welfare, care for the environment and eating quality. It adopts a whole of chain approach providing assurances from farm to point of purchase. While guaranteeing eating quality the measures used relate only to the physical characteristics of animal age and sex overlaid by aging regimes for primal cuts. This somewhat hopeful emphasis on eating quality differentiates it from the Red Tractor scheme.

In Ireland the Bord Bia Quality Mark tells a story to its consumers of how products have been produced to the highest levels of care and attention from the farm to the shop shelf. It also reassures consumers that the food has been produced and processed in the Republic of Ireland. The Bord Bia Quality Assurance Scheme is accredited to international standards.

To overcome the proliferation of schemes and symbols causing confusion amongst shoppers the 'British Farm Standard', known as the Red Tractor, was developed by Assured Food Standards in 2000 to provide a single stamp of approval. Taking a more whole of chain approach it concentrates on three main criteria – food safety, traceability and animal welfare.

In addition to farm assurance, it requires animal feed suppliers, livestock markets and collection centre, livestock haulers, abattoirs, cutting and packing plants and further processing businesses to be assured to the appropriate standards – (British Retail Consortium (BRC) Global Standards for Food).

Its logo was re-designed in 2005, and in 2014 a 'MadewWith' module was included on the logo for use on ready meals and pies. While numerous assurance schemes exist it is the only scheme that offers full traceability from farm to pack.

Associated with the above assurance schemes to varying degrees are the following organisations:

Freedom Foods focuses on welfare standard and condition or animals on farm.

Leaf is a global organisation with its logo representing an assurance system recognising sustainably farmed products based on LEAF's Integrated Farm management principles. All LEAF certified farms must also be Red Tractor assured so LEAF farms will also meet all of their farming and food standards.

Soil Association & Organic Farmers & Growers are two logos indicating that the food is organic.

Within the EU structure there are a variety of legal certification categories which promote and protect names of quality agricultural products and foodstuffs (Hocquette *et al.* 2014) including:

- PDO (protected designation of origin), which covers agricultural products and foodstuffs which are produced, processed and prepared in a given geographical area using recognised know-how.
- PGI (protected geographical indication), covering agricultural products and foodstuffs closely linked to the geographical area. At least one of the stages of production, processing or preparation must take place in the area.
- TSG (traditional speciality guaranteed) that highlights the traditional character, either in the composition or means of production.

These EU schemes encourage diverse agricultural production, protect product names from misuse and imitation, and help consumers by giving them information concerning the specificity of the products. Besides this system, the 'Organic Farming' label certifies that the product derives from a mode of production and processing that is protective of natural balances and animal welfare as defined in a highly stringent set of specifications backed by systematic controls. *Figure 6* shows some European and French labels for the various schemes.

The French industry, perhaps reflecting their wine and cheese traditions, is also particularly focussed on the concept of 'terroir' where the local soils and environment are often supporting or even primary product descriptors creating a plethora of breed and regional label variations.

In Japan some recognised brands such as Kobe and Matsuaka attract large premiums and reflect strong regional identification also associated with the highest quality.

Figure 6: European and French logos for official quality labels

	Protected Designation of Origin (PDO)	Protected Geographical Indication (PGI)	Traditional Specialty Guaranteed (TSG)	Organic Farming	Label Rouge
EU	APPELLATION D'ORIGINE PROTÉGÉE	INDICATION GÉOGRAPHIQUE PROTÉGÉE	SPÉCIALITÉ TRADITIONNELLE GARANTIE		
France	appellation d'origine contrôlée AOC FRANCE			AB AGRICULTURE BIOLOGIQUE	label Rouge

Major retailers have a significant impact on brand awareness, availability and on the use of symbols representing factors from eating quality, raising claims and health. This is of particular note in Europe and Australia.

Beef language should accommodate the addition and use of specific non eating quality certifications and where possible link these to formal standards to ensure consistent meaning.

Effort should also be made within the language to streamline and standardise the flow of information required from farm source through processing and on to wholesale, food service and retail description.

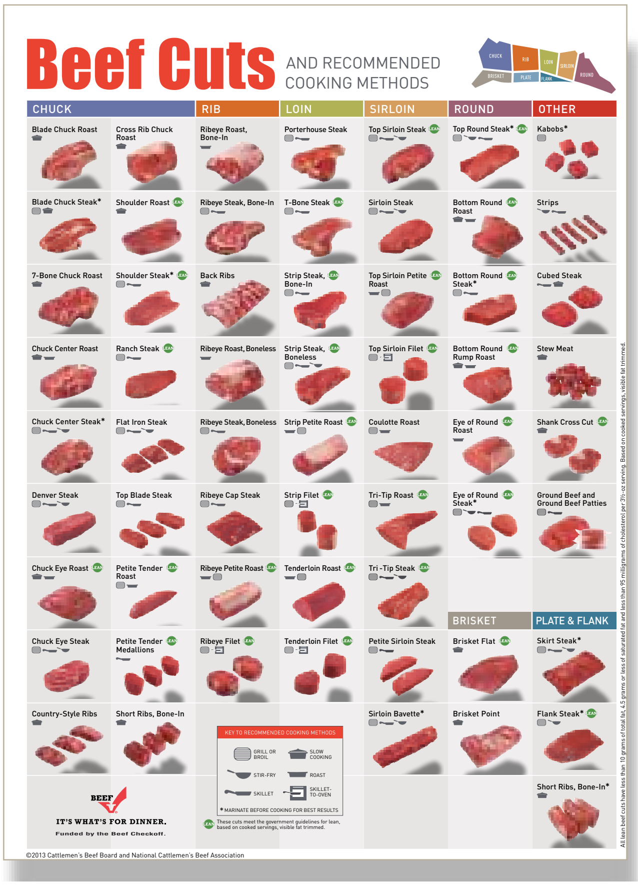
THE AMERICAN EXPERIENCE

In America in the early nineties meat scientists' research priorities were also aimed at addressing eating quality. They had developed the concept of Palatability Critical Control Points (Morgan 1992) and this along with other key research findings remain fundamental to eating quality knowledge. However, as with Europe, their priorities changed as the first of their food safety scares pushed key scientists into this area of research. It is only in recent years that consumer research has become more of a focus for American beef industry Checkoff funding. As part of this focus research into the 'flavour' attributes of beef is increasing in importance.

Each year the perceptions, attitudes and behaviours of 1406 US consumers regarding fresh and processed meat and poultry are explored. In 'The Power of Meat 2014 – An In-Depth Look at Meat and Poultry through the Shoppers' Eyes' – Published by the American Meat Institute, Food Marketing Institute – Prepared by 2010 Analytics, LLC the key findings were:

- While price per pound and total package price remain the most important factors in meat purchasing decisions the dominance of price is waning in favour of higher rankings for nutrition, knowledge and convenience.
- The desire for convenience is being seen in the increased frequency of heat-and-eat and ready-to-heat particularly in one-pot meals.
- Whereas five years ago consumers bought natural or organic meat for health reasons the chief reason to buy in this category now is about substance avoidance (such as hormones, steroids or antibiotics).
- Nutritional information has a greater influence on what people bought whereas cooking instructions influenced the amount.
- The influence of brands is increasing along with increasing brand loyalty particularly for national brands.
- By 4.30pm one third of households do not have a plan for dinner. This provides an opportunity to increase sales with convenient and cost effective meal solutions.
- Smaller and high income households and younger shoppers are more inclined to purchase convenient solutions that require minimal preparation time.
- More than ever today's consumers are not a homogenous group but rather a multifaceted community with a great variety of segments with substantial differences in purchasing behaviour.

The Beef Checkoff has also conducted extensive research to understand the gaps in consumer knowledge about fresh beef cut names (URMIS) and determine the most effective ways to share information through a targeted redesign of on-pack labels. The findings of this research led their industry to update URMIS nomenclature and develop new labelling best practices to boost shopper confidence.



Their research highlighted the following:

1. Consumers are confused by industry standard cut names. Their research confirmed that consumers find meat cut names 'lengthy, confusing and sometimes… unappealing'.

2. Consumers want on-pack information to be easy to read and quick to understand.

3. Consumers lack confidence in choosing the right cut for different cooking methods and are often 'wary of purchasing new cuts for fear of preparing them poorly'.

4. Consumers want healthy and delicious recipe ideas and inspiration.

5. Inconsistencies across the industry are adding to consumers' confusion.

In response to this research the following changes were recommended:

- List two components:
    1. Cut identifier or descriptor (Sirloin Tip, T-Bone, Tenderloin)
    2. Cut form or shape (Steak, Roast, Filet)
- Eliminate redundancy
- Use consumer-friendly and recognizable terms (Strip, Filet)
- Short, concise and unique
- Beef characteristics are listed below the common name, and follow this simple format:
    - o Class/Specie
    - o Primal or sub-primal
    - o Bone state
    - o Cutting standard

Figure 7: Examples of a current labels along with a proposed new label which incorporates user friendly terms to describe the contents and suggested uses

The research conclusions above have quite clear implications for the Australian beef language and when combined with similar research over the years send a strong message about the need for change. However the URMIS application is still driven by conventions that support describing physical characteristics (such as cuts) as opposed to the cooked meal outcome.

Unlike the American eating quality system which is carcase based, the Australian system is a cuts based system which can place 39 different muscles into their appropriate cooking x quality product category.

Automatically the cut name is displaced and the consumer reference becomes the cooking or 'meal style' – Grill, Roast, Stir Fry, Casserole, Shabu Shabu, Yakiniku.

This simple categorisation saves the consumer time, confusion and the need to access apps and recipes to decide how each cut should be used. As it also guarantees a quality experience the purchaser is empowered, instilling confidence that the anticipated outcome will measure up to the actual outcome. This then becomes a key driver in helping the consumer to make a value judgement and repeating the purchase.

FOOD SERVICE

The other point a consumer interacts with language is at foodservice. The sector ranges from fast food outlets, petrol stations, 'fast casual' dining, cafes, hotels, clubs, fine dining and institutions. The language requirements of these food service sectors will vary in detail and relative importance however, be it nutritional data, quality guarantees or 'credence' information related to provenance and 'stories', claims must be verified.

Branded beef is increasingly appearing on meal menus – restaurants may offer grass and/or grain fed steaks from one or multiple branded selections, consumer's in McDonalds are offered Angus beef burgers or 'Healthy Choice' rump wraps, some extrapolate flavour differences. Language needs to technically deliver the meal performance and assist in transparency around these claims.

American attitude and usage studies done by Technomics Inc. (Consumer Trend Reports, Technomics Inc. www.technomic.com) highlight that consumers are becoming increasingly more demanding in their expectation of food quality, innovation and the overall restaurant experience offered as follows:

- Preferences for freshly prepared 'artisanal food' is growing, reflecting an expectation of better taste, quality and healthiness – there is a rise in snacking as consumers purchase items that fit their needs 'whatever, whenever' regardless of 'day part or menu part' along with innovation with flavours, ingredients and new meal experiences.
- Grassfed beef has been identified as one of the top trends in the American food service industry.
- Consumer use of smartphone technology will become increasingly interconnected with dining out use and the overall eating experiences (Consumer Trends Report, Technomics Inc).

In Australia, the following trends are highlighted:

- Foodservice operators are buying more ready-to-serve meat products and secondary cuts to offset costs.
- Red meat brands are becoming more prevalent on restaurant menus as increasingly sophisticated consumers seek a greater depth of knowledge.
- Measurement technology allowing accuracy of fat content labelling for trimmings is available but not being used (Environment Future Scan: Megatrends to 2030, McKinna *et al.* 2012).

As with other sectors worldwide consumer trends around the environment, food sourcing, sustainability and healthiness will increasingly impact on the foodservice sector. The response taken by, for example, a restaurant chain on these issues will effectively help position its brand as socially aware, eco-friendly and in tune with its customers.

Whether providing eco-friendly packaging, locally sourced products, using suppliers that have high animal welfare standards, natural or organic, grass or grain fed, or as McDonalds has undertaken in the UK, a large project aimed at reducing its carbon footprint, involving 350 beef farms across the UK and Ireland, the implications for the supply chain and language delivery are significant.

THE AUSTRALIAN EXPERIENCE AND FUTURE OPPORTUNITIES

Australia's response to the very clear consumer message in the nineties which saw consumption of beef declining was to undertake key research to identify its causes and develop a response. The first Meat Industry Strategic Plan (MISP) had 'guaranteeing the eating quality of beef and lamb' as one of its six imperatives (Polkinghorne *et al*. 2008).

In research commissioned by the Meat Research Corporation (MRC) in 1996 (Anon 1996), The Centre for International Economics (Sydney and Canberra) in their Beef and Lamb Eating Quality Key Program Report brought together consumer research, market research and scientific research to lay out the basis for a voluntary 'national product quality description scheme'. The key requirements were that it 'must be consumer driven, involve standards that could not be compromised, be simple to communicate and be continually monitored and improved to ensure accurate application of standard against consumer sensory responses'.

It highlighted that as attempts by Australian researchers to measure eating quality objectively had been unsuccessful research should move to using actual consumer responses. This led to the development of a standardised protocol for sensory testing and the data obtained when linked to other determinants of eating quality from on-farm and during processing forms the basis of the MSA Eating Quality Prediction Model.

While Europe and the United Kingdom were developing their responses to changing consumer demands over the last 15 years based on assurance schemes to deliver food safety and provenance – factors which according to Grunert *et al* (2004) apply only to '*extrinsic*' values and which do not substantially influence shopper behaviour and hence beef consumption - Australia had by 2000 developed a scheme which went to the heart of influencing consumer behaviour by helping to define '*intrinsic*' values - the key to consumer purchasing decisions.

Further this lessened the gap between what the consumer 'expected' from their beef purchase and what was actually 'experienced'. The merging of a consumer's expectations with a guaranteed outcome was a powerful tool and firmly established Australia as the global leader in guaranteeing eating quality outcomes for beef consumers.

The ability to provide a simplified beef offering to beef consumers in a matrix which reflected their everyday cooking styles tied to a quality outcome reflecting the occasion they were buying for opened up many opportunities for innovation throughout the value chain. Changed retail displays, the development of beef brands now underpinned by a robust eating quality tool which guaranteed consumer satisfaction and provided consistent qualities, a strong base on which to build brand equity and on-farm premiums for cattle which were identified as delivering the required quality outcomes (Polkinghorne *et al*. 2008).

A system which could increase the 'overall pie' and add value throughout the whole chain driven clearly by the needs of the end consumer offered a way for the industry to move away from a commodity driven culture to an industry that could be more aligned with the expectations of consumers in the new century.

REFERENCES

Polkinghorne R, Philpott J, Gee A, Doljanin A, Innes J. (2008). Development of a commercial system to apply the Meat Standards Australia grading model to optimise the return on eating quality in a beef supply chain. Australian Journal of Experimental Agriculture, 48 1451-1458.

Polkinghorne R, Thompson JM, Watson R, Gee A and Porter M. (2008). Evolution of the Meat Standards Australia (MSA) beef grading system. Australian Journal of Experimental Agriculture, 48 1351-1359.

Polkinghorne R, Meat Standards Australia – A red hot look. Address to Australian Lot Feeders BeefWorks seminar, Toowoomba, Qld 2010.

Anon 1996 – Meat Research Corporation (MRC) - Beef and Lamb Eating Quality Key Program – Implementation of a national product quality description scheme. (Centre for International Economics, Canberra and Sydney)

McKinna et al.2012 . 'The APC Environmental and Future Scan to 20:30: MegaTrends for the red meat processing industry', 'Future of Fresh. Transforming the Fresh Food Landscape over the next 20 years'. Part of the Woolworths Trolley Trends Series. www.woolworthslimited.com.au/icms_docs/137928_the_future_of_fresh.pdf)

Why Millennial's Matter: A Research Overview. Excerpted from a Winter 2012 Beef Issues Quarterly article by Neuman and the 2012 Millennial Parents Study Executive Summary, R.McCarty, W.Neuman

Hajikowicz et al 2012. Our Future World: Global Megatrends that will change the way we live, CSIRO Australia

Anon (2014) 17th Annual Global CEO Survey – Fit for the Future, Capitalising on global trends. PWC

Anon (2013) PWC . A new Era in Buying – Retailing in China's Digital Age. China Digital Byte series.

Anon (2012) Retailing 2020 – Winning in a Polarised World (www.pwc.com/us/en/retail - consumer/publications/assets/pwc-retailing-2020.pdf)

Anon. The Decade Ahead: Trends that will shape the consumer goods industry.pdf (McKinsey & Company)

Klaus G. Grunert, Lone Bredahl, Karen Brunso (2004). 'Consumer perception of meat quality and implication for product development in the meat sector – a review'. Meat Science, 66 (2004) 259-272

Klaus G. Grunert. (2006). 'Future Trends and Consumer Lifestyles with Regard to Meat Consumption'. Meat Science 74 (2006) 149-160

Klaus G. Grunert (1997). What's in a steak? A cross cultural study of the quality perception of beef. Food Quality and Preference, 8, 157-174.

'The Power of Meat 2014 – An In-Depth Look at Meat and Poultry through the Shoppers' Eyes' – Published by the American Meat Institute, Food Marketing Institute – Prepared by 210 Analytics, LLC

URMIS Consumer Research: Beef Retail – 2015 (www.beefretail.org/urmisconsumerresearch.aspx)

Schroeder E, Tonsor G and Mintert J (2013). 'Beef Demand: Recent Determinants and Future Drivers'. US Beef Consumer Research Report accessed by www.beefboard.org/evaluation/130612demanddeterminantstudy.asp

Common Agricultural Policy (CAP) Review 9

Lyford C, Thompson J, Polkinghorne R, Miller M, Nishimura T, Neath K, Allen P and Belasco E. Is Willingness to pay (WTP) for beef quality grades affected by consumer demographics and meat consumption preferences. Australasian Agribusiness Review Vol 18, 2010

Lyford C, Thompson J, Polkinghorne R, Miller M, Nishimura T, Neath K, Allen P and Belasco E. Is Willingness to pay (WTP) for beef quality grades affected by consumer demographics and meat consumption preferences. Australasian Agribusiness Review Vol 18, 2010

Hocquette JF, Botreau R, Legrand I, Polkinghorne R, Pethick D, Lherm M, Picard B, Doreau M and Terlouw C, 2014. Opportunities and Challenges for Predicting and Manipulating Beef Quality – Animal Production Science. www.publish.csiro.au/nid/72htm

(Anon 2013). The 2013 Consumer Trend Report – Executive Summary. Attitude and usage study highlights for foodservice executives. Technomic Inc (www.technomic.com)

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MEAT & LIVESTOCK AUSTRALIA

APPENDIX C:

CURRENT CARCASE TRAITS IN THE AUSTRALIAN BEEF LANGUAGE

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CONTENTS

INTRODUCTION

This paper reviews current measurements used in the Australian beef language. Firstly, the definition of the trait is discussed, followed by background on what the trait is measuring and the history of its implementation. A discussion on the accuracy of the current technology follows with comment on any corrective action that may be required in the short to medium term to address any biases. New technology that may be relevant to either replace or improve the measurement in the short, medium or long term is also briefly reviewed. Finally, recommendations are made for the short and longer term.

The traits in the Australian Beef Language are:

- Standard carcase
- Marbling score
- P8 fat depth/12th ribfat
- Carcase maturity (age, ossification score and dentition)
- Meat colour score
- Fat colour score
- Eye muscle area
- Ultimate pH
- Hump height
- Butt shape
- Sex category

THE ON-SITE-CORRELATION AND PRACTICE SYSTEM (OSCAP)

Before discussing the individual carcase traits it is appropriate to describe the audit procedure developed and currently operated by AUS-MEAT. The OSCAP system is the internal audit system developed by AUS-MEAT to standardise the all subjective scores and measurements given by graders. This includes marbling, ossification and meat colour scores, hump height, fat depth and fat colour and eye muscle area. The system draws from a large bank of photographs of the traits that are displayed on a true colour screen. At two monthly intervals accredited graders are required to grade a random selection of images and achieve a threshold in accuracy. The database of photographs is accessed on-site drawing on the central database.

The accuracy of individual graders is assessed after measurements/grades are assigned to individual images selected randomly. The criteria for accuracy are complicated formulae for the correct allocation plus allowances for where there are differences (Anon 2013). It would be an improvement if the measure of accuracy was expressed as a correlation. This would provide a simple figure that could more easily plot progress of how graders are tracking both between graders and across time.

1. STANDARD CARCASE

1a) DEFINITION FOR STANDARD CARCASE

The standard beef carcase is defined by AUS-MEAT (Anon 2010a) as the body of a slaughtered bovine after bleeding, hide removal and removal of all internal digestive, respiratory, excretory, reproductive and circulatory organs. Its definition also stipulates removal of the head (between the skull and the first cervical vertebrae), the forefeet (between the carpal and metacarpal bones), hock (between the tarsal and metatarsal bones), tail (at the junction of the sacral and coccygeal bones), skirts (both thick and thin skirts), kidneys, kidney fat and fat within the pelvic channel, testes, penis and udder, pre-crural fat and fat on the channel rim from the ischiatic tuber to the sacro-coccygeal junction.

In addition to the above, excessive fat is trimmed from the topside (to 10 mm depth) and external fat from the brisket point end (to 10 mm depth). Intra-thoracic fat and the xiphoid cartilage and the linea alba that extends from the xiphoid cartilage to the most caudal point of the thin flank are also removed.

Hygiene trims which result from operational processes such as Halal sticking are also removed along with sufficient trimming of any contaminated areas on the carcases.

Finally the carcase as defined above must be weighed within two hours of slaughter and the actual weight reported with no deduction for shrinkage.

1b) BACKGROUND TO THE MEASUREMENT OF THE STANDARD CARCASE

The standard carcase definition was set up to facilitate "over the hooks" (OTH) trading by providing a standard definition of the carcase that was repeatable both over time and between operators (Anon 2010b). The intention was to provide a means by which producers could compare the different grid prices used by processors in OTH trading. Prior to this, adjustments were required to account for whether certain organs or carcase components were retained or removed from the carcase at different plants.

The introduction of the standard carcase put an end to the practise of discounting hot carcase weight for shrinkage that occurs in the chiller. The evaporative loss from chilling ranges from 0.5 to 3% depending upon chiller loading, fatness, windspeed and humidity of the chilled air. As the variation in weight loss depends upon chiller efficiency, as opposed to producer efficiency, AUS-MEAT decided that processors should pay on the hot standard carcase with no deductions for chilling loss when using OTH trading (Hall 1988).

1c) ACCURACY AND BIAS IN THE MEASUREMENT OF THE STANDARD CARCASE

The intention of the carcase definition was to standardise removal of variable components such as tail, kidneys etc and also to reduce variation in low value components such as excessive fat over the brisket and topside cuts. There would appear to be little dispute over what components are removed or retained on the carcase. However greater oversight is needed to ensure that the same level of trim is being applied in all plants.

There is some anecdotal evidence from producers that since dressing percentage differs in mobs that have been trucked to different plants it must be due to different carcase dressing procedures. Efforts need to be made (perhaps by AUS-MEAT) to investigate these incidents with well-designed trials that allow valid comparison between groups.

The level of fat trim over the topside and brisket is obviously a point that has caused some producers to feel that fat has been excessively trimmed and carcase weight reduced in some plants. From the processor's view, if a variable amount of fat was left on the carcase this would reduce the yield of trimmed primals for some carcases and therefore the average price would need to be adjusted to take account of this. The question of how to standardise the level of trim is difficult to answer.

The degree of hygiene trim from sticking is another variable that causes producer concerns. Other sources of discontent include bruise trimming. On the slaughter floor it is difficult to attribute whether bruise trim has been caused by producer or processors inputs. Similarly, hygiene trim for gut contamination could be argued as being the processor's responsibility but that it needs to be done on the slaughter floor so the carcase can be certified as being suitable for human consumption before being placed in the chiller.

There is often comment in the popular press of anecdotal evidence that dressing percentage varies between lots which have been split and sent to different plants. The immediate conclusion by producers is that such differences are due to differences in carcase trimming, yet there are also differences in trucking distance/time, lairage etc. As producer confidence in the beef language underpins the success of value based marketing there may be a need for an independent team to investigate these occurrences. Whilst an individual investigation might not be conducted in every instance, guidelines should exist to allow claims to be viewed in a structured manner.

1d) TECHNOLOGY TO MEASURE STANDARD CARCASE

As part of a project assessing the accuracy of whole carcase Video Image Analysis (VIA) scanning using a commercially available system called 'VIASCAN', Ferguson and Thompson (1995) collected lateral, medial and dorsal images on 38 sides before and after AUS-MEAT trim. The aim was to evaluate the VIA as a tool to monitor compliance of the level of trimming with that permitted by the standard carcase definition. Trim weight was collected and weighed from the 38 sides. Unfortunately analysis of images resulted in the conclusion that it was not feasible to discriminate between sides which were under- or over-trimmed with respect to the standard carcase definition. This was also reinforced by the fact that such a task was extremely difficult even to naked eye.

If there is continuing dissatisfaction from producers regarding application of the trim standards it may be prudent to revisit this area, particularly considering the recent advances in image analysis. The hygiene trim on the neck is one area that should be easily monitored by images captured at the scales.

1e) RECOMMENDATION FOR STANDARD CARCASE

The current standard carcase definition provides a sound basis for OTH trading and should be retained. Consideration should be given to developing vision systems to audit the level of trimming of the brisket and topside and hygiene trim due to sticking to ensure it complies with the definition in the standards.

2. MARBLING SCORE

2a) DEFINITION OF MARBLING SCORE

Currently, marbling score is assessed subjectively against digitally-constructed standards. The Australian language currently has two systems (AUS-MEAT and Meat Standards Australia, MSA) to describe marbling. The AUS-MEAT marble score is assessed by graders and scored against the AUS-MEAT marbling reference standards. These standards are on a 0 (devoid of marbling) to 9 (abundant marbling) scale and have been digitally enhanced to contain variable amounts of white relative to red pixels. The AUS-MEAT score is based on the total amount of white in the muscle. AUS-Meat currently requires that muscle is below 12oC for grading, with a recommended temperature of 4-8oC (Anon 2004).

The MSA system is based on the United States Department of Agriculture (USDA) marble score system which cover the range from 100 to 1190. MSA marbling is based upon the amount of intramuscular fat as well as fineness and distribution of the marbling within the eye muscle (Anon 2011). MSA marbling has the advantage that it increases in smaller increments (measured in units of 10, although the photographic standards refer to increments of 100). MSA marbling is a continuous score with up to 110 categories and is therefore more suited for use as a predictor in the MSA model than the AUS-MEAT scores which have only 10 discrete categories.

The AUS-MEAT website states that the two systems "can be used in harmony to provide more detail about the product" (Anon 2005). However "MSA Tips and Tools" (Anon 2011) states that there are no formulae to compare MSA and AUS-MEAT marbling scores as the assessment criteria are different. Clearly, equivalence between the two measurements of marbling is an area that needs to be addressed. The results of Muir et al (1998) are interesting in that they found that the grader effect was larger when Japanese Meat Grading Association (JMGA) standards (which use stylised representations of marbling) were used compared with the USDA system (which use photographs of actual rib eye areas).

Much of the world is familiar with USDA marbling scores as they form part of a number of other grading systems around the world (Polkinghorne and Thompson 2010). If the systems were to be merged it would be logical that the new standard for the Australian Beef Language be based on the USDA marbling standards which are currently used by MSA. This would effectively provide some degree of equivalence with a number of other grading systems around the world.

2b) BACKGROUND TO MARBLING SCORE

Marbling in beef refers to the white flecks of visible fat between the bundles of muscle fibres in skeletal muscle. These white flecks of fat comprise clumps of adipocytes which are at various stages of filling with triglycerides. These adipocytes are embedded in a connective tissue matrix in close proximity to blood capillary networks (Harper and Pethick 2004).

Historically, increased marbling or fat content in meat has been associated with increased eating quality, but it was not until the middle of last century that researchers began to collect data to confirm the link (see Smith and Carpenter 1976). Since then numerous studies have examined the association between marbling and eating quality. These were recently reviewed by Mafi et al (2012) who concluded that whilst most studies reported positive relationships between marbling and sensory scores the strength of the relationships were often low and variable. However, marbling scores do provide some assurance for eating quality and hence have been used in this role in the majority of grading schemes around the world (NSLMB 1995, Polkinghorne and Thompson 2010).

Marbling scores (by either the AUS-MEAT or MSA systems) are highly related to intramuscular fat percentage with correlations ranging from 0.7 to 0.9 (Greiner 2002).

However as stated above marbling score is a subjective score of visible fat in the muscle, whilst intramuscular fat is a measure of the total amount of chemical fat within the muscle and so includes both visible fat and invisible triglycerides and phospholipids associated with the cell wall structure. This invisible fat comprises a relatively constant proportion of the muscle as it appears not to vary with short-term changes in nutrition (Masoro 1967). Therefore, it may be possible to adjust chemical fat levels for the invisible fat to better reflect the visible fat levels.

If the tenderness advantage of marbling is due to dilution of a more dense protein matrix by a less dense fat matrix (Park et al 2008), then visual marbling is probably the more appropriate measure. If however the main advantage of marbling is via an increase in juiciness then chemical fat may be the more appropriate measure of marbling.

Alternatively the Queens group in Belfast have suggested that the main advantage of marbling is via increased flavour scores due to the volatiles stored in the lipids being released more slowly (LJ Farmer, personal communication). If this is the case it is not clear whether this would favour a visual or chemical measurement of intramuscular fat.

2c) ACCURACY AND BIAS IN THE MEASUREMENT OF MARBLING SCORE

A major concern that has been raised by industry is the potential bias in subjective marble scores. If there are substantial biases an obvious solution would be to move to objective grading technologies. However the first question that needs to be addressed is to quantify the magnitude of the bias with the current system of subjective marbling scores and, if bias exists, to investigate corrective action to minimise this bias. The second question of objective technologies that could accurately assess marbling without grader bias is a longer-term solution at best.

GRADER BIAS

Analysis of slaughter records indicates several sources of bias in grader marbling scores (Thompson JM and Polkinghorne R *unpublished data*). Using a large industry data set of over a million carcase records the effects on grader on MSA marbling scores were examined after adjustment for production (Hormonal Growth Promotants (HGPs), sex), processing (grader, time from slaughter to grading) and carcase traits (hot standard carcase weight (HSCW), ossification score, ribfat and ultimate pH). To gain an appreciation as to whether the grader effect was repeatable the analyses were repeated in grain and grassfed carcases over a number of plants and showed an average range of 40 marbling units between the highest and lowest marbling scores at each plant, i.e. at each plant the highest grader was consistently giving scores which were on average at least 40 units different from the lowest grader. It is important to note that the grader effects were evident after the marble scores were adjusted for production and processing effects and also were adjusted to the same HSCW, ossification score, ribfat and pH. Muir et al (1998) also reported large grader effects in allocating marbling scores to beef carcases. It was interesting to note that inconsistencies between graders was one of the main reasons the US system has pursued development of VIA systems (Moore et al 2010).

Whilst the analysis of the industry grade data showed significant grader effects, the different graders did not score the same carcases and so one interpretation could be that the grader giving the highest marble score may have actually been presented with more highly marbled carcases and vice versa for the grader with the lowest marble scores presented with poorly marbled carcases. As mentioned, the grader effects were independently analysed in grain and grass fed carcases to gain an appreciation of the repeatability of the grader effect. These analyses showed that within plant the predicted mean marbling scores for the different graders in grain and grass carcases were highly correlated. In other words, the same ranking of graders was evident in both grain and grass fed carcases (with an average correlation between graders of adjusted marble score in grain and grass fed within plant of greater than 0.6, and as high as 0.9 in one plant). This suggested that grader bias was real and that at a number of plants individual graders were consistently giving marble scores that were 40 marble units apart for similar type carcases. It was important to note that these grader effects were apparent even with bi-monthly audits using the OSCAP system.

A possible criticism of the OSCAP system is that these audits are not conducted in a real world environment and hence whilst graders may be complying with accuracy thresholds with OSCAP, this may not relate back to their performance in the chiller. Whilst the motives of the OSCAP system are well placed it would appear that there has never been any investigation to quantify the benefits of the OSCAP system in terms of increased grader accuracy and a reduction in the bias due to individual graders.

The analyses described above clearly showed there were large grader effects on the marble scores currently operating in industry. There are a number of corrective actions that could be taken. An initial suggestion would be to regularly undertake analyses of plant grading data to allow early identification of grader bias. This would only require the statistical inputs to regularly review and analyse plant grading data. It would be possible to set up this analysis up on at least a monthly or bi-monthly basis. It needs to be stressed that the above suggestion is aimed at early identification of grader bias and implementation of corrective action to help graders recalibrate and reduce this bias.

Consideration would also need to be given to the structure of any retraining programs conducted at the plant once problems came to light. As part of any retraining program plant graders would need to be continually retested and the results presented back to them in real time to maximise the effectiveness of any retraining program.

As mentioned previously the AUS-MEAT marbling standards are digitally enhanced as opposed to the USDA standards which are based on photographs. In this context the results of Muir et al (1998) are interesting where they showed larger grader effects when the digitally enhanced JMGA standards were used as opposed to the USDA photographic standards. This would support adoption of the USDA standards.

TIME FROM GRADING TO SLAUGHTER

There is a common perception in industry that if carcases are held over a weekend before grading they will have a higher marble score. It is interesting that there is little published information on this aspect of carcase grading.

The effect of delayed quartering on AUS-MEAT marbling scores was examined using 200 Wagyu carcases where alternate right and left sides were quartered and graded 24 hours post slaughter and the remaining side left for 48 hrs before quartering and grading (JM Thompson *unpublished data*). The results showed an increase in 0.8 of an AUS-MEAT marble score in the 48 hr versus the 24 hr quartered sides. It was interesting that the increase in marbling score was not a temperature effect. Rather it was likely that the increase in marbling was in part due to a structural change in the fat which lead to greater visualisation of marbling fat (R Tume, *personnal communication*).

In addition, the large industry data set referred to previously (JM Thompson and R Polkinghorne *unpublished data*) was also used to estimate the magnitude of the increase in the MSA marbling score by quartering carcases at 18 hrs, 2 and 4 days post slaughter. As for previous analyses the data were adjusted for production, processing and carcase traits. The results showed a curvilinear response for all plants in that there was a 40 point increase in marbling score from grading at 18 hrs compared to grading at 48 hrs but only a 6 point increase if carcases were graded at 96 hours post slaughter. These increases in marble score were substantial and would explain the preference for a Friday kill by many Wagyu producers.

To counter the bias of grading at different times after slaughter a number of strategies could be put in place. The easiest solution would be to quarter and grade all carcases a standard time after slaughter. Therefore, Friday's kill could be quartered on Saturday morning, rather than Monday morning. The exposed eye muscle could be covered with plastic to minimise evaporative loss. If for operational reasons this was not suitable a correction factor could be calculated and applied when carcases were quartered on Monday morning. This would effectively adjust all marble scores to a standard grading time for payment and use in the MSA prediction model. The accuracy of such a correction factor has not been calculated and this would need to be done prior to moving down this path. It is also worthwhile to mention that any correction factor would have error and this could become a source of discontent in the industry.

From the literature, muscle temperature at grading is known to affect the visualisation of marbling. Similarly differences in fatty acid composition can also impact on the visualisation of marbling (Tume 2001). It was interesting that in all analyses of the factors that impacted on marbling scores, muscle temperature over the narrow range experienced in the chillers did not have an effect (JM Thompson *unpublished data*).

2d) TECHNOLOGY TO MEASURE MARBLING SCORE

In the longer term consideration should be given to objective technologies which may reduce some of the biases in measuring marble score. There are a number of technologies that use image analysis to objectively measure marbling. The images are captured from the quartered carcase and then converted to a marble score using various algorithms. Certainly the VIASCAN chiller assessment unit is capable of measuring marbling and is currently approved by AUS-MEAT (Anon 2013). The current Australian VIASCAN unit has the disadvantage of being large and cumbersome and requiring a power connection. In the USA, VIA has been approved to measure marbling for some time (Moore et al 2010).

More recently a high definition camera to capture high quality images and partitioning the resultant images into a number of traits which are related to marbling score has been developed by Kuchida et al (1997a, b). Simple traits such as percentage of white area in the muscle are highly correlated with AUS-MEAT marbling scores (Maeda et al 2014). The technology also calculates a large number of related traits such as fineness and distribution. However it is not clear whether the greater detail on these traits delivers any worthwhile information in terms of customer requirements, or a better insight into eating quality.

With technology developments in cameras and image analysis it is highly likely that a much smaller and more easily transportable unit with a simple output could be developed using tablet technology. However any system that depends upon image capture at grading will suffer from the substantial biases that occur with variation in temperature and differences in the time between slaughter and grading. As previously discussed, this may be addressed by developing appropriate correction factors.

Multispectral scanning collects and processes information from across the electromagnetic spectrum and, as such, has more potential to capture information than a conventional photograph. Certainly initial work in this area (Qiao et al 2007, Elmasry et al 2013) suggests that it can accurately estimate marbling.

An alternative approach is to measure aspects of chemical fat that are not dependent upon visualisation of fat in the quartered carcase. An approach that warrants further investigation is Velocity of Sound (VOS). This technology measures the time it takes an ultrasound signal to travel between two transducers embedded in the eye muscle. An initial investigation Thompson and Bradbury (2005) reported that VOS was capable of measuring chemical fat in the muscle but it was sensitive to muscle temperature. This technique had the advantage that it could be used to measure intramuscular fat or marbling in the hot carcase with subsequent advantages in sorting carcase prior to boning.

Impedance probes also offer another technology to predict chemical fat in beef. A review by Altmann and Pliquett (2006) indicated there were problems at the lower levels of intramuscular fat and that the technology was not yet ready for commercialisation in the meat industry.

Computer Tomography (CT) is another technology capable of delivering an accurate measure of intramuscular fat or marbling. Recent studies have confirmed the accuracy of this technology (Ross et al 2014, McPhee 2014) in beef. Conventional CT passes an object through a donut of emitters and detectors which would relegate the technology to post boning and therefore not able to be used to sort carcases. However, while it would not be useful in conventional boning establishments, CT may well provide a viable technology to sort cuts to exacting specifications post boning. As CT technology becomes more robust and capable of scanning larger objects it may be capable of scanning the hot carcase.

Perhaps in the future there will be the capacity to take a three dimensional CT scan of the side at line speed and deliver an estimate of marbling (adjusted for temperature) of all major primal cuts prior to chilling so carcases could be sorted to better meet market specifications.

2e) RECOMMENDATION FOR MARBLING SCORE

Both the AUS-Meat or MSA scoring systems to describe marbling are referenced against images standards. It is recommended that the two systems be merged in the interests of simplifying the message to the Australian industry and also to improve equivalence with other grading schemes around the world.

The current marbling scores are subject to substantial bias both by graders and the time from slaughter to grading. Systems need to be put in place to quantify and rectify this in real time. In the short term grader bias needs to be monitored by regularly analysing all grade data and where appropriate supplying more training.

Assessment of marbling score using image analysis could remove grader bias but if marbling score is based on visual fat in the muscle the bias due to time from slaughter to grading will still be present. A longer term solution may be to measure intramuscular fat content using other techniques such as impedance or VOS.

3. FAT DEPTH MEASUREMENT

3a) DEFINITION OF FAT DEPTH

P8 fat depth is defined as fat depth at the intersection of a horizontal line from the third sacral vertebra and a vertical line from the sacro-sciatic ligament and dorsal tuberosity of the sacral bone (Anon 2013). P8 fat depth is measured manually using a cut and measure knife, or it can be measured using the Hennessy Grading Probe. P8 fat depth is a mandatory trait for AUS-MEAT. If the P8 site is damaged by dressing or hide puller damage then the other side is measured. If both sides are damaged then fat depth is recorded as an estimate on the kill sheet.

As part of MSA grading fat depth at the quartered rib site is measured as the total fat depth over the last quarter of the eye muscle. Given the quartering site may vary, the site for the measurement of ribfat will vary accordingly. To be eligible for MSA grading carcases require a minimum of 3mm over the ribs. Ribfat is also used as a predictor of eating quality in the MSA model given the positive correlation between marbling and fat depth (Watson et al 2008).

Whilst MSA uses fat depth as an indicator of eating quality its primary use in the Australian beef language is as a predictor of carcase yield. Once the carcase is boned and primals are boxed fat depth is not used as a specification, presumably on the assumption that all primals are trimmed to the same wholesale trim in the boning room.

3b) BACKGROUND TO THE MEASUREMENT OF FAT DEPTH

Fat depth measurement in the beef carcase has been a source of debate over the years. Initially in research studies in the 1970s fat depth was measured at the 10th rib (where most carcases were quartered at this time). Subsequently the quartering site moved back to the 12th rib presumably because the cube roll was extracted from the rib set and sold as a grilling cut. Around this time mechanised hide pullers were introduced resulting in some damage at the proposed fat depth site at the 12th rib. It was also at this stage that AUS-MEAT was establishing the national language for beef carcases. Based largely on the data of Moon (1980) and Johnson and Vidyadaran (1981) the P8 site was selected for inclusion into the language, on the premise that it suffered less hide puller damage than the 12/13th rib site. Subsequent studies by Johnson (1987) and McIntyre and Frapple (1988) showed that when considered in conjunction with hot carcase weight, 12th rib and P8 fat depth were equally accurate at predicting carcase yield. Hopkins (1989) analysed data on ca. 11,000 carcases from Tasmanian slaughter plants and found little difference in fat damage at either the 12th rib or P8 sites. He concluded that there was no evidence that one site was more reliable than the other.

McIntyre (1994) argued for the 12th rib site on the basis that other measurements (such as eye muscle area marbling and meat colour) were recorded at that site. It should be noted that live animal fat or condition scores are based largely on palpation of the loin over the dorsal and lateral spines of the lumbar vertebrae. Hence, fat depth at the 12th rib should better align live animal condition scores. The P8 site in the live animal is much harder to subjectively score as there is no bone to help assess the covering of soft tissue as there is at the 12th rib site.

If fat depth is used as an indicator of carcase yield then a single point estimate at any site on the carcase is likely to be deficient for reasons of operator effects, damage and variation between sites in the carcase. It is likely that in the near future other techniques which measure more than a point estimate of fat depth will be used to accurately measure carcase yield and so the industry will not be reliant on fat depth measurements to predict yield.

MSA has a requirement for greater than 3mm of fat over the loin along with a subjective assessment of fat distribution on the carcase as a means of minimising variation in carcase chilling and hence problems in eating quality (Anon 2011).

3c) ACCURACY AND BIAS IN THE MEASUREMENT FAT DEPTH

Until recently it was difficult to find data on the accuracy and bias associated with measurement of P8 fat depth. Rather than being measured by individual graders, P8 fat depth is measured by one grader at the scales.

Recent analysis of industry data sets showed that after adjustment for production, processing and carcase traits there were significant grader effects on the measurement of ribfat (JM Thompson and R Polkinghorne *unpublished data*). After adjustment for production, processing and carcase traits, grader means generally had a range of 2 to 3mm which although relatively small represented a range of ±20% when expressed as a percentage of the mean ribfat. Using the same approach as for marbling score (see section 2) the ranking of graders for ribfat was assessed in grain and grass fed carcases and their correlation used to assess the repeatability of the grader effects. The correlations for ribfat between graders in grain and grass carcases were positive and significant ($P<0.05$), with a mean correlation of 0.67 (individual plants having correlations ranging from 0.25 to 0.98). This suggests that within some plants (but not all) graders consistently reported high or low ribfats and the grader ranking was the same in grain and grass fed carcases. A number of reasons could be put forward to explain this bias including recording a subjective assessment of fat depth or graders were not measuring the traits correctly.

The other significant effect was that after adjustment for production, processing and carcase traits there was a curvilinear trend for ribfat to decrease with longer times from slaughter to grading. The largest decrease occurred in the first increment from 18 to 48 hours and was generally of the magnitude of 0.2mm. Thereafter the declines were of the order of 0.1mm or less. There are no reports in the literature of a time from slaughter to grading effect on ribfat, but presumably it occurred because the fat was drying out. The effect was evident in all plants surveyed and although statistically significant the magnitude of the effect meant that it was unlikely to be of commercial importance.

The bias due to graders in contrast was large and commercially important given that fat depth generally comprises part of any marketing grid. It is important to note that these biases have occurred in the presence of OSCAP which currently is the only tool used to audit grader performance. Furthermore if yield prediction equations were to utilise fat depth as a trait, grader bias on fat depth would be a greater concern.

Clearly OSCAP is not eliminating grader bias and more needs to be done in monitoring grader performance. As recommended for marbling score, a regular analysis of grade data would allow grader bias to be monitored. If large effects are evident then a retraining program should be undertaken in plant to correct this.

3d) TECHNOLOGY TO MEASURE FAT DEPTH

Australia is the only country that uses fat depth at the P8 site, with most using a fat depth measurement at the site of quartering (Polkinghorne and Thompson 2010). The literature indicates that all point measurements of fat depth are subject to some degree of dressing variation and fat tearing. Perhaps the solution is to investigate new traits that are less influenced by fat tearing and dressing. This is not simply suggesting another site on the carcase but rather measuring a new trait such as the area of fat coving the loin muscle in the quartered side.

Options include measurement on the animal before carcase dressing and any fat tearing has occurred. Ferguson (1996) reported results from a number of studies that showed that ultrasonic measurement of fat depth taken hide-on had a similar accuracy at predicting carcase yield as ribfat measured on the hot carcase. However the commercial adoption of ultrasound technology is currently hampered by the lack of suitable ultrasound devices and also ensuring good contact between the ultrasound head and the hide. Given recent advances in ultrasound this could be worth revisiting.

If an image of the quartered carcase is collected, other traits such as fat area over the eye muscle could be measured and these have been shown to be a more accurate measure of yield and subject to less bias from fat tearing (Anon 2013). The need for a single fat depth would also be negated if a side image of the carcase was used to estimate yield directly, or to assess subcutaneous fat distribution, using technology such as VIASCAN. Alternatively a DEXA image of the whole carcase would provide a direct estimate of yield. As mentioned, the consumer does require some covering of fat over certain cuts. The problem is that a system that just predicts yield could lead to extremely high-yielding, low-fat carcases being produced. This could be avoided if a minimum threshold for subcutaneous fat depth was incorporated in any yield specification.

The grader effects on the measurement of fat depth are large and need to be addressed. Image analysis using technology such as VIASCAN chiller assessment cameras are certainly capable of recording an image which can be used for multiple traits including fat depth, meat colour, fat colour and marbling score. An average of fat depth across the eye muscle would be less prone to the influence of fat tearing. Algorithms could be developed that would exclude points where fat tearing had occurred.

3e) RECOMMENDATION FOR FAT DEPTH

Although fat depths are collected for different purposes, AUS-MEAT measures fat depth at the P8 site and MSA at the rib site. In the interests of equivalence with other schemes around the world it is recommended that a single measurement at the rib site be used. Adoption of fat depth at the rib site would better align condition scores in the live animal and carcase fat depth. If ribfat was adopted then a standard quartering site would be necessary.

There are large grader effects on fat depth measurement which suggests that current auditing methods need improvement. In addition to the current OSCAP auditing tool it is recommended that regular analysis of grader data be undertaken to help identify those graders which consistently give high or low fat depths.

In the short to medium term, measurements of carcase fatness should be developed that are more accurate at predicting carcase yield than a single fat depth and less prone to bias by fat tearing. Image analysis of the quartering site and measurement of total fat area could address accuracy, grader bias and fat tearing problems. In the longer term it is recommended that other traits to assess fatness (and hence yield) be developed. These could involve X-Ray (eg DEXA or CT Scanning) and would assess fatness or yield of the whole side. Any yield specification may have to include a minimum fat depth to avoid ultra-lean carcases being produced.

4 . CARCASE MATURITY

4a) DEFINITION OF CARCASE MATURITY

Carcase maturity can be assessed in three ways:

- ***Age***

  The age of the animal noted in days or months. The impact of animal age on eating quality has recently been reviewed by Tatum (2011) and Purslow (2014). In young animals, collagen fibres tend to be characterised by heat-labile crosslinks that gelatinise during cooking. As animals get older the collagen crosslinks tend to stabilise to an insoluble heat-resistant form so that less collagen is solubilised during cooking then rendering the meat less tender.

- ***Ossification***

  Carcase maturity may be assessed as a subjective score on the degree of ossification of the dorsal spinous processes of the vertebrae, the fusing of the vertebrae and the shape and colour of the rib bones. The USDA scale for ossification is based on photographic standards which range from 100 to 590 in 10 point increments (Romans et al 1994). MSA ossification scores are based on the US standards.

- ***Dentition***

  Dentition is based on the number of permanent incisors that have erupted on the lower jaw of the bovine. An animal may be born with or without teeth but by one month of age they will have eight temporary teeth or baby incisors. These temporary incisors are replaced by pairs of permanent incisors. Animals with 1 or 2 erupted incisors are recorded as two-tooth, whilst three or four erupted incisors are recorded as four-tooth. Tables for the average age and range in age for incisor eruption in beef have been published by AUS-MEAT (Anon 1998).

  Age can be measured by recording birth date, but in the Australian production systems this is not practical and rarely done. Dentition has the advantage that it can easily be assessed in the live animal, whereas this is not possible with ossification.

  Conversely in carcase form, in the absence of age or dentition, any age estimate is reliant on ossification score. The estimation of any age category is reliant on carry-through of information obtained from the live animal (actual age) slaughter floor (dentition) or at grading (ossification).

4b) BACKGROUND TO THE MEASUREMENT OF MATURITY

AGE

There have been a number of studies which have shown that increasing animal age results in decreased collagen solubility with little or no change in total collagen content (Taylor 2004). This decrease in solubility results in increased toughness in older animals although the relationship is not strong. Shorthose and Harris (1990) examined the effect of animal age (ranging from 1 to 60 months) on the tenderness of a number of muscles in the carcase. They showed that age-associated toughening was more pronounced in high collagen muscles (e.g. silverside or m. biceps femoris) than in the low connective tissue muscles (fillet or *m. psoas major*).

OSSIFICATION

Shackelford et al (1995) reported that ossification was moderately related to chronological age (R^2=0.60). Analysis of over 5000 records in the MSA data base showed a lower coefficient of determination when using ossification score to predict age (R^2=0.46, JM Thompson, *unpublished data*). An interesting outcome of the MSA analyses was the significant interaction between *Bos indicus* content and ossification score which indicated that at the same age, high *Bos indicus* content carcases were more ossified than *Bos taurus* carcases, although there was little difference at the lower ossification scores.

A major factor influencing skeletal maturity is oestrogen activity in the animal (Lawrence 2001a). Studies by Field et al (1996) showed that single calved cows had higher ossification scores than their heifer counterparts. They concluded that any biological event associated with elevated oestrogen levels in the female such as oestrus, late gestation, parturition and lactation would increase ossification score. This was supported by a survey of slaughtered animals where females that had calved had more mature skeletal ossification than heifers (Waggoner et al 1990). Similarly heifers have greater skeletal maturity than steers at the same age (Tatum 2011).

Tatum (2011) reviewed the literature on the effect of HGP implants on ossification and concluded that implants that contained zeranol and oestradiol increased ossification scores in beef carcases. Trenbolone acetate, on the other hand, does not affect skeletal maturation (Crouse et al 1987, Apple et al 1991). In reality most HGP implants contain combinations of hormones and therefore in the Australian context most implanted carcases show some increase in ossification scores.

Spray chilling has also been reported to impact on ossification scores. A report by Allen et al (1987) concluded that the spray hydrated the chine buttons and their ossification appeared to be less mature. This certainly is a potential problem in Australia given the number of plants that have recently installed spray chilling misters. An option that has recently been adopted by a number of Australian plants is to move to scoring ossification hot on the slaughter floor rather than after chilling at grading. A preliminary analysis undertaken by MSA concluded that there was little effect of whether carcases were scored for ossification on hot or cold carcases not subjected to spray chilling (R Watson, *unpublished data*).

A commonly held belief is that ossification score reflects the growth path of the animal, with a varied growth path resulting in an increased ossification score. Practically, the ossification scores from fast and slow growing groups are often confounded with age, in that the slower growing groups are older and hence more ossified.

When the literature is examined more closely there are few studies to support the hypothesis that a variable growth pattern results in increased ossification at the same age. McIntyre et al (2009) showed that slow or restricted growth path compared to fast growth tended in result in higher ossification scores and slightly reduced palatability. However it should be noted that in their study the fast growth group were feedlot finished and so were younger and the carcase had decreased ossification scores and increased intramuscular fat content. Perhaps of more interest were the slow and compensatory growth treatments which underwent vastly different growth paths to be slaughtered at the same age with no effect on ossification scores. Greenwood and Café (2007) showed that when growth restriction occurred in utero followed by ad libitum feed intake there was an effect on ossification score (i.e. low growth had higher ossification score). However if the growth restriction occurred pre-weaning there was no effect on ossification score. A study by McKiernan et al (2009) grew steers at fast and slow growth rates to the same slaughter endpoint. They showed that whilst the slow growth group had slightly greater ossification score they were also five months older and had less marbling than the fast growth group. It was worth noting that the slower growing group (which were older and more ossified) had slightly lower eating quality scores (JR Wilkins, *unpublished data*). Most other studies have failed to report effects of growth path on ossification score.

The effect of growth path effects was further complicated by the review of Purslow (2104). He cited several studies where restricted growth had resulted in increased collagen solubility which would be expected to impact positively on palatability. However Purslow (2014) suggested that simply describing the effects of different growth paths in terms of heat-soluble collagen was perhaps too simplistic. He cited the results of Cassar-Malek et al. (2004) who found changes in connective tissue solubility with restricted growth were muscle dependent.

DENTITION

Estimates of the time of eruption of permanent incisors into the oral cavity of the bovine were reviewed by Lawrence et al (2001a). They found that of the 14 published estimates in the literature the mean eruption times were 24, 30, 38 and 46 months for 2, 4, 6 and 8 teeth respectively. The estimates from AUS-MEAT (Anon 1998) were 18, 30, 36 and 42 months for the same four categories. Therefore, although AUS-MEAT estimates aligned well for categories for 4, 6 and 8 teeth, they underestimated the age of eruption of the first pair of incisors by ca. 6 months compared to mean eruption times from other studies. Hearnshaw et al (1996) provided data from the Grafton crossbreeding project which also supported a later eruption time for the first pair of incisors (a mean eruption time of 27 months for 2T). Their results showed that lower nutrition delayed eruption of the first pair of incisors by up to two months and breed effects could be of the order of two months or more.

CONCLUSION

In his review on maturity measurements and their relationships with eating quality, Tatum (2011) concluded that over a wide range of chronological ages, ossification scores and dentition classes, there were only moderate relationships between these three measures of carcase maturity and eating quality.

Field et al (1997) examined collagen characteristics groups of heifers at the same age which differed in ossification class (category A which were between 100 and 190 ossification score and category C which were between 200 and 290 ossification score). They found no association between percentage collagen, the degree of crosslinking, sensory or objective quality with skeletal maturity. They concluded that collagen traits in the muscle were not directly associated with skeletal maturity. Similarly, one could argue that the physiological changes that occur with age or incisor eruption are not directly associated with collagen metabolism and therefore it is not surprising that the associations between measures of carcase maturity and collagen characteristics were moderate at best.

The question then becomes which measurements of maturity are the most appropriate to use in a beef language aimed at describing variation in eating quality. A useful insight into this question was provided using the Beef CRC data where consumer evaluations were undertaken on 2,300 striploin samples at 14 days' ageing (JM Thompson, *unpublished data*). Using the MSA model inputs which included sex, HGP status, hot carcase weight, marbling score, pH and ribfat, the addition of either dentition or ossification accounted for similar proportions of variance in the prediction of eating quality of the striploin (both ossification and dentition had coefficients of determination of ca. 30%). If age was included in the model then dentition and ossification were both not significant ($P>0.05$), whereas age remained an important predictor of eating quality ($P<0.05$). These results suggest that age as a predictor of eating quality would be the preferable maturity measure, but unfortunately it is not commercially practical for most Australian production systems.

A disadvantage of using dentition is that it is a categorical trait with no ability to discriminate between carcases within a dentition category. Therefore the above MSA analyses were rerun within dentition class. In this data set 60% of the carcases were in the milk tooth category. Within the milk tooth category ossification score accounted for a significant proportion of variation in eating quality, whereas no discrimination was possible with dentition. As production systems improve growth rates will also improve and a greater proportion of the Australian kill will be slaughtered at younger ages. Therefore ossification score does provide a means of describing eating quality on a continuous scale, whereas the dentition can only separate carcases into broad categories.

From the above it can be concluded that chronological age would be a preferable maturity index to use. Over a wide range of maturity, indices had a similar relationship with eating quality. However an important distinction between dentition and ossification score is that effectively dentition has no predictive value below 24 months of age where ossification does. In the short term ossification would be the preferred measure of maturity to use in the Australian beef language, although research is needed to either develop techniques to estimate age or to develop new measurements of maturity that are better related to the development of cross linkages in collagen.

4c) ACCURACY AND BIAS IN THE MATURITY MEASUREMENT

AGE

Whilst it is compulsory in some countries such as the UK to record age it is often dismissed as being impossible in extensive systems in Australia. However there are many different ways age could be measured. If the time at which the bull is introduced is recorded and assuming a gestation length of 284 days then age could be defined as the oldest for that drop of calves simply from joining date and an estimate of gestation. Therefore from a three-month joining and tagging at marking an age within three months could be measured with little additional cost.

Currently age is simply required as a threshold trait for market access. Examples of this are the 30-month limit imposed by the UK government. An age estimate which could guarantee that carcases were less than a threshold age would allow cattle to be marketed with this trait attached to an NLIS number. If a buyer was interested in accessing markets with an age threshold this could add to the value of the animal at sale. The system to capture the data and lodge it with NLIS would need to be part of an audit packages on the property.

It would be naive to assume that this could be adopted across the Australian industry, but it may be a measure that would allow some producers to add a premium to their animals by having a date of birth/birth month/birth quarter recorded.

DENTITION

An area of uncertainty with dentition scoring could arise with partially erupted incisors. The convention is that, upon the first sign of a new eruption, the animal is advanced to the next category. Broken mouths and missing incisors in older cattle such as cull cows are unlikely to be a problem to an experienced grader.

OSSIFICATION SCORES

There is little data on the biases that occur with ossification scoring. This was investigated using the industry data set used for previous traits (JM Thompson and R Polkinghorne, *unpublished data*). The analyses adjusted ossification score for production, processing and carcase traits within grass and grain fed carcases. Grader effects were significant, although within a plant there was no significant relationship between graders in grass and grain fed carcases. Within feed type the differences between graders were of the order of 5 to 10 ossification units. There are several conclusions that can be drawn. Firstly the differences between graders were small, and secondly the small bias occurring between graders was not consistent for grain and grass fed carcases.

4d) TECHNOLOGY TO MEASURE MATURITY

AGE

As slaughter date is available for all slaughtered animals an estimate of birth date would allow age to be calculated. This could be done manually for all animals or as previously described an estimate age calculated for the oldest animal within a calf drop. Where restricted joining is practised there are a range of options to estimate birth date /birth month /birth quarter.

In extensive production systems technology such as walk over weighing (WOW) could be used to monitor live weight of animals remotely. The WOW system is capable of estimating birth date by identifying when the cows weight dropped by approximately 60 to 70 kg weight (i.e. the weight of the newborn calf – Tim Driver, *personal communication*). Such technology would come at a cost and the producer would need to decide if the extra information warranted the capital and labour investment.

DENTITION

Currently dentition is manually or electronically captured on the slaughter floor. Given advances in vision technology it would be possible to develop a system where an image of the hide-off head was captured and the number of incisors counted automatically.

OSSIFICATION

Ossification is currently a subjective score given by a grader on either the hot or cold carcase. Analysis of industry grading data would suggest that graders currently give a score which is not prone to large biases.

In a review by Zheng et al (2014) work by the authors on a vision system to capture and score skeletal ossification was described. The system involved capturing an image of the sawn vertebrae and then devolving the images into bone and cartilage portions. Using a number of data sets which had been divided into training and validation sets they achieved an accuracy of 70-80% in allocating carcases to the correct ossification category (i.e. in 100 unit increments) as assessed by subjective graders. This technology holds promise for the future.

4e) RECOMMENDATION FOR MATURITY MEASUREMENTS

Skeletal maturity may be measured by a number of traits. In terms of predicting eating quality, animal age is probably the best predictor but not easily achievable across the industry at this stage. For some niche markets simple management procedures such as tagging at marking would allow producers to give a guarantee that an animal is younger than a specified age.

Over an extended range of maturity, ossification score and dentition had similar accuracy at predicting eating quality. However for milk tooth carcases, ossification score does predict eating quality, whereas there is no ability for dentition to discriminate between carcases.

In the short term it is therefore recommended that the Australian beef language adopt ossification as a measure of carcase maturity. Given that ossification score and dentition are only moderately related to retain both measures would only be a source of dispute in the industry.

Whilst technology could be developed to predict ossification score R&D funds would be better directed to ways to predict age or alternative maturity measures.

5. MEAT COLOUR

5a) DEFINITION OF MEAT COLOUR

Meat colour is the colour assessed at the rib eye (m. longissimus dorsi) on the chilled quartered carcase after the muscle surface has been exposed to air for at least 20 minutes and not more than 3 hours. The colour scores are referenced against the AUS-MEAT meat colour reference standards in the area of rib eye that displays the most predominant colour. There are nine chips, labelled 1A, 1B, 1C and then numerically up to 7 (Anon 2004).

5b) BACKGROUND TO THE MEASUREMENT OF MEAT COLOUR

The colour of meat is dependent upon the chemical state of the colour pigment myoglobin, which in muscle can occur in three different oxidative states (Mancini and Hunt 2005). In meat that has not been exposed to air the myoglobin pigment is in the form of deoxymyoglobin, which is dark purple in colour. Once the carcase is quartered the oxygenation of the deoxymyoglobin occurs to form oxymyoglobin which is a bright cherry red pigment. As exposure to oxygen increases the oxymyoglobin penetrates deeper into the meat surface. The depth of oxygen penetration and therefore thickness of the oxymyoglobin layer on the cut surface will depend upon muscle pH, muscle temperature, oxygen partial pressure and the competition for oxygen by other respiratory processes. The conversion of deoxymyoglobin to oxymyoglobin is a direct reaction, however the reverse oxidation reaction occurs via metmyoglobin (a rust coloured pigment). Metmyoglobin is formed at a lower partial pressure and hence is prevalent at the bottom of the oxymyoglobin layer in fresh meat which has been allowed to bloom. This rust coloured layer increases in thickness as the oxygenation capacity of the myoglobin decreases it becomes visible from the surface as a muddy brown meat colour.

Ultimate pH is one of the important factors that impact on the changes in meat colour in beef. High pH meat has an increased water-holding capacity (Lawrie 1988) which effectively reduces the penetration of oxygen and hence the formation of oxymyoglobin in the cut surface of the meat. Hughes et al (2014) showed that higher ultimate pH was associated with darker meat and is often referred to as ‘dark firm and dry’ or DFD meat. They concluded that higher ultimate pH meat was associated with more tightly packed muscle fibres, reduced light scattering and only a thin layer of oxymyoglobin on the surface of the meat. It also has a different taste, a higher water holding capacity and is more susceptible to microbial proliferation (Purchas and Aungsupakorn 1993). As there is a curvilinear relationship between ultimate pH and eating quality, DFD meat is not necessarily tougher but is generally more variable in eating quality than normal meat (Wulf et al 2002).

High pH also impedes colour formation or blooming in muscle after quartering (Abril et al 2001). Also, the higher the muscle temperature, the slower the blooming rate because at the higher temperatures the cellular enzyme system are competing with the myoglobin for oxygen. The AUS-MEAT standards require that meat colour be assessed in a window from 20 minutes to 3 hours post quartering (Anon 2004). It is of interest that the USDA beef grading scheme only requires a minimum of 10 minutes between quartering and grading (Anon 1997). Young et al (1999) examined bloom time in beef carcases over a range of ultimate pH and concluded that measures of chroma continually increased up to 10 hrs post quartering. Young et al (1999) and Suman et al (2014) have questioned the value of meat colour at grading as a predictor of meat colour in the display cabinet. Certainly the longer the meat is aged the poorer the relationship between colour at grading with colour at display.

Generally there is a strong relationship between ultimate pH and meat colour score. Recent data would indicate that this is not always the case and examples of producers having carcases excluded on meat colour but having acceptable pH have become relatively common.

Murray (1989) investigated the effect of early grading of carcases on meat colour scores and ultimate pH. The study was prompted by an industry survey that showed if grading was done early then nearly 4% of carcases had dark meat colour, whereas only 0.5% had pH over 6.0. Murray's study showed that if grading was done at 15-18h post mortem dark meat colour scores were three times more likely than if grading was done at 23-26h post-mortem, apparently because of incomplete development of muscle colour at the early grading time.

Hughes et al (2014) also investigated the effect of time from slaughter to grading on meat colour scores. They showed that over the time interval between 14 and 31 hours from slaughter to grading there was a difference in meat, with earlier grading resulting in darker meat colour scores. They suggested that this was possibly due to slightly higher pH with earlier grading resulting in swollen myofibres allowing greater light penetration into the meat which is absorbed by the myoglobin. Consequently with early grading times there is less scattered light and the meat is initially darker. As the time from slaughter to grading is increased the muscle fibres shrink with greater oxygen penetration resulting in brighter meat colour scores. Both the studies by Murray (1989) and Hughes et al (2014) support a lightening of meat colour as the time between slaughter and grading increases.

Hughes et al (2014) also reported that the rate of pH fall can also impact on meat colour scores. A rapid decline in pH relative to temperature can result in protein denaturation due to the effect of the hot acid. As reported by Kim (et al (2014) the increased protein denaturation results in lower water holding capacity which generates drip and increases light scattering on the surface of the muscle, hence lighter meat colour.

5c) ACCURACY AND BIAS IN MEAT COLOUR

Some of the factors that can impact on the accuracy and repeatability of meat colour scores have been mentioned, in particular temperature at grading. As discussed previously at higher temperatures the competition for oxygen to form oxymyoglobin is greater and the resultant meat colour scores are darker.

Grader effects on meat colour scores have received little attention in the literature but are likely given the subjective nature of meat colour scoring systems. Utilising a large industry dataset the effect of grader on meat colour scores was examined after adjustment for production, processing and carcase traits (JM Thompson and R Polkinghorne, *unpublished data*). In these analyses the categorical meat colour scores were treated as a continuous variable with 1A, 1B and 1C treated as 1.0, 1.33 and 1.67 respectively. At all plants examined, grader effects on meat colour scores were highly significant ($P<0.05$). Within plants the mean differences between graders were of the order of 0.8 of a colour score. To test the repeatability of the grader effects the correlation between graders within plants was examined in grass and grain fed carcases. In some plants grader means were highly correlated, whilst in others there was no relationship. This showed that in all plants there were large differences between graders and that in some plants similar ranking of graders was found in grain and grass finished carcases. In other words, in some plants individual graders were on average scoring almost 1 colour unit higher in both grain and grass fed carcases. It was important to note that this bias occurred with graders being audited bi-monthly using the OSCAP system.

The dataset also allowed the effect of time between slaughter and grading on meat colour scores to be examined within grain and grass carcases. In all cases the time between slaughter and grading had an effect on meat colour scores. If grading was delayed from 18 to 48 hours the meat colour scores decreased by 0.1 to 0.3 of a meat colour score. This result aligns with the results of Murray (1989) who also showed a significant decrease in dark meat colour of carcases that were graded later. Presumably this improvement was associated with more rapid blooming as the enzyme activity which was competing for oxygen declined and the conversion of deoxymyoglobin to oxymyoglobin increased. In some plants the meat colour became darker if carcases were left another 48 hours before grading. As discussed by Young et al (1999) this could indicate that all enzyme systems were slowing down after four days post-mortem.

The industry data set (JM Thompson and R Polkinghorne *unpublished data*) also allowed the lack of correlation or disconnect between meat colour score and ultimate pH to be investigated. As mentioned previously ultimate pH and meat colour scores are highly correlated, but in some instances there are a significant proportion of carcases graded with high meat colour and low pH. Effectively this excludes these carcases from MSA grading.

At five different plants the level of disconnect between meat colour and pH in grain finished carcases varied from 0 to 3.0% of cattle graded. However in grass finished carcases it was much higher, ranging from over 1.0% to 7.0% of cattle graded at those plants suggesting that the problem was associated with particular processing plants and also to particular producers supplying cattle to those plants. Whilst at a national level the disconnect between pH and meat colour scores was relatively small it had a large financial impact on particular producers supplying to those plants. It was of note that McGilchrist (2014) examined the disconnect in over 1 million carcases processed in southern Australia and found that overall the disconnect between pH and meat colour at grading at these plants to be negligible.

Time to grading had a large effect on the disconnect supporting the results of Murray (1989) that in early-graded carcases there is incomplete development of muscle colour at ca. 18 h after slaughter. Following on from Murray (1989) where a proportion of carcases were found to have low pH but dark meat colour Holdstock (2014) examined eating quality in carcases from three groups, namely those that were normal (i.e. Canadian grade AA low pH and low meat colour), atypical (i.e. AT low pH and high meat colour) and finally DFD carcases (i.e. high pH and high meat colour). They reported a significant increase in sensory toughness scores in the AT group (i.e. with low pH and high meat colour). However, this was contrary to the results of a recent analysis by Kelly and Thompson (2014) which used data from the Long Distance Transport experiment. This study showed no difference in eating quality between striploin samples from normal carcase (AA, i.e. low pH and low meat colour) and atypical (AT, i.e. low pH and high meat colour carcases) and DFD carcases (i.e. high pH and high meat colour).

If expression of meat colour at grading is delayed this can have a large financial impact on individual producers as most Australian grids include a threshold for meat colour scores, above which carcases are excluded. What is concerning is that when carcases with a dark meat colour score but low pH are re-graded many of the re-graded meat colours are acceptable (JM Thompson and R Pokinghorne *unpublished data*). Also relevant to the question about meat colour scores are the conclusions of Young et al (1999) and Suman et al (2014) that the relationship between meat colour scores at grading and later at retail display is poor at best. With the review of the Australian Beef Language it is timely to ask whether meat colour at grading is a useful trait for inclusion in the beef language. Since the introduction of MSA the beef language includes ultimate pH. It is possible that ultimate pH at grading does a much better job of identifying primals which are dark at retail than meat colour score at grading.

It is clear that there are many questions about the usefulness of meat colour scores. The MSA Pathways group recently removed meat colour from its specifications as it concluded that meat colour scores did not contribute to prediction of eating quality in the presence of other inputs (including pH) for the MSA model. There are many unanswered questions as to why blooming of meat colour is delayed in some carcases and the relevance of meat colour scores at grading to meat colour at retail display.

5d) TECHNOLOGY TO MEASURE MEAT COLOUR

The magnitude of the grader bias in scoring meat colour indicated that in future if meat colour scores are included as a trait in the Australian beef language then efforts should be made to move towards an objective measurement of meat colour. When the current AUS-MEAT chips are assessed using a Minolta colour meter the relationships between the CIE L*a*b* dimensions and the 10 colour chips are not linear for the a* and b* dimensions (Thompson JM and Polkinghorne R, *unpublished data*). This is particularly noticeable for the 1A chip which has similar a* and b* readings to the 6 meat colour chip. As digital data capture and analysis within the supply chain increases the need to treat meat colour as a continuous variable will become more important.

Colorimeters are used across a range of industries as a means of objectively describing colour. The most widely used is the CIE, L*a*b* system which describes colour as a three-dimensional space. As discussed by Tapp et al (2011) there are problems in standardisation and use of the colorimeters which need to be addressed. However even if these are addressed a number of recent studies have shown that the vision systems have the capability to provide a better description of meat colour than the colorimeters (Tinderup et al 2015).

More recently there have been a number of studies that have evaluated multispectral imaging systems to describe meat colour and have concluded that they are superior to simple red, green and blue (RGB) analysis of captured images and have the potential to provide a better description of what the eye captures in terms of meat colour. The Sheep CRC is currently evaluating a multispectral vision system for intramuscular fat percentage in lamb. This would provide an opportunity to broaden their study to include meat colour of bloomed meat in beef.

5e) RECOMMENDATION FOR MEAT COLOUR

In the short term, research inputs are required to quantify the benefits of meat colour at grading as a tool to predict display colour over and above the measurement of ultimate pH.

Also, the magnitude of the grader bias on the allocation of meat colour scores is concerning and needs addressing. The disconnect between meat colour and pH is also a concern and needs to be addressed, because whilst not a huge problem on a national level it does appear to be a particular problem for some plants and some producers.

The preference would be to discard meat colour as a trait in the Australian Beef Language and rely on ultimate pH to identify dark cutting meat at retail. Failing that if the measurement of meat colour is to be retained as a trait in the Australian Beef Language research inputs are required to development technology to measure meat colour in an accurate and repeatable manner. This would most likely involve use of a vision system, but more likely would utilise technology such as colorimeters (such as the Hunter or the Minolta) or multispectral scanning.

6. FAT COLOUR

6a) DEFINITION OF FAT COLOUR

Fat colour is a subjective assessment of the colour of the intermuscular fat lateral to the rib eye muscle and adjacent to the m. iliocostalis. It is assessed on the chilled quartered carcase and scored against the AUS-MEAT fat colour reference standards on a 10-point scale from white (0) to yellow (9) (Anon 2005).

6b) BACKGROUND TO THE MEASUREMENT OF FAT COLOUR

White fat is more acceptable to consumers in both domestic and export markets and hence fat colour is often included as a specification in marketing grids as a threshold where the fat must have a colour score less than a specified colour chip (usually less than a fat colour 3, Anon 2013). Yellowness in fat is due to the presence of carotenoid pigments within the adipocytes. The main pigment causing yellowness is beta-carotene which is a major precursor of Vitamin A (Tume 1995).

An early Australian abattoir survey conducted by Walker et al (1990) found significant effects of feed type, breed, breed age and sex along with several interactions on fat colour. Feedlot carcases had whiter fat than grass fed carcases as did British breed carcases compared with dairy breeds. Steers had whiter fat than females and those with less than eight erupted incisors had whiter fat than those with more than eight incisors erupted. From a sample of 662 carcases (of which 63% were pasture fed and 37% grain fed), Walker et al (1990) reported that using fat score 3 as a threshold 15% of the carcases would incur a penalty on fat colour. Using a more recent data set with over a million carcases the proportion of carcases with fat colour scores greater than 3 was 8% whilst in grain fed carcases it was less than 0.1% (JM Thompson and R Polkinghorne *unpublished data*). This decrease in yellow fat in the more recent data was possibly due to improved growth rates for cattle resulting in slaughter at a younger age.

There is a perception by the consumer that fat colour impacts on negatively on eating quality. This most likely stems from yellow fat accumulating more in older dairy type cows which in turn produce tougher meat. Small changes in fatty acid composition and antioxidant content are detectable but whilst associated with yellow fat are more a consequence of pasture feeding, as opposed to grain feeding (Dunne et al 2009).

6c) ACCURACY AND BIAS IN THE FAT COLOUR

There are few published data on the accuracy or biases in fat colour scores. The industry data set described previously was also used to quantify the significance and magnitude of the grader effects on fat colour scores after adjustment for production, processing and carcase traits (JM Thompson and R Polkinghorne *unpublished data*). Analysis showed a significant grader effect at all plants ($P<0.05$). The magnitude of the range of grader means was of the order of 0.2 to 1.0 fat colour scores. Given the bulk of the carcases had very low fat scores this was a relatively large grader effect and cause for concern.

These grader effects are occurring with OSCAP being used as the auditing tool. As for other traits a corrective action would be to regularly analyse grading data and provide feedback to graders and further training where necessary.

6d) TECHNOLOGY TO MEASURE FAT COLOUR

The colour dimension b* of the CIE, L*a*b* system represents the change from blue to yellow and has been used successfully by several researchers as an objective tool to measure fat colour in beef carcases (Walker et al 1990, Dunne et al 2004). Certainly in the medium term the industry should try to develop objective techniques to measure fat colour, but it is stressed that the technology should be bundled so that it is capable of measuring a number of traits (e.g. marbling score, meat colour, fat depth or fat area over loin and eye muscle area) to warrant the development and capital costs of the equipment.

6e) RECOMMENDATION FOR FAT COLOUR

Whilst fat colour has little relationship to yield or eating quality traits it is considered important by consumers and generally the market specifications are for whiter fat colours.

Even though it is audited by OSCAP, grader bias is often evident and large relative to mean fat colour scores. It is recommended that regular analysis of grader data be undertaken to help identify those graders which consistently give high or low fat colours.

In the longer term resources should be invested to develop image analysis methods providing the technology is bundled to include a number of traits.

7. EYE MUSCLE AREA (EMA)

7a) DEFINITION OF EYE MUSCLE AREA IN BEEF CARCASES

AUS-MEAT defines EMA as the area of the surface of the *M. longissimus dorsi* at the ribbing site and is calculated in square centimetres. Currently with AUS-MEAT, EMA may be measured at the 10th, 11th, 12th or 13th rib sites (Anon 2010).

EMA is measured using the AUS-MEAT acetate grid which has one cm squares marked. This grid is laid over the quartered eye muscle and the number of square centimetres which are either inside or touching the boundary of the eye muscle are counted. The number of squares inside the muscle are weighted by 1 and the number that are only partially within the boundary are weighted by 0.5. The numbers of full and partial squares are added to estimate eye muscle area.

7b) BACKGROUND TO THE MEASUREMENT OF EYE MUSCLE AREA

Currently EMA is provided as a stand-alone measurement. Obviously it is positively related to carcase weight but as EMA is a two-dimensional measurement and carcases are three-dimensional the expectation is that EMA will increase less slowly than carcase weight (i.e. EMA is early maturing relative to carcase weight). Therefore simply expressing eye muscle area as a ratio of carcase weight will disadvantage heavier carcases.

Whereas EMA has little value as a standalone measurement it is a useful indicator of muscle or lean in the carcase when it is considered along with other carcase measurements as an input into regression equations to predict carcase yield. A number of authors have published equations to predict percentage carcase yield which use a combination of hot carcase weight, fat depth and eye muscle area (e.g. Johnson et al 1995, Hopkins and Roberts 1995, Johnson and Baker 1995). As expected due to different numbers of carcases used, their weight ranges, the location of the measurements and the carcase trim specifications the accuracy varies enormously. Generally eye muscle area accounted for a significant amount of the variation, which testifies to its important in any equation to predict percentage carcase yield.

7c) ACCURACY AND BIAS IN THE MEASUREMENT OF EMA

Hopkins and Roberts (1995) compared methods of measuring EMA at the 10th and 5th rib sites. They found that the acetate grid method only accounted for ca. 65% of the variance in planimeter measurements at the same site. In addition they showed no relationship between eye muscle area at the 5th and 10th rib sites.

Currently EMA is simply reported as a carcase trait and is not part of an algorithm to predict carcase yield. If EMA were incorporated into a yield prediction model standardisation of the measurement would be much more important. This would include ensuring a square cut across the loin muscle at the quartering point, ensuring a standard rib number was used and exclusion of adjoining muscles such as the *Mm. mutifidius dorsi*, *spinalis dorsi* and *iliocostalis*.

Obviously, dropping the spencer roll on the forequarter negates any useful measurement of EMA at grading unless a digital system can be devised to measure EMA on the hind quarter portion.

7d) TECHNOLOGY TO MEASURE EMA

The acetate grid was perhaps the only option available to measure EMA when AUS-MEAT was implemented. Currently EMA is only reported as a standalone measurement and is seldom part of any grid specifications.

If as anticipated the push to develop value based marketing increases the importance of EMA as an accurate standardised predictor of carcase yield will increase. Given this, it is recommended that digital technology such as VIASCAN be used to capture an image of the quartered carcase to calculate an accurate EMA. Algorithms already exist that can automatically trace the boundary of the eye muscle to calculate area. If VIASCAN is not suitable then more portable alternatives should be developed.

7e) RECOMMENDATIONS FOR EMA

Currently EMA is reported as a stand-alone measurement. If it is to be used as part of an algorithm to predict carcase yield the site of measurement needs to be standardised.

The measurement of EMA using digital technology, with internal standards to account for varying focal length, should be investigated.

8. ULTIMATE PH

8a) DEFINITION OF ULTIMATE PH MEASUREMENT IN MEAT

Ultimate pH measures the acidity and alkalinity in post-rigor muscle. pH is measured on a 1 to 14 scale, although in meat the range is rather restricted from 7.0 in the live animal to a minimum of 5.4 in the post rigor carcase. pH is measured as the negative antilog of the hydrogen ion concentration in the meat. The live animal has a pH around 7 (ie a concentration of hydrogen ions of 10-7).

After death anaerobic metabolism in the muscle converts muscle glycogen to lactic acid and hydrogen ions. If there is sufficient glycogen at slaughter hydrogen ion concentration will increase and the muscle pH will decline to a plateau of 5.4 (i.e. a concentration of hydrogen ions of 10-5.4) before the acidic conditions in the muscle inhibit further enzyme activity.

8b) BACKGROUND TO THE MEASUREMENT OF ULTIMATE pH

Ultimate pH was first used in the Australian meat industry as a measurement tool to exclude high pH carcases from chilled vacuum pack export consignments. Vacuum packs with high ultimate pH meat had a higher risk of 'greening' during shipment which led to down-grading or rejection of consignments at the destination port.

More recently pH has been used by MSA as an objective measurement of whether the animal had sufficient glycogen reserves to achieve an ultimate pH consistent with acceptable eating quality, meat colour and shelf life. Ultimate pH has a curvilinear relationship with eating quality (Bouton et al 1973, Purchas 1990, Jeremiah et al 1991), with a trend for the most tender meat to be either low (i.e. pH of 5.5) or high (i.e. pH of 6.5) pH, with intermediate pH meat being the toughest (i.e. pH 6.0). The curvilinear relationship is thought to be due to greater activity of calpains and cathepsin at higher and lower pH levels (Lomiwes et al 2013). Unfortunately at high pH the higher tenderness is also associated with a different taste and greater susceptibly to spoilage. Watanabe et al. (1996) reported that as meat is aged the curvilinear relationship between ultimate pH and tenderness weakened, although this was not a universal finding (see Purchas et al 1999). High pH meat also has a darker meat colour and higher water holding capacity (Monin 2004). Reasons for the differences in meat colour between normal and high pH meat are discussed in section 5 (meat colour).

The higher water-holding capacity means that meat from high pH cuts can often appear to be drier, although this does not always translate to lower juiciness scores in the cooked meat. It should be noted that although ultimate pH is related to eating quality the predictive accuracy of this measurement in isolation of other input traits is not particularly high (Watson et al 2008).

8c) ACCURACY AND BIAS IN THE MEASUREMENT OF ULTIMATE pH

A question often asked about pH measurements is their repeatability. A small study on the repeatability of the current TPS glass electrode pH meter was undertaken for AUS-MEAT (JM Thompson, A Blakely and P Reynolds, *unpublished data*). Analysis of over 750 repeated pH measurements using different cuts/primals, operators and allowing for recalibration of the meters concluded that an error range of ±0.05 of a pH unit would be expected to contain ca. 90% of the readings. If these sources of variation were ignored then an error range of ±0.05 pH units would be expected to contain ca. 80% of the readings. In effect this showed that readings from the pH probe were very repeatable with a standard deviation of ±0.04 pH units. In other words 66% of the readings would lie within ±0.04 units of the true value.

There was also an opportunity to use industry data to examine the effect of grader and time from grading on pH measurements (Thompson JM and Polkinghorne R *unpublished data*). Analyses of over one million grading data from five separate plants showed four had significant ($P<0.05$) grader effects for the measurement of ultimate pH, after adjustment for production and processing and effects. However the magnitude of these grader differences were generally less than 0.10 pH units and given the standard deviation for pH measurements would not be considered large.

Similarly there were also significant time from slaughter to grading effects, whereby pH decreased a further 0.01 units from the reading obtained at 18 hours compared to grading at 48 hours after slaughter. Again given the variance associated with the pH measurement this would not be considered important.

What was of concern for pH measurements were the results of McGilchrist (2014). He examined the distribution of pH readings from a total of 1.25 million carcases from nine processing plants. The pH readings appeared to be normally distributed in all plants, except around the MSA threshold of 5.7 where there appeared to be a significant decrease in the numbers of carcases grading just over 5.7. This drop in the number of carcases with pH readings between 5.70 and 5.72 was unexpected. Reasons for this are not clear but do suggest that readings were being manipulated by graders to pass carcases that were just above the threshold. Whatever the reason for the change in the pH distribution it suggests that pH readings were not being reported in an unbiased manner.

8d) TECHNOLOGY TO MEASURE ULTIMATE pH

Ultimate pH in meat is commonly measured using a multimeter to detect the current between a glass and reference electrode. In pre-rigor carcases the small amount of current is thought to accelerate glycolysis and therefore if the pH meter is left in the muscles or the probe is reinserted into the same hole in the muscle the reading from the pH meter will be below the real value. Whilst this is not a problem in post-rigor carcases where chemical energy in the muscle has been depleted and the glycolytic enzymes are no longer active, this has implications for developing pH probes to automatically log pH decline in pre-rigor carcases.

Other technologies to accurately and rapidly measure pH in post-rigor muscle are limited. Colour indicator strips have been examined in earlier MLA studies but found to lack the required accuracy. Colour indicator strips are also cumbersome for use in the chiller.

There are alternative electrode methods available for pH measurement. These use different electrodes made from platinum, quinhydrone or antimony. Most have problems with protein coagulation in the meat.

More recently a semiconductor pH sensor has been developed. This sensor, known as an ion sensitive field effect transistor (ISFET), is not only resistant to damage but also easily miniaturised. Miniaturisation allows the use of smaller amounts of sample for measurement, and makes it possible to perform measurements in very small spaces and on solid state surfaces. This sensor promises useful applications in measurement in the fields of biology and medicine. However, to date prototypes of such devices have been disappointing in real-world applications for the meat industry.

The measurement of ultimate pH is currently undertaken as part of MSA chiller grading. Whilst in the hands of a trained operator the technology provides a reasonably accurate measurement of pH there are problems with repeatability, cleaning the probe (protein build-up), calibration, equilibration and temperature correction. As the pH measurement is a function of the sample temperature MSA has incorporated a ‘Bendall correction’ to adjust ultimate pH readings to 7oC (Bendall and Wismer-Pedersen, 1962).

One of the problems with the measurement of ultimate pH is that it cannot be determined until the meat has effectively depleted glycogen reserves, or that the activity of the glycolytic enzymes in the muscle has ceased due to low pH in the muscle. Young et al (2004) proposed collecting a muscle sample from the pre-rigor carcase, reacting it with amyloglucosidase and using a diabetic meter to measure the liberated glucose which could be converted into an estimated ultimate pH. They also found the prediction of ultimate pH was improved if lactate was also included in the calculation. Young et al suggested that the method was suitable for on-line application in beef slaughter chains with a sample turnaround was of the order of 7 minutes. Knowing ultimate pH at the end of the slaughter chain would allow sorting of carcases into boning runs prior to chiller entry and would be invaluable for hot boning plants.

The evaluation by Young et al (2004) did not quantify the error rate of their predicted ultimate pH in a commercial environment. This was investigated as part Beef CRC II (G Gardner and JM Thompson; *unpublished data*). In this study muscle samples from 602 domestic grain-fed carcases were taken at the hide puller along with a pH measurement. Overall accuracy of prediction was high at 80%, however the misclassification rate was a concern. Eighteen percent of carcases classified by the glucose reading as being low pH (ie <5.7) were in fact high pH (ie >5.7). Of less importance but still a concern were those carcases which were predicted as high pH, where 42% of the time they were low pH. These results were obtained in a sample with a relatively low level of dark cutting (11% had pHu > 5.7) and the usefulness of the technique may improve with higher levels of dark cutting. However the misclassification rate of the rapid glycogen technique was too high for implementation in the Australian industry.

Other technologies to measure ultimate pH in muscle include visible-near infrared spectroscopy (NIR). In the post-mortem carcase NIR appears capable of providing an accurate measurement of ultimate pH (Craigie et al 2014). Given that NIR can predict glycogen in muscle it follows that it can predict ultimate pH from pre-rigor measurements (Reis and Rosenvold 2014). As discussed previously a pre-rigor measurement of pH would be valuable particularly in hot boning plants, although the value of NIR to measure pH in the post-rigor carcase could simply be viewed as replacing a simple cheap robust measure (i.e. pH meter) with a more expensive complicated predictor (i.e. NIR).

8e) RECOMMENDATION FOR ULTIMATE pH

The industry should continue to use the glass electrode to measure pH in both pre- and post-rigor carcases. In the hands of a trained operator the measurement is accurate to ±0.04 pH units, which is sufficient for industry needs. Other technologies such as NIR could predict ultimate pH, although there would appear to be limited gain in any investment to replace the pH meter unless a number of technologies were bundled to measure a range of carcase traits.

9. HUMP HEIGHT

9a) DEFINITION OF HUMP HEIGHT

Hump height is measured using a ruler parallel to the surface of the sawn chine and perpendicular to the 1st thoracic vertebrae. Height hump is measured from the paddy wack (*Ligamentum nuchae*) to the highest point of the hump. Hump height is measured with a ruler in 5 mm increments.

9b) BACKGROUND TO THE MEASUREMENT OF HUMP HEIGHT

The MSA model uses *Bos indicus* content as one of the key predictors of eating quality. Numerous studies have shown that varying degrees of *Bos indicus* content impact negatively on eating quality (Crouse et al 1989; Hearnshaw et al., 1998; Wheeler et al 1999. Morgan et al 1991, Sherbeck, et al 1995, Rymill, 1997) and that the magnitude of the effect interacts with muscle (Shackelford, et al 1995, Thompson et al 1999).

Initially *Bos indicus* content was declared on the National Vendor Declaration (NVD) and this was visually verified by the MSA grader using photographic standards. In mixed lots the *Bos indicus* content was taken as the highest in the lot, primarily as a safeguard to protect the consumer against receiving a piece of meat which ate below expectation.

Hump height was introduced as a MSA measurement as a cross-check to assist phenotype assessment against declared tropical breed content (TBC) and to assist in accurate estimation of tropically-adapted *Bos taurus* or Africander cattle. In addition there was a request from the feedlot sector for a carcase measurement that did not necessitate drafting animals into like phenotypic groups at the abattoirs

Sherbeck et al (1996) showed that the *Bos indicus* content was positively associated with hump height. In lieu of other commercial predictors MSA quantified the relationship between *Bos indicus* content and hump height adjusted for carcase weight and included it as an option in the MSA model. Initially this option was only for feedlotters but over time it was used by all sectors of the beef industry as an alternative method of estimating *Bos indicus* content from carcase measurements. A recent review of grading records indicated that using hump height and carcase weight was now the preferred method of estimating *Bos indicus* content for MSA cattle, particularly in northern Australia where lots have varying content Brahman content (MSA, *unpublished data*).

9c) ACCURACY AND BIAS IN THE MEASUREMENT OF HUMP HEIGHT

As hump height is a relatively recent addition to the Australian Beef Language there is little information on the accuracy or bias that can occur in measuring the trait. MSA has examined hump height taken on hot and cold carcases and concluded that there was no difference between the two measurements (J Lau personal communication).

Using a large industry dataset of 82,500 records, an analysis was undertaken of hump height measurements that had been recorded on carcases of known TBC (JM Thompson and M Kelly, *unpublished data*). The analyses examined variation between graders in measurement of hump height from the different works after adjustment for TCB and carcase traits (carcase weight, marbling, ossification, rib fat and pH). The results showed that whilst significant ($P<0.05$), grader effects only accounted for a small proportion of variance in hump height within works. In effect most graders had mean hump height measurements which were within a range of 10 to 15mm. However, what was concerning was the difference between works.

Again these differences in carcase traits due to location are occurring in the presence of the OSCAP system, which suggests that if carcase measurements are to be applied in a standard manner across the country more attention to grader assessment is needed.

9d) TECHNOLOGY TO MEASURE HUMP HEIGHT

A recent MLA project (Kelly and Thompson 2014) used DNA single nucleotide polymorphisms (SNP) to accurately describe *Bos indicus* content in a number of MSA data sets. After imputation, the 10K SNP chip was capable of accurately predicting *Bos indicus* content (R2=98%). However the cost of the SNP chip at $40/profile is unlikely to be routinely used in the foreseeable future and therefore measurement of traits such as hump height and carcase weight are the only option currently available to industry.

The results from Kelly and Thompson (2014) showed that when evaluated with the other MSA traits, *Bos indicus* content predicted from hump and carcase weight was of similar accuracy as *Bos indicus* content predicted from DNA technology, even though the current algorithm using hump height and carcase weight tended to underestimate *Bos indicus* content at the lower levels. Therefore when used to predict eating quality both methods accounted for a similar proportion of variance in eating quality because in effect the curvilinear relationship between *Bos indicus* content by hump and *Bos indicus* content by SNP chip did not change the ranking of carcases in these analyses. This change in the algorithm to calculate TBC from hump height and carcase weight will be reviewed by the MSA Pathways Committee.

Using a large industry data set where *Bos indicus* content was known the MSA algorithm was optimised so that the bias in using hump and carcase weight to estimate *Bos indicus* content was minimised across the range of *Bos indicus* content.

From a practical viewpoint there may be issues with accurately measuring hump height at grading in the chiller if the neck has been hot boned and the paddy wack removed prior to chilling. As neck boning occurs after the scales, hump height could be recorded hot on the floor or as part of the routine AUS-MEAT measurements at the scales.

Although no data are available it is possible that images used to monitor compliance with the standard carcase definition could be used to automate a measurement of hump height.

9e) RECOMMENDATION FOR HUMP HEIGHT

It is recommended that the industry continue to use hump height and carcase weight to predict Bos indicus content in carcases. Sources of bias for hump height measurement are not well understood and should be further investigated. In addition removal of the paddy wack should be investigated and if necessary measurement of hump height at the carcase scales before any neck boning occurs should be investigated.

10. BUTT SHAPE

10a) DEFINITION OF BUTT SHAPE

Butt shape is a subjective shape score based on the visual silhouette of the beef hindquarter. The scores are on a five point scale from A to E, with A being the most convex and E the most concave (McKiernan, 2001).

Although not supported by data, purportedly the more convex the butt shape the higher proportion of butt cuts and also higher carcase yield. There is also the belief in some sectors of the industry that a convex butt shape is also associated with higher eating quality.

10b) BACKGROUND TO THE MEASUREMENT OF BUTT SHAPE

Butt shape, or a conformation score, has been a feature of many beef carcase description schemes around the world (Jones et al 1977, Bass et al 1981, Kempster et al 1982). Initially AUS-MEAT included butt shape as a mandatory measurement in the beef language (Anon 1987). Since then a number of studies have questioned the usefulness of butt shape as a predictor of carcase yield traits. Taylor et al (1990) concluded that butt shape had no relationship to percentage saleable meat yield, muscle or fat in the carcase. In addition they showed that even in the presence of HSCW and fat depth, butt shape added nothing to the prediction of yield measurements.

In a report to the Australian Meat and Livestock study into butt shape Thornton (1991) gave the strong recommendation that "there is no indication of a useful role for butt profile in the estimation of saleable meat yield". This was supported in a study by Johnson et al (1996) in which the usefulness of butt shape was examined in several different breeds. They concluded that butt shape was not related to proportions of intermuscular fat, muscle or bone, but was associated with the proportion of subcutaneous fat. The implications of these results were that as butt shape score increased from E to A there was a trend for increased subcutaneous fat which was the opposite effect of the intention of the butt shape score.

Subsequently butt shape or butt profile was dropped as a mandatory trait for AUS-MEAT but it was still retained in the AUS-MEAT Language as an optional trait. It is often included as a specification in market grids and at various times has been the subject of criticism from producers who feel that they have been unfairly penalised by a subjective trait that is not related to yield or carcase value.

Butt shape is not to be confused with muscling score which has been shown in a number of studies to have moderate association with lean meat yield. Muscle score in both the live animal and in the carcase is a score which is based on the thickness of the muscle with the scorer making an adjustment for carcase fat. McKiernan (1995) makes the case that unlike butt shape, muscle score is a three-dimensional score of the muscularity of the carcase rather than the two-dimensional silhouette for butt shape which makes no adjustment for fatness. The earlier work of Perry et al (1993) reported a correlation of 0.6 between carcase muscle score and percentage saleable meat yield. These results aligned well with a number of European studies which showed that EUROP score (a subjective conformation score measured on a 15-point scale) was moderately related to carcase yield, although less so with the distribution of high-priced cuts (Drennan et al 2007, Craigie et al 2012).

There are few data on the eating quality of cattle which differ in butt shape /conformation /muscling score. An early study by Taylor (1982) used Yeates' fleshing index to describe carcase shape and showed that it did not impact on eating quality as assessed by sensory and objective methods. Care needs to be taken with these results as carcase numbers were low. A more recent study utilised steers from the high and low muscling lines developed by the NSW Department of Agriculture to examine if there were differences in eating quality between the extremes in muscling between the lines (Café et al 2012). Steers with one copy of the myostatin gene were excluded from the analysis. The difference between the high and low lines in muscling was larger than the between-breed extremes which exist in the Australian industry. Using the MSA consumer tasting protocol the results showed no difference between the high and low muscling lines in tenderness, juiciness, like flavour overall liking and the composite MQ4 score.

It is interesting to note the history of conformation score in the USDA beef grading scheme. In 1962 it was proposed that conformation be dropped from the grading scheme because it had been shown to be unrelated to differences in palatability and the relationship to yield was better measured by yield grades (Anon 1997).

10c) ACCURACY AND BIAS IN THE MEASUREMENT OF BUTT SHAPE

Kempster et al (1982) made the point that subjective conformation scores are always subject to error, the magnitude of which will depend upon the competence of the assessors. However in reporting these studies this error is rarely quantified. No results were found to quantify the repeatability of butt shape scoring in beef carcases.

It is interesting to examine the frequency distribution for butt shape scores in industry data sets. Using over 1 million records it was found that over 99% of the butt shape scores were C. Within plants some graders exclusively scored all carcases as butt shape C, with no other scores given. In addition to the lack of relationship between butt shape and carcase yield or eating quality the results from the industry data set effectively means that butt shape has no ability to discriminate between carcases.

10d) TECHNOLOGY TO MEASURE BUTT SHAPE

Initially, simple linear dimensions taken on the carcase or an image of the carcase provided relatively poor prediction of conformation in carcases (Kempster et al 1982), although if measurements were expressed as ratios rather than simple linear measurements their prediction accuracy improved (Bass et al 1981). With the development of Video Image Analysis (VIA) techniques in Australia, the US and Europe the accuracy of using a large number of linear measurements provided a reasonable measure of carcase conformation (see Craigie et al 2012). However the logic of developing sophisticated technology to measure something like conformation (or butt shape) which at best only has a moderate to poor relationship with carcase yield must be questioned.

10e) RECOMMENDATION FOR BUTT SHAPE

A large body of research has concluded that a more convex butt shape is not related to improved carcase yield and it is therefore recommended that this trait be removed from the Australian Beef Language.

Subjective conformation or muscling scores have some predictive power for carcase yield but given the potential in the medium term for whole body scanners to directly predict yield it is unlikely that conformation or muscling would be useful additions to the Australian Beef Language.

11. SEX CATEGORY

11a) DEFINITION OF SEX CATEGORIES

The current AUS-MEAT language refers to sex in the basic and alternate categories for beef and bull with reference to dentition (Anon nd).

BASIC CATEGORY

- Veal (V) – carcases with no permanent incisors under 70 kg carcase weight. Carcases can be from heifers, steers or bulls, the latter showing no secondary sex characteristics (SSC).
- Beef (A) – carcases with less than eight permanent incisors greater than 70 kg carcase weight. For Beef A carcases can be from heifers, steers or bulls, the latter showing no SSC.
- Bull Beef (B) – carcases with less than eight permanent incisors greater than 70 kg carcase weight and can be entire male or castrate male showing SSC.

ALTERNATIVE CATEGORIES TO BEEF

In these categories sex is defined within dentition categories.

- 0 permanent incisors carcases can be either yearling beef (Y) or yearling steer (YS)
- 0-2 permanent incisors carcases can be either young beef (YG) or young steer (YGS)
- 0-4 permanent incisors carcases can be either young prime beef (YP) or young prime steer (YPS)
- 0-6 permanent incisors carcases can be either prime beef (PR) or prime steer (PRS)
- 0-8 permanent incisors carcases can be either ox (S) or steer (SS)

ALTERNATIVE CATEGORIES TO BULL

- Yearling (YE) is from an entire male (not assessed for SSC) having no permanent incisors with a carcase weight greater than 150kg
- Yearling entire (YGE) is from an entire male (not assessed for SSC) having 0-2 permanent incisors with a carcase weight greater than 150kg
- Young bull (BYG) is from an entire male showing SSC having 0-2 permanent incisors with a carcase weight greater than 150kg

Secondary sex characteristics are masculine traits in the carcase. They are assessed on pizzle muscle size, pizzle muscle characteristics, development of the ‘jump’ muscle (*m. biceps femoris*) and overall masculinity (Pietersen 1992).

11b) BACKGROUND TO THE MEASUREMENT OF SEX CATEGORIES

Historically, castration was practised as a means of taming oxen for draught purposes. Castration also provided a management tool to control unwanted breeding, decrease aggression and enable easier handling of males. In an era where fat in slaughtered carcases was prized, castration was an easy tool to increase fatness and improve eating quality along with the management benefits. Castration is widely practised in in Britain, the Americas (both North America and South America) and Australia. In contrast, much of Europe uses entire males for beef production which are generally slaughtered from 12 to 30 months of age.

The literature appears to be universal on older entire males being tougher than females or castrates. Field et al (1971) reviewed the results from seven studies comparing bulls and steers and concluded that bull beef had less tender meat when assessed by both objective and sensory panels. Hedrick et al (1969) showed that at 16 months there was no difference in palatability, but in contrast Forrest et al (1979) showed that at 15 months sensory scores were lower in bulls than steers.

Seideman et al (1982) concluded that whilst the meat from young bulls was not always tougher than steers it did appear to be more variable. They made the point that unless processing was controlled (i.e. carcases were stimulated) leaner bull carcases were often more prone to processing problems, including cold shortening. They reviewed a number of studies which showed it was possible to slaughter bulls up to 24 months without detrimental effects on eating quality. Dransfield et al (2003) showed no increase in toughness and a small increase in flavour in the older carcases from entire males slaughtered at 13, 19 and 24 months of age. More recently Thompson et al (2011) reported on a Polish study which showed no differences in a number of muscles from dairy and beef bull carcases slaughtered at 16 and 28 months of age. It should be noted that in this study only 30 carcases were sampled although consumer testing was carried out on 11 different muscles per carcase. It was likely that some carcases had cold shortened. In this study heifers at 27 months produced the highest consumer sensory scores due largely to their higher marbling scores. As expected old cows with a mean age of 110 months had the lowest eating quality.

The lack of difference between steers and heifers was supported by a recent study by Moss et al (2013) who showed no difference in eating quality between steers and heifers, although consistent with other studies bulls had the lowest eating quality. A recent review by Venkata Reddy et al (2015) also concluded that the often-cited advantage in eating quality from heifers relative to steers was due largely to the higher marbling levels in these carcases.

From the literature it is clear that carcases from older bulls were tougher but not always less flavoursome than steers at the same age. The question remains as to what age bulls become less palatable than steers and heifers. Certainly the literature questions whether there should be any separation of bulls, heifers and steers in the younger age category (milk teeth animals). Once adjusted for marbling there would appear to be little difference in eating quality between steers and heifers. This questions the current language categories where carcases from steers and heifers can be bulked under Y, YG, YP and PR, but then there is a separate category for steers as YS, YGS, YPS, PRS. The need to separate steers from heifers in the latter case cannot be justified on an eating quality basis.

There have been numerous reports which have shown that entire males have less fat and more muscle in the carcase (see Seideman et al 1982). These changes would be described either currently by changes in fat depth and eye muscle area, or perhaps in the future using technology that scans the carcase to directly measure composition and distribution of fat and muscle.

In conclusion, the categories used in the current beef language are more complex than necessary. There is a good case to differentiate older bull beef from that of heifers and steers. There is no literature to justify the separation of steer and steer plus heifer categories within dentition classes as currently occurs in the alternate beef categories. It is also not clear based on the ability of the consumer to detect differences in palatability at what age bull beef needs to be separated from heifer and steer beef.

The new MSA model has an input term for a bull category. The penalty in terms of eating quality depends upon ossification with different functions for variation in Bos indicus content. This bull input term has been currently developed on a trial basis and needs more data to confirm the empirical functions across a range of muscle and cooking types, in particular the ages at which the bull effect can be detected by the consumer.

Differences in carcase composition between steers, heifers, bulls and cows will be described by other beef language traits.

11c) ACCURACY AND BIAS IN THE MEASUREMENT OF SEX CATEGORIES

The criteria for classing a carcase as a bull is based on an assessment of SSC of the carcase. A recent MLA project slaughtered a total of 526 animals from four different sex treatments being early and late castration treatments, along with short scrotum and entire treatments (Fitzpatrick 2011). Although individual ages were not known the cattle were between 25 and 28 months of age and the short scrotum bulls and the entire bulls should have expressed their SSC. Of the early and late castrates less than 1% of the steers were classed as bulls by plant graders. However what was disturbing was that ca. 70% of the short scrotum and entire carcases were also classed at steers by plant graders. Given that this was a relatively small sample of only 500 animals these results are not conclusive, but do suggest that the current system of categorising carcases into bulls or steers based on SSC was not working and the system either needs modification or the company graders need retraining.

These results suggest there is a strong case to determine if sex category should be determined on the primary sex characteristics (i.e. the presence of testes on the stunned animal or if testes were left on the carcase) rather than secondary sex characteristics.

11d) TECHNOLOGY TO MEASURE SEX CATEGORIES

It is possible that SSC could be determined using images captured on the slaughter floor. However primary sex characteristics (i.e. testicles) on the live animal would be much less prone to error. Rather than the vagaries of classifying sex category on SSC it may be better to have the carcase allocated to a sex category based on inspection of primary sex characteristics after inspection at the knocking box or if testes were left on the carcase until the carcase could be stamped at the offal table.

11e) RECOMMENDATION FOR SEX CATEGORIES

It is recommended that the industry investigate changing the current method of describing sex on SSC to one where primary sex characteristics are used. Also, the need for the partial segregation of steer and heifer carcases into eating quality categories is questioned.

Further research is required to better understand when consumers can detect differences in bull beef compared with steers and heifers. It is likely that the MSA model will have an option to include sex in the MSA prediction model.

REFERENCES

Abril M, Campo MM, Onenc A, Sanudo C, Alberti P, Negueruela (2001) Beef colour evolution as a function of ultimate pH. Meat Science. 58:69-78.

Allen, DM, Hunt MC, Filho AL, Danler RJ, and Goll SJ (1987). Effects of spray chilling and carcase spacing on beef carcase cooler shrink and grade factors. Journal of Animal Science. 64:165–170.

Altmann M, Pliquett (2006) Prediction of intramuscular fat by impedance spectroscopy. Meat Science. 72:666-671.

Anon (1987) AUS-MEAT Language. Authority for the uniform specifications meat and livestock. Australian Meat and Livestock Corporation, Sydney.

Anon (1997) United States Standards for grades of Carcase beef. USDA, Washington. (http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELDEV3002979 accessed on 21/1/2015).

Anon (2004). Visual assessment of marbling and meat colour. Meat technology update Newsletter 2/04. CSIRO, Brisbane.

Anon (2005) Beef carcase grading system. Red Meat Industry (http://www.ausmeat.com.au/custom-content/preview/ham/pdf/MSA.pdf accessed on 11/6/2016).

Anon (2010a) Australian Beef Carcase Evaluation. Beef and Veal Chiller Assessment Language. (http://www.AUS-MEAT.com.au/media/1711/Chiller %20 10%20Low.pdf accessed on 8/1/2015).

Anon (2010b) AUS-Meat Language changes. Beef Standard carcase trim. Advice 05/10. Aus-Meat Ltd, Brisbane (https://www.AUS-MEAT.com.au/Advices/advice0510.pdf accessed on 15/1/2015).

Anon (2011) Meat Standards Australia. Beef information Kit. Meat and Livestock Australia Sydney (http://www.google.com.au/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=Meat+Standards+Australia.+Beef+information+Kit.+Meat+and+Livestock+Australia+Sydne accessed on 11/6/2016).

Anon (2013a) ACMF Standards Bovine (Beef) Workbook. AUS-MEAT Limited, Brisbane (http://www.AUS-MEAT.com.au/images/publications/soup/1383.pdf accessed on 10/1/2015).

Anon (2013b) Meeting market specifications. More beef from pastures Meat and Livestock Australia Sydney (http://www.mla.com.au/mbfp/meeting-market-specifications/Tool-71-beef-cattle-market-specifications accessed on 13/1/2015).

Anon (2013c) Viascan chiller assessment system. Cedar Creek Company (http://cedarcc.com/product-solutions/viascan/viascan%C2%AE-chiller-assessment-system.aspx accessed on 2/1/2015).

Anon (nd). Handbook of Australian Meat. 7th edition. AUS-MEAT Ltd (http://www.ausmeat.com.au/custom-content/cdrom/Handbook-7th-edition/English/93FE592A-F68A-11DA-AA4B-000A95D14B6E.html accessed on 5/2/2105)

Apple, JK, Dikeman ME, Simms DD, Kuhl G (1991) Effects of synthetic hormone implants, singularly or in combinations, on performance, carcase traits, and longissimus muscle palatability of Holstein steers. *Journal Animal Science.* 69:4437-4448.

Bass JJ, Colomer-Rocher F and Johnson DL (1981) Relationships between New Zealand beef conformation classes, carcase composition and muscle dimensions. *New Zealand Journal of Agricultural Research.* 24:281-284.

Bendall, JR and Wismer-Pedersen J (1962) Some properties of the fibrillar proteins of normal and watery pork muscle. *Journal of Food Science.* 27: 144-159.

Café LM, McKiernan WA, Robinson DL, Walmsley BJ (2012) Additional measurement on the muscle line cattle. Final report Project B.BFG,0049 Meat and Livestock Australia, Sydney.

Cassar-Malek I, Hocquette JF, Jurie C, Listrat A, Jailler R (2004). Muscle-specific metabolic, histochemical and biochemical responses to a nutritionally induced discontinuous growth path. *Animal Science*. 79:49–59.

Craigie CR, Navajas EA, Purchas RW, Maltin CA, Bünger L, Hoskin SO, Ross DW, Morris ST, Roehe R (2012) A review of the development and use of video image analysis (VIA) for beef carcase evaluation as an alternative to the current EUROP system and other subjective systems. *Meat Science*. 92:307-318.

Craigie CR, Ross D, Maltin C, Purchas R, Morris S, Roehe R (2014) Prediction of ultimate pH in beef M. longissimus thoracis using visible-near infrared spectroscopy. British Society of Animal Science, Nottingham University Jubilee Campus; page 149.

Crouse, J.D., Cundiff, L.V., Koch, R.M., Koohmaraie, M., and Seideman, S.C. (1989). Comparisons of Bos indicus and Bos taurus inheritance for carcase beef characteristic and meat palatability. *Journal of Animal Science*. 67:2661-2668.

Crouse, JD, Schanbacher BD, Cross HR, Seideman SC Smith SB (1987) Growth and carcase traits of heifers as affected by hormonal treatment. *Journal Animal Science.* 64:1434-1440.

Dransfield E, Martin JF, Bauchart D, Abouelkaram S, Lepetit J, Culioli J, Jurie C, Picard B (2003) Meat quality and composition of three muscles from French cull cows and young bulls. *Animal Science.* 76:387-399.

Drennan MJ, McGee M, and Keane MG (2008) The value of muscular and skeletal scores in the live animal and carcase classification scores as indicators of carcase composition in cattle. *Animal.* 5:752-760.

Dunne PG O'Mara FP, Monahan FJ, Moloney AP (2004) Colour of subcutaneous adipose tissue and muscle of Irish beef carcases destined for the Italian market. *Irish Journal of Agricultural and Food Research*. 43:217-226.

Dunne PG, Monahan FJ, O'Mara FP, Moloney AP (2009) Colour of bovine subcutaneous adipose tissue: A review of contributory factors, associations with carcase and meat quality and its potential utility in authentication of dietary history. *Meat Science*. 81:28-45.

Elmasry G., Barbin D.F., Sun D.-W., Allen P. (2012) Meat quality evaluation by hyperspectral imaging technique: An overview. *Critical Reviews in Food Science and Nutrition*. 52:689–711.

Ferguson (1994) Beef Carcase description. Have we succeeded over the last 30 years and how do we satisfy the increasingly complex specifications? New Technologies Ultrasound. Proceedings of the Australian Society of Animal Production, 20:40-42.

Ferguson DM and Thompson JM (1995). MRC Final Report. Project M.630. VIA Yield trials, Queensland. Meat Research Committee, Sydney.

Field R, McCormick R, Balasubramanian V, Sanson D, Wise J, Hixon D, Riley M and Russell W (1997) Tenderness variation among loin steaks from A and C maturity carcases of heifers similar in chronological age. *Journal of Animal Science*. 75: 3: 693-699.

Field RA (1971). Effects of castration on meat quality and quantity. *Journal of Animal Science*. 32:849-858.

Field RR, McCormick V, Balasubramanian D, Sanson J, Wise D, Riley M, Russel W (1996) Growth, carcase and tenderness characteristics of virgin, spayed and single calf heifers. *Journal of Animal Science*. 74:2178-2186.

Fitzpatrick L (2013) Growth and meat quality of grain finished entire male *Bos indicus* cattle. Final Report B.NBP.0486 Meat and Livestock Australia, Sydney.

Forrest RJ (1975). Effects of castration, sire and hormone treaunents on the quality of rib roasts from Holstein-Friesan males. *Canadian Journal of Animal Science*. 55:287-290.

Foutz CP, Doilezal RG, Gardner TL, Gill DR, Hensley JL Morgan JB (1997 Anabolic implant effects on steer performance, carcase traits, subprimal yieldsand longissimus properties. *Journal of Animal Science*. 75:1256-1265.

Griener SP (2002) The relationship between marbling and intramuscular fat Livestock Update. Virginia Cooperative extension. Virginia State University. (http://www.sites.ext.vt.edu/newsletter-archive/livestock/aps-02_12/aps-171.html accessed on 12/1/2015).

Hall WJA (1988) Integrated marketing systems. Meat 88. Proceedings of Industry Day Australian Meat and Livestock Corporation, pages 10-31.

Harper GS and Pethick DW (2004) How might marblingbegin? *Australian Journal of Experimental Agriculture and Animal Husbandry*. 44:653-662

Hearnshaw H, Stephenson P, Morris S, Woodhead A. Hoffman WD (1996) Proceedings of the Australian Society of Animal Production. Effect of genotype and pasture quality on dentition in beef cattle. 21:402.

Hearnshaw, H., Arthur, P.F., Stephenson, P.D., Dibley, K., Ferguson, D., Thompson, J.M., O'Halloran, J., Morris, S. and Woodhead, A. (1998). Meat quality of Angus, Braham and Piedmontese-sired progeny: Results from the first calf crop. Proceedings of the Sxith World Congress on Genetic Applied to Livestock Production. 25: 165-168.

Hedrick HB, Thompson GB, Krause GF (1969) Comparison of feedlot performance and carcase characteristics of half-sib bulls, steers and heifers. *Journal of Animal Science.* 29:687-694.

Holdstock J, Aaldus JL, Uttaro BA, Lopez-Campos O, Larsen IL, Bruce HL (2014) The impact of ultimate pH pn muscle charactyeristics and sensory attributes of the longissimus thoracis within the dark cutting (Canada B4) beef carcase grade. *Meat Science*. 98:842-849.

Hopkins DL (1989) Reliability of three sites for measuring fat depth on the beef carcase. *Australian Journal of Experimental Agriculture.* 29:165-168.

Hopkins DL and Roberts AHK (1995) The value of carcase weight, fat depth measures and eye muscle area for predicting the percentage yield of saleable meat in Australian grass-fed beef carcases for Japan. *Meat Science*. 41:137-145.

Hughes JM, Kearney G, Warner RD (2014) Improving beef meat colour scores at carcase grading. *Animal Production Science*. 54:422-429.

Johnson and Baker DA (1997) Use of linear measurements of the *m. longissimus* to predict the muscle content of beef carcases. *Meat Science.* 45:321-327.

Johnson ER (1987) Comparison of twelfth rib and rump fat thickness measurements for predicting commercial beef yield in local market carcasses. *Australian Journal of Experimental Agriculture.* 27:613.

Johnson ER and Vidyadaran MK (1981) An evaluation of different sites for measuring fat thickness in beef carcases to determine carcase fatness. *Australian Journal of Agricultural Research*. 32:999-1007.

Johnson ER, Taylor DG and Priyanto R (1995) The estimation of beef carcase muscle using cross-sectional area of *M. longissimus dorsi* at the fifth rib. *Meat Science.* 40:13-19.

Johnson ER, Taylor DG Priyanto R (1996) Anatomical factors influencing butt shape of steers prepared for the Australian domestic market. Proceedings of the Australian Society of Animal Production. 21: 185-188.

Kelly MJ and Thompson JM (2014) Utilising genetic markers to improve the understanding of the relationship between *Bos indicus* content and consumer eating quality. Final Report Project V.EQT.1420. Meat and Livestock Australia, Sydney.

Kempster AJ, Cuthbertson A Harrington G (1982) The relationship between conformation and the yield and distribution of lean meat in the carcases of pigs, cattle and sheep: A review. *British Meat Science*. 6:37-63.

Kim YBH, Warner RD, Rosenvold K (2014) Influence of high pre-rigor temperature and fast pH fall on muscle proteins and meat quality. A review. *Animal Production Science*. 54:375-395.

Lawrence TE Whatley JD, Montgomery TH, Perino LJ (2001) A com parison of the USDA ossification-based maturity system to a system based on dentition. *Journal of Animal Science*. 79:1683-1690.

Lawrie RA (1988) *Meat Science.* Permagon Press.

Lomiwes D (2008) Rapid on-line Glycogen measurement and prediction of ultimate pH in slaughter beef. Master of Applied Science Thesis, Auckland University of Technology, Auckland.

Lomiwes D, Farouk MM Wu G Young OA (2013) The development of meat tenderness is likely to be compartmentalised by ultimate pH. *Meat Science.* 96:646-651.

Macini RA and Hunt MC (2005) Current research in meat colour. *Meat Science.* 71:100-121.

Mafi G, Harsh B, and Scanga J (2012) Review of Instrument Augmented Assessment of USDA Beef Carcase Quality Grades. American Meat Science Association, 1-11.

Masoro EJ (1967) Skeletal muscle lipids III. Analysis of the functioning of skeletal muscle lipids during fasting. *The Journal of Biochemical Chemistry.* 242:111-1114.

McGilchrist P (2014) Addressing key issues affecting compliance rates of pasture-fed cattle in Southern Australia. MLA Project B.SBP.0110 Meat and Livestock Australia, Sydney.

McIntyre BL and Frapple PG (1988) Estimation of the yield of beef carcases from measurements of fat thickness over the rib and rump. Proceedings of the Australian Society of Animal Production. 17:242-245.

McKiernan WA (2001) Shape assessment and muscle score in beef cattle. AgNote DA1-256. NSW (http://www.dpi.nsw.gov.au/agriculture/livestock/beef/appraisal/publications/shape-muscle-score#Butt-profile accessed on 20/1/2015).

McKiernan WA, Wilkins JF, Irwin J, Orchard B, Barwick SA (2009) Performance of steer progeny of sires differing in genetic potential for fatness and meat yield following post-weaning growth at different rates: 2. Carcase traits. *Animal Production Science*. 49:525-534.

McPhee M (2014) Quantifying the benefits of developing a CT marbling solution. Project A.TEC.0100. A final report presented to Meat and Livestock Australia, Sydney.

Monin G (2004) Conversion of muscle to meat: Colour and texture deviations *Encyclopedia of Meat Sciences*. Editor-in-Chief: Werner Klinth Jensen. pages 323-330.

Moon JB (1980) An investigation of alternative sites for measuring fat depth in beef carcases. Promotional thesis. Slaughtering and meat inspection Branch. Queensland Department of Primary Industries Brisbane.

Moore CB, Bass PD, Green D, Chapman PL, O'Connor ME, Yates LD, Scanga JA, Tatum JD, Smith GC, Belk KE (2010). Establishing an appropriate mode of comparison for measuring the performance of marbling score output from video image analysis beef carcase grading systems. *Journal of Animal Science.* 88:2464–2475.

Morgan JB, Savell JW, Hale DS, Millar RK, Griffin H, Cross R, Shackelford SD (1991). National beef tenderness survey. *Journal of Animal Science*. 69:3274-3283.

Moss B, Fearon A, Whitworth M, Chau A Tolland E, Devlin D (2013) Meat quality from bulls, steers and heifers. British Society of Animal Science (http://www.bsas.org.uk/animal_bytes/meat-quality-from-bulls-steers-and-heifers/ accessed on 6/2/2015).

Muir PD, Smith DR, Smith NB, Wallace GJ (1998) Variability in marbling in Angus steers and an evaluation of subjective marbling assessment, *New Zealand Journal of Agricultural Research*. 41:3, 335-346.

Murray AC (1989) Factors affecting beef colour at time of grading. *Canadian Journal of Animal Science.* 69:347-355.

Pace JE, Wakeman DL (2003). Determining the age of cattle by their teeth. CIR253. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida Gainesville FL. http://www.extension.umn.edu/youth/mn4-H/projects/docs/Beef-Mouthing-Info-Sheet.pdf accessed on 11/6/2016).

Parish JA, Karisch BB (2013) Estimating cattle age using dentition. Mississippi State University Extension Service. (https://extension.msstate.edu/sites/default/files/publications/publications/p2779.pdf accessed on 11/6/2016).

Park BY, Hwang IH, Cho SH, Y. M. Yoo YM. Kim JH, Lee JM, R. Polkinghorne R, Thompson JM, (2008) Effect of carcase suspension and cooking method on the palatability of three beef muscles as assessed by Korean and Australian consumers. *Australian Journal of Experimental Agriculture*. 48:1396-1401.

Pietersen T, Bruwer GG, Naud RT (1992) Secondary Sexual Development (Masculinity) of Bovine Males: 1. Influence on Carcase Composition, Cutability, Economic Value and Certain Muscles. *Meat Science*. 31:435-450.

Purchas RW (1990) An assessment of the role of pH

Purchas RW, Aungsupakorn R (1993) Further investigations into the relationship between ultimate pH and tenderness for beef samples from bulls and steers. *Meat Science.* 34:163-178.

Purchas RW, Yan X, Hartley DG (1999) The influence of a period of ageing on the relationship between ultimate pH and shear values of beef *m. longissimus thoracis*. *Meat Science*. 51:135-141.

Qiao J, Ngadi MO, Wang N, Gariépy C, Prasher SO (2007) Pork quality and marbling level assessment using a hyperspectral imaging system. Journal of Food Engineering. 83:10–16.

Reis MM, Rovenvold K (2014) Prediction of meat attributes from intact muscle using near infrared spectroscopy. *Encyclopedia of Meat Sciences*: 3 volume set. Elsevier Pages 70-82.

Romans, JR, Costello WJ, Carlson C.W, Greaser ML, Jones, K. W. (1994). The meat we eat. Danville, IL: Interstate Publishers.

Ross, D, Navajas, E, Prieto N, Hyslop, J, McLean, K, Rius, E, Lambe, N, Bunger, L, Simm, G, Roehe, R (2014) Investigations into the potential of Video Image Analysis (VIA) and Computerised Tomography (ST) on Live animals and Carcases in Beef and Sheep, (http://www.knowledgescotland.org/images_db/davidrossfinal[1].pdf accessed on 10/12/2014).

Rymill SR (1997). Factors affecting the sensory evaluation of cooked meat. Master Rural Science thesis, University of New England, Armidale.

Seidman SC, Cross HR, Oltjen RR, Schanbacher BD (1982). Utilization of the intact male for red meat production: A Review. *Journal of Animal Science*. 55:826-840.

Shackelford SD, Koohmaraie M, Wheeler TL (1995) Effects of slaughter age on meat tenderness and USDA carcase maturity scores of beef females. Journal of Animal Science. 73:3304-3309.

Shackelford, S.D., Wheeler, T.L. and Koohmaraie, M. (1995). Relationship between shear force and trained sensory panel tenderness ratings of 10 major muscles from *Bos indicus* and *Bos taurus* cattle. *Journal of Animal Science*. 73:3333-3340.

Sherbeck JA, Tatum JD, Field TG, Morgan JB, Smith GC (1995). Feedlot performance, carcase traits, and palatability traits of Hereford and Hereford x Brahman steers. *Journal of Animal Science.* 73:3613-3620.

Sherbeck JA, Tatum JD, Field TG, Morgan JB, Smith GC. (1996) Effect of phenotypic expression of Brahman breeding on marbling and tenderness traits. *Journal of Animal Science*. 74;304-309.

Shorthose WR, Harris PV (1990) Effect of age on the tenderness of selected beef muscles. *Journal of Food Science* 55:1-8.

Smith GC, Carpenter ZL (1976) Eating Quality of Meat Animal Products and Their Fat Content. In “Fat Content and Composition of Animal Products”: Proceedings of a Symposium. National Academy of Sciences Washington DC, pages 143-182.

Strydom PE (2011) Quality related principles of the South African beef classification system in relation to grading and classification systems of the world. *South African Journal of Animal Science*. 41:177-193.

Suman SP, Hunt MC, Nair MN, Rentfrow G (2014) Improving beef colour stability. Practical strategies and underlying mechanisms. *Meat Science*. 98:490-504.

Tapp WN, Yancey JWS Apple JK (2011) How is instrumental colour of meat measured? *Meat Science*. 89:1-5.

Tatum D (2011) Animal age, physiological maturity and associated effects on beef tenderness. (http://www.beefresearch.org/CMDocs/BeefResearch/PE_White_%20Papers/Animal_Age.pdf accessed on 20/1/2015).

Taylor DG (1982) A comparative study of Hereford and Friesian steers. 2. Carcase characteristics and meat quality. *Australian Journal of Agricultural Research*. 33:157-163

Taylor DG, Meehan DP, Johnson ER, Ferguson DM (1990) Shape score of beef carcases as a predictor of saleable meat yield, muscle and fat content. Proceedings of the Australian Society of Animal Production. 18:392-395.

Taylor RG (2004) connective tissue structure, function and influence on meat quality. *Encyclopedia of Meat Sciences Elesiver*. Pages 306-314.

Thompson J, Polkinghorne R, Woniakc A, Gutkowskad K, Wierzbickae A, Wierzbicki J (2011). Consumer responses to Polish beef. A report prepared for Polish Beef Association, Warsaw.

Thompson J, Polkinghorne R, Hearnshaw H, Ferguson D (1999). Meat Standards Australia, A 'PACCP' based beef grading scheme for consumers. 2) PACCP requirements which apply to the production sector. In: 45th International Congress of Meat Sciences and Technology, Yokohama, Japan 45:16-17.

Thompson JM, Bradbury R (2005) Development Proposal for VOS Marbling Probe (Proof-of-Concept). SNGPI.026 Final Report to Meat and Livestock Australia, Sydney.

Thornton RF (1991) "Report on muscle score trials". Australian Meat and Livestock Corporation, Sydney.

Tume RF (1995) Fat quality in Australian Export beef. Meat Update CSIRO Brisbane.

Tume, RF (2001) Environmental factors on fatty acid composition and its impact on assessment of marbling, Marbling Symposium (Coffs Harbour).

Unruh JA, Gray DG. Dikeman ME (1986) Implanting young bulls with zeranol from birth to four slaughter ages: I. Live measurements, behavior, masculinity and carcase characteristics. *Journal of Animal Science.* 62:279-289.

USDA (n.d.) http://www.fsis.usda.gov/OFO/TSC/bse_information.htm

Venkata Reddy B, Sivakumar AS, Jeong DW, Woo YB, Partk SJ, Lee SY, Kim CH, Cho SH, Hwang IH (2015) Beef quality traits of heifer in comparison with steer, bull and cow at various feeding environments. *Animal Science.* 86:1-16.

Waggoner AW, Dikeman ME, Brethour JR, Kemp KE (1990). Performance, carcase, cartilage calcium, sensory, and collagen traits of longissimus muscles of open versus 30-month-old heifers that produced one calf. *Journal Animal Science*. 68:2380-2386.

Walker PJ, Warner RD, Winfield CG (1990) Sources of variation in subcutaneous fat colour in beef carcases. Proceedings of the Australian Society of Animal Production. 18:416-419.

Watanabe A, Daly CC, Devine CE (1996) The effects of the ultimate pH of meat on tenderness changes during ageing. *Meat Science*. 42:67-78

Watson R, Polkinghorne R, Gee A, Porter M, Thompson JM, Ferguson D, Pethick G McIntyre B (2008) Effect of hormonal growth promotants on palatability and carcase traits of various muscles from steer and heifer carcases from a Bos indicus–Bos taurus composite cross. *Australian Journal of Experimental Agriculture*. 48:1415-1424.

Watson R, Polkinghorne R, Thompson JM (2008) Development of the Meat Standards Australia (MSA) prediction model for beef palatability. *Australian Journal of Experimental Agriculture*. 48:1368–1379.

Weiner G, Forster J (1982) Variation in the age at emergence of incisor teeth in cattle of different breeds. *Animal Production.* 24:368-373.

Wheeler, TL, Cundiff LV, Koch RM (1994). Effect of marbling degree on beef palatability in *Bos taurus* and *Bos indicus* cattle. *Journal of Animal Science*. 72:3145-3151.

Wulf D, Emnett R, Leheska J, Moeller S (2002) Relationships among glycolytic potential, dark cutting (dark firm and dry) beef, and cooked beef palatability. *Journal of Animal Science*. 80:1895-1903.

Wythes JR and Shorthose WR (1991) Chronological age and dentition effects on carcase and meat quality of cattle in northern Australia. *Australian Journal of Experimental Agriculture*. 31:145 – 152

Young OA, Prilo A, Simmons NJ, West J (1999) Effects of rigor attainment temperature of meat blooming and colour on display . *Meat Science.* 52:47-56.

Young OA, West J, Hart AL, van Otterdijk FFH (2004) A method for the early determination of meat ultimate pH. *Meat Science* 66:493-498.

Zheng L, Sun DW, Tan J (2014) Quality e\valuation of meat cuts. In computer Vision Technology for Food Quality Evaluation. Edited by DW Sun. Elsevier.

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APPENDIX C:

INNOVATION IN CARCASE YIELD AND EATING QUALITY MEASUREMENT

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CONTENTS

INTRODUCTION

The beef language traits need to accurately describe attributes of the carcase and its components without bias so that both buyers and sellers have confidence in the traits which allows them to arrive at a value for the product. If the beef language performs this task it will facilitate communication up and down the chain and allow the market to perform more efficiently.

There are really only two broad attributes of the carcase that the beef language has to describe:

- Firstly it needs to describe the amount of product that is produced, whether this be lean meat, trimmed primals, trim or bone weight.
- Secondly it must describe the quality of the various components. Quality of the fresh carcase components is well described by Meat Standards Australia (MSA). This is a unique system which takes commercial inputs and uses them in the MSA model to predict eating quality of individual muscles when prepared using a variety of cooking methods (Polkinghorne et al 2008). Currently MSA focuses on the prediction of eating quality in fresh product although there are plans to develop the model to include prediction of eating quality for value added products.

Section A of this paper will detail new traits to measure carcase yield. Section B will review objective methods to measure eating quality in beef.

PREDICTION OF WEIGHT OR PERCENTAGE YIELD IN THE CARCASE

1.1 PURPOSE

When predicting carcase yield there is the option to predict either the weight, or the percentage of trimmed or denuded product in the carcase. The former is generally predicted with much greater accuracy than the latter figure. An example of the large differences in predicted accuracy can be seen in the equations reported by Perry et al (1993). They showed that when predicting the weight of saleable meat using carcase weight along with a combination of carcase measurements the accuracy (or R^2) of the prediction equation was 95%, compared with using the same data to predict the percentage of saleable meat where the accuracy was down to 58%. The reason for this is the very high correlation between carcase weight and the weight of saleable meat. In the example by Perry et al (1993), just using carcase weight to predict the weight of saleable meat had an accuracy of 89%, whereas using just carcase weight to predict the percentage of saleable meat only accounted for 4% of the variance. In other words carcase weight alone accounted for most of the accuracy in predicting weight of saleable meat, but only a small proportion of the variance in the prediction of percentage saleable meat in the carcase.

This explains why the choice of the variable to be predicted has a large bearing on the accuracy of the prediction equation. However the question that needs to be asked is how the predicted yield trait is to be used, either as a measure of efficiency in the boning room, or as a feedback trait to the producer. To measure efficiency of the boning room the weight of the saleable cuts needs to be assessed relative to the carcase weight entering the boning room – in other words, the percentage saleable meat in the carcase. Similarly for the producer the percentage saleable meat yield is more meaningful than simply the weight of saleable cuts in the carcase.

For payment to both the processor and producer, it is the weight of saleable meat that is important. It should be noted that predicted percentage saleable meat yield can be obtained by simply multiplying predicted percentage yield by carcase weight.

1.2 MEASUREMENT OF PERCENTAGE YIELD IN THE CARCASE

At boning the carcase is broken into primal cuts which vary enormously in eating quality and their subsequent value. The amount of fat which is left on the cuts will vary with the different market specifications. As fat left on the cuts is not separated at retail it effectively assumes the same value as the lean tissue in the primal. However the fat that is trimmed from the primal generally has a lower value and is either mixed with lean trim for grinding, or rendered. Similarly, bone which is retained in the primal effectively assumes the same value as the lean in the primal, but increasingly the consumer is becoming more focused on obtaining value for money and more cuts are prepared as boneless. In the UK concerns regarding BSE have meant that all primals have been free of bone since 1977 (Webster and Young 1997).

The saleable meat yield (SMY%) of the carcase can be defined as the weight of trimmed primals expressed as a proportion of carcase weight (Anon 2002). Whilst this may be the relevant commercial definition for processors to use in valuing the carcase it can, as discussed above, vary widely according to the trim specifications for a particular market and also how this is applied in specific boning rooms.

A more robust and less variable definition of carcase yield would be the weight of lean tissue in the carcase as a proportion of carcase weight (LMY%). Williams et al (1974) made a strong case for using LMY% as a precise and accurate measure of carcase yield which could be used by the market to arrive at a carcase value. This support was made on the basis that the accuracy of prediction of any technology used to predict carcase yield was directly affected by the accuracy with which the joints/tissues could be separated and weighed under commercial abattoir conditions. An accurate measure of LMY% should be independent of market specifications and boning room and as such provide an unbiased measurement of carcase composition.

As some fat and also in some circumstances some bone is left on the trimmed primal cuts, SMY% will generally be greater than LMY%. Whilst SMY% tends to be less consistent than LMY% due to variations in applying a standard trim it would be possible to relate LMY% to a specific market/boning room definition of SMY% for the purpose of the market valuing the carcase. Whether this adjustment is an off-set which is simply added to LMY%, or a non-linear relationship with fatness, will be determined by the accuracy required and the range in carcase weight and fatness of those carcases being processed. Therefore a LMY% of 71% may translate to a SMY% of 74% with forequarter cuts being boned to go to Chile and hindquarter cuts into Europe. The same carcase being boned for the domestic market may have a SMY% of 73%.

There can also be differences in the cutting lines used to define primal boundaries in the carcase. However, in the main, most beef carcase cutting lines tend to follow natural seams and so the differences between carcases are relatively small.

1.3 CURRENT MARKET GRIDS

If the beef language accurately describes yield (as LMY%) and eating quality (as an MSA grade) then it is well placed to underpin the development of value based payment trading systems (VBT).

It was clearly demonstrated by Ferguson and Thompson (1995) that payment grids based on weight, fatness, dentition and marbling perform poorly at predicting individual carcase value realised in the boning room. They examined the ability of commercial market grids to predict carcase value within a number of five different categories (these included cow, Korean grass fed, Domestic grain fed, Japanese grass fed and Japanese grain fed 150 days). In their experiment 30 to 40 sides (total 158 sides for all categories) were selected for each category from the slaughter floor and all cuts, lean trim, fat and bone weighed. Using the company's current wholesale values for each of the trimmed boneless primals, manufacturing trim, fat and bone the $ value was multiplied by their weights and then summed for each side. Realised value was expressed as $/kg cold carcase weight. Similarly current market grids were used to calculate the grid price for individual sides. When the realised value ($/kg) in the boning broom was graphed against grid value ($/kg) there was no relationship between realised value and the grid value (ie what the producer was paid) for each of the five categories. In fact three categories showed a slight negative trend which was disturbing.

Perhaps this was not surprising as individually the traits in the grid (such as weight, fatness, meat colour, marbling and dentition) have only a low relationship with realised value. This low relationship for individual traits was further eroded by categorising the input variables into weight, fatness and marbling classes. Therefore when categorical traits were the basis of any marketing grid it was not surprising there was no relationship between realised value in the boning room and grid value paid to the producer.

1.4 YIELD TECHNOLOGIES

Technologies to predict LMY% can range from simple regression models that predict yield to state-of-the-art computer tomography (CT) scanners. These will require an investment from the processors which could range from using simple carcase measurements which are currently part of the AUS-MEAT chiller assessment language to sophisticated X-ray technologies currently under development by several external providers (e.g. Scotts Technologies). Accuracy of these technologies will vary, most likely in accordance with the investment. The important point is that all technologies predict LMY%, albeit with varying accuracy. There should be an option for processors to state what the accuracy of their particular yield prediction technology is.

a) Yield equations utilising current grading traits

A number of workers have developed yield prediction equations using basic chiller assessment measurements collected at grading. When carcase weight, fatness and eye muscle area are used to predict SMY% the R^2 (or coefficient of determination) tends to be of the order of 30 to 40% (Johnson 1987, Perry et al 1993 Thompson et al 2012). The level of accuracy provided by these simple equations was probably considered too low to underpin a VBT system.

Given these low accuracies Thompson et al (2012) investigated the value of including selected cut weights on the accuracy of the prediction equations. By including carcase portions (butt or loin weights) accuracy increased to 60% and if individual cut weights were included the R^2 rose to over 70%. These improved accuracies were definitely high enough to support a VBT system, however the data set was not sufficiently large to confirm transportability of these functions.

If transportability of this approach was confirmed these equations would provide a simple cheap technique whereby a small plant operator could implement a yield prediction system with virtually no investment in expensive technology. The only capital investment would be several load cells to be installed on the chain or scales to weigh selected cuts. Such a system would be labour intensive but this may not be a problem if throughput was small, or these equations were used in the early development stages of a VBT system.

As discussed previously the measurement of SMY% is prone to errors in maintaining a constant level of level of trim for all cuts and carcases. An interesting set of analyses was recently undertaken by Jose et al (2014) where they used the current MSA grading measurements of HSCW, ribfat and eye muscle area to predict LMY% as calculated from the CT analysis of boned untrimmed cuts. The analysis used data from 5 different experiments where the cuts from full sides had been CT scanned to calculate LMY%. With a more accurate and consistent measurement of the end-point (i.e. LMY%) the accuracy of the equation increased to the order of 70 to 80%. However when the transportability of the equations was tested (i.e. the equations from one data set were applied to an independent data set) the accuracy fell to 40%. This lack of transportability could have arisen for several reasons. Firstly the data sets were each rather small and often weights were not normally distributed because they were part of other experiments. Secondly, the low transportability could have been due to grader effects in the accuracy of collecting the carcase measurements. This line of research needs to be further developed because it suggests that, if accurately collected, simple carcase measurements may provide a useful means to accurately predict LMY%.

b) Ultrasound

Ultrasound is used routinely to measure eye muscle area and backfat in live animals. More recently it has been used for measurement of marbling. Given that it is based on reflection of sound waves from a transducer placed over the loin it is mostly applicable to subcutaneous fat depth and to a lesser extent eye muscle area. Care needs to be taken to ensure good contact between the transducer and the animal, which generally necessitates shaving the hide and the use of oil.

Problems with using ultrasound on the carcase include bubbles of air that may be trapped in fat after removing the hide. For this reason ultrasound measurements taken hide on immediately after knocking may provide the best position to measure fat depth. As the hide has not been removed this has the advantage that fat tearing would not be an issue.

Velocity of sound (VOS) is another option to use ultrasound on the live animal or the carcase although the early equipment used by Wood et al (1991) was rather cumbersome and slow.

Another option examined for both the live animal and the carcase was digital A mode technology. This was a cheap A mode scanner that was capable of measuring the hide/fat and fat/muscles interfaces. By subtracting the two interfaces it gave an accurate estimate of fat depth in mm (Lake 1991). A commercial probe which was accurate and cheap was produced as part of an earlier MLA project, although there were problems with commercialisation and the equipment is no longer available.

c) Video Image Analysis (VIA)

Research into VIA was initiated in the early 1980s by Cross et al (1983). Since then Australia, Canada, Germany, Denmark and the US have undertaken significant research programs. VIA works by capturing images either on the whole carcase (WC) or the chiller assessment system on the quartered carcase (CAS). For the WC the Australian system analysed the carcase by segmenting into portions and measuring colour within these patches. On the other hand the German and Danish systems work by light stripping where an elongated beam is shone at an angle onto the carcase. The curvature of this line effectively allows a measurement of shape or conformation.

Allen and Finnerty (2001) compared the Australian, German and Danish WC systems in two experiments. They showed that all three systems were comparable in accuracy at predicting fat and conformation class based on the EUROP system. They also had similar accuracy at predicting SMY% explaining over 70% of the variation.

At the same time comparisons undertaken in Australia by Smith (2009) showed that the CAS and WCS each explained ca. 55% of the variance in SMY%, however when the data from the WCS and CAS were combined the two systems explained over 70% of the variance. In this data set the VIA system outperformed HCW, fat depth and eye muscle area which only explained ca. 45% of the variance.

A number of researchers have concluded that VIA provides a useful tool by which the industry could predict SMY%. It would be expected that if VIA was calibrated against LMY% the accuracy would increase further. However, for whatever reason, the Australian industry has not embraced VIA technology and currently no beef VIA systems (either WC or CAS) are operational in Australian plants.

In contrast in America and in Europe the VIA technology has been implemented in the beef industry. The US approved the use of VIA to measure firstly eye muscle area, followed by fat thickness and more recently marbling and yield grade. In 2009 two vision grading instruments were approved by the USDA for beef grading and by November 2012 there were seven companies (18 plants) approved for instrument grading and of those, five companies (10 plants) were actively using instrument grading. Canada has also adopted a computer vision grading system called the e+v Technology. This was approved by the Canadian Food Inspection Agency in 1999 for use by the Canadian Beef industry. VIA is also an integral part of the Danish beef classification system and installed in all major plants in the Republic of Ireland.

d) Dual Energy X-ray Absorptiometry (DEXA)

DEXA is a low-radiation technology that beams X-rays with different energy levels through a body. The resultant scans are much more accurate at discriminating between density of tissues than conventional X-ray technology, although the technique has the constraint that the density is recorded as a two dimensional images. Therefore the DEXA technology is less accurate in cuts with a high proportion of bone.

Another constraint with the DEXA technology is that it was developed for humans and therefore the scanning bed is rather small and most suited to small domestic animals such as pigs and sheep. Pearce et al (2009) examined the accuracy at predicting carcase composition in live sheep and their carcases. They showed that the accuracy (R^2) to predict muscle and fat % in the carcase was of the order of 65 and 80%. Understandably bone % had the lowest accuracy.

The early beef studies by Mitchell et al (1997) processed rib sections through DEXA scanners and showed R^2 values in excess of 80% for both lean and fat in the rib joint. More recently Lopez Campoz et al (2105) processed all beef cuts from 158 full sides through a DEXA and found R^2 values in excess of 80% for both fat and lean.

The DEXA technology will most likely be implemented as part of robotic systems to guide automated cutting of the carcase. There are already such systems which have been developed for lamb. Given the small scale of the conventional DEXA plates there are several ways this could be scaled up for beef. The first is to assume a part/whole relationship between the portion scanned and the whole carcase. This would allow the composition of a defined portion scanned by the DEXA to be used to predict the composition of the full side. This may not be ideal and so the second option would be to link a number of DEXA plates together to allow the full side to be scanned.

Given the research input in this area (Canada, New Zealand USA, Australia) it is likely that results will be available for trialling within two to three years.

e) Computer Axial Tomography (CT)

CT uses a system where an emitting X-ray source is rotated around the body with the resultant X-rays collected by a ring of detectors after passing through the body. The speed at which the X-rays pass through the body varies with tissue density. Mathematical algorithms convert the detected X-rays to reconstruct a two-dimensional image using the principles of the magic square. These images clearly separate the two-dimensional slice into fat muscle and bone. From the series of two dimensional images a three-dimensional image of the body can be constructed.

The early CT scanners were developed in the 1960s with the Nobel Prize being awarded to Cormick and Houndsfield in 1979. The first CT occupied a whole room for the scanner and another for the computing system. Since then the speed of scanning has increased followed by the development of spiral scanners. This has meant that a body can be scanned in a matter of seconds, the data stored and used to reconstruct images later. As the number of detectors and computing power has increased the clarity and resolution of the images has improved considerably.

The early CT scanners were complex and unsuitable for use in abattoirs. Since those early days the stability of the electronic equipment and the size and speed of the associated computer resources have improved considerably. In the 1980's scanners were installed in University Departments in Norway, New Zealand and Armidale.

The current CT scanners have the constraint of the donut of detectors and emitters rotating around the body which limits the size of the bodies that can be scanned. Although in the early development stages, work has started on three-dimensional scanners where the emitters and detectors are contained in large rectangular plates. These plates could be well shielded and potentially could be used to scan live animals or more particularly carcases at chain speeds.

Again there is a large research effort being undertaken to use CT as a tool to predict carcase composition on line. MLA currently has over 10 projects in this area (see project A.SCT.0029, MLA 2014), although they are still some way from delivering a practical system that will be sufficiently robust to operate in an abattoir environment.

f) RGBD technology (Wii cameras)

The RGBD camera technology and data acquisition software is an offshoot of the computer gaming industry (Wii cameras). Briefly, it uses a number of small cameras to collect a large number of images and integrate them into a three-dimensional image. To date it has successfully been used to estimate P8 fat depth and muscle scores in live cattle with accuracies in excess of 80% (McPhee 2013). There are no estimates of the accuracy of this technique when applied to carcases but it is expected that it will perform well. The technology is cheap and does not require much space on the slaughter floor.

It is likely that using this technology it would be relatively straightforward to use the RGBD camera and software to develop a vision system for installation on the slaughter line. As mentioned the system is compact, cheap, and appears to be robust. There is potential alignment of these studies with work currently underway in the use of Wii cameras to predict fatness in the live animal. Again this work is being progressed by MLA.

MEASUREMENT OF TRIMMED PRIMAL CUTS

The above refers to technologies to predict the percentage of trimmed primals in the carcase. This need to predict carcase yield may be obviated by technology that is capable of weighing and recording individual ID on trimmed primals as they are packed in the boning room. Given advances in data handling and robotics such a system is currently possible. Unfortunately attempts to set this up as a commercial operation have not been successful in Australia.

CALIBRATION OF YIELD TECHNOLOGIES

Calibration of the different technologies will underpin the industry's confidence in any future VBT systems that are developed. There is a need for the Australian beef industry to take a leadership role in setting up a calibration protocol. Obviously AUS-MEAT would be the most likely organisation to have the role in developing the standard for calibration and auditing the results.

The calibration procedure would require the processor installing the particular technology and recording measurements on their site at operating chain speeds. Using a standard protocol (say 100 sides) carcases would be boned into untrimmed primals which would be vacuum packed and transported to an industry facility for measurement of lean meat yield. Side weigh and individual bone weights would be recorded in the boning room.

The calibration facility y could initially comprise a medical CT scanner that would be used to scan the vacuumed primals. Images would be analysed to calculate lean and fat within each of the cuts and along with side and bone weights used to calculate LMY%. The data would also be capable of describing distribution of lean and fat in the carcase.

In the future, a purpose-built CT scanner could be used for calibration. There could also be an opportunity for a third party provider to set up a commercial calibration service for industry, or alternatively companies could set up their own calibration system which could be transported between plants.

After scanning the untrimmed primals would go back to the boning room for further trimming prior to sale. The processor may be interested in calibrating the LMY% to a particular trim specific for their markets/boning room (i.e. the company's specifications for SMY%). Depending upon the market specifications this could involve more than one level of trim. The final product could then be sold in the domestic market with only a minimal loss in value.

As technologies improve/come on-line they can be implemented in any plant. As previously mentioned it is likely that different plants will use different technologies because of differences in throughput, accuracy and investment required to support their VBT programs. Advances in medical technologies (e.g. DEXA, CT) are likely to provide real opportunity for the beef industry to develop cheap, accurate options to measure carcase yield. It is important to remember that the market for yield technologies in the beef industry is small and it is therefore unlikely that the beef industry can undertake the basic research required to develop new technologies from scratch. Rather it will always be adapting technologies such as DEXA and CT which have come from medical research.

A calibration standard or service would allow the meat industry to calibrate and validate a range of yield prediction technologies. In effect this is only part of the required changes that need to occur as there are also changes in the infrastructure within the company and perhaps more importantly the cultural changes that are required within the company to ensure successful implementation of new initiatives. For too long the promise of a 'new' technology just around the corner that was capable of revolutionising yield prediction has been used as an excuse by both researchers and the meat industry to wait for new technology to arrive. What is needed is for the industry to use the yield technologies that are currently available and start the process of change within their companies.

2. PREDICTION OF EATING QUALITY

2.1 THE MSA GRADING SYSTEM

Australia is unique in that it has a beef grading scheme that is capable of predicting eating quality of a cooked meal outcome for individual cuts in the carcase. The inputs used for the MSA prediction model are easily available in a commercial environment and are collated or measured on the carcase at grading. The accuracy of the MSA model to predict quality was reviewed by Thompson (2002). In an analysis of over 19,000 individual cuts which had been cooked in a variety of ways and consumer tested it was found that the MSA grading model correctly classified between 50 and 70% of the samples into their correct grade. This was an order of accuracy greater than is possible by just using other carcase grading systems.

Given that Australia has implemented the MSA grading system the criteria for a success of a new technology to predict eating quality are perhaps more stringent than those being applied in other markets around the world. In Australia the challenge for new technology to predict eating quality is to complement the current MSA grading scheme and predict eating quality within 3, 4 or 5 star grades. In contrast, in countries without an MSA grading system the challenge of new technology to predict eating quality is perhaps less daunting as there would be a much broader range in eating quality in the population of cattle produced.

Other technologies which have been investigated to predict beef eating quality – the Tendertec probe, Beef Cam, near-infrared reflectance and slice shear force – are discussed below.

2.2 TENDERTEC PROBE

The Tendertec probe was an Australian invention supported by MLA. It comprised a mechanical probe which measured resistance when inserted into the muscle of the chilled carcase. The efficacy of the probe in predicting tenderness was evaluated by several groups. The Beef CRC concluded that the probe was not capable of measuring tenderness and that previous evaluations had over-defined the calibration data by the large number of measurements collected on a single pass. The Beef CRC studies showed that any equations that were generated were not transportable between data sets. Evaluations of the Tendertec probe were also carried out in the US by Belk et al (2001) and George et al (1997) and their results concurred with this conclusion.

2.3 COLORIMETERS AND BEEF CAM

The US have also investigated the use of colorimeters to predict beef tenderness. Initial studies were promising (Wulf et al 1997) but a large evaluation by Wulf and Page (2000) found that colour dimensions added little accuracy to the prediction of eating quality over that explained by pH. The current MSA model uses pH as one of its input variables.

Beef Cam was a further development of a colorimeter which used colour analysis of a VIA images to predict tenderness. Whilst some predictive accuracy was obtained it was concluded the error rate was such that at this stage it was not suitable to progress to commercialisation (Wyle et al 2003).

2.4 SLICE SHEAR FORCE

The moderate relationship between shear force and tenderness led the scientists at Clay Centre to develop a slice shear test that could operate at line speed. The equipment operated at chain speed and a slice shear reading at grading was moderately related to the feedback of sensory panels at 14 days (Shackelford et al 1999 a,b).

However the industry has not embraced this technology, possibly because it is a destructive measurement.

2.5 NEAR INFRARED REFLECTANCE

Near-infrared reflectance technology (NIR) utilises spectroscopic methods to measure the quantity of reflectance in the near-infrared region of the spectrum. The technology is quick easy to use and is non-destructive and is used to predict chemical traits of a wide variety of materials (e.g. protein in wheat).

Workers from a number of laboratories have investigated its use to predict palatability in beef. MLA funded a large co-operative project between the Victorian DPI and Denmark which examined the role of NIR as a tool for use in on-line prediction of meat quality (Baud et al 2011). They showed that the NIR could predict objective colour, intramuscular fat and pH at 24 hours as well as muscle glycogen and/or glycolytic potential and muscle heme pigment levels at 30 minutes post slaughter. However, even though some of these predictors are used as inputs in the MSA model it was found that NIR was a poor predictor of objective tenderness. Similar conclusions were reached by De Marchii et al (2013).

3. RECOMMENDATION

There is a large research effort currently underway to customise medical and other technologies to predict LMY% of the carcase. Ultimately there will be a range of technologies which vary in cost and accuracy operating in the beef industry to measure LMY%. There is a need for the beef industry to develop protocols (and maybe resources) to calibrate the accuracy of these technologies as they become available for trialling in beef plants in Australia. Ultimately the need to predict yield may be obviated by technology capable of weighing every cut from a carcase.

The MSA grading system predicts the eating quality of individual cuts according to how they are cooked. The challenge for new technologies aimed at predicting eating quality is to add value to the existing MSA grading scheme. Whilst a number of other technologies have been trialled they have failed to provide an accurate, non-destructive and transportable measurement of eating quality at grading.

REFERENCES

Allen P, Finnerty N (2001) Mechanical grading of beef. Teagasc, Ballsbridge, Dublin.

Anon (2002) Understanding Meat Yield. Meat Technology Update. Newsletter 02/4 (http://www.meatupdate.csiro.au/data/MEAT_TECHNOLOGY_UPDATE_02-4.pdf accessed 6/12/2014).

Baud S, Kerr M, Weston P, Nantharampatha A, Borggaard C (2011) On line technology to predict beef and sheep meat quality traits using near infra red and other predictive techniques Final Report A.MQT.0016, Meat and Livestock Australia Sydney.

Belk KE, George MH, Tatum JD, Hilton GG, Miller RK, Koohmaraie M, Reagan JO, Smith GC (2001) Evaluation of the Tendertec beef grading instrument to predict the tenderness of steaks from beef carcases. Journal of Animal Science. 79:688.

Cross HR., Gilliland DA, Durland PR, Seideman S (1983). Beef carcase evaluation by use of a video image analysis system. Journal of Animal Science. 57:908–917.

De Marchi M, Penasa M, Cecchinato A, Bittante G (2013) The relevance of different near infrared technologies and sample treatments for predicting meat quality traits in commercial beef cuts. Meat Science. 93:329-335.

Ferguson DM and Thompson JM (1995) VIA Yield Trial Queensland, Final Report Project M.630. Meat Research Committee, Sydney.

George MH, Tatum JD, Dolezal HG, Morgan JB, Wise JW, Calkins CR, Gordon T, Reagan JO, and Smith GC. 1997. Comparison of USDA quality grade with Tendertec for the assessment of beef palatability. Journal of Animal Science. 75:1538.

Johnson (1987) Comparison of twelfth rib and rump fat thickness measurements for predicting commercial beef yield in local market carcasses. Australian Journal of Experimental Agriculture 27:613-617.

Jose C, McGilchrist P, Pethick D, Gardner G (2014) Addressing key issues affecting compliance rates of pasture-fed cattle in Southern Australia. Final Report Project B SBP.0110, Meat and Livestock Australia, Sydney

Lake R (1991). Ultrasonic evaluation: Image analysis and industrial applications. In the Proceedings of Electronic Evaluation of Meat in Support of Value Based Marketing, Purdue University. *West Lafayette*, 25-46.

López-Campos O, Larsen I, Prieto N, Juárez M, Aalhus JL (2015) Using Dual Energy X-Ray Absorptiometry technology for rapid and non-invasive fat and lean predictions in beef carcases Meat Science 99:144

McPhee M (2013) Initiative – trait measurement from 3D images. MLA final report for project B.BSC.0339. Meat and Livestock, Sydney.

Mitchell AD, Solomon MB, Rumsey TS (1997) Composition Analysis of Beef Rib Sections by Dual-energy X-ray Absorptiometry. Meat Science 47:115-124.

Nade T, Fujita K, Fujii M, Yoshida M, Haryu T, Misumi S, Okumura T (200?) Development of X-ray computed tomography for live standing cattle. Animal Science. 76:513-517.

Pearce KL, Ferguson M, Gardner G Smith N, Greef J, Pethick DW (2009) Dual X-ray absorptiometry accurately predicts carcase composition from live sheep and chemical composition of live and dead sheep. Meat Science 81: 285-293.

Perry D, McKiernan WA, Yeates P (1993) Muscle score: its usefulness in describing the potential yield of saleable meat from live steers and their carcases *Australian Journal of Experimental Agriculture*, 33,27-281

Polkinghorne R. Thompson JM, Watson R, Gee A Porter M (2008) Evolution of the Meat Standards Australia (MSA) beef grading system. *Australian Journal of Experimental Agriculture*, 48:1351-1359.

Shackelford SD, Wheeler TL, Koohmaraie M (1999a). Tenderness classification of beef: II. Design and analysis of a system to measure beef *longissimus* shear force under commercial processing conditions. Journal of Animal Science. 77:1474.

Shackelford, SD, Wheeler TL, and Koohmaraie M (1999b). Evaluation of slice shear force as an objective method of assessing beef *longissimus* tenderness. Journal of Animal Science. 77:2693.

Smith CR (2009) The ability of the VIAscan® Beef Carcase System and Chiller Assessment System to predict Saleable Meat Yield for 100 day Grain Fed cattle. A report to Cargill Pty Ltd by The Cedar Creek Company

Thompson JM (2002) Managing meat tenderness Meat Science. Meat Science. 62:295-308.

Thompson JM, Polkinghorne R, Griffiths G (2012) A value based marketing system incorporating quality and yield for Teys supply chains. A report for Teys Pty Ltd, Brisbane.

Webster P and Young R (1997) Beef on bone banned over CJD fears. (http://mad-cow.org/~tom/bone_ban.html accessed on 6/12/2014)

Williams DR., Pomeroy RW, Harries JM, & Ryan PO (1974). Composition of beef carcases: II. The use of regression equations to estimate total tissue components from observations on intact and quartered sides and partial dissection data. The Journal of Agricultural Science, 83, 79–85.

Woerner DR and Belk KE (2008) The history of instrument grading of beef. A focus on the last ten years. National Cattleman's Association

Wood JD, Newman PB, Miles CA and Fisher AV (1991). Video image analysis: Comparisons with other novel techniques for carcase assessment. In Proceedings of Electronic Evaluation of Meat in Support of Value Based Marketing, Purdue University. *West Lafayette*, 147-174.

Wulf, DM, O'Connor SF, Tatum JD, and Smith GC 1997. Using objective measures of muscle color to predict beef *longissimus* tenderness. Journal of Animal Science. 75:684.

Wulf, DM and Page JK (2000). Using measurements of muscle color, pH, and electrical impedance to augment the current USDA beef quality grading standards and improve the accuracy and precision of sorting carcases into palatability groups. Journal of Animal Science. 78:2595.

Wyle AM, Vote DJ, Roeber DL, Cannel RC. Belk KE, Scanga JA, Goldberg M, Tatum JD, Smith GC. (2003). Effectiveness of the SmartMV prototype BeefCam System to sort beef carcases into expected palatability groups. Journal of Animal Science. 81:441.

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APPENDIX C:

THE JAPANESE BEEF LANGUAGE

Author: R. Polkinghorne

Technical papers for the Australian Beef Language 'WHITE PAPER'

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The Japanese Beef Language. R. Polkinghorne (2016)
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Technical papers for the Australian Beef Language 'White Paper'.
Meat and Livestock Australia, Sydney, 40 Pages

CONTENTS

KEY POINTS

- There is a clear distinction at all trade levels between full blood Japanese Black (Wagyu[1]) cattle, dairy beef and the F1 cross between the two.
- Beef cattle represent 65% of the Japanese cattle herd and 46% of Japanese beef production.
- Imported beef accounts for 60% of total beef supply with Australia the largest supplier.
- Most traditional Japanese farms are either breeding or fattening with the connecting point a live animal auction. Some vertical integration is occurring in response to the small scale and increasing age of traditional breeding farm owners.
- Pedigree data is critical for full blood Japanese Black calves but less so for dairy and of intermediate importance for F1.
- Cattle must have individual ID and whole of life RFID traceability. Japanese Black cattle are also identified by nose print, the cattle equivalent to fingerprints.
- The farmer pays a charge for slaughter and grading, retaining ownership until carcase sale post grading. The processor acts as an agent to market the co-products and arrange the slaughter and grading service.
- Grading data is the primary value determinant and while not compulsory 90% of carcases are graded.
- Grading is conducted by the Japanese Meat Grading Association (JMGA), an independent public company.
- Independent yield (A, B or C) and quality (1 to 5) grades are combined to produce carcass grades such as A5 or B3 etc.
- Grader training is extremely detailed and heavily based on extensive field experience with toward 20 years required to achieve the highest certification level.
- Both yield and quality grades are calculated from multiple contributing inputs.
- Despite high levels of appraisal consistency and multiple inputs, correlation between the grades assigned and actual Japanese consumer sensory response is moderate at best.
- The assignment of a single grade to the carcase may partially explain the reduced precision.
- Around 40% of carcases are sold by auction and the remainder by negotiation.
- While exhibiting strong traditions new innovations including advanced image analysis and NIR fatty acid composition are being utilised in developing grading standards.
- Brand names and regional sources contribute heavily to value at wholesale and retail in conjunction with breed and JMGA grade.
- Individual animal ID is maintained to the retail pack for all but ground beef products.
- Retail display is of an exceptional standard further underlying the premium and special nature of beef in Japanese

1 Wagyu is used loosely in this report to denote full blood domestic Japanese black cattle. Within Japan these are described by kanji. Japanese MAF guidelines discourage the use of Wagyu for describing imported beef as it is not of Japanese origin and therefore not regarded as full blood Wagyu although some importers are describing high quality imported beef with “Wagyu” genetics as a crossbreed.

BACKGROUND TO THE JAPANESE BEEF INDUSTRY

Japan's total cattle population of 4,065 million head in December 2013 comprised 2.64 million (65%) beef cattle and 1.42 million (35%) dairy (Anon, 2014). Beef produced is categorised as Japanese Black, which account for 98% of "Wagyu" cattle. The remaining 2% include Japanese Brown, Shorthorn, Polls and their crosses. Beef cattle represent 45% of total head slaughtered and 46% of carcase tonnage, the remainder being categorised as dairy and 1% of other. The 534,846 tonne of imported beef in 2013 represented 60% of total supply with Australia the largest supplier at 286,545 tonne. Imported Australian beef is utilised in various market sectors ranging from manufacturing to food service and direct retail outlets.

The majority of higher quality Australian imported product aligns with the domestic Japanese dairy category.

It is somewhat a tale of two markets, Japanese Black and the rest, at all points of the supply chain from original genetics to final retail product. Japanese culture places great importance on tradition and on perfection with these traits also evident in the production, description, marketing and consumption of beef. Pricing differences are extreme and heavily weighted toward Japanese Black with F1 (Japanese Black x dairy) steers midway between the Japanese Black and dairy benchmarks as displayed in Table 1.

Table 1: Japanese beef carcase wholesale pricing[2] (2013) – Yen/kg cold carcase weight and % of A4 Japanese Black steer

	Steers						Cows	
	Wagyu	Wagyu	F1	F1	Dairy	Dairy	Dairy	Dairy
JMGA Grade	A4	A3	B3	B2	B3	B2	C2	C1
JPY	¥1,873	¥1,717	¥1,227	¥1,112	¥859	¥768	¥485	¥411
AUD	$20.31	$18.61	$13.30	$12.06	$9.31	$8.33	$5.26	$4.46
	100.0%	91.7%	65.5%	59.4%	45.9%	41.0%	25.9%	21.9%

2 Australian $ to Japanese Yen conversion rate 92.24 (www.xe.com, accessed on 14 Feb 2015).

A similar relationship is exhibited at retail with average 2013 Tokyo beef sirloin pricing (Anon, 2014) reported at Y1,189 per 100gm for Wagyu relative to Y621 for dairy (52%) and Y335 for Australian (28%). High quality beef in Japan remains a status item displayed and marketed as a luxury good but beef is also sold at more assessable prices as hamburger, hamburg (formed) steaks and meatballs together with imported and Japanese dairy beef consumed in traditional Japanese cooking styles such as yakiniku, shabu-shabu and guydon. Channel distribution data 2012 (Anon, 2014) for all Japanese beef consumption, including imported beef, indicates that foodservice utilised 62% of beef with home consumption 32% and processing 6%.

Japanese consumption has been stable at 5.9 to 6kg per head (Anon, 2014) since 2011 with growth potential influenced by economic conditions. The predominant retail display is within cooking style with lesser association to the source cut but an overwhelming emphasis on Japanese Black, the traditional Japanese breed, and marbling level. Given the prestige and premium pricing associated with high end domestic Japanese Black it is unsurprising that farming practices, live cattle marketing and beef grading display a similar focus.

BEEF LANGUAGE, LIVE CATTLE AND CARCASE TRADING

Japanese beef farmers may be breeders or fatteners and tend to specialise in either area with a live cattle auction the interconnecting transaction point. In line with the meat value chain those breeding Japanese Black are more heavily involved in livestock pedigree and performance recording with attendant heavy use of AI from proven high reputation sires. Regional bloodlines also feature through proud and competing tradition (Kuchida *pers comm*).

A recent trend is for some of the larger fatteners to vertically integrate back in to breeding to assure supply. This has been influenced by concerns relating to the small scale and increasing age of traditional breeding farm suppliers (P Troja *pers comm*).

All cattle must have RFID by law with birth date, dam ID, date of birth and lifetime movement recording also mandatory. In addition Japanese Black cattle are identified by a nose print, the cattle equivalent to fingerprints, used for registration in conjunction with complete pedigree data. Given the relative value it is critical that they maintain Japanese Black certification.

There is an extensive Japanese Black progeny testing scheme where 20 progeny from test bulls are raised to 28 months and slaughtered to provide the all-important carcase data. There is strong involvement by local government at prefecture level in Japanese Black genetics

Figure 1: Kyushu cattle farm

in addition to private companies. The Government controlled Livestock Improvement Association of Japan is a further influential body. The genetics providers publish EBVs for carcase yield and quality plus growth data. The decade's long concentration on carcase attributes has resulted in the breed excelling in marbling but often at the expense of other trait such as milk production, fertility and structure. Most Japanese Black calves are either fully hand fed or supplemented with milk replacer.

Most calves are sold to fattening farmers through a physical calf auction market. Electronic bidding systems are generally used in both live and carcase markets. The electronic bidding is "blind" in that buyers press a button on their handheld electronic device to bid and there is no visual indication of the bidder other than the increased price registered on the sale screen. Data provided in the sale catalogues includes birth date, sex and liveweight. Pedigree data is critical for full blood Japanese Black calves and important for F1 whereas visual body type and condition is the primary assessment for dairy stock.

In contrast to Australian practice finished cattle ownership is retained by the farmer until after carcase grading. The farmer pays the processor a slaughter fee and receives payment for the hide and offal. While managed by the processor on behalf of the farmer, the by-products are purchased by different groups reflecting traditional arrangements where this franchise was granted to a particular class. The standard carcase is traded with the head, hocks and tail removed but with the kidneys and kidney fat retained. It should be noted that Japanese Black fat is valued and often provided in small blocks by department stores for cooking. It is also commonly mixed with imported Australian cow beef by the retailer, further processing plant or restaurant to provide extra flavour or exported to Asian markets. Consequently fat carries a far higher value connotation relative to that in Australian processing where "over fat" carcases are strongly discouraged.

Figure 2: Store cattle auction

Grading charges, paid by the farmer, are levied by the Japanese Meat Grading Association (JMGA) with these data owned by the farmer and not automatically passed on or accumulated. Depending on location the carcase may be sold either by auction (40%) or negotiation (60%) with the grading data the principal price determinant. Pricing is in yen/kg of carcase weight. Major carcase auctions are held in Tokyo and Osaka.

JAPANESE CARCASE GRADING

Carcase grading is conducted by the Japanese Meat Grading Association (JMGA). The JMGA was established in 1975 to administer grading standards through an independent public company structure although carcases had been graded into Choice, Select and Prime from 1961. Carcase grading standards are established by the association under the approval of the Minister for Agriculture, Forestry and Fisheries (MAFF) (Anon, 2000). Standards were amended in 1976, 1979 and 1988.

The 1988 amendment established separate yield and quality grades. Graders operate at 10 central wholesale markets, 22 local wholesale meat markets and 96 meat centres throughout Japan (Anon, 2014a). While not compulsory 90% of carcases are graded with those not graded mostly very old cows or internal company owned cattle. If graded, both yield and quality grades are required. Currently the grading fee is ¥540 per head.

GRADER TRAINING AND CALIBRATION

There are 200 beef graders in Japan, all employed by the JMGA. Beef grading is a highly skilled occupation with many years' experience and training required to attain first grade status. Trainee graders, generally from an agricultural or meat science university background, are selected after sitting a written general exam (unrelated to grading knowledge). They may progress to assistant grader rank after 3 years (and attaining a minimum age of 25) and then work with a grader recording data for a minimum further 5 years at which point they sit both practical and written exams to attain a third class grader ranking. A further minimum 5 year period is required to move up to second grade status and a final 5 years to attain first grade. Consequently the youngest first grade JMGA grader will be 40 years old and have a minimum 18 years of practical experience (K.Kuchida *pers comm*). This provides an interesting comparison with USDA and Australian grader training and certification standards.

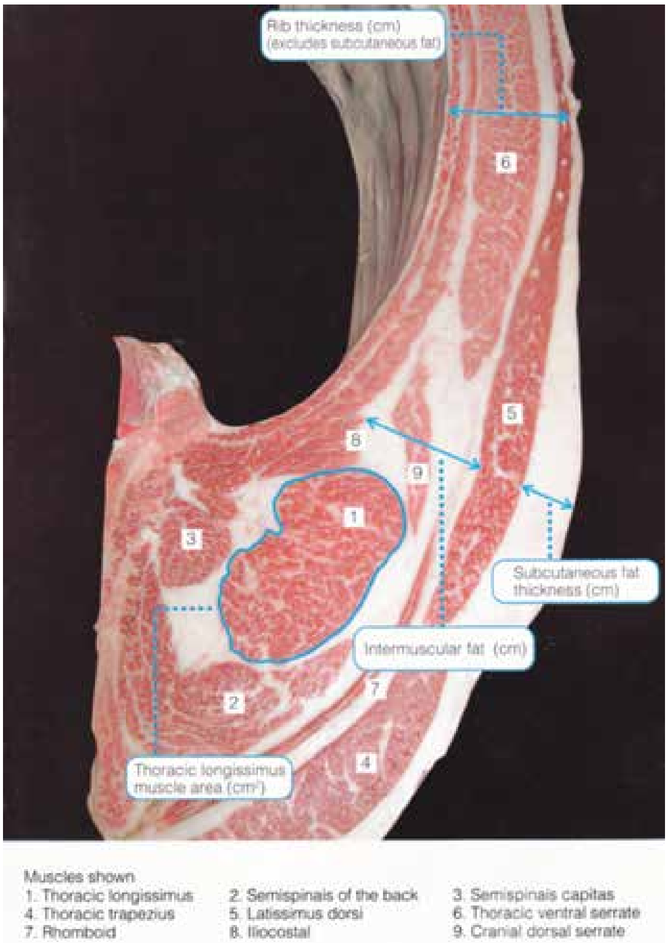
Consistent standard application is taken extremely seriously and involves a mix of direct "human eye" calibration and image analysis appraisal. Professor Kuchida of Obihira University currently leads the annual calibration meeting which involves farmer, government, industry and JMGA representatives. Professor Kuchida specialises in image analysis systems with his beef carcase camera system and software used to produce the JMGA photographic standards for marbling (BMS – Beef marbling score) and meat colour (BCS – Beef colour score). Following the annual national meeting the JMGA delegates return to their regions where they in turn establish calibration among the local graders, normally two to three times per year.

The Japanese grading standards are applied to a cold carcass with standard trim and quartered between the sixth and seventh thoracic vertebrae with the cut surface of the sixth rib viewed for assessment. The final grade comprises a yield and quality component with the yield designated by A, B or C and the quality component a numeral form 1 to 5. Thus a carcase may have a grade of A4 or B3 etc denoting the balance of yield and quality.

JMGA YIELD GRADE (Anon 2014a)

The yield grades denote estimated total cut yields of above average (A), average (B) or below average (C). The related formulae are reviewed at the annual standards meeting with A currently estimated as a yield of 72% or above, B 69 to 72% and C below 69%. The yield grade is determined from four factors further illustrated in the figure below.

Figure 3: Measurements taken at the 6th/7th rib cross section for JMGA Yield Grade calculation



The yield calculation is as follows:

Estimated yield = 67.37 + [0.130 x thoracic longissimus area (cm^2)]

+ [0.667 x rib thickness (cm)]

– [0.025 x cold split carcase weight (kg)]

– [0.896 x subcutaneous fat thickness (cm)]

A further 2.049 is added to this for Japanese Black carcases.

The carcase can be moved down one grade if fat relationships are outside limits of 12cm^2 for seam fat, if the fat seam between the *M.thoracic trapezius* and *M.throacic longissimus* muscles exceeds 4.0 cm or if the intermuscular fat in the rib exceeds 8cm. To achieve the calculated grade rib eye areas must be at or above 45cm^2 for Japanese Black, 44cm^2 for F1 and 35cm^2 for dairy.

Due to the extreme cost of beef in Japan and also to the number of variations in retail cutting lines the accuracy of the yield grade equation is not regularly tested but believed to have a correlation of 0.8 or better (K.Kuchida *pers comm*).

JMGA QUALITY GRADE (Anon 2014a)

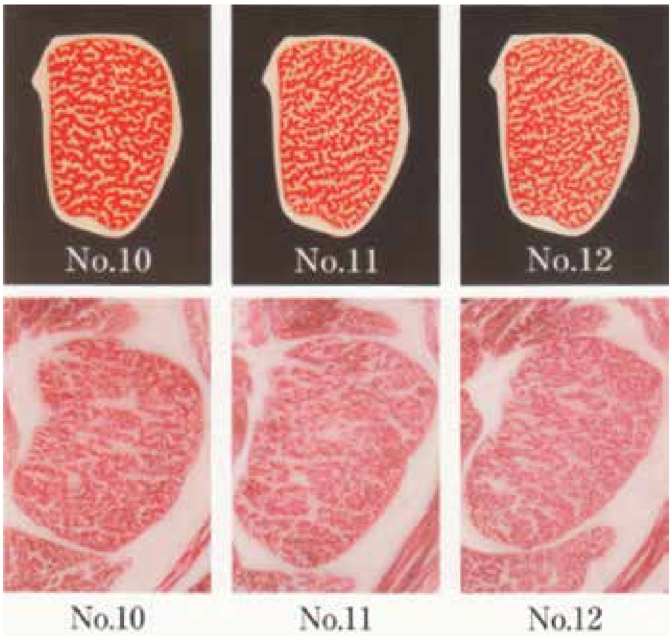
Four factors are considered when determining the quality grade. These are marbling level, meat colour and brightness, meat firmness and texture and fat colour, lustre and quality. A score between 1 and 5 is assigned for each factor with the lowest determining the carcase grade; for example if marbling was 4, meat colour and brightness 4 and meat firmness and texture also 4 the carcase quality grade would be 2 if the fat colour, lustre and quality was 2.

Marbling is assessed within 12 levels with silicon and photographic standards from 3 to 12. Beef Marbling Score (B.M.S) 1 is defined as practically devoid of marbling with B.M.S 2 described as a failure to meet BMS 3. No silicon or photographic standards are produced for B.M.S 1 or B.M.S 2. The silicon model standards are prepared by the National Institute of Animal Industry under MAFF. The original silicon standards were developed in 1988. Equivalent photographic standards were developed in 2009 and updated in 2014. Advances in image analysis technology and accumulation of many thousands of images facilitated use of a combination of marbling percent and new fineness index measures to produce a close to linear photographic series that is now the primary assessment tool. A portion of the series is shown in illustration 2. Table 2 below defines the linkage between the B.M.S score and the 1 to 5 marbling grade allocation.

Table 2: Relationship of JMGA B.M.S ranking and assigned marbling Grade[3]

B.M.S. Rank	1	2	3	4	5	6	7	8	9	10	11	12
Grade	1	2	3		4			5				

Figure 4: JMGA Beef Marbling Standards (B.M.S)[3]



Meat colour is judged against the objective Beef Colour Score (B.C.S) standard silicon chips. Brightness is determined by visual appraisal. There are 7 BCS reference standards, again related to a 1 to 5 grade allocation as depicted in Table 3 below.

3

Table 3: Relationship of JMGA B.C.S scores to assigned meat colour and brightness Grade (Anon 2014a).

		B.C.S. Score							
GRADE		1	2	3	4	5	6	7	Brightness
5	Very good			VERY GOOD					Very good
4	Good		GOOD						Good
3	Average	AVERAGE							Average
2	Below average	BELOW AVERAGE							Below average
1	Inferior	INFERIOR		Any Rank other than 2 to 5					

The meat firmness and texture grade is assigned from visual appraisal in accordance with the descriptions in Table 4.

Table 4: Assignment of JMGA meat firmness and texture grade (Anon 2014a).

GRADE	Firmness	Texture
5	Very good	Very fine
4	Good	Fine
3	Average	Average
2	Below average	Below average
1	Inferior	Course

Fat colour, lustre and quality is the fourth appraisal considered in the grading process. There are 7 Beef Fat Standard (B.F.S) beef fat colour standards used to assign the B.F.S score in conjunction with a visually-appraised lustre and quality adjustment. The relationship between the final fat colour, lustre and quality grade and the factors analysed is shown in Table 5.

Table 5: Assignment of JMGA fat colour, lustre and quality grade (Anon 2014a).

<table>
<tr><td colspan="2" rowspan="2">GRADE</td><td colspan="7">B.C.S. Score</td><td></td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>Brightness</td></tr>
<tr><td>5</td><td>Very good</td><td colspan="4">VERY GOOD</td><td></td><td></td><td></td><td>Very good</td></tr>
<tr><td>4</td><td>Good</td><td colspan="5">GOOD</td><td></td><td></td><td>Good</td></tr>
<tr><td>3</td><td>Average</td><td colspan="6">AVERAGE</td><td></td><td>Average</td></tr>
<tr><td>2</td><td>Below average</td><td colspan="7">BELOW AVERAGE</td><td>Below average</td></tr>
<tr><td>1</td><td>Inferior</td><td colspan="8">Any Rank other than 2 to 5</td></tr>
</table>

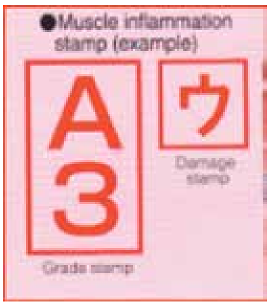
In addition any carcass damage is assessed and the carcass stamped with a damage stamp if applicable. The carcase damage classifications used are displayed in Table 6. The "other – KA" description is used for damage not listed in the other categories and includes poor carcase splitting, broken bones, incomplete bleeding, foul smell, unusual colour and significant contamination.

Table 6: JMGA carcase damage classifications (Anon 2014a)

Type of damage	Symbol
Muscle bleeding (stain)	A
Muscle edema	I
Muscle inflammation	U
Missing part	O
Other	KA

The detailed scores for the four quality factors and the resultant 1 to 5 grades are recorded in standard JMGA format and the final carcass grade computed from the lowest quality factor and the yield grade. The final carcass grade is then stamped on the carcase as shown in Figure 5 which includes a damage stamp for muscle inflammation.

Figure 5: Example of JMGA carcass grade and damage stamps (Anon 2014a).



FURTHER JMGA GRADE DEVELOPMENT

The JMGA grading system is highly regarded by the industry and an important part of the commercial trade description and valuation. There is no doubt that the intense and long term dedication to the art of beef grading in Japan develops extremely high skill levels and the highest of professional standards. The training is by far the most rigorous in the world and meat grading is a well-respected profession. The cattle population also represents an extreme with the strong influence of Japanese Black genetics, the related grade standards and strong retail price signals leading to an aura around highly marbled beef at the premium end. This cattle population sits at an extreme end relative to countries other than Korea with progressively less overlap from USA>Australia>Europe.

As such it is highly likely that the consistency of appraisal, particularly at the high marbling extreme, is better than might be expected from Australian or other graders not regularly exposed to similar carcases. This contention is supported by camera and image analysis data collected in conjunction with AUS-MEAT, but not MSA, grading parameters in Australia from Wagyu cattle and reported by Maeda et.al. (2013). Their study suggested that image analysis approaches could provide superior accuracy and definition with associated improved genetic correlations (marbling heritability 0.54 vs 0.23 from AUS-MEAT marbling scores). The Australian Wagyu Association has purchased a camera and image analysis software and is utilising this in Australian appraisal work.

Within Japan there is also considerable further study devoted to improved grading accuracy and potential linkage to consumer sensory response. Image analysis system development has proceeded extensively over the past 10 years and now forms the basis for establishment of official standards. Equipment variations have been developed to operate at cut level in boning rooms and faster automated image analysis software suitable for on line grading use are being developed.

In other work on-line analysis of fatty acid composition using NIR technology has been progressed with a pilot scheme in Nagano Prefecture providing a certified deliciousness rating for Japanese Black carcases with defined levels of B.M.S and oleic acid. The standards applied to attain a delicious certification are:

- A BMS number of 7 or greater and oleic acid of 55% or higher or
- A BMS of 5 or higher and oleic acid of 58% or better or
- A BMS of 8 or higher and oleic acid of 52% and above.

The certified delicious beef is supplied only to registered outlets within the prefecture.

Other brands have since added an oleic acid standard, adding further refinement to grading and associated branding.

RELATIONSHIP OF JMGA CARCASS QUALITY GRADES AND INPUTS TO CONSUMER SATISFACTION

While the JMGA grading system ensures very consistent application of grading standards the relationship of the standards applied and final consumer enjoyment is less clear and appears to be subject to less rigorous formal evaluation. An opportunity to evaluate this issue arose from an MSA study that used MSA protocols for grill, yakiniku and shabu shabu cooking methods across 1620 Japanese consumers in Tokyo and Osaka (Watson, 2008). The research included striploin, outside flat and chuck from Japanese Black, F1 and Dairy beef, slaughtered in Kyushu, and the same cuts from a range of Australian cattle.

The relationship of all the individual JMGA grade inputs and the final yield and quality grades assigned was examined statistically with the correlations to the sensory grades assigned by consumers as shown in table 7. While, as might be expected, many of the yield inputs are at the low end the quality factors also have a relatively poor relationship to the consumer response, including the JMGA Quality grades. These low correlations reflect the difficulty of accurately predicting consumer response from a carcase grade with at least part of the problem being the application of a common grade to all cuts.

The dotplots for consumer assessed grade versus JMGA Yield grade (Figure 1) and JMGA Quality grade (Figure 2) further demonstrate the considerable overlap between either grade and ultimate consumer response with the yield grade not dissimilar to the quality grade in discriminate ability.

Within the Japanese beef trade there is some concern regarding a disconnect between producers striving to achieve the highest A5 grading standard and the reducing premium obtainable at consumer level relative to A3 (P Troja *pers comm*). The extent to which reduced demand for A5 represents economic pressures, health concerns or experienced quality is not known but the current situation is challenging trade margins.

While the cause of any preference change is not known Japanese consumers are reported to consistently identify beef quality and to assign samples to alternate quality grades (Polkinghorne et.al., 2011). Further the Japanese consumers assigned very similar ratings to Australian consumers for paired samples cooked as yakiniku and shabu shabu but generally lower scores when grilled (Polkinghorne et.al., 2012).

Table 7: Correlations of JMGA Grades and grade components to Japanese consumer grade star (Watson, 2008).

Attribute	r
BMS	0.442
Fat lustre	0.441
Fat Grade	0.441
Marbling Grade	0.439
JMGA Grade	0.428
Yield	0.425
JMGA Quality Grade	0.412
Firmess	0.406
Firmess and texture Grade	0.406
Brightness	0.386
Beef Colour Grade	0.386
Texture	0.376
JMGA Yield Grade	0.376
Rib thickness	0.312
Rib eye area	0.293
BFS	0.282
Subcutaneous fat	0.197
BCS	0.150
Fats in carcase weight	0.028

Figure 6: Dotplot of consumer allocated quality grade (star) vs JMGA Yield grade (Watson, 2008).

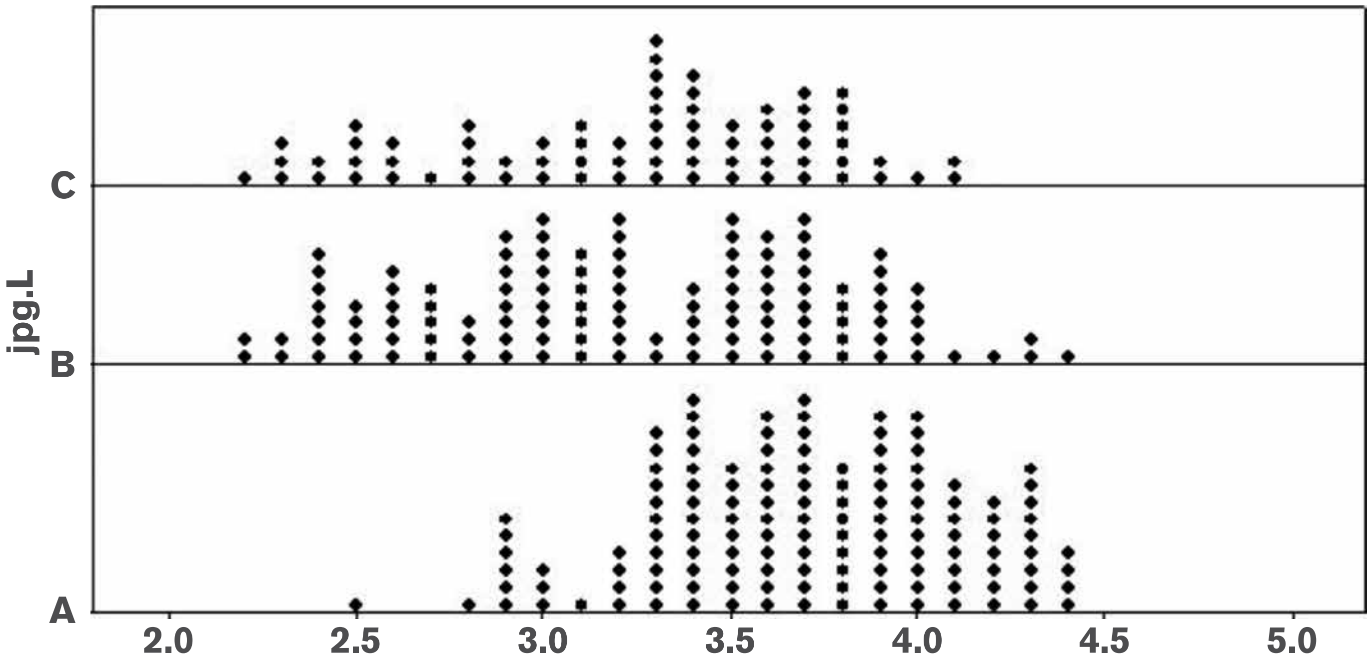
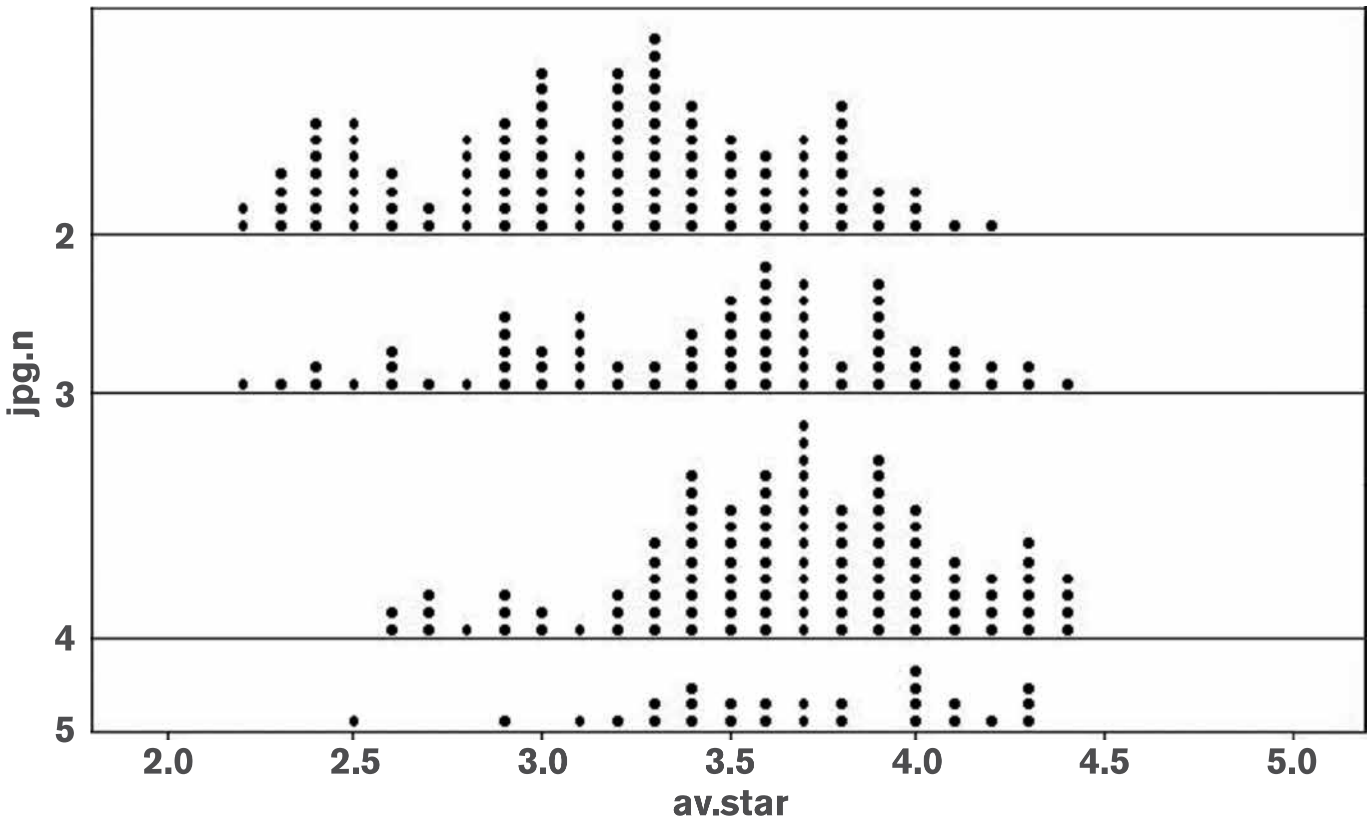


Figure 7: Dotplot of consumer allocated quality grade (star) vs JMGA Quality grade (Watson, 2008).



JAPANESE WHOLESALE AND RETAIL BEEF LANGUAGE

Japanese wholesale and retail beef language embodies a strong emphasis on quality, pristine presentation and provenance factors including many regional identifications and source identification. Individual animal identification is maintained and included on retail cut labels for grill, yakiniku and shabu shabu although only at batch level for hamburger.

Figure 8: Retail packs for sale in Japanese supermarkets

Slightly different official cut guides exist for Hokkaido and Tokyo and are used for wholesale cut trade. There are 13 common basic cuts then special cuts in addition and derived from the basic group. (Kuchida pers.comm). Trading is in Y/kg with important specification continuing to identify FB (full blood Japanese Black), F1 and Holstein/dairy derived product independent of grade so that a trading specification might be FB A4 momo (round and rump) etc. If Japanese Black is specified it must be 100% derived from full blood cattle with blending prohibited. A restaurant may order A5 Japanese Black sirloin or just "beef for yakiniku" with brand name often an important value attribute, Kobe and Matsuaka being well known examples. The menu description may simply be Matsuaka beef. The highest quality and reputation brands are in short supply and difficult to source adding to their prestige and price. As an example, given an Australian $ exchange rate of Y100, the Matsuaka product in the following photograph (Picture 4) is priced at the equivalent of A$525 per kg. As shown in this example retail pricing is displayed in Yen per 100 gm.

Figure 9: A highly marbled striploin on display in a Japanese butcher shop

The use of cut name varies widely in both restaurant and retail description which may also commonly describe regions of the carcase such as beef rib or hindquarter rather than more detailed cut names. A high percentage of retail beef is presented under a cooking method description such as "Wagyu for curry" or shabu shabu. The presentational standards are exceptional by any measure emphasising the special nature of beef.

Willingness to pay (WTP) data reported from the Tokyo and Osaka study, published by Lyford et al (2010), also supports the strong value association with beef quality and Japanese consumers. Relative to 3* (good everyday quality) Japanese consumers valued unsatisfactory beef at 48% of the 3* price, 4* (better than everyday) at 169% of 3* and 5* (premium quality) at 286% of 3*. While the ratio of 3* to unsatisfactory and 4* reported was very similar to that for Ireland, USA and Australia the 5* ratio was considerably higher with the other countries reported close to 200% rather than the close to 300% found in Japan. In each of the four countries reported there was essentially no demographic influence on WTP other than a lower value for 5* product with older consumers. For the Japanese, age groups under 39 years rated 5* at over 300% of 3* whereas for those over 40 years old the premium reduced to 290% (41–50) and to 266% over 51 years old. This indicates that beef quality will continue to be a very strong driver in future.

REFERENCES

Anon (2000). *Beef Carcass Grading Standard*. Japan Meat Grading Association, Tokyo, Japan. (http://wagyu.org/uploads/page/JMGA%20Meat%20Grading%20Brochure_english.pdf)

Anon (2014a). *Statistical review. Key statistics for the Australian red meat and livestock sector*. (July 2013 – June 2014). Meat & Livestock Australia Limited, Sydney. (http://www.mla.com.au/Prices-and-markets/Market-news/2014-MLA-Statistical-Review-now-available, accessed 11/6/2016)

Anon (2014b). *Beef Carcass Grading Standard* (May 2014) Japan Meat Grading Association, Tokyo, Japan.

Lyford, C., Thompson, J., Polkinghorne, R., Miller, M., Nishimura, T., Neath, K., Allen, P., & Belasco, E. (2010). Is willingness to pay (WTP) for beef quality grades affected by consumer demographics and meat consumption preferences? *Australasian Agribusiness Review*, Vol 18, ISSN 1442-6951. (http://agrifood.info/review/2010/Lyford_et_al.pdf)

Maeda, S., Grose, J., Kato, K., & Kuchida, K. (2013) Comparing AUS-MEAT Marbling Scores Using Image Analysis traits to estimate genetic parameters for marbling of Japanese Black cattle in Australia. *Animal Production Science*, 54, 557-563.

Polkinghorne, R., Nishimura, T., Neath, K. & Watson, R. (2011). Japanese consumer categorisation of beef into quality grades, as based on Meat Standards Australia methodology. *Animal Science Journal*, 82, 325-333

Polkinghorne, R., Nishimura, T., Neath, K. & Watson, R. (2012). A comparison of Japanese and Australian consumers' sensory perception of beef. *Animal Science Journal*, 85, 69-74.

Watson, R. (2008). *Japan-Australia consumer beef tasting trial*. Report to Meat and Livestock Australia Limited, Sydney.

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MEAT & LIVESTOCK AUSTRALIA

APPENDIX C:

LANGUAGE USED IN THE AUSTRALIAN DAIRY INDUSTRY

Author: R. Polkinghorne

Technical papers for the Australian Beef Language
'WHITE PAPER'

Published by Meat and Livestock Australia, Sydney.

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Technical papers for the Australian Beef Language 'White Paper'.
Meat and Livestock Australia, Sydney, 40 Pages

CONTENTS

KEY POINTS

- Dramatic change with deregulation has reduced farm numbers by two thirds over 30 years.
- Despite cow numbers reducing by 20% milk production has essentially remained stable with per cow productivity continuing to increase.
- Milk is supplied as a single product and then transformed prior to sale. As with beef carcases and cuts all milk components must be sold in proportion to those supplied.
- The dairy product mix is extensive and highly varied in relation to the proportion of protein, fat and other solids plus water in the products marketed.
- The ruling domestic and international prices for each product create a weighted value for raw milk components and directly influence farm gate pricing.
- The absolute and relative value of milk components will vary with the manufacturer and product mix.
- Each farmer is paid on the basis of components supplied and additional market related factors including seasonality, volume and microbiological standards.
- When coupled with herd test data individual cow values can be calculated.
- The accurate value of individual cows rather than herd average is a major driver of on-farm productivity improvement through improved genetics and management.
- This contrasts to the beef experience where the true value of individual animals is lost within an average sale price with an associated reduced ability to drive improvement.

MILK PRODUCTION

The Australian dairy industry has experienced traumatic change over the past 30 or so years in conjunction with extensive deregulation of the liquid milk market at all levels from farm production to packaging and distribution. This has effectively merged the manufacturing and liquid milk markets which had been largely state based and separate in the past and created a national milk market. While farm numbers have declined by two thirds, from 20,060 in 1983 to 6,398 in mid 2013 (Anon, 2013), those remaining have become larger with average herd size increasing from 90 cows in 1982 to 258 currently (Anon, 2013).

Total dairy cow numbers have fallen from around 2 million (1.88m in 1979/80, 2.176m in 2000/01 (Anon, 2013)) to around 1.6 million currently. The drop in cow numbers has however been offset by continual productivity gains with average per cow production rising from 2,848 litres in 1979/80 to 5,891 litres in 2011/12 (Anon, 2013). The dairy industry is the third largest Australian rural industry valued at $13 billion in the 2012/13 year, producing 9,200 million litres of milk with a farm gate return of $4 billion. Approximately 40% is used in export product with annual export sales of $2.76 billion making Australia the third largest global dairy exporter (Anon, 2013).

MILK UTILISATION

In common with beef cattle the item supplied to the processor – an animal for beef and liquid milk for dairy – comprises multiple components that are unlikely to be an ideal fit for any single desired product mix or market. The processor however must take delivery of the whole and then manage the process to dispose of all components in the pre-determined balance. In beef this equates to marketing the hide, blood, tallow, bone, offal, "sweet" cuts, other primals and trim whereas in dairy the equivalent may be seen as water, the major component and 87% of milk, and solids with protein, fat and lactose the major solids but minerals and micro nutrients also important for nutritional reasons. Essentially both are disassembly processes and the invert of conventional manufacturing.

In dairy the final products often comprise some reassembly of components with a varied number of intermediate steps and often further intermediate by-products such as whey from cheese. While traditional liquid milk manufacture is relatively simple with pasteurisation and standardising of fat, and sometimes protein content, newer products such as Physical™ require further processing capability to adjust component ratios. Large volume traditional manufactured products such as butter, milk powders and cheese have been used in combination to clear all components whereas new highly technical processes are now applied to extract valuable micro-components, somewhat equivalent to blood utilisation in the beef industry. Total utilisation of Australian milk is displayed in Table 1.

Table 1: Percentage utilisation of Australian Milk (2013) (Anon, 2013)

Cheese	33%
Skim milk powder & butter	28%
Drinking milk	27%
Whole milk powder	9%
Other	3%

This broad distribution of product categories can be further viewed in terms of their major components in Table 2 (Anon, 2012). The diversity of component makeup and relative proportion of the primary protein to fat ratio is evident.

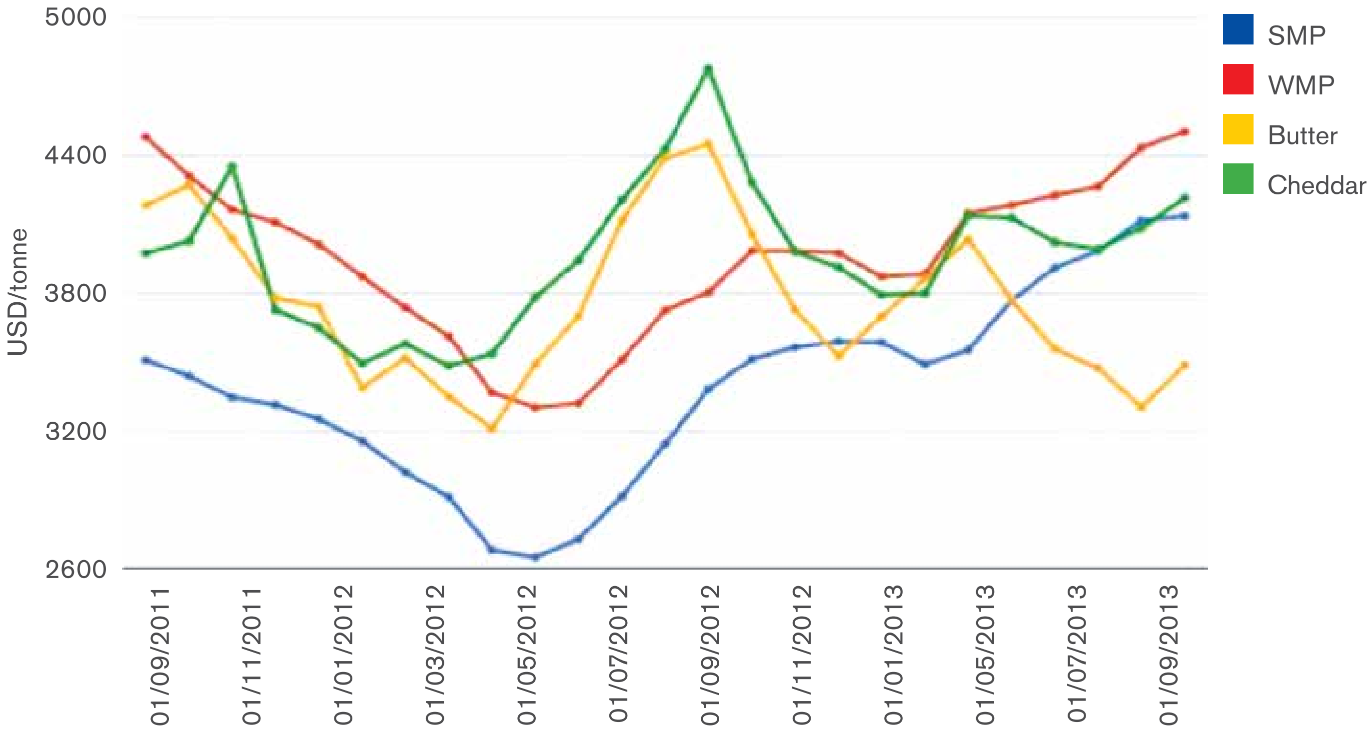
A dairy factory product mix must be tuned to align with raw milk intake by either a complementary mix of product or by trading unwanted components. It can be readily seen that a factory specialising in liquid milk will be best served by farm supply close to the base 3.5% of fat and protein whereas another factory specialising in milk powders would prefer much higher solids milk to reduce cartage and drying costs. The base balance between fat and protein has traditionally been managed by a mix of butter, to utilise fat, and skim milk powder (SMP), to utilise protein, or by production of a mix of cheese types and whey product.

Table 2: Proximate analysis (%) of selected dairy products and associated protein:fat ratios

Product	Water	Protein	Total fat	Carbohydrate	Protein/fat
Milk (regular)	90.5	3.5	3.5	6.3	1.0
Milk (low fat)	93.3	3.8	1.2	6.1	3.2
Milk (skim)	94.2	3.7	0.1	5.0	37.0
Milk (high protein & calcium)	91.6	4.2	1.6	5.6	2.6
Buttermilk	90.7	4.4	2.1	5.6	2.1
Whole milk powder	2.7	27.2	26.3	38.3	1.0
Skim milk powder	3.9	36.3	0.9	50.4	40.3
Yoghurt (natural)	84.8	6.0	4.4	5.0	1.4
Yoghurt (low fat)	86.6	6.8	0.3	6.2	22.7
Blue vein cheese	41.4	20.3	32.4	0.0	0.6
Camembert cheese	52.6	19.5	25.0	0.1	0.6
Cheddar cheese	34.0	24.6	32.8	0.5	0.8
Cream cheese	55.0	8.2	31.9	2.5	0.3
Feta cheese	52.9	17.4	22.8	0.2	0.8
Mozzarella cheese	46.8	26.0	22.5	0.7	1.2
Butter (salted)	15.5	1.1	81.5	0.0	0.013
Ghee	0.0	0.3	99.9	0.0	0.003
Cream (pure)	60.1	2.3	35.9	1.8	0.06
Icecream (Vanilla)	34.4	2.1	5.9	11.5	0.36

While traditionally the price of liquid milk was relatively stable and regulated the relative export demand and pricing of major products such as butter, SMP and cheddar cheese has been volatile leading to dramatic change over time. The following graph provides an illustration of pricing volatility within a relatively short recent period.

Figure 1: USA indicative export prices for major dairy product types (Sept 2011 to Sept 2013) (Anon, 2014)



A classic historic example of the change in relative component values was the transition from farmers selling cream to the factory and having to utilise the skim to feed pigs to a position where cream (milk fat utilised in butter) was later of very low value with the world market awash in EU butter but SMP, made from the skim, in high demand. These market changes in turn dramatically affected the true value of farm milk and prompted an associated realisation that "milk was not milk" but rather a collection of components, the value of which differed widely.

FARM MILK PRICING

Prior to 1980 Australian milk pricing mostly followed a practice of cents/litre for contracted market milk, with associated compositional and hygiene standards, and $ per kg of butterfat for manufacturing milk. Dairy farms were predominantly of one type or the other with manufacturing production concentrated in the south and highly seasonal while market milk contracts required year round production with farms located within range of State based population areas.

This pricing basis encouraged two strongly differentiated farm systems: on the market milk side an almost total dominance of high production, low milk solids, Holstein herds calving year round and requiring substantial supplementary concentrate feeding and, on the manufacturing side, predominantly entirely grass based seasonal calving herds producing higher solids milk from crossbred herds retaining some traditional Jersey or Guernsey content.

Increasing deregulation, growing interstate trade and the abolition of milk contracts, firstly in Victoria, triggered substantial changes in every facet of dairy operation as the industry readjusted to the new economic environment. A critical driver was a change in farm gate milk pricing systems which provided clear market signals to suppliers. Factories that specialised in market milk were concerned regarding year round supply and developed seasonal pricing incentives and supply strategies whereas the large manufacturing co-operatives began paying differential pricing for fat and protein. This immediately drove home the fact that, at that time, while traditional payment was entirely butterfat based, fat was of relatively low value due to global oversupply with principal value being derived from protein. The demand for higher protein milk with a lesser fat percentage was clearly communicated and reacted to by farmer suppliers.

Farm milk prices have continued to reflect market demand at a component level as global supply and demand for alternative products changes. Further pricing components for low cell count (higher microbiological standard) and out of season supply have become the norm as has a volume charge to discourage low solids milk for companies drying a large percentage of intake for milk powder. Specialist product producers have developed individual incentive schemes related to their specific needs. While not perfect the farm gate milk price is largely aligned with market prospects and final performance of the companies. In all cases the "language" of payment directly relates to the milk components utilised and reflects related costs or opportunities through volume, seasonality and bacteriological quality. A further aspect, not seen within the beef sector, is the use of "step ups" where an initial or "opening" seasonal price is stepped up by further payments as product is actually sold and a final value crystallised.

The current 2014 pricing system (Southern Milk Region) from the Murray Goulburn Co-operative, the largest Australian dairy group processing around a third of all Australian milk, provides a working example of farm milk pricing. Table 3 displays the advised base price per kg of fat and protein by month. Two factors are encompassed within this; an advised change of fat to protein pricing ratio to 1:2.2 (protein is currently valued at 2.2 times fat per kg reflecting an increase in relative fat value from historic ratios of 1:3) and a strong indication of seasonal value differences. These arise from product mix changes in each month with fresh high value products such as drinking milk requiring constant production and representing a higher percentage of production in months of lower farm milk supply.

Table 3: Murray Goulburn Southern Region Opening Milk Price 2014/15 (Anon, 2014b).

Month	Butterfat $/kg	Protein $/kg
July	$4.15	$9.14
August	$3.78	$8.33
September	$3.66	$8.06
October	$3.66	$8.06
November	$3.66	$8.06
December	$3.66	$8.06
January	$3.86	$8.49
February	$3.96	$8.73
March	$4.00	$8.81
April	$4.15	$9.14
May	$4.23	$9.30
June	$4.30	$9.47

In addition to the above further incentives in the form of Productivity Incentive (PI), Growth Incentive (GI) and Flat Milk Incentive (FMI) are available to farmers (Anon 2014c). The PI incentive recognises scale efficiencies in milk collection and ranges from $0.02 per kg of fat and $0.05 per kg of protein, for monthly supply from 1,701 to 3,800 kg of fat and protein, to $0.17 and $0.38 per kg of fat and protein where monthly supply exceeds 80,000 kg. The GI recognises the value to the company of increased supply through improved utilisation of company asset capacity. The 2014/15 GI incentive is $0.33/kg for fat and $0.72/kg protein for amounts above the previous 2 years average supply. The FMI, displayed in table 4, can be elected by farmers and provides a further premium or discount relating to the percentage of milk supplied in the off-peak period (July, 50% of August and February plus all March to June production).

Table 4: Murray Goulburn Flat Milk Incentive (Excludes unacceptable milk) (Anon, 2014c)

MonFMI%th	Butterfat Cents/kg	Protein Cents/kg
< 40.00%	-4	-9
40.00% – 40.99%	4	9
41.00% – 41.99%	14	31
42.00% – 42.99%	26	57
> 40.00%	39	86

Other pricing signals include milk collection charges related to the number of collections required and penalties for milk quality ranging from 0% for premium quality milk to 32% for poor quality. In addition statutory levies are deducted from milk proceeds.

This pricing structure transparently reflects factory product return opportunities and production costs. Individual farmers can directly assess their individual position in regard to the incentives and discounts offered and related farm business costs while developing their farm plans and budgets.

The evolvement across the dairy industry of farm gate pricing directly aligned with product demand and relative value has been a trigger for substantial on-farm adjustments to genetics and management. Clear communication using relevant language and transparent pricing systems have been fundamental in this transition.

RETAIL PRODUCT INNOVATION

The retail dairy case(s) has substantially changed over 20 years post deregulation as companies have sought to create points of difference and attract further revenue through consumer demand. Milk is no longer milk with the category incorporating a wide range of packaging types and sizes in addition to alternate fat levels and a growing number of specialty products aimed at niche markets. These have grown from basic variations such as low or high fat and flavours, solids modification through SMP or concentrate addition, enhanced protein and calcium through ultrafiltration, shelf stable UHT products and more recently to lactose free, organic and A2 milk etc. Cream has also grown to a category and yoghurts and dairy desserts expanded exponentially beyond the original vanilla ice cream. These products together with the huge array of cheese types and brands within types combine to create a very contemporary consumer offer occupying considerable retail display space. An important characteristic is that each product is targeted at a specific consumer need and, as a matter of course, expected to perform in a uniform and predicted manner.

DAIRY FARM DATA FEEDBACK AND RESPONSE TO PRICE SIGNALS

In contrast to beef, dairy farmers supply product on a daily basis and have an accurate volume measure of each delivery. The composition of each delivery is determined, from a sample taken at the farm, by laboratory analysis conducted by the processor and, together with further pricing signals such as bonuses for quality and deductions for volume determines the monthly milk payment. While payments are monthly they are not necessarily final with the large manufacturing cooperatives advancing an initial “opening” price and then supplementing this with progressive “step-ups” that add further return as product is sold. The actual final price for manufacturing milk is consequently generally not known at the time of delivery and often spread over a year or more. A degree of trust must exist between the farmer and processor for the system to operate. The factory generated payment detail each month typically provides year to date production summaries and year and month comparisons to the previous year, often in graphical format.

At the point of sale farm milk revenue represents an average value across the herd, a position not dissimilar to selling a line of steers. For many dairy farmers this remains the position but, to the great benefit of the industry, a substantial number, around 40% (S. McRae pers comm), herd test all cows monthly while many with modern milking technology also record individual cow volume at every milking. This expands the overall herd production data into individual cow contributions and values.

The herd test reports provide a wealth of accessible management data at herd and individual cow level. Typical reports include the following:

- Individual cow milk (litres), fat (kg), protein (kg) production on the test day, the previous test day and year to date basis.
- Production reports for cow groups defined by calving period, age and breed.
- Benchmarking to district averages or local research farm production including per hectare comparisons.
- Somatic cell counts for each cow (used in mastitis detection and a payment component).
- Reports on mastitis infections with comparisons to prior periods together with counts and listing of cows above threshold cell count levels.
- Summary reports for all cows within age groups.
- Reports for all cows that have completed their lactation at the last test including their lifetime production history.
- Lists of cows sorted within highest and lowest production index (PI).

The PI is a crucial number driving culling decisions within the individual herd. The PI is a measure of a cow based on her performance in the current lactation, compared to other cows of the same breed in the same herd (Anon, 2009). The calculation takes the current and any previous test day data from the current lactation, adjusts for cow age and estimates the total lactation. The PI for each cow is then estimated with a PI of 100 the average. The PI provides an immediate relative rating of all cows in the herd and is a principal tool for production based culling decisions.

All herd test data is also uploaded to the Australian Dairy Herd Improvement Scheme (ADHIS) database which generates genetic evaluations of all recorded cows and bulls. All Australian data is in turn uploaded to the Interbull database in Sweden which combines data from most significant dairy producing countries. This provides international evaluation and comparison of dairy sires.

ADHIS use the production data to calculate Australian Breeding Values (ABVs) for cows and bulls. In practice three levels of bull ABVs are generated: ABV(g) for unproven young bulls where the ABV is based solely on genomic and pedigree data, ABV(i) for bulls proven overseas but without tested Australian daughters and ABV for proven bulls using Australian milking daughter information (Anon, 2014d).

While at a base level this is similar to beef Breedplan the data is considerably more powerful at industry level due to the typically high percentage of AI, and consequent concentration on a small pool of globally outstanding bulls, but also due to the inclusion of all commercial herd recorded daughters. The proof becomes more reliable as it moves from an ABV(g) to a high reliability ABV where daughter performance predominates. In contrast the majority of beef sires never have recorded progeny and commercial cows are essentially excluded from the principal genetic evaluation process.

Further national reports are generated of elite dairy cows which are further targeted by genetics companies for bull breeding and indexes such as the Australian profit ranking (APR) generated by combining the production indexes with other factors including type measures, disease resistance, temperament and longevity.

Dairy farmers who do not participate in herd testing also make progress via access to the same bank of proven AI sires and continual attention to other management aspects including nutrition and related pasture management strategies. Those working at the elite end further multiply the rate of genetic progress, estimated at an overall industry average of 3% per year (S. McRae *pers comm*), by multiplying the impact of elite cows through embryo transfer.

The powerful combination of a payment system directly related to final consumer product value and tools that provide detailed financial knowledge at individual cow level with allied accurate genetic data continually drive productivity improvement across the dairy industry. While the past 30 years, at least, have been traumatic and profitability still periodically challenged there is no doubt that industry survival reflects continual productivity improvement at farm level. A typical 1980s dairy herd could not survive in the current environment.

DAIRY IMPACT ON BEEF PRODUCTION

The dairy herd contributes to overall Australian beef production through cull cows, heifers and male offspring. Currently around 98% of male calves are sold within a week of birth for bobby veal (S. McRae pers comm). Consequently any large scale shift from sale of bobby calves to growing out male calves as bulls or steers has potential to further impact the beef market. It is assumed that a majority of the 709,000 (Anon, 2014e) calves slaughtered in 2013/14 were of dairy origin and loosely aligned to dairy cow numbers of 1.67 million at June 2013 (Anon, 2014f). While dairy cattle are typically disdained by beef producers across the globe consumer based eating quality studies consistently find at least equal eating quality outcomes.

In recent years there has been a strong export demand for live dairy heifers. Given that a 6 month old Australian dairy heifer may bring $1,800 (S. McRae *pers comm*) on farm at present few will enter the beef supply chain but the availability of live export markets and related pricing may be volatile, creating potential for increased transfer to the beef supply chain. Due to production pressure, conception standards and competition from superior heifer genetics many dairy cows are sold for meat at 6 years of age or less (S. McRae *pers comm*). While a traditional source of 95% CL grinding beef, economic signals could readily transform many of these carcases to higher value outcomes through pre slaughter fattening.

The percentage of beef bull semen used in joining dairy heifers and cows varies widely but, should sexed semen become sufficiently reliable, could expand considerably with consequences for beef quality and tonnage. The normal use of AI as a primary joining method in dairy enterprises provides an avenue for rapid genetic progress and market response.

While Australian beef cow numbers are substantially larger than dairy (90% vs 10% (Anon, 2014f)) the reverse is true in many countries where beef production is largely a by-product of dairy, New Zealand becoming a regional example with dairy cattle numbers (6.59m head) substantially above those of beef (3.69m head) (Anon, 2014g). New Zealand breeding cow numbers are even more spread with 5.1 million dairy and 1 million beef cows at June 2013 reflecting a 20% decline in beef cattle numbers and a 29% growth in dairy over the 10 year period to 2013 (Anon, 2014g). Poland provides a more extreme European example with dairy cows comprising 95% (Anon, 2014h) of female breeding cattle. In both situations the majority of male dairy calves remain as bulls with associated implication for the overall beef supply. In both countries the driving force behind the numbers is relative profitability.

POSSIBLE BEEF PARALLELS

As discussion points the following possible parallels from dairy to beef are advanced:

1. The "language" used in describing dairy products, milk components, animal characteristics, health measures and genetic ratings is clear and uniform. In most cases it is also common internationally facilitating global trade of both consumer products and livestock genetics.
2. Similar uniformity could facilitate beef trading if the Australian language accurately reflected consumer outcomes and was accepted as a voluntary international standard.
3. Beef carcase "components" could be viewed as MSA 3*, 4* and 5* and also include trim, hide or offal components if deemed appropriate.
4. A combination of reliable weight (yield) in conjunction with "beef component" prices would provide value based payment and an accurate individual animal measure.
5. Production responds to payment so that value based payment would be expected to lead to substantial management change at farm level.
6. Pertinent evidence is provided at a macro level by observation of International grading and payment systems; High muscle lean European breed cross bulls in response to EUROP payment; Wagyu crosses and extreme marbling in response to JMGA grading.
7. Accurate individual animal payment rather than average values could drive innovation and consistent productivity and herd improvement across the beef industry.
8. Dairy and beef herds are both cattle; similar rates of productivity gain should be possible with genetic and many management tools common to both industries.

SUPPLY DIFFERENCE TO BEEF

While a number of parallels between beef and dairy are drawn above there is one important difference that may also be relevant: milk must be delivered to a processor daily, or at most every second day. This fundamental requirement creates a smoother supply to the processor and less day to day price fluctuation. While dairy farmers can and do change processors this represents a major decision not taken lightly and in general infrequently.

There are only a small number of processor options in most regions and relationships tend to be medium to long term. Whereas a beef producer may hold over cattle to utilise a good season or in anticipation of higher prices a dairy farmer cannot do the same with milk. It is far easier for the beef producer, mostly with a few irregular sale consignments per year, to "play the field" and market to a range of alternative processors.

REFERENCES

Anon (2009). *Technote No. 11 Production Index (PI)*. (Version 1. May 2009). Melbourne, Australia: Australian Dairy Herd Improvement Scheme Pty. Ltd.

Anon (2012). *Proximate Composition of Australian Dairy Foods*. Melbourne, Australia: Dairy Australia Limited.

Anon (2013). *Australian Dairy Industry in Focus 2013*. Melbourne, Australia: Dairy Australia Limited.

Anon (2014a). *US Indicative export prices*. Dairy Australia Limited. (www.dairyaustralia.com.au/Markets-and-statistics/Prices/World/export/price/us.aspx) Accessed 30th October 2014

Anon (2014b). *Opening Price Circular 2014/15: Southern Milk Region*. Melbourne, Australia: Murray Goulburn Co-operative Co Limited.

Anon (2014c). *Supplier Handbook Southern Milk Region.* Melbourne, Australia: Devondale Murray Goulburn Co-operative Co Limited.

Anon (2014d). *The Good Bulls Guide April 2014*. Melbourne, Australia: Australian Dairy Herd Improvement Scheme Pty Ltd.

Anon (2014e). *Statistical Review July 2013 – June 2014*. Sydney, Australia: Meat & Livestock Australia.

Anon (2014f). *Agricultural Commodities*, Australia, 2012 – 2013. (Publication 7121.0). Canberra: Australian Bureau of Statistics.

Anon (2014g). *Compendium of New Zealand Farm Facts 2014*. (38th ed). Wellington: Beef & Lamb New Zealand.

Anon (2014h). *Przegląd Hodowlany nr 5/2014 (Animal Production Review)*. Poland: Polskie Towarzystwo Zootechnicze. (http://ptz.icm.edu.pl/category/numery-ph/, accessed on 11/6/2016).

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APPENDIX C:

LANGUAGE USED IN THE AUSTRALIAN WHEAT INDUSTRY

Author: R. Pattinson

Technical papers for the Australian Beef Language 'WHITE PAPER'

Published by Meat and Livestock Australia, Sydney.

June 2016

Pattinson R (2016) Language used in the Australian Wool Industry.
Technical papers for the Australian Beef Language 'White Paper'.
Meat and Livestock Australia, Sydney, 12 Pages

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CONTENTS

KEY POINTS

- Wheat is Australia's largest cereal crop
- In 2013–14 there was 13.5m Ha planted in Australia producing 22m tonnes at a value of about $7.5 billion
- Wheat has a higher protein level than most other cereals
- Protein is a key determinant of grain quality and has a big impact on the products that can be made from processed flour
- Wheat yield and quality is an outcome determined by the genetic potential of the variety interacting with the environment (P=GxE)
- There is a detailed process for classifying varieties by growing zone (region) – undertaken by Wheat Quality Australia
- Wheat trading standards are also in place and managed by Grain Trade Australia
- There is a huge array of wholesale and retail consumer products derived from wheat

WHEAT PRODUCTION

Wheat is grown throughout many regions of Australia – south east Queensland, New South Wales, Victoria, south east South Australia and the wheat belt of Western Australia. Wheat grown in Western Australia is mostly exported while about 40% of wheat grown in the eastern regions of Australia is used for domestic consumption and animal feed. The major export markets for Australian wheat are in the Asian and Middle East regions, including Indonesia, Japan, South Korea, Malaysia, Vietnam and Sudan. In 2013–14, Australia had over 13.5 million hectares planted producing approximately 22 million tonnes of wheat with a gross value reported at over AU$7.5 billion.

CHARACTERISTICS

Wheat grain is a staple food used to make flour for breads, baked goods, breakfast cereal, pasta and noodles; for fermentation to make beer and other alcoholic beverages; and as a stock feed. Wheat has a higher protein content than most other cereals and it is protein levels that is the major quality determinant – with protein levels largely dictating the type of foodstuff that can be best prepared from it.

The protein level of wheat is directly related to the variety of wheat planted and the environment in which it is grown.

VARIETIES

There is a wide range of wheat varieties for farmers to choose from, with individual research required to determine the most suitable variety for the environment and end use. Sources of information of wheat varieties grown in Australia can be found from Anon (nd, a):

- National Variety Trials – online database, visit www.nvtonline.com.au
- State department of Primary Industries variety guides
- Companies that market varieties
- Local advisors and agronomists

Most wheat varieties are covered by Plant Breeders Rights and a royalty or fee is payable to the breeder of the variety for every tonne of grain produced. The point of collection for this royalty or fee may differ between varieties and growers need to be aware of the arrangements for the variety they grow.

Each year, all varieties of wheat are classified into grades by specific growing zones (regions). These classifications are the responsibility of Wheat Quality Australia Limited (WQA) (Anon nd, b). WQA is an independent not for profit company that was established and owned by Grains Research and Development Corporation (GRDC) and Grain Trade Australia Limited (GTA) and has been responsible for wheat variety classification and related activities since January 2011.

WQA produce a Wheat Variety Master List (Anon nd, c) which classifies all varieties into a class or grade based on processing and end product quality and determines the highest grade that a variety can be accepted into at delivery by zone, as indicated below (these are the first of hundreds of varieties listed).

The Classification System is updated several times a year and aims to deliver grain of consistent physical quality, processing performance and end-product quality to customers and end-users.

CODE	VARIETY NAME	WESTERN ZONE	SOUTHERN ZONE	SOUTH EASTERN ZONE	NORTHERN ZONE	CLASSIFICATION YEAR	REVIEW DATE
540	KIORA	APW*	AH	AH	APW*	2014	2024
539	CONDO	APW*	AH	AH	AH	2014	2024
538	SUNMATE	APW*	APW*	AH	APH	2014	2024
537	MITCH	APW*	APW*	APW	AH	2014	2024
536	SUPREME	ANW	FEED*	FEED*	FEED*	2014	2024
535	VIKING	APW*	APW*	APH	APH	2014	2024
534	DBA AURORA	FEED	ADR	FEED	ADR	2014	2024
533	HARPER	APW	APW	ASW*	ASW*	2014	2024
532	SCENARIO	FEED	FEED	FEED	FEED	n/a	n/a
531	ADAGIO	FEED	FEED	FEED	FEED	n/a	n/a
530	MANNING	FEED	FEED	FEED	FEED	n/a	n/a
529	TROJAN	APW	APW	APW	ASW*	2013	2023
528	LANCER	APW*	APW*	APH	APH	2013	2023
527	SHIELD	APW*	AH	APW*	APW*	2012	2022
526	GRENADE	APW	AH	APW*	APW*	2012	2022
525	SUNTOP	APW*	AH	APH	APH	2012	2022
524	DART	APW*	AH	APH	APH	2012	2022
523	PHANTOM	APW*	AH	APW	APW*	2012	2022
522	GAZELLE	AGP*	ASF1	ASF1	ASF1	2012	2022

QUALITY – GRADES/CLASSES

Wheat grain quality is classified first by variety and then by various grain quality specifications such protein concentration, screenings test weight, weather damage and foreign matter. The quality of the grain will affect the price achieved for the crop. Damage from frost, heat (due to high drying temperatures), black point and sprouting can affect the quality of the end product.

Wheat in Australia is classified into nine primary grades, although there are a range of sub-grades within each: Australian Prime Hard, Australian Hard, Australian Premium White, Australian Standard White, Udon Noodle, Durum, Australian Soft, General Purpose and Feed wheat, with the price paid for grain dependent on its classification.

The following table lists the classes of wheat and their main production zones (Wheat Quality Australia, 2013).

Classes of wheat currently available for classification by zone.

Wheat Class	Classification zone
Australian Prime Hard (APH)	Northern and South Eastern
Australian Hard (AH)	All zones
Australian Premium White (APW)	All zones
Australian Standard White (ASW)	All zones
Australian Premium Durum (ADR)	All zones
Australian Soft (ASFT)	All zones
Australian Standard Noodle (ANW)	All zones
Australian Premium Noodle (APWN)	Western
Australian Feed (FEED)	All zones

Wheat delivered into the marketplace must meet certain grain quality specifications to be classified into the aforementioned grades as they are critical in determining flour yield and quality for different bread, bakery, pasta and noodle products (see ‘Products’ below). The following grain tests are applied at receival points to measure quality and ensure the high standards of Australian wheat grade classification are maintained (Queensland Department of Primary Industries and Fisheries, 2009).

Protein content – Protein content is assessed using near infra-red (NIR) technology on delivery to the silo, and payment is largely based on protein content. Wheat with 11–13% protein is used for pan bread, 10.5% for Udon noodles and 8.5–9.5% for biscuits and cakes.

Protein quality – Protein (gluten) quality differs between wheat varieties and thus production applications. For example, bread makers may require a wheat type with strong protein whilst a steam bun manufacturer may seek moderate protein strength. For millers, this is an extremely important quality characteristic as it affects flour water absorption and dough mixing characteristics. Protein quality is accounted for at the receival point by variety declaration.

Falling number – The falling number test is an indication of rain damage at harvest. Rain causes mature wheat grains to sprout and activates the alpha-amylase enzyme which breaks the starchy endosperm into sugars. In this test, wheat is ground, mixed with water and heated to form a gelatinous suspension. Wheat that has been weather-damaged forms a more viscous suspension and so has a lower falling number. End products are sensitive to flour with low falling numbers as it can result in dough stickiness, excessively dark bread or poor crumb texture and poor slicing ability.

Screenings – Impurities such as white heads, chaff, weed seeds, and shrivelled and broken grains may need to be removed before milling. Payment is influenced by screening levels as extensive grading adversely affects mill profit. Whilst some grain varieties are more susceptible to high levels of screenings, the environment in which the wheat is grown is a major contributor.

Stained grains – Enzymic discolouration such as Black point and staining caused by fungal infection such as Fusarium, Eppicoccum or Drechslera spp. adversely affects grain quality. In particular, black specks detract from the appearance of noodles.

Hardness – Wheat can be physically hard or soft. Hardness affects milling properties. Hard wheats are used to make pan breads, yellow alkaline noodles and flat breads. Soft wheats are used for biscuits and cakes. Variety declaration is used to segregate hard from soft wheat at receival.

Moisture content – When wheat is delivered into a silo, moisture content is assessed at receival using NIR technology—payment is also based on moisture content. Water content impacts on the value of grain (water versus flour) and affects the maintenance of quality during handling and storage.

Test weight – Test weight is also known as hectolitre weight and assessed by weighing a fixed volume of grain. Hectolitre weight informs the miller of the wheat's cleanness, plumpness and packing density, and guides the miller in predicting flour yield. The test weight varies between varieties due to their difference in size and shape. Shrivelled and rain-damaged grains reduce test weight.

Briefly the primary uses of classes of Australian wheat are:

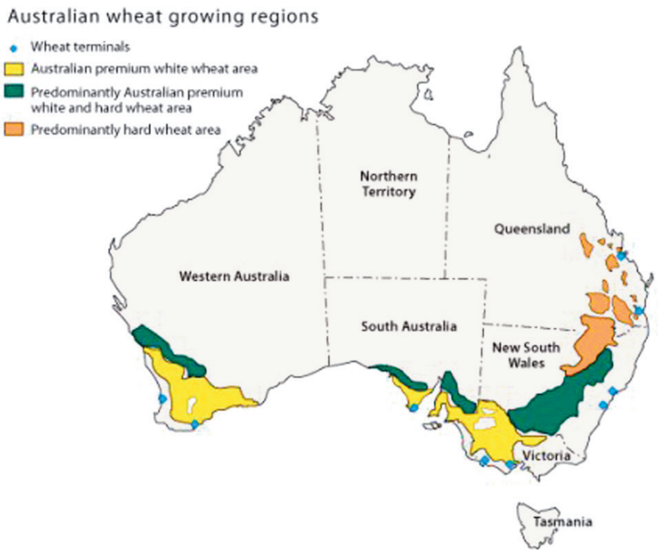
- **Australian Prime Hard (APH) –** normally segregated and sold at guaranteed minimum protein levels of 13%. Produces high-protein Chinese-style yellow alkaline noodles, Japanese Ramen noodles, high-protein, high-volume breads and wanton dumpling skins.
- **Australian Hard (AH) –** segregated at a minimum protein level of 11.5 % is suitable for the production of a wide range of breads including European-style pan and Middle Eastern flat breads and a variety of bread products.
- **Australian Premium White (APW) –** minimum 10% protein level and hard grain characteristic is suitable for a wide range of products including varieties of Asian noodles such as Hokkien, instant and fresh noodles. It is also ideally suitable for the production of Middle Eastern and Indian-style breads and Chinese steamed bread.
- **Australian Standard White (ASW) –** versatile medium- to low-protein white wheat used in the production of a wide range of products including Middle Eastern, Indian and Iranian-style flat breads, European-style breads and rolls.
- **General Purpose (AGP) –** the General Purpose grade comprises wheat that has failed to meet minimum receival standards for milling wheat grades, either on account of low test weights (68 kg/hl or below), presence of screenings, foreign material or a mild degree of sprouting. Falling number counts are generally at 200 or above. This product is general used in the feed grains industry.
- **Feed wheat –** consists of severely sprouted wheat deliveries with falling number tests below 200 and test weights at or below 62 kg/hl. Feed wheat is suitable for animal feed purposes.
- **Australian Durum (ADR) –** ADR1 consists of selected wheat varieties with vitreous, amber-coloured kernels with a minimum protein of 13%. It produces superior quality semolina ideally suited to the production of a wide range of high-quality wet and dry pasta products.

Key characteristics of each wheat class, their location of production, key markets and primary use in export markets is provided in the chart on the following page (Queensland Department of Primary Industries and Fisheries, 2009).

Table 1. Australian Wheat Grades, Varieties and Share of Production

Grade	States Grown	Production	Protein	Markets	Export Uses
APH Australian Prime Hard	QLD NSW	<5%	13–14%	Japan, Korea, Thailand, Malaysia, Italy	Primarily used for Japanese style ramen noodles
AH Australian Hard	QLD northern NSW southern NSW Victoria South Australia Western Australia	15–20%	11.50%	Japan, Indonesia, Iraq, Malaysia, Middle East	Suitable for a wide range of baked products including European pan breads, Middle Eastern flat breads, Chinese steamed products and Chinese yellow alkaline noodles
APW Australian Premium White	QLD northern NSW southern NSW Victoria South Australia Western Australia	30–35%	10%	Indonesia, Iraq/ Iran, Malaysia, Other Asian and Middle Eastern countries, Japan/Korea	Suitable for production of a variety of Asian noodles. It is also suitable for Middle Eastern and Indian style breads and Chinese steamed bread
ASW Australian Standard White	southern NSW South Australia Western Australia	20–30%	9–10%	Indonesia, Iraq/Iran, Malaysia, other Asian and Middle Eastern countries, Japan/Korea	Suitable for straight milling and blending purposes – typically in less discerning markets such as Egypt and Iran for Middle Eastern, Indian and Iranian style flat breads
ASWN Australian Standard Wheat Noodle	Western Australia		10.50%	Japan/Korea	Developed for use in. noodle manufacture Outside of this use,wheat is too soft so loses value, but can be s blended into cargoeto the Middle East
ADR Australian Durum Wheat	QLD northern NSW South Australia	<5%	Min. 13% 11.5% and 10%	Italy, Morocco and Algeria	Pasta

As noted above, grain classification is a combination of variety by zone or growing region. An indication of main wheat growing regions by general classification is depicted in the map opposite (Queensland Department of Primary Industries and Fisheries, 2009).



WHEAT TRADING STANDARDS

Since 2006 Grain Trade Australia (GTA) has on an annual basis reviewed, produced and published the Wheat Trading Standards (Grain Trade Australia, 2014) on behalf of the industry. The standards are developed by the GTA Grain Standards Committee.

The Standards provide a comprehensive list of definitions and grades (Variety Master List – more detailed than above), test methods and procedures and the specifications for each wheat grade. An example GTA specification (not all components of the specification) for one grade of wheat (APH1) is provided below.

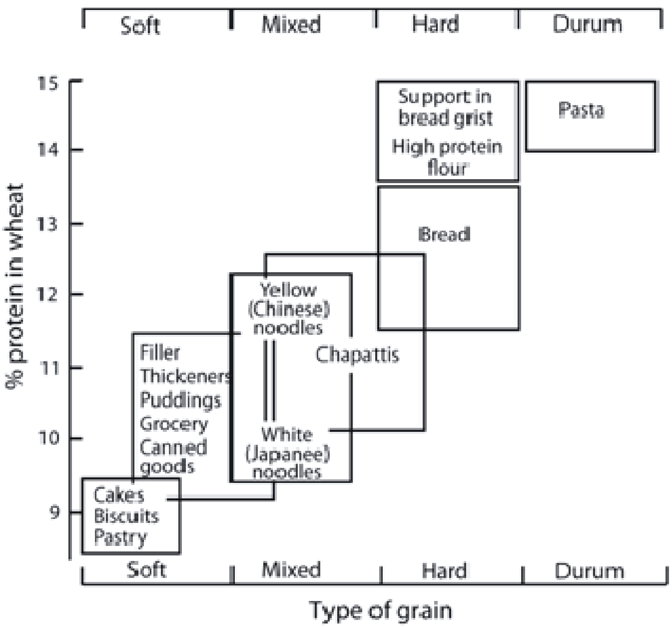
Commodity: Wheat **Grade:** APH1		**Season:** 2014/15 **Standard Reference No.:** CSG-110	
QUALITY PARAMETER	**SPECIFICATION**	**COMMENT**	
Variety Restrictions	Yes	Approved varieties only	
Protein Min (%	14.0	N X 5.7 @ 11% Moisture Basis	
Protein Max (%)	n/a		
Moisture Max (%)	12.5		
Test Weight Min (kg/hl)	76.0		
Unmillable Material Above the Screen Max (% by weight)	0.6	Includes whiteheads (with grains removed), chaff, backbone, Wild Radish pods, Milk Thistle pods or other seedpods not otherwise listed. Excludes contaminants where tolerances already exist	
Screenings Max (% by weight)	5.0	All matter passing through a 2.0mm slotted screen – 40 shakes in the direction of the slots	
Falling Number Min (sec)	350	Falling Number result overrides the visual assessment for Sprouted grains	
Defective Grains Max – (% by count, 300 grain sample [500 grain sample for WA], unless otherwise stated)			
Sprouted	Nil	Frost Damaged	1.0
Stained, including Staining due to Moist Plant Material, of which;	5.0	Heat Damaged, Bin Burnt, Storage Mould (count per half litre)	1.0
– Pink Stained	2.0	All Smuts except Loose Smut (entire load)	Nil
– White Grain Disorder / Head Scab / Flaked Grain	1.0	Takeall Affected	1.0
Field Fungi (count per half litre)	10.0	Insect Damaged	1.0
Dry Green or Sappy	1.0	Over-Dried Damaged	Nil

PRODUCTS

Wheat is milled into flour and other products and these are used to make many types of food. For example, Manildra mills, which is the biggest player in the Australian wheat flour market with approximately 35 per cent market share, packs forty—two different products. These products are being sold to bakeries large and small Australia wide as well as exported

The balance between protein content, wheat hardness and the end product that the wheat may be used for is shown in the figure below (Queensland Department of Primary Industries and Fisheries, 2009).

Figure 1: Balance between protein content, hardness and end product requirements



Just a sample of some of the products made from wheat (of differing qualities) is provided below:

- **Bread** – one of the oldest and most diverse foods. Wheat (and to a lesser extent rye) is the only grain that can produce dough capable of holding gases produced by yeast well enough to give well-risen loaves. This property is related to the presence of gluten.
- **Biscuits, cakes and pastry** – doughs made for biscuits must be capable of being sheeted prior to cutting. Low protein, soft wheat is used for cake flour.
- **Middle Eastern Flat or Pocket Breads** – these products come in many shapes and sizes and are baked in very hot ovens for short times.
- **Pasta** – is made from semolina (high protein flour) from durum wheat. The dough is extruded through a die.
- **Noodles** – are produced by cutting strips from rolled sheets of dough. They can be boiled, steamed, dried or fried.
- **Gluten** (protein) and **starch** (carbohydrate) – are the two main '**by-products**' of flour:
  - o Gluten is used to help natural gluten in flour to make better breads and buns. It is also used in pet food, small goods, glues and other chemicals.
  - o Starch has many uses. These include glues, fillers, confectionary, soft drinks, cordials, food thickeners, paper making, textile sizing, mineral flocculation. Other by-products include glucose and bran.

REFERENCES

Anon (nd, a) Australian Wheat Board. Australian Wheat. http://www.awb.com.au/customers/australianwheat (accessed on 11/6/2016)

Anon (nd, b) Wheat Quality Australia. http://wheatquality.com.au

Anon (nd, c) FINAL 2014/15 WQA Wheat Variety Master List. https://www.graintrade.org.au/sites/default/files/file/Commodity%20Standards/WQA%20Wheat%20Variety%20Master%20List.pdf accessed on 11/6/2016)

Grain Trade Australia (2014). Section 2 – Wheat Trading Standards, 2014/15 Season.

Queensland Department of Primary Industries and Fisheries (2009). Wheat quality and markets in Queensland.

Wheat Quality Australia (2013), Wheat Classification Guidelines.

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APPENDIX C:

LANGUAGE USED IN THE AUSTRALIAN WOOL INDUSTRY

Author: R. Pattinson

Technical papers for the Australian Beef Language 'WHITE PAPER'

Published by Meat and Livestock Australia, Sydney.

June 2016

Pattinson R (2016) Language used in the Australian Wool Industry.
Technical papers for the Australian Beef Language 'White Paper'.
Meat and Livestock Australia, Sydney, 12 Pages

Email: miracledog@bigpond.com

Reviewed by Chris Wilcox,
Poimena Analysis

CONTENTS

KEY POINTS

- Over 98% of Australian wool is exported
- The pipeline for Australian wool is long and complex – from farm to consumer product. Change of ownership is frequent
- The product is modified at each stage in the pipeline and the language changes accordingly
- For most raw wool, over 95% of price variation can be determined by measured (and unmeasured) characteristics
- Over 25 years ago some in the industry thought it was on the verge of ‘sale by description’ (selling wool without viewing a sample). That hasn’t happened to any great extent because of the purchasers desire to see a sample, especially for unmeasured characteristics (e.g. style)
- An emerging market issue (mulesing) was quickly incorporated (voluntarily) into the language when needed
- The greatest determinant of price of raw (greasy) wool also has a large impact on consumer product quality. It features in product language in different forms throughout the pipeline
- The IWTO plays an important role in establishing the rules for the trading of wool products through the pipeline. This may be of relevance to red meat
- A certification mark (the Woolmark) is licensed to a range of wool manufacturers and provides assurance to consumers in relation to wool content and a range of product characteristics.

WOOL CLASSING

The wool industry language starts in the shearing shed where wool is classed by a registered woolclasser. The Australian Wool Exchange (AWEX) registers woolclassers and oversees clip preparation standards which are detailed in the Code of Practice (Anon 2016).

The functions of the woolclasser and thus the language used can best be described by the descriptions used on bales of wool (called lines). These are shown below and have been taken from the Code. Coverage includes:

- Breed
- 'Type' of wool (e.g. main fleece wool, skirtings, locks etc)
- Estimated fibre diameter, length, strength etc
- Imperfections or impurities

Figure 1: Bale descriptions for Australian wool

AWEX-Baledescriptions

we know wool AWEX

1. Classed Line (Where Applicable) (*Optional for Non-Fleece Wool) ▶ **2. Breed Group** (Mandatory) ▶ **3. Wool Category** (Mandatory for Non-Fleece Wool) ▶ **4. Pigmented/Medullated** (Only if Applicable)

1. Classed Line

Extra Premium Line for SUP only	XXXX*
Second Premium Line for SUP only	XXX*
Premium/Main Line for SUP or M only	AAAA*
Main Line for any Breed Group	AAA*
Second Line for any Breed Group	AA*

OR

Cast Lines

Stain	STN
Heavy Unscourable Colour	COL
Medium/Hard Cott	COT
Dermatitas	DER
Doggy	DGY
Overgrown/Double	OG
Very Tender	TDR
Black	BLK
Plucked and Dead Fleece Wool	DDD
Flyblown	FLY
Skin Pieces	SKN
Brands	BND

2. Breed Group

Superfine Merino	SUP
Merino	M
Afrino	FO
SAMM	SM
Comeback	CBK
Fine Crossbred	FX
Medium Crossbred	MX
Coarse Crossbred	CX
Corriedale	CD
Downs	DN
Carpet Wool	CW
Shedding Breeds	SB

3. Wool Category

Adult Fleece	
Broken	BKN
Necks	NKS
Backs	BKS
Pieces	PCS
Jowls	JWL
Bellies	BLS
Weaner Fleece	WNS
Weaner Pieces	WPCS
Weaner Bellies	WBLS
Lambs Fleece	LMS
Lambs Pieces/Bellies	LPCS
Locks	LKS
Crutchings	CRT
Shanks	SHK
Dags	DAG

4. Pigmented/Medullated

Note. Y and K can be used together in a description

Visible Black Fibres	Y
Visible Medullated Fibres	K
Run with Shedding Breeds	R

Note. Shanks and Jowls are for Merino Wool only

See Examples Below

1. Classed as	2. Breed Group	3. Wool Category	4. Pigmented/Med	= Bale Description
Premium Line	Superfine	Adult Fleece	-	= XXXX SUP or AAAA SUP
Main Line	Merino	Adult Fleece	-	= AAA M
Main Line	Merino	Adult Pieces	-	= M PCS
Main Line	Merino	Locks	-	= M LKS
Main Line	Merino	Lambs Pieces	-	= M LPCS
Tender Line	SAMM	Fleece	Run With	= TDR SM R
Second Line	Fine Crossbred	Fleece	-	= AA FX
Stain Line	Comeback	Bellies	-	= STN CBK BLS

A description of the classed wool is entered on to the Woolclasser's Specification which also incorporates the National Wool Declaration (for issues such as Dark Fibre Risk and Mulesing status) (Anon 2016). As a case in point, Mulesing Status was quickly introduced in 2008 (as a voluntary option) into the language in response to market pressures.

The handling agent (usually a broker) uses the Woolclasser's Specification to assist them in making lotting decisions for subsequent sale.

RAW (GREASY) WOOL

Once the wool has been prepared it is offered for sale primarily via public auction. Approximately 85% to 90% of shorn wool is offered by woolgrowers through the auction system via a selling broker. Between 10% and 15% of wool is purchased privately from the farm, mainly by private treaty wool merchants.

Each selling broker publishes an auction sale catalogue for a nominated sale. The catalogue contains pages of sale lots each of which is sold as one unit and will vary in size, quantity and type. The information provided for each lot changes considerably from that provided by the woolclasser as it includes a range of objective measures including (Anon 2016):

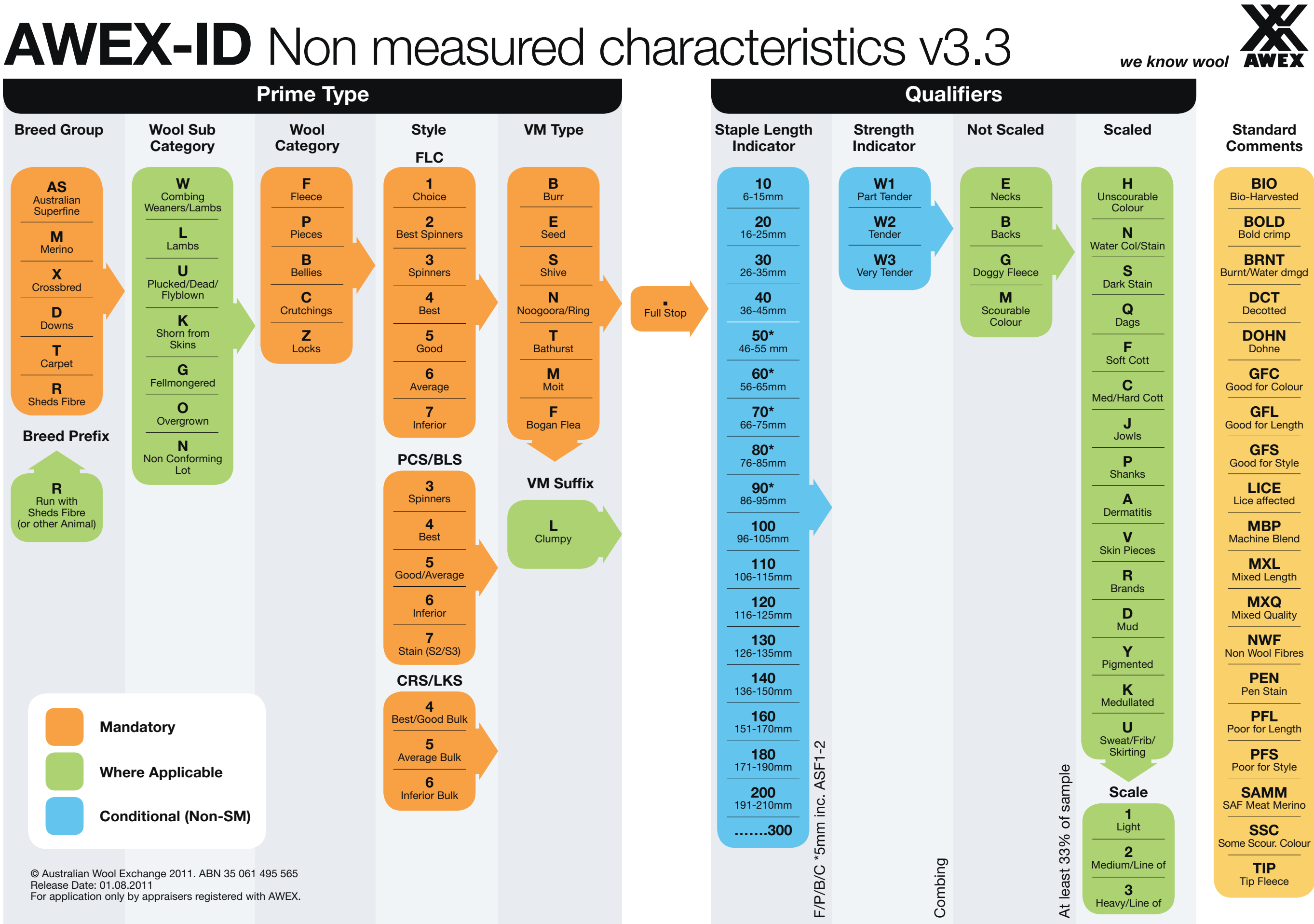
- The wool grower's farm or property brand (e.g. DIMBOOLA)
- The number of bales in the lot (e.g. 6 bales)
- The total greasy and clean weights (in kilograms) of the lot
- The wool description by the wool classer (e.g. AAAM)
- Objective test results such as:
  - o Mean fibre diameter (MFD) 18.7 micron
  - o Coefficient of variation MFD 19.8%
  - o Vegetable matter content (VMB) 0.7 %
  - o Yields (SCH, JCSY, SCD, ACY) 73.6 %
  - o Staple length (S/L) 87 mm
  - o Staple strength (S/S) 44 N/Kt
  - o Position of break (POB) TIP/MID/BASE 17%/22%/61%
  - o Certificate type P
  - o Wool Selling Area (WSA) N24
  - o As well as grower supplied information in relation to mulesing status etc.

Figure 2: Example of a wool sale catalogue

B/S/H	ACY	JCSY	SCD	SCD	SCH	VMB	MIC	S/L		S/S	POB			SS25	LOT	BLS
MULES			17%	16%	DRY	NETT		MM	CV%	N/KT	T	M	B	DMFR	No	
0.0	70.8	74.6	76.7	76.0	73.6	0.7	18.7	87	16	44	17	22	61	31	C4001	2
0.7	254	268	275	273	264	359	19.8%							1		
0.0								DOMBOOLA							P	
								N24 AAAM								
0.1	62.9	66.8	68.4	67.8	65.8	0.4	17.2	53	18	0	0	0	0		C4002	1
0.3	118	125	128	127	123	187	22.7%							1		
0.0															P	
								AAAM								
0.3	63.2	67.1	69.1	68.5	65.9	0.7	18.5	94	12	50	7	36	57	40	C4003	2
0.4	231	246	253	251	241	366	20.0%							NA		
0.0								<JL>/HAZELDEAN							P	
								N24 AAAM								

In addition to this information, AWEX-accredited appraisers (mostly broker staff) also apply an Industry Description (AWEX-ID, see Figure 3) to describe the appraised, non-measured characteristics of the wool (such as style, impurities etc.). When combined with the objective measurements on the lot this provides a complete product description which is used by brokers and some buyers. Samples of each lot are displayed to allow buyers to inspect the lots and assess the non-measured characteristics. Some buyers use their own typing to complete the product description, rather than using AWEX-ID. AWEX-ID is also used as the basis for market reporting.

Figure 3: AWEX ID (Anon 2016)



It may be of note that over 25 years ago some thought the industry was on the verge of 'sale by description' (selling wool without viewing a sample). That largely hasn't happened because of the purchasers' desire to see a sample, especially for unmeasured characteristics (e.g. style).

WOOL PROCESSING

Once wool is sold, there are two primary processing routes. The processing route is primarily determined by the length of the fibre, with longer wools going into the worsted system (yarn that features a smooth texture and finish) while shorter wools go into the woollen system (yarn that is used in the production of bulkier garments). Garments produced using the worsted system have a crisp, smooth appearance and include the typical suiting fabrics as well as fine wool knitwear. The woollen system produces garments which are bulkier with a soft, fuzzy appearance such as lambswool sweaters and tweed fabrics.

As wool moves through the pipeline its structure is modified considerably and the language changes at each stage. Some of these changes in the physical characteristics of the wool can be predicted from the greasy wool measurements, especially mean fibre diameter (which is also the most important raw wool characteristic) as this is usually only marginally changed during processing and has a big impact on final product quality.

TOPMAKING

'Top' refers to a strand of longer fibres that have been straightened, made parallel and separated from the shorter fibres by combing.

Using the objective measurements of the greasy wool combined with subjective appraisal and the knowledge of the processing mill, characteristics of the top (or carded product in woollen system) are predicted. At the top stage the language used alters to describing the characteristics of the top required by the processor covering:

- Top yield / noil
- Mean fibre diameter and co-efficient of variation
- Fibre length characteristics such as Hauteur and Coefficient of Variation of Hauteur
- Colour
- Fibre strength (bundle tenacity) (but only when the fibres may have been damaged, for example by dyeing)
- Contaminants and faults including any remaining vegetable matter (VM), dark fibre, neps, slubs, coloured fibre and other impurities
- Total fatty matter (TFM) - a combination of what was left on the wool after scouring and what oils were added in topmaking.

SPINNING

Spinning is the process by which wool fibre is turned into yarn – fibres are drawn out and twisted together to form yarn. Parameters of yarn (and thus the language used in the specification) can include:

- Yarn appearance – including any imperfections such as neps (tightly tangled mass of unorganised fibre), slubs (an abruptly thickened place of yarn), thick and thin places
- Yarn evenness – variation in the linear density of a yarn
- Linear density of yarn – fineness (mass per unit length)
- Strength testing – force required to break a single strand of yarn of unit length
- Twist testing – both direction and number of turns per unit length

KNITTING AND WEAVING

There are three main types of knitting in the Merino wool industry: complete garment knitting; fully-fashioned where knitted panels are linked together to make knitted garments; and fabric from circular knitting which is cut into panels and made into garments.

Weaving is the process of fabric formation in which 'warp' and 'weft' yarns are interlaced using a weaving machine (loom).

Specifications for yarn will depend on both the type of product to be produced and the equipment to be used.

Yarns specifications focus predominately on yarn count which is defined by the yarns weight and fineness. While there are a range of specification systems the most widely used is Nm which is the length in metres per 1 gram of mass – the finer the yarn the high the Nm. The following table provides a summary of typical knitwear yarns [Australian Wool Innovation (nd, a)].

For weaving yarns, specifications are for both count and twist.

Figure 4: Yarn types by fibre diameter

<table>
<tr><th colspan="16">TYPICAL FIBRE QUALITIES OF MERINO WOOL KNITWEAR YARNS</th></tr>
<tr><th></th><th>17</th><th>18</th><th>19</th><th>19.50</th><th>20</th><th>21</th><th>22</th><th>23</th><th>24</th><th>25</th><th>26</th><th>27</th><th>28</th><th>29</th><th>30</th></tr>
<tr><td rowspan="11">WORSTED SPUN YARNS</td><td colspan="4" rowspan="2">Merino Extrafine
2/24 to 2/48Nm</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Pure Merino wool</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3" rowspan="2">Other
2/14 - 2/32Nm</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="10">58 - 70mm length</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="5" rowspan="2">Lambswool blend
2/24 to 2/48Nm</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="5">55 - 65mm length</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>WOOLLEN SPUN YARNS</td><td colspan="5">Pure Lambswool
2/15 to 1/27Nm
35 - 55mm length</td><td colspan="4">Lambswool blends
2/12 to 1/14Nm
40 - 50mm length</td><td colspan="3">Soft Shetland
2/12 to 1/14Nm
48 - 60mm length</td><td colspan="3">Shetland
2/8 to 2/12Nm
48 - 60mm length</td></tr>
</table>

PRODUCT CHARACTERISTICS

Knitted or woven fabrics are then converted into consumer products. The language used at product level will be a combination of product type and characteristics, retail brand and of course price.

Fibre diameter is the key driver behind product softness and feel, so a scheme has been developed and introduced both for wool suiting fabrics and wool suits known as the Super S scheme. The Super S scheme comprises a range of numbers ranging from Super 80's to Super 250's. The higher the "S" number, the finer and hence softer the wool. For example a Super 80's denotes that the maximum mean fibre diameter does not exceed 19.75 microns, whilst at the other end of the scale, a Super 250's label denotes that wool with a mean fibre diameter less than 11.25 microns has been used.

Wool products that carry the Woolmark are subject to The Woolmark Company's quality standards, which are backed up by Woolmark test methods.

THE WOOLMARK COMPANY

Woolmark specifications cover five areas of performance:

- Wool content
- Physical properties related to wear performance (tensile strength, burst strength, abrasion resistance, seam slippage, pilling etc.)
- Colour fastness
- Dimensional stability in relation to 'care claims'
- Visual appearance upon manufacturing

IWTO

The wool industry is served internationally by the International Wool Textile Organisation (IWTO) which is a non-profit, private sector organisation representing the interests of wool industry stakeholders at an international level. Its membership covers the woolgrowers, traders, primary processors, spinners and weavers of wool and allied fibres in its member-countries, as well as all kind of organisations related to wool products and the wool business in general [Anon (nd b)].

Through IWTO the industry has developed commercial test methods, regulations and conditions under which most of the world wool trade conducts its business. There are three primary elements:

- IWTO Arbitration Agreement (Blue Book) – The Blue Book is the basis for the conditions under which most of the world wool trade conducts its business. The rules contained in it are agreed between those who are involved in the buying and selling of the various wool-textile products. The Blue Book incorporates the International Wool Textile Arbitration Agreement, used as a dispute settlement tool for conflicts arising between partners from different countries.
- IWTO Specifications (Red Book) – IWTO Specifications include all test methods and draft test methods developed within the Committees of IWTO for the measurement of wool fibre, yarn and fabric properties. Full Test methods provide the objective, technical and scientific measurements required for issuing IWTO test certificates.
- IWTO Regulations (White Book) – IWTO Regulations define the sampling and certification procedures and detail the procedures for resolving disputes in relation to certified test results. Hence they are important to the application of IWTO test methods in commercial trading.

IWTO also undertakes a role in laboratory licensing, market intelligence / statistics and helping coordinate specific marketing programs.

REFERENCES

Anon (2016) Code of Practice (COP). AWEX (http://www.awex.com.au/woolclasser/code-of-practice-cop/ accessed on 11/6/2016)

Anon (nd b) http://www.iwto.org/about-iwto/

Australian Wool Innovation (nd, a) Australian Merino Wool. *Introduction to Knitwear Training Manual*. http://www.woolmark.com/knowledge/training-manuals/

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APPENDIX C:

THE AUSTRALIAN LEGISLATIVE FRAMEWORK FOR DESCRIBING BEEF AND BEEF PRODUCTS

Author: R. Biddle

Technical papers for the Australian Beef Language
'WHITE PAPER'

Published by Meat and Livestock Australia, Sydney.

June 2016

Biddle R (2016) The Australian legislative framework for describing beef and beef products. Technical papers for the Australian Beef Language 'White Paper'. Meat and Livestock Australia, Sydney, 12 Pages

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CONTENTS

THE AUSTRALIAN LEGISLATIVE FRAMEWORK FOR DESCRIBING BEEF AND BEEF PRODUCTS

OVERVIEW

The application of a reliable trade description to products offered for sale is fundamental to the sustainable operation of markets. The maintenance of consumer confidence in perishable products such as meat and dairy has seen governments institute a wide ranging legislative framework to underpin this objective. In addition to the general application of consumer law in Australia, specific trade description provisions apply to meat and meat products.

In respect of trade descriptions for beef and beef products, it is the product description component that is of particular relevance to this White Paper project. However, because of the degree of interdependence of the product description and other trade description elements, it is important to understand the broad scope of these elements.

These trade description elements typically include (in addition to product description provisions):

- A net weight or volume statement
- A country of origin statement (e.g. "Product of Australia")
- An indication of place of slaughter or further processing
- The date of packaging and packer details (if packaged)
- An ingredient list (for beef products)
- A batch identifier
- A storage statement (e.g. "Keep Chilled").

For the domestic market, a degree of flexibility exists as to how these trade description elements may be conveyed from the point of slaughter to the consumer of the beef or beef product. This flexibility is necessary given that beef may be purchased by the consumer, for example, from a butcher who breaks down a carcase; from a supermarket as fresh portions in a labelled tray; or in a packaged and processed form with or without the need for further preparation before consumption. Essentially, the trade accommodates these trade description requirements by maintaining appropriate records so that an accurate label can be applied to packaged products or displayed with products sold in the unlabelled state or conveyed to the purchaser upon their request of the vendor.

Additionally, for public health and consumer protection reasons such as facilitating food recalls, Australian laws impose traceability and associated record keeping requirements, which in part rely upon elements of the trade description requirements.

The *Australian Meat Industry Guidelines for Numbering and Bar Coding of non-Retail Trade Items*, as developed in conjunction with Global Standards One (GS1) Australia, provide an European Article Number-Uniform Code Council (EAN-UCC) system compatible means of underpinning product traceability in the domestic and export sectors of the industry. Although use of the Guidelines is not mandated by legislation, their widespread use by industry significantly underpins their need to comply with current traceability requirements.

More detailed trade description, including product description, requirements apply to beef and beef products for export. There are clear historical reasons for this circumstance, in large part deriving from the need to meet requirements set by importing country authorities and to protect the reputation of Australian product.

A more detailed discussion of Australian product description requirements for beef and beef products follows under headings which describe elements which are common to both domestic and export markets and which describe elements specific to export markets.

ELEMENTS APPLYING TO BOTH EXPORT AND DOMESTIC MARKETS

Australian law provides broad protections for consumers, including for consumers of meat and meat products. The *Australia New Zealand Food Standards Code* (The Code, Anon 2002) plays a key role given its incorporation by adoption into the consumer protection laws of the States and Territories and, through reference, by the *Australian Meat Standard* (Anon 2007). As the latter Standard is called up by the export meat legislation and by State/Territory legislation, the Code therefore operates so that a common set of minimal requirements apply to the export and domestic sectors of the meat industry.

Following is a discussion of the trade description elements of the Code and the *Australian Meat Standard* with particular reference to the operation of a beef product description language.

THE CODE

The Standards which comprise the Code are legislative instruments under the *Legislative Instruments Act 2003*. Part 1.2 of Chapter 1 (General Food Standards) of the Code details labelling and other information requirements for foods. There are currently some 11 Standards included in Part 1.2 and all have application to meat and meat products, depending on the extent to which the food is packaged or transformed or on the extent of claims made about the food. Matters covered in Part 1.2 are:

- Standard 1.2.1 Application of Labelling and other Information Requirements
- Standard 1.2.2 Food Identification Requirements
- Standard 1.2.3 Mandatory Warning and Advisory Statements and Declarations
- Standard 1.2.4 Labelling of Ingredients
- Standard 1.2.5 Date marking of Packaged Food
- Standard 1.2.6 Directions for Use and Storage
- Standard 1.2.7 Nutrition, Health and Related Claims
- Standard 1.2.8 Nutrition Information Requirements
- Standard 1.2.9 Legibility Requirements
- Standard 1.2.10 Characterising Ingredients and Components of Foods
- Standard 1.2.11 Country of Origin Labelling.

In respect of meat and meat products, the general application of the Part 1.2 labelling provisions is qualified by Chapter 2 (Food Product Standards) and, specifically, by provisions contained in Standard 2.2.1. This Standard requires, *inter alia*, the declaration of the offal content of a meat product, the declaration of the fat content of minced meat, and the use of specified product descriptions for various types of fermented, comminuted meat whether or not the product is labelled at the point of sale.

Although the Code is largely silent on the need to use a specific language or languages to describe beef and beef products, its labelling provisions also need to be interpreted in the context of the *Australian Consumer Law* (Anon 2010) and the associated consumer laws of the States/Territories. Specifically, these broader laws contain powers which prohibit misleading and deceptive practices. In effect, the use of a product description for beef and beef products which is false or misleading exposes the person applying that description to the risk of prosecution under consumer law.

It is of interest to note that neither Standard 1.2.7 (Nutrition, Health or related Claims) nor other parts of the Code contain provisions regulating use of the terms “organic”, “bio-dynamic” or similar. This is in clear contrast to the export legislation (see later) .Additionally, the Code has been amended in recent years to require the disclosure of the country of origin of fresh beef, including that sold unlabelled.

THE AUSTRALIAN MEAT STANDARD

This Standard was elaborated under the auspices of Primary Industries Ministerial Council and does not stand part of the *Food Standards Code*.

While this Standard is primarily concerned with the hygienic production of meat and meat products, it does include provisions related to labelling, product identification and product integrity.

Section 14 of the Standard relates to packaging and specifies the following outcome: “During packaging the wholesomeness of meat and meat products is not jeopardised and all packaging and labelling comply with the requirements of the Food Standards Code.”.

In relation to identification, traceability and integrity matters, Section 16 of the Standard specifies the following outcome: “Meat and meat products are appropriately identified. Meat and meat products that should be recalled are recalled.”. While this Section is primarily concerned about batch identity and associated record keeping to facilitate a product recall, Clause 16.7 does require that packaged meat and meat products are identified with the following information no later than at the time they are packed:

- The species of the animal from which it is derived
- The date of packaging
- The identity of the meat business of packaging.

Although the Australian Meat Standard is called up by the export legislation, the provisions of Clause 16.7 do not apply to export product as more stringent provisions are specified (see later).

Notwithstanding its referencing of the Food Standards Code, the Australian Meat Standard with its specific provisions for packed product (at Clause 16.7) would appear, with the exception of its reference to ‘species’, to not constrain the use of any beef product description language provided that language could not be construed to be deceptive or misleading in its application.

ELEMENTS APPLYING TO EXPORT MARKETS

As previously noted, more exacting trade description (including product description) requirements generally apply to meat and meat products for export. The legislative requirements of importing countries are an historical driver of this circumstance, as have been some notable market failures attributable to wrongly described and /or out of specification product.

The *Export Control Act 1982* was enacted in response to a major meat substitution incident, which threatened access to Australia’s then main export market for beef. Regulations and Orders made pursuant to this Act led to the repeal of the *Export (Meat) Regulations* made under the *Commerce (Trade Descriptions) Act 1905*. These legislative changes introduced significant penal provisions in relation to false trade descriptions and had the effect of restoring export market confidence in the integrity of meat exported from Australia. It is of interest to note that the *Export (Meat) Regulations* included grading standards for beef and specified permitted quality types, aspects not included under the current export Orders.

The *Australian Meat and Live-Stock Industry Act 1997* provides an additional mechanism to underpin standards in the export meat industry, including by imposing through regulation licensing conditions on exporters. This regulatory framework allowed the establishment of AUS-MEAT Ltd. as a “Standards Body”, and provided for attaching AUS-MEAT Accreditation as a condition of licence for export abattoir and boning room operators. The requirement for AUS-MEAT Accreditation does not apply to the domestic meat sector. However, the operators of domestic sector abattoirs and boning rooms may elect to obtain this accreditation.

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AUS-MEAT Accreditation provides an important mechanism underpinning the operation of a uniform beef language for product description and the relevant AUS-MEAT Manual is referenced as a guidance document under the trade description provisions of the *Export Control Act 1982*.

The following discussion will consider relevant trade description provisions contained in Orders made pursuant to the *Export Control Act 1982* and in relation to product description provisions associated with AUS-MEAT Accreditation.

ORDERS UNDER THE EXPORT CONTROL ACT 1982

Regulations (Anon 2002) made under this Act provide a power to make Orders in relation to Prescribed Goods, a term which includes meat and meat products. In this regard the *Export Control (Prescribed Goods-General) Orders 2005* provide the powers to refuse export documentation for goods that do not comply with trade description requirements. Other sets of Orders lay down requirements for describing game meat (Anon 2013) and organic produce (Anon 2005a) for export, but largely lie outside the scope of this discussion. It is, however, of interest to note that game meat/products are covered by the Australian Meat Standard and there is no domestic regulatory counterpart to the Export Orders for organic produce.

As a general consideration, the Export Orders for meat and meat products need to be interpreted in light of the significant penalties (up to 5 years imprisonment) established by the present Act for making a false trade description. In this regard, the Act contains the following definitions:

- Trade description, in relation to prescribed goods means any description or statement (whether in English or any other language), a pictorial representation, indication or suggestion, direct or indirect: as to nature, number, quantity, quality, purity, class, grade, breed, measure, gauge, size, mass, colour, strength, sex, species, or age of the goods;
- False trade description means a trade description that, by reason of anything contained in or omitted from the description, is false or likely to mislead in a material respect as regards to the goods to which it relates, and includes any alteration of a trade description, whether by way of addition, effacement or otherwise, which makes the description false or likely to mislead;
- Label includes any tag, band, ticket, brand or pictorial or other descriptive matter.

It is thus evident that the broad scope of these trade description related definitions requires that any product description language cannot be construed in a way that would constitute a false or misleading trade description.

The *Export Control (Prescribed Goods-General) Orders 2005* do not add product description requirements for meat and meat products. However, these Orders include provisions for declaring official marks, such as the “Halal” mark and the “E-in-circle” stamp (applied to EU-eligible product). If necessary, these Orders could be amended in the future to provide for a mark designating a specific age or other category of beef.

The *Export Control (Meat & Meat Products) Orders 2005* provide several elements of prescription in relation to product description applying to beef and beef products and call up other standards that apply to these products.

These Orders include key definitions to inform their interpretation, including:

- “Beef” means meat derived from a) a female bovine animal or a castrate male bovine animal; or b) an entire male bovine animal showing no secondary sexual characteristics
- “Bull” means meat derived from a) an entire male bovine animal showing secondary sexual characteristics, or b) a castrated male bovine animal showing secondary sexual characteristics
- “Veal” means meat derived from a female, castrated male or entire male bovine animal a) that shows no evidence of eruption of permanent incisor teeth and b) the carcase of which is no more than 150 kilograms by reference to hot carcase dressed weight and c) that in the case of males shows no evidence of secondary sexual characteristics.

Thus any beef language used to describe export product would need to be congruent with these definitions or the Orders would need to be amended to allow use of that language.

Order 44 of these Orders further requires in relation to trade descriptions that export product must comply with the Australian Meat Standards (save for Clause 16.7 provisions – see above), and have an accurate trade description applied at the time of packaging for export, which includes the following:

- The species of animal from which the meat or meat product was derived
- Beef, bull or veal, as appropriate
- Net weight
- The country of origin
- The establishment of the last premises of packaging
- The name and address of the occupier of the registered establishment or the exporter or consignee
- The dates of packaging
- A list of ingredients for meat or meat products containing more than one ingredient
- The identity of the batch
- A keep chilled or frozen statement for non-shelf stable goods
- Certain other provisions for canned goods.

The requirement for a trade description to be accurate is further qualified in Schedule 6 of these Orders. Specifically, Clause 4.1 of Division II of this Schedule notes that guidance on the requirement for accuracy is provided by the *Australian Meat Industry Classification System Manual 1*, as published by AUS-MEAT Ltd.

Additionally, Clause 4.2 of the same Division provides that the use of the description “beef offal” is accurate if it is applied to offal derived from a beef, veal or bull carcase.

Schedule 7 of these Orders includes requirements for EU eligible beef (notably segregation and marking requirements for beef from animals not treated with HGPs) and in relation to categories of beef labelled as “Grain Fed”. Use of this latter term in a trade description requires that provisions contained in the AUS-MEAT Manual 1 are met.

In summary, these Orders place a clear obligation on an exporter to apply an accurate trade description and indicate that compliance with the product description language contained in the relevant AUS-MEAT Manual guards against the risk of applying a false trade description. Additionally in relation to the development of a new beef language for describing product, these Orders would, aside from the definitions of “beef”, “bull”, and “veal”, the requirement to disclose species and the preparation and segregation elements set down for some categories of product (e.g. “Halal Beef”), not appear to be significantly constraining of that objective.

THE AUS-MEAT FRAMEWORK FOR BEEF DESCRIPTION

The role of AUS-MEAT Ltd. as a "Standards Body" for product description under the *Australian Meat and Livestock Industry (Export Licensing) Regulations 1998* has been noted previously. In addition to the guidance role of AUS-MEAT product description standards specified in Orders made under the Export Control Act 1982, a Memorandum of Understanding (MOU) exists between the Department of Agriculture (now Department of Agriculture and Water Resources) and AUS-MEAT Ltd. in relation to verification of trade description requirements for export product.

Resulting from this MOU and its Standards Body designation, AUS-MEAT Ltd. therefore has an important role in the management of trade descriptions through its Australian Meat Industry Classification System, also termed the "AUS-MEAT Language". In order to underpin the application and use of its product language, AUS-MEAT Ltd. has a system of National Accreditation Standards for meat industry enterprises.

THE AUS-MEAT LANGUAGE

The AUS-MEAT language for describing beef, bull and veal is set out in the *Handbook of Australian Meat* (Anon 2005b). This Manual defines some 11 alternative categories for beef (based on age as determined by dentition, sex, and absence of secondary sexual characteristics), some 3 alternative categories for bull (based on age determined by dentition and minimum hot carcase standard weight) and some 3 alternative categories for veal (based on age determined by dentition and specified ranges of hot carcase standard weight).

The Manual further specifies beef primal cuts, bone-in and boneless beef items, combination packs and manufacturing bulk pack types. Offal types ("Fancy Meats") are also specified.

The level of specification provided by the Manual is intended to relate a given product description to an item number, which can be reliably be ordered as true to description. It is relevant that the starting definitions in the Manual for beef, bull and veal are fully compatible with those outlined by Orders made under the *Export Control Act 1982*. Any future beef language would need to also be compliant or have definitional changes made to the Orders.

AUS-MEAT ACCREDITATION

Accreditation under the AUS-MEAT Standards is compulsory for export abattoirs and boning rooms. The completion of prescribed training courses is necessary to both attain and maintain this accreditation.

In order to underpin trade description integrity for the Australian meat industry, AUS-MEAT Ltd. offers more broadly based training, accreditation and verification services to both the producer and processor segments of the industry.

In this regard AUS-MEAT Ltd. has the capacity to recognise a range of Industry Programs through a combination of formal agreements and via accreditation and auditing arrangements. The National Feedlot Accreditation Scheme underpins minimum standards for grain fed beef and is audited by AUS-MEAT Ltd. Under this Industry Program, the product descriptions "grain fed" and "grain fed young beef" may only be used for beef from cattle meeting certain feeding standards at accredited feedlots and that additionally complies with certain age limits (determined by dentition), fat cover and colour scores (for fat and muscle).

Such accreditation arrangements therefore operate to underpin the accuracy of product descriptions, especially where live animal production methods are essential to the beef product characteristics being described. Similar arrangements could equally be utilised to underpin key elements of a future beef language.

MSA ACCREDITATION

Meat Standards Australia (MSA) is a separate entity to AUS-MEAT Ltd. and was established to oversee a scheme to specify the eating quality of beef. Under MSA certification arrangements, the consumer is provided with a guarantee of the eating quality of a cut at three quality levels of tenderness in conjunction with cooking method.

Under the MSA arrangements, Meat and Livestock Australia is the owner of the MSA Trade Marks and grants a licence to use the trade marks. The licensing conditions are rigorous and operate to underpin the integrity of the scheme. Misuse of the MSA trade marks would constitute an infringement of rights which attach to the use of a registered trade mark under the applicable Australian legislation.

The MSA scheme provides an additional model for the control of product description provisions directed primarily at meeting consumer expectations of eating quality as distinct from describing a category of product. The MSA Scheme necessarily incorporates a strong consumer education element concerning the meaning of the various MSA trademarks. A future beef language which seeks to better define outcomes for the consumer could draw on trade mark protected approaches similar to the MSA scheme or directly incorporate eating quality descriptions into the language.

REFERENCES

Anon (2002) FOOD STANDARDS AUSTRALIA NEW ZEALAND ACT 1991. A compilation prepared on 29 July 2002 taking into account amendments up to Act No. 63 of 2002. Prepared by the Office of Legislative Drafting, Attorney-General's Department, Canberra Accessed https://www.legislation.gov.au/Details/C2004C00171(11/6/2016)

Anon(2005a) The Export Control (Organic Produce Certification) Orders 2005. https://www.legislation.gov.au/Details/F2005C00434 accessed on 11/6/2016)

Anon (2005b) *The Handbook of Australian Meat. International Red Meat Manual.* 7th edition. AUSMEAT Brisbane.

Anon (2007) *Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption.* AS 4696:2007 (http://www.publish.csiro.au/Books/download.cfm?ID=5553, accessed on 11/6/16)

Anon (2010) The Competition and Consumer Act 2010, Schedule 2. (http://www.austlii.edu.au/au/legis/cth/consol_act/caca2010265/sch2.html, accessed on 11/6/2016)

Anon (2013) Export Control (Wild Game Meat and Wild Game Meat Products) Orders 2010 Compilation of the Export Control (Wild Game Meat and Wild Game Meat Products) Orders 2010 as amended and in force on 21 March 2013. (https://www.legislation.gov.au/Details/F2013C00415, accessed on 11/6/2015)

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MEAT & LIVESTOCK AUSTRALIA

APPENDIX C:

THE AUSTRALIAN BOVINE LIVESTOCK LANGUAGE

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Technical papers for the Australian Beef Language 'WHITE PAPER'

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CONTENTS

EXECUTIVE SUMMARY

Language is used across all sectors of the beef industry from genetic selection to final consumer purchase. The "livestock" section, defined as all points prior to slaughter and as such including genetic description, is addressed in this paper while companion papers cover later production stages in meat and consumer language sections. In addition to commercial use the livestock language relates to legislation for welfare of animals on farm, during transport and live export.

In contrast to the AUS-MEAT "meat" language, livestock description is far from uniform with a plethora of terms commonly used but not defined and other descriptions being understood differently in different regions. While the AUS-MEAT Livestock language (Anon, 1984) is the official language it has not been reviewed since 1993, no electronic copy appears to exist and responsibility for its' further evolution and custodianship is confused (Blackwood et.al., 2014). These issues demand consideration if the language is to be used to potential.

Construction of a standard high quality livestock language is challenging due to the wide array of traits involved and the essential need to inter-relate to different commercial sectors. The lifetime potential of a calf is established at conception and progressively lost or maintained throughout its life span as a result of environmental and management factors. Consequently a desirable feature is to progressively describe potential future performance at multiple points and for multiple traits: calving ease, growth under different environments, maturity type, ultimate carcase yield and consumer assessed eating quality across all muscle groups. For breeding stock these traits are delivered by progeny in addition to their own ultimate carcase.

Livestock language must also describe the current state of an animal, the net combination of genetics, environment and management to that point, in addition to future performance potential and constraints. Description is required at birth, for performance recording, for structural soundness and estimated breeding performance, for sale to backgrounders and finishers using grass based or feedlot systems, for live export, for welfare assessment and immediately prior to slaughter where accurate assessment of carcase characteristics is required. Further information may be required to substantiate animal raising claims, branding standards or market eligibility.

Description must be suitable for individual animals and mobs and suitable for application in paddock sale, saleyard and electronic auction systems together with associated market and statistical reporting. The language should also directly relate to dairy cattle within the beef sector requiring coordination with dairy product related language to ensure common terminology and description for all stock to be processed as beef or veal in addition to welfare assessment where applicable.

This paper summarises the principal detail of the existing language and seeks to stimulate discussion over potential areas identified where both minor and extensive change may be considered.

STRENGTHS OF THE CURRENT LANGUAGE

The strength of the existing livestock language is the common and consistent use of its base fat and muscle score terminology in market reporting as used by the NLRS, Auctions Plus and in calculation of the ECYI. It also has provided a base for many other descriptive terms used in describing and trading cattle.

WEAKNESSES OF THE CURRENT LANGUAGE

There are a number of serious weaknesses with the current Livestock language. This is not surprising given that it appears to be something of an orphan with no clear understanding of who is responsible for either its development or custodianship.

A primary weakness shared with the "meat" language is the use of dentition to define category. While this may have appeared a viable option historically it now represents a distortion in description, being shown to have poor association with both actual animal age and eating quality, two key components relating to market access and consumer value.

Other weaknesses reflect incomplete description, arising in part from the confusion of responsibility for upkeep; a number of common descriptive traits being omitted and a lack of linkage to a range of related industry recording structures including different terminology for various descriptions.

SUMMARY OF ISSUES ARISING WITHIN SEGMENTS OF THE LIVESTOCK LANGUAGE

LIVESTOCK CATEGORY ISSUES

1. The interchangeable use of actual age and dentition as a description of age. Other than the general observation that dentition will change as an individual animal grows older there is at best a very poor relationship between actual age and dentition. The two descriptions must be separated to avoid confusion.

2. The primary use of dentition within category descriptions rather than actual age contrasts with most livestock transactions and potentially creates a conflict which extends to utilisation in the "meat" language. This warrants examination.

3. Should dentition remain a primary language component consideration might be given to aligning live and carcase descriptive ciphers.

4. Definition of bull sex including use of PSC and SSC or alternate castration definition. Can a castrated animal be a bull? Can a male with testicles not be a bull? Further testicular description is used for breeding stock but not within the language. Castration and banding are also not described but may relate to welfare, livestock or carcase trading.

5. Differences between the current language category codes and definitions and those used in other Industry systems such as Auctions Plus.

6. Consideration of jointly evaluating the Auctions Plus terminology in conjunction with that used in the "official" livestock language as a base for any livestock language review.

LIVESTOCK DESCRIPTION ISSUES

1. The confusion inherent in use of Body Condition Score (BCS) and Fat Score systems.
2. Disparity between scales and measurement for dairy and beef cattle description.
3. The recommended addition of a 0 Fat Score to assist in description of stock experiencing muscle depletion after fat reserves have been utilised.
4. The difficulty of managing alphanumeric scoring descriptors in electronic systems, statistical analysis and in producer understanding.
5. The phasing out of Body Condition Score description and universal application of independent fat and muscle score standards to provide a uniform live animal description base.
6. Possible addition of inputs to facilitate estimates of transit loss and relate weight at assessment to estimated dressed or live weight at delivery.
7. Extension of muscle score to the AUS-MEAT “meat” language replacing butt shape.
8. Definition of Frame Score in months or kg live weight and formal maturity type description.
9. Consideration of standard breed coding to remove existing anomalies and facilitate description of crossbreeds including complex crosses or composite populations while also providing a suitable system to accommodate genomic descriptions.
10. Consideration of BeefSpecs silhouette or base breed type % to describe crossbred commercial cattle.
11. Addition of Joined and Un-joined to pregnancy descriptions.
12. Consideration of CashCow standard descriptions to facilitate analysis and comparison of breeding performance in conjunction with a review of Southern Australian breeding systems.
13. Completion of an agreed lexicon for beef terminology used in the Australian livestock and “beef” language and related commercial and research applications.
14. Standard temperament terminology and provision for addition of a stress measure in the livestock language.
15. Measurement standards to define tipped horn length and full horn span.
16. Future provision for inclusion of hide standards within the language.

ISSUES RELATING TO CRITERIA CURRENTLY NOT INCLUDED WITHIN THE LIVESTOCK LANGUAGE

1. Development of standard terms for commercial reporting of genomic trait.
2. Further definition of the interaction of the livestock language and multiple industry systems. At what level or point do measures or terms used as inputs or outputs become incorporated in the livestock language? Should they be defined in a language lexicon and should standard terminology be agreed to ensure consistent language linkage?
3. Incorporation of Estimated Breeding Values (EBV’s) and Genomic Breeding Values (GBV’s) in the Livestock language. Standards should be developed in the context of proposed changes to livestock recording systems and greater use of multi-breed and cross-bred formats.
4. Cross referencing or inclusion of semen and embryo descriptions and standards in the Livestock language.

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5. Adoption of a standard structural soundness description base within the Livestock language to facilitate clear description.
6. Consideration of standard description or coding for transfer of animal health, therapeutic drug and HGP treatment history.
7. Consideration of performance estimates including beef and dairy sire EBV's/GBV's for dairy and dairy cross calves including assessment standards for maturity type, fat and muscle score at a very young age and the relationship of these to subsequent measures when older.
8. Consideration of standard descriptive language for breeding cattle including the use of broader "quality" descriptive terms.
9. Inconsistency between common use of age and age proxies such as vealer, weaner or yearling and the primary language use of dentition to describe category.
10. Review of terminology for store stock condition and any conflict or ambiguity with livestock language fat and muscle score standards.
11. Priority research and development to prove and introduce objective systems that provide useful predictions of subsequent store cattle performance to facilitate Value Based Marketing (VBM) and appropriate market targeting.
12. Standard estimating procedures for predicting live and carcase weight losses post assessment under varying conditions.
13. Possible language inclusions to support live export certification schemes.
14. Evaluation of a national animal age recording system as a precursor to replacing or reducing the use of dentition as a primary category descriptor.
15. Replacement of P8 fat measurement with whole of carcase fat and muscle scores to improve yield prediction and associated carcase valuation.
16. Accelerated development and evaluation of camera and scanning technologies to predict carcase yield from live animal, hide on and hide off carcase scans.
17. Simplification of information transfer at the point of slaughter via increased use of electronic data transfer both to the processor and return to suppliers and genetic evaluation systems.
18. Facilitation of transparent value based marketing structures via standardised language and more accurate yield and eating quality estimates.
19. The importance of trust, supported by enhanced education to ensure full appreciation of standards and processes, and priority development of objective measurement technologies for live cattle and carcase beef.
20. Potential requirements for more stringent property QA programs and auditing of such programs. Industry may consider leading this development including training in order to stay ahead of customer or government demand and facilitate acceptance of new initiatives designed to improve profitability.
21. Development of an information transfer system, using the NLIS RFID tag as a key, to access multiple data bases and aggregate information of value in livestock transactions throughout the supply chain. This may be incorporated within the MLA Livestock Datalink project.

BACKGROUND

While AUS-MEAT Ltd is responsible for quality standards and uniform description of meat and livestock (Anon, 2014a) the meat component of the language is by far the most recognised and utilised.

In considering beef language the White Paper is adopting a broader view of language elements starting with genetic data used in sire selection, continuing throughout the live animal phase, linking to conversion to meat and ultimately to final consumer meal description.

In essence this may be viewed as three interlinked language sections: Livestock, Meat (carcases and cuts) and Meal (consumer).

This background paper (Section A) addresses the National Livestock Language – Cattle (Anon, 1994) which, while the official "livestock language", enjoys far less recognition and uniform application than the AUS-MEAT administered "meat" language component, perhaps reflecting voluntary rather than mandatory use. The livestock language is also far less encompassing having significant gaps in relation to many common livestock terms and descriptions used in trading and legislation. There is also significant confusion and multiple "look alike" descriptions in common use with considerable confusion and overlap between livestock sectors and federal, state and territory jurisdictions.

This confusion extends to even a clear understanding of who is the custodian of the language, who is responsible for its' ongoing development and who, if anyone, holds an official copy as illustrated by the following quote from Blackwood et.al (2014).

"The National Language has not been reviewed since June, 1993 and there is no electronic format of the document held by either MLA or Cattle Council of Australia.

AUS-MEAT handed over responsibility of the National Live Stock Languages (Cattle and Sheep) to AMLC when they attained individual status (personal communication Ian King, Managing Director, AUS-MEAT).

Within MLA the project has had difficulty finding any function that has responsibility for the currency of the Language.

Advice from CCA has been to assume that the CCA Board in 1993 'accepted' the review of June 1993".

The description relied upon in this report is a hard copy of National Livestock Language-Cattle:Bovine (Anon, 1994) supplied by AUS-MEAT.

This report also seeks to include all cattle related transactions and language related events prior to slaughter as components, or potential components, of livestock language. This broad definition encompasses description in relation to genetics and genomics utilised in specifying or describing gene markers and estimated breeding values (EBV) in association with semen, embryos, live animals and predictions of their progeny.

CURRENT LIVESTOCK LANGUAGE SUMMARY

The Livestock Language – Cattle (Anon, 1994) comprises definitions under the general headings of category and cattle descriptions.

LIVESTOCK CATEGORY

Category is defined as a combination of age and sex with further advice that age may be described by dentition, age in months or, for store cattle only, month and year of drop. The nominated approximate age ranges for each of the dentition categories carry an approximate age range of 12 months, and 18 months for 0 to 2 teeth, and clearly add no additional information to year of birth. The 2 teeth threshold of 18 months is not supported by the literature.

The interchangeable use of actual age and dentition is a critical fundamental flaw that carries forward into assumptions within the "meat" language and some international market access agreements. Other than the general observation that dentition will change as an individual animal grows older there is at best a very poor relationship between actual age and dentition (Lawrence et. al., 2001). The two descriptions must be separated to avoid confusion.

The combination of sex and dentition as a category description essentially mirrors that used in the "meat" language although utilising different summary terminology, for example use of VL (vealer), WN (weaner) and YL (yearling) versus the "meat" language description of Y for cattle with zero permanent incisor teeth.

Sex alternatives are described in more detail within livestock categories with male sex dependent on observation of primary (PSC) and secondary (SSC) sexual characteristics. PSC are defined as the development of genitalia evidenced by the thickening or growth of one or more of the following:

- testicles
- sheath
- prepuce
- penis

SSC are defined as pronounced muscular development (cresting) of the neck. Definition of SSC is more complex in the "meat" language which essentially incorporates the PSC. The sex categories recorded in Auctions Plus (Anon, 2011a) assessments utilise different codes of MA (male), FE (female), CA (castrate) and MI for mixed sex mobs. Standardisation of sex description and coding should be considered in any subsequent language review.

A further reference point for alternative sex description could be the United States Department of Agriculture (USDA) standards (Anon, 2000). These differ from the Australian livestock, and in particular "meat", languages in firstly relating to castration with secondary evaluation and adjustment for SSC.

The USDA descriptions for slaughter and feeder cattle are:

a) Steer. A steer is a male bovine castrated when young and which has not begun to develop the secondary sexual characteristics of a bull.

b) Bullock. A bullock is a young (approximately 24 months of age or less) uncastrated, male bovine that has developed or begun to develop the secondary physical characteristics of a bull.

c) Bull. A bull is a mature (approximately 24 months of age or older) uncastrated, male bovine. However, for the purpose of these (USDA) standards, any mature, castrated, male bovine which has developed or begun to develop the secondary physical characteristics of an uncastrated male also will be considered a bull.

d) Cow. A cow is a female bovine that has developed through reproduction or with age, the relatively prominent hips, large middle, and other physical characteristics typical of mature females.

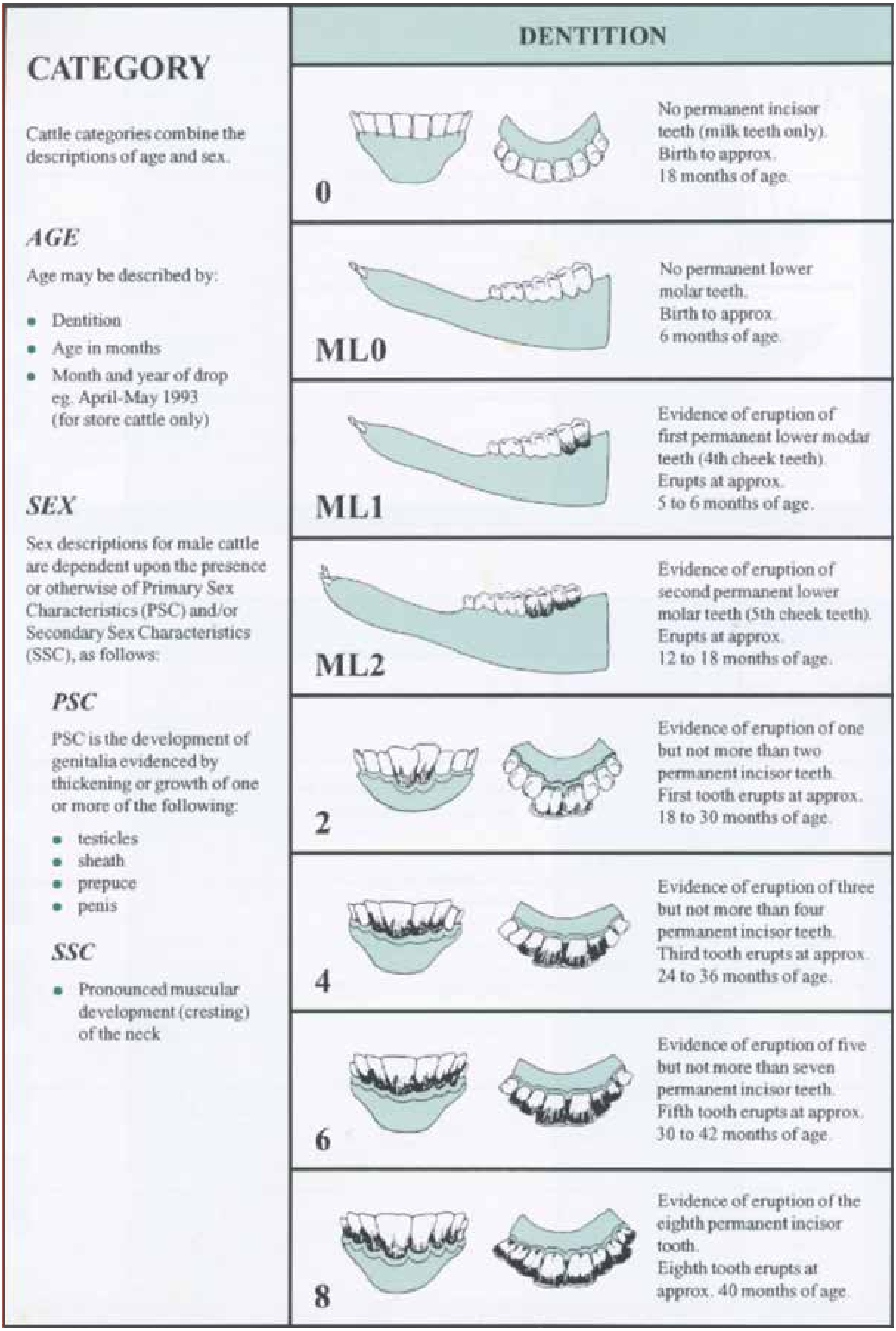
e) Heifer. A heifer is an immature female bovine that has not developed the physical characteristics typical of cows.

Further clarification of the bull definition and adoption of common terminology and assessment within livestock and meat language segments may be useful while noting that more detailed description of testicle size, condition and shape is required within breeding bull description but currently not within the livestock language. Castration method and time including retention of testicles by banding is also not within the current language and may warrant definition to accommodate welfare, livestock and carcase trading.

The livestock language defines dentition categories as 0, 2, 4, 6 and 8 permanent incisor teeth. In addition, within the 0 teeth category, dentition can be further described as

ML0, ML1 and ML2 relating to the eruption of permanent lower molar teeth (none, first and second) prior to the first permanent incisors. Figure 1 displays the diagrammatic and verbal description used in the language. (Note: it is extremely difficult to assess molars in the live animal and not easy in the carcase).

Figure 1: Livestock language Category description. (Anon, 1994)



Despite the statement that category can be defined by age or dentition all subsequent category descriptions within the livestock language for cattle younger than adult (8 teeth) only define dentition and sex relationships. The theoretical alternative of using age and sex, while more common in actual commercial livestock trading, is not described other than as an alternative for cattle with 8 teeth (adult) or aged.

While commonly regarded as a proxy for age, dentition is extremely variable with published estimates including those in the AUS-MEAT "meat" language (Anon, 2014a) and as listed in the Auctions Plus assessment manual (Anon, 2011a) and shown in Table 1 having a 12 to 18 month range for given dentition standards.

Table 1: Estimated age for teeth eruption (Anon, 2011a)

Teeth	Age
Milk or 0 permanent incisors	0–18 months
2 permanent incisors	18–30 months
4 permanent incisors	24–36 months
6 permanent incisors	30–42 months
8 permanent incisors	36+ months

It would seem that any producer could readily provide age to within a 12-month period raising the question as to why dentition has been, or should continue to be, used as an age proxy.

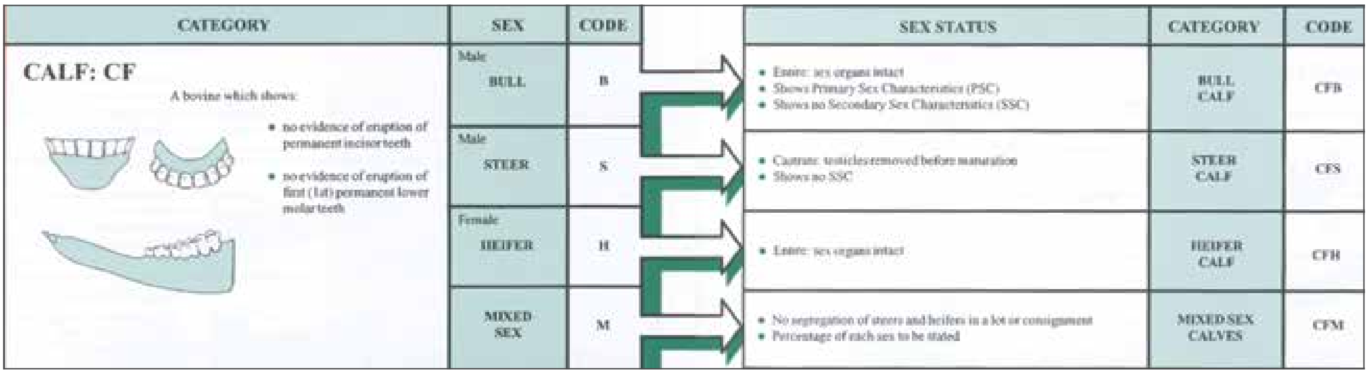
This principal and the related "meat" language structure is regarded as a critical principal for discussion. The mandatory input of age in months for all Auctions Plus assessments (Anon, 2011a) indicates that an age estimate is possible in a majority of circumstances.

Livestock categories are defined as Calf (CF), Vealer (VL) or Weaner (WN), Yearling (YL), Cattle, Adult (AD) and Aged (AG). Each category is defined by dentition with calf and vealer or weaner segregated on the basis of eruption of permanent lower molar teeth, calves having none and vealers or weaners having the first erupted. A vealer is further defined as not being weaned (or more than 3 days off the cow). Yearlings have both permanent molars erupted but no permanent incisors whereas cattle may have 2, 4, or 6 permanent incisors. The adult category is defined by 8 permanent incisors and aged by the loss of one or more permanent incisors.

Within the category descriptions above further sub categories, but described as category, are derived from differentiated sex description with codes related to the primary category and the sex divisions, for example YFB to describe a yearling bull. Further sex descriptions are also introduced to describe mixed sex mobs in CF, VL or WN and YL categories. Stag (G) and spay (P) sex descriptions are added to a base bull (B), steer (S) and heifer (H) description for other than Adult and Aged categories where bullock (K) replaces steer and cow (C) replaces heifer.

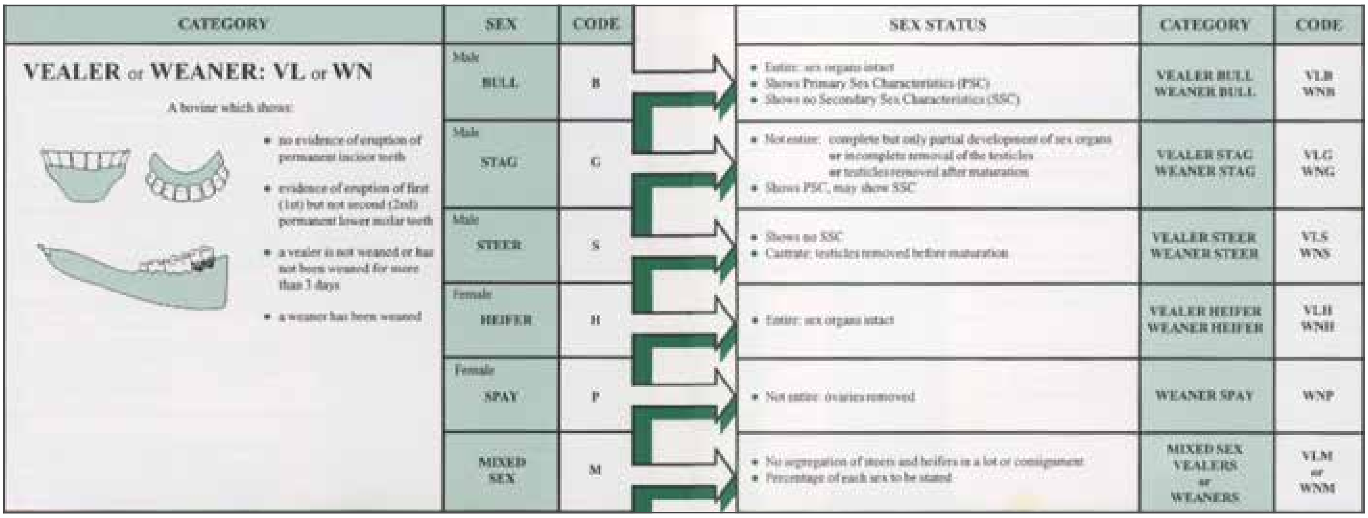
Figures 2.1 to 2.6 show the language descriptions for each category and the progressive codes. While the codes represent common dentition standards to the alternative categories in the "beef" language the beef ciphers are different. Were the livestock codes to be widely used this could lead to confusion. Should dentition remain a fundamental language parameter consideration might be given to adopting common coding and description to live and carcase beef where possible to generate improved clarity.

Figure 2.1: Australian Livestock Language (Anon, 1994) detailed description within the CALF: CF Category



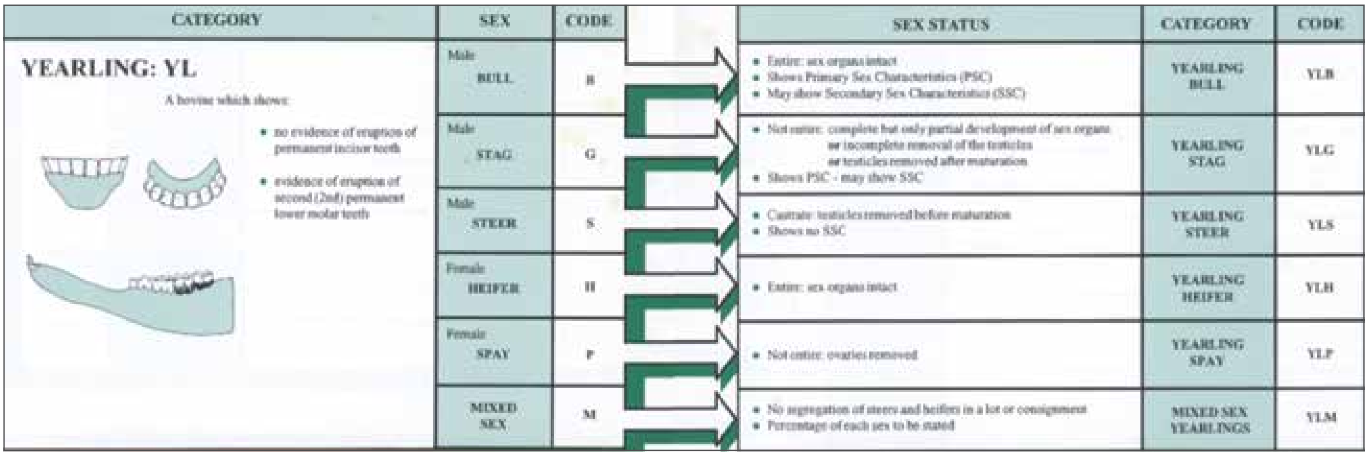
CATEGORY	SEX	CODE	SEX STATUS	CATEGORY	CODE
CALF: CF A bovine which shows: • no evidence of eruption of permanent incisor teeth • no evidence of eruption of first (1st) permanent lower molar teeth	Male BULL	B	• Entire: sex organs intact • Shows Primary Sex Characteristics (PSC) • Shows no Secondary Sex Characteristics (SSC)	BULL CALF	CFB
	Male STEER	S	• Castrate: testicles removed before maturation • Shows no SSC	STEER CALF	CFS
	Female HEIFER	H	• Entire: sex organs intact	HEIFER CALF	CFH
	MIXED SEX	M	• No segregation of steers and heifers in a lot or consignment • Percentage of each sex to be stated	MIXED SEX CALVES	CFM

Figure 2.2: Australian Livestock Language (Anon, 1994) detailed description within the VEALER or WEANER: VL or WN Category



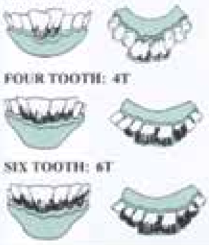
CATEGORY	SEX	CODE	SEX STATUS	CATEGORY	CODE
VEALER or WEANER: VL or WN A bovine which shows: • no evidence of eruption of permanent incisor teeth • evidence of eruption of first (1st) but not second (2nd) permanent lower molar teeth • a vealer is not weaned or has not been weaned for more than 3 days • a weaner has been weaned	Male BULL	B	• Entire: sex organs intact • Shows Primary Sex Characteristics (PSC) • Shows no Secondary Sex Characteristics (SSC)	VEALER BULL WEANER BULL	VLB WNB
	Male STAG	G	• Not entire: complete but only partial development of sex organs or incomplete removal of the testicles or testicles removed after maturation • Shows PSC, may show SSC	VEALER STAG WEANER STAG	VLG WNG
	Male STEER	S	• Shows no SSC • Castrate: testicles removed before maturation	VEALER STEER WEANER STEER	VLS WNS
	Female HEIFER	H	• Entire: sex organs intact	VEALER HEIFER WEANER HEIFER	VLH WNH
	Female SPAY	P	• Not entire: ovaries removed	WEANER SPAY	WNP
	MIXED SEX	M	• No segregation of steers and heifers in a lot or consignment • Percentage of each sex to be stated	MIXED SEX VEALERS or WEANERS	VLM or WNM

Figure 2.3: Australian Livestock Language (Anon, 1994) detailed description within the YEARLING: YL Category



CATEGORY	SEX	CODE	SEX STATUS	CATEGORY	CODE
YEARLING: YL A bovine which shows: • no evidence of eruption of permanent incisor teeth • evidence of eruption of second (2nd) permanent lower molar teeth	Male BULL	B	• Entire: sex organs intact • Shows Primary Sex Characteristics (PSC) • May show Secondary Sex Characteristics (SSC)	YEARLING BULL	YLB
	Male STAG	G	• Not entire: complete but only partial development of sex organs or incomplete removal of the testicles or testicles removed after maturation • Shows PSC - may show SSC	YEARLING STAG	YLG
	Male STEER	S	• Castrate: testicles removed before maturation • Shows no SSC	YEARLING STEER	YLS
	Female HEIFER	H	• Entire: sex organs intact	YEARLING HEIFER	YLH
	Female SPAY	P	• Not entire: ovaries removed	YEARLING SPAY	YLP
	MIXED SEX	M	• No segregation of steers and heifers in a lot or consignment • Percentage of each sex to be stated	MIXED SEX YEARLINGS	YLM

Figure 2.4: Australian Livestock Language (Anon, 1994) detailed description within the CATTLE Category



CATEGORY	SEX	CODE	SEX STATUS	CATEGORY	CODE
CATTLE: Bovines which: • are described according to sex descriptions only • are differentiated by dentition or age in months	Male BULL	B or BUL	• Entire: sex organs intact • Shows Primary Sex Characteristics (PSC) • Shows Secondary Sex Characteristics (SSC)	BULL	2TB 4TB 6TB or BUL
TWO TOOTH: 2T — Shows evidence of eruption of one (1) but not more than two (2) permanent incisor teeth	Male STAG	G or STG	• Not entire: complete but only partial development of sex organs or incomplete removal of the testicles or testicles removed after maturation • Shows PSC	STAG	2TG 4TG 6TG or STG
FOUR TOOTH: 4T — Shows no evidence of eruption of three (3) but not more than four (4) permanent incisor teeth	Male STEER	S or STR	• Castrate: testicles removed before maturation • Shows no SSC	STEER	2TS 4TS 6TS or STR
SIX TOOTH: 6T — Shows evidence of eruption of five (5) but not more than seven (7) permanent incisor teeth	Female HEIFER	H or HFR	• Entire: sex organs intact	HEIFER	2TH 4TH 6TH or HFR
	Female HEIFER SPAY	P or HSP	• Not entire: ovaries removed	HEIFER SPAY	2TP 4TP 6TP or HSP

Figure 2.5: Australian Livestock Language (Anon, 1994) detailed description within the ADULT: AD Category

CATEGORY	SEX	CODE	SEX STATUS	CATEGORY	CODE
ADULT: AD A bovine which: • has a full set of eight (8) permanent incisor teeth • may be described by sex description only • is differentiated by dentition or age in months as required	Male BULL	B or BUL	• Entire: sex organs intact • Shows Primary Sex Characteristics (PSC) • Shows Secondary Sex Characteristics (SSC)	(ADULT) BULL	(ADB) BUL
	Male STAG	G or STG	• Not entire: complete but only partial development of sex organs or incomplete removal of the testicles or testicles removed after maturation • Shows PSC and SSC	(ADULT) STAG	(ADG) STG
	Male BULLOCK	K or BCK	• Castrate: testicles removed before maturation • Shows no SSC	(ADULT) BULLOCK	(ADK) BCK
	Female COW	C or COW	• Entire: sex organs intact	(ADULT) COW	(ADC) COW
	Female COW SPAY	P or CSP	• Not entire: ovaries removed	(ADULT) COW SPAY	(ADP) CSP

Figure 2.6: Australian Livestock Language (Anon, 1994) detailed description within the AGED: AG Category

CATEGORY	SEX	CODE	SEX STATUS	CATEGORY	CODE
AGED: AG A bovine which: • shows evidence of incomplete dentition due to the loss of one (1) or more permanent incisor teeth from a full set of eight (8) permanent incisor teeth • is differentiated by dentition or age in months as required	Male BULL	B or BUL	• Entire: sex organs intact • Shows Primary Sex Characteristics (PSC) • Shows Secondary Sex Characteristics (SSC)	(AGED) BULL	(AGB) BUL
	Male STAG	G or STG	• Not entire: complete but only partial development of sex organs or incomplete removal of the testicles or testicles removed after maturation • Shows PSC and SSC	(AGED) STAG	(AGG) STG
	Male BULLOCK	K or BCK	• Castrate: testicles removed before maturation • Shows no SSC	(AGED) BULLOCK	(AGK) BCK
	Female COW	C or COW	• Entire: sex organs intact	(AGED) COW	(AGC) COW
	Female COW SPAY	P or CSP	• Not entire: ovaries removed	(AGED) COW SPAY	(AGP) CSP

The active use of the specifications defined in the language appears somewhat confused, particularly in relation to the codes and detailed sub-codes as defined. Examples of this are evident in comparing the language specifications presented in figures 2.1 to 2.6 with the stock category codes utilised for slaughter and store stock by Auctions Plus, a major Industry user of livestock description language.

While the livestock language (Anon, 1994) does not mention live or carcase weight in relation to category description it appears as a major descriptor in the Auctions Plus specification (Table 2). Further disparity may be seen in some category codes with YLG denoting a yearling stag in the official livestock language but yearling in Auctions Plus and the language having WN for weaner versus WNR in Auctions Plus store stock description (Anon, 2011a). Auctions Plus also provides significantly more divisional description within the cattle category, presumably reflecting Industry requirements. It would be prudent to evaluate these and other discrepancies and to attempt to resolve differences to establish common agreed definitions and descriptive standards within any language review.

Given that Auctions Plus is actively using livestock language on a significant industry scale, and that it appears to utilise a modified or enhanced adaption of the official language it may be prudent to evaluate both the Livestock Plus (Anon, 2011a) and Livestock language (Anon, 1994) versions conjointly in any formal language review. Given willing collaboration this could facilitate more uniform language use and facilitate training.

Table 2: Auctions Plus Stock Categories (Anon, 2011a)

B1 – Stock categories			
Stock Category			**Dentition/Comments**
CLF	Calf	Up to 70kg HSCW	
VLR	Vealer	Above 70kg HSCW	Still on cow
YLG	Yearling	70–260kg HSCW	No permanent incisor
YNG	Young Cattle	70–260kg HSCW	No more than 2 permanent incisors
STL	Steer Light	90–240kg HSCW	3 or more permanent incisors
STM	Steer Medium	180–320kg HSCW	3 or more permanent incisors
STH	Steer Heavy	280–420kg HSCW	3 or more permanent incisors
HFL	Heifer Light	90–240kg HSCW	3 but not more than 7 permanent incisors
HFH	Heifer Heavy	180–320kg HSCW	3 but not more than 7 permanent incisors
CWL	Cow Light	90–220kg HSCW	8 permanent incisors
CWH	Cow Heavy	200–340kg HSCW	8 permanent incisors
BLL	Bull Light	70–240kg HSCW	3 or more permanent incisors
BLH	Bull Heavy	220–400kg HSCW	3 or more permanent incisors
MX	Manufacturing Mixed	110–300kg HSCW	
All weights in this table are dressed weights			

WNR	Weaner	140–400kg LWT	Use for Store Cattle Only No permanent incisor
C/C	Cow & Calf	180–520kg LWT	Use for Store Cattle Only

LIVESTOCK CATEGORY ISSUES:

1. The interchangeable use of actual age and dentition as a description of age. Other than the general observation that dentition will change as an individual animal grows older there is at best a very poor relationship between actual age and dentition. The two descriptions must be separated to avoid confusion.
2. The primary use of dentition within category descriptions rather than actual age contrasts with most livestock transactions and potentially creates a conflict which extends to utilisation in the "meat" language. This warrants examination.
3. Should dentition remain a primary language component consideration might be given to aligning live and carcase descriptive ciphers.
4. Definition of bull sex including use of PSC and SSC or alternate castration definition. Can a castrated animal be a bull? Can a male with testicles not be a bull? Further testicular description is used for breeding stock but not within the language. Castration and banding are also not described but may relate to welfare, livestock or carcase trading.
5. Differences between the current language category codes and definitions and those used in other Industry systems such as Auctions Plus.
6. Consideration of jointly evaluating the Auctions Plus terminology in conjunction with that used in the "official" livestock language as a base for any livestock language review.

CATTLE DESCRIPTIONS DEFINED IN THE NATIONAL LIVESTOCK LANGUAGE

WEIGHT

The language provides for description of live weight, estimated live weight and estimated hot standard carcase weight with notation that weight descriptions for a lot or consignment are specified by average and range.

Live weight is defined as being stated in kilograms and any time off feed, or feed and water immediately prior to weighing stated with the example shown being:

	Liveweight
Average:	300kg, 4 hours off feed
Range:	280 – 320kg, 0 hours off water

Estimated hot standard carcase weight, abbreviated as EHSCW, is defined as being determined from the liveweight.

More elaborate description and guidelines are utilised within Auctions Plus (Anon, 2011a) for slaughter and store stock. These include extensive procedures to adjust for gut fill, transit losses, feed type (including type of country and feedlot), weather, breed and pregnancy. Within the system these factors are utilised within computerised calculations to adjust bids in a live or carcase weight basis.

Accurate estimates of transit shrink are also important in the live cattle trade both from property to delivery depot and though the shipping process to ultimate destination. Domestically the live weight relationships are important in transactions between breeders and growers or fatteners through both direct and sale yard marketing systems. For slaughter cattle accurate carcase weight estimates via dressing % adjustment are important. Both live and estimated carcase weight predictions are at the core of NLRS market reporting and of individual company performance measures.

These more advanced inputs and standard terminology might be considered in reviewing the livestock language.

CONDITION SCORE (FAT SCORE)

The language states that condition of cattle is described by fat depth or condition scores according to the estimated fat depth at the P8 site as detailed in Table 3 below. This in itself raises a practical challenge as there are no bony structures to palpate against, making it extremely difficult to assess fat at this point. Most scorers find it difficult to discern between fat and muscle, hence European cattle often have overestimated subjective fat depths at the 12th rib compared to British breeds (J Thompson *personal communication*).

Table 3: Condition Score (Fat Score) Livestock language standards (Anon, 1994)

CONDITION SCORE (FAT SCORE)

Condition of cattle is described by fat depth or condition scores according to the estimated fat depth at the P8 site as detailed below.

STANDARD		OPTIONAL	
Scores	Fat Depth (mm) at P8 site	Scores	Fat Depth (mm) at P8 site
1	0 to 2		
2	3 to 6	2 Low (L) 2 High (H)	3 to 4 5 to 6
3	7 to 12	3L 3H	7 to 9 10 to 12
4	13 to 22	4L 4H	13 to 17 18 to 22
5	23 to 32	5L 5H	23 to 27 28 to 32
6	over 32	6L 6H	33 to 42 over 42

A number of issues arise from the definition and use of Condition Score and Fat Score terms, not the least being a general understanding that they relate to two different matters with Fat Score strictly describing fat depth, although derived from observations that include distribution, whereas Condition Score includes an overlap with carcase muscle.

In Northern Australia a 0 to 5 point Body Condition Score (BCS) system is in common use (Blackwood et.al., 2014) whereas the language standard of a 1 to 6 point Fat Score system is generally adopted in the South and for on property and official market reporting including the National Livestock Reporting Service (NLRS) (Anon, 2005), Auctions Plus assessors (Anon, 2011a) and for calculation of the Eastern Young Cattle Indicator (EYCI) (Anon, 2014b). As depicted in Table 3 the higher fat scores may also be subdivided into high (H) and (L) in effect creating a potential 16 point scale; 1, 2L, 2, 2H…6H.

The dairy industry utilises yet another variation with a 1 to 8 condition scoring system used in Australia, a 1 to 10 in New Zealand and 1 to 5 in the USA and Ireland. In Australia healthy productive dairy cows are described as falling between 3 and 6 on the 8 point scale. Dairy cow condition scores relate to both muscle and fat and are assessed by a two part appraisal based on observation of the pin and tail area plus backbone. While this system is heavily used in managing milking herds equivalence would be useful when dairy animals transfer to meat production.

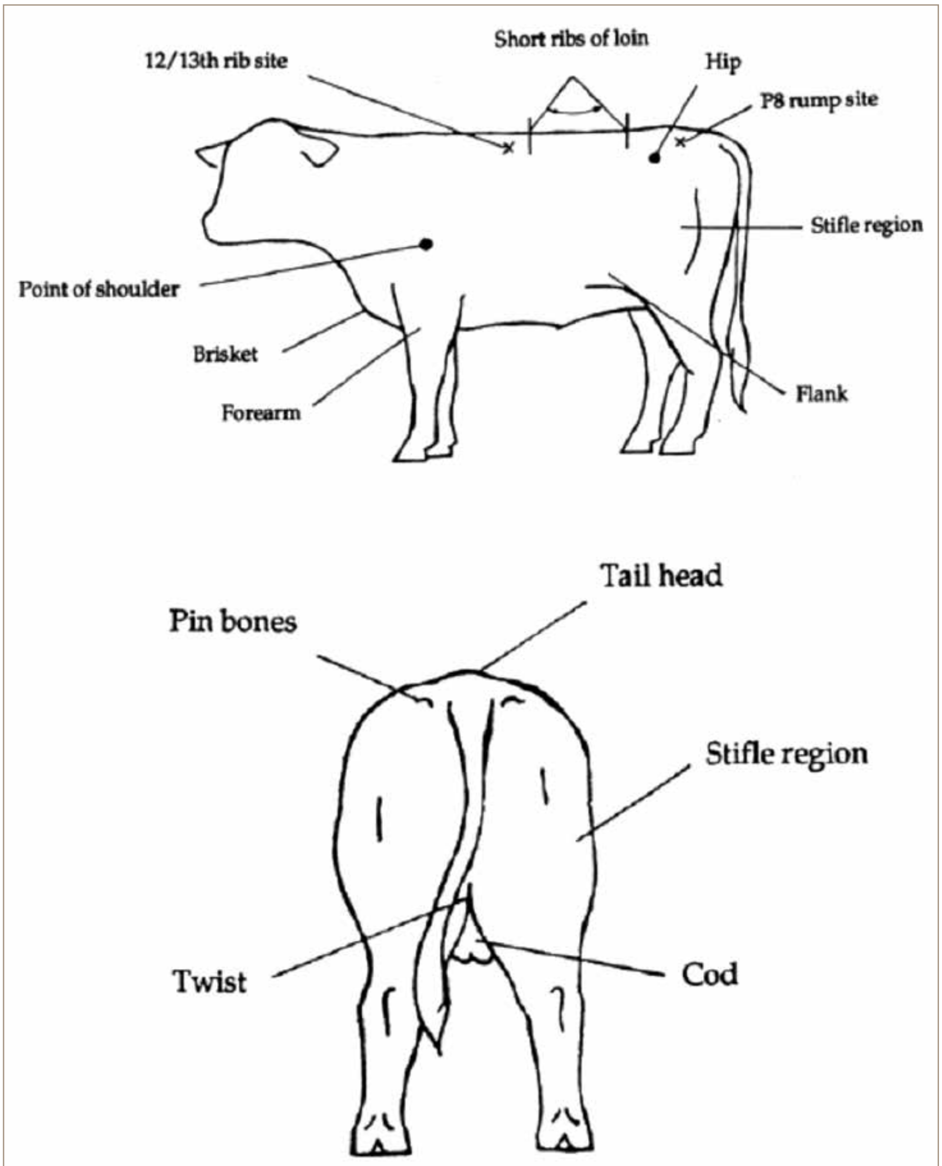
In all there are at least 15 alternative condition, muscle and fat scoring systems utilised within Australia (B Littler *personal communication*) providing considerable scope for simplification and reduced confusion. Alternative direct description of mm P8 or rib fat may also be an alternative to Fat Score if these point measures remain the Industry norm for carcase grid criteria.

Further pertinent fat score considerations are the commonality of fat classes as used in the AUS-MEAT "meat" language and the suitability of alphanumeric codes for electronic data recording and analysis. Whereas the "meat" language classes are aligned for P8 mm the subdivisions are denoted as + and – rather than H and L. Either option creates some difficulty when entering data electronically and in particular when analysing data where a continuous numeric variable is easier to manage. From this viewpoint a continuous numeric scale utilising either whole numbers or the existing classes with standard decimal subdivision is desirable. Industry might consider either the option of adopting a standard numeric scale for Fat Score or, should the H and L or + and – subdivisions be preferred in the field, the specification of a standard conversion to numeric when creating electronic records. Should the later be preferred it would appear advantageous to standardise both descriptive terms and P8 mm within each category across livestock and carcase language components.

Recent work relating to welfare assessment of cattle has recommended that a 0 Fat Score be added to the current 1 to 5 range to provide adequate description of cattle where muscle loss has occurred after depletion of fat reserves. This recommendation is associated with the description of trigger points in relation to breeding, trucking and general welfare assessments. It has been proposed that the criteria be recognised as "industry advisories" to the National Standards and Guidelines – Cattle and to the Australian Standards for Export of Livestock (ASEL). It is contended that this would provide more equitable regulatory activity to the producer and regulator through having standards defined within the language and endorsed by the Animal Welfare sub-committee (Blackwood et.al., 2014). Validation of the use of the proposed scoring system is reported by Ferguson & Matthews (2011) with guidelines for use in assessing cows presented by Blackwood (2010) and in relation to live export by MLA (Anon, 2011b). This breadth of evaluation and related experience supports the incorporation of the 0 Fat Score and related trigger point definitions within the Livestock language.

Attention is also drawn to the means of live animal fat assessment in relation to the nominated score assigned. While the standard is described in mm of P8 fat the actual assessment goes well beyond assessing a single point (P8). It could be argued that the assessment inputs may be more accurate than the measure reported. As described in illustration 3 from the Auctions Plus Cattle Assessment Manual (Anon, 2011a) the fat score is derived from observing multiple body sites.

Figure 3: Sites observed in assessing Fat Score (Anon, 2011a)



In addition the Auctions Plus assessment of slaughter stock requires a comment on evenness of distribution. The standard terms are even, slightly uneven and uneven with uneven to be further specified with an example being "uneven around the tail head". The use of an ultrasound backfat probe, which produces a digital measurement of backfat, would be a useful training tool for assessors including differentiation of the P8 site and other fat depots used in assessment.

An alternative standard Fat Score definition to P8 mm, related to overall body fat coverage and distribution, might be considered for application in both live animal and carcase description. A potential model may be an adaption of the EUROP carcase fat assessment. Given the level of concern expressed within Industry in regard to single point carcase fat measurements and the risk of hide puller site damage this may have some merit although a more subjective measurement may raise concern unless delivered by objective technology. Development of camera based technology is regarded as highly likely to deliver accuracy in this regard (A Ball, J Thompson and B Littler *personal communication*). Progression of this technology should be considered as part of a language review.

The standard base assessment of fat and muscle is applicable to store and slaughter stock although different supplementary descriptions may be applied to each as provided within the Auctions Plus Assessment manual (Anon, 2011a). This aspect is discussed further later in this report.

MUSCLE SCORE

The livestock language defines muscle score as being assessed in relation to five classes, A to E, derived from comparison to side and rear cattle views together with descriptions from very Heavy Muscle (A) to Light Muscle (E). Experienced assessors also may report + and – categories within each muscle score creating a 15 point scale. The same issues discussed in relation to subdivided fat scores and electronic data management apply in this context. A possible source of confusion embedded within the existing language is that whereas fat increases from score 1 to 5 muscle declines from class A to E.

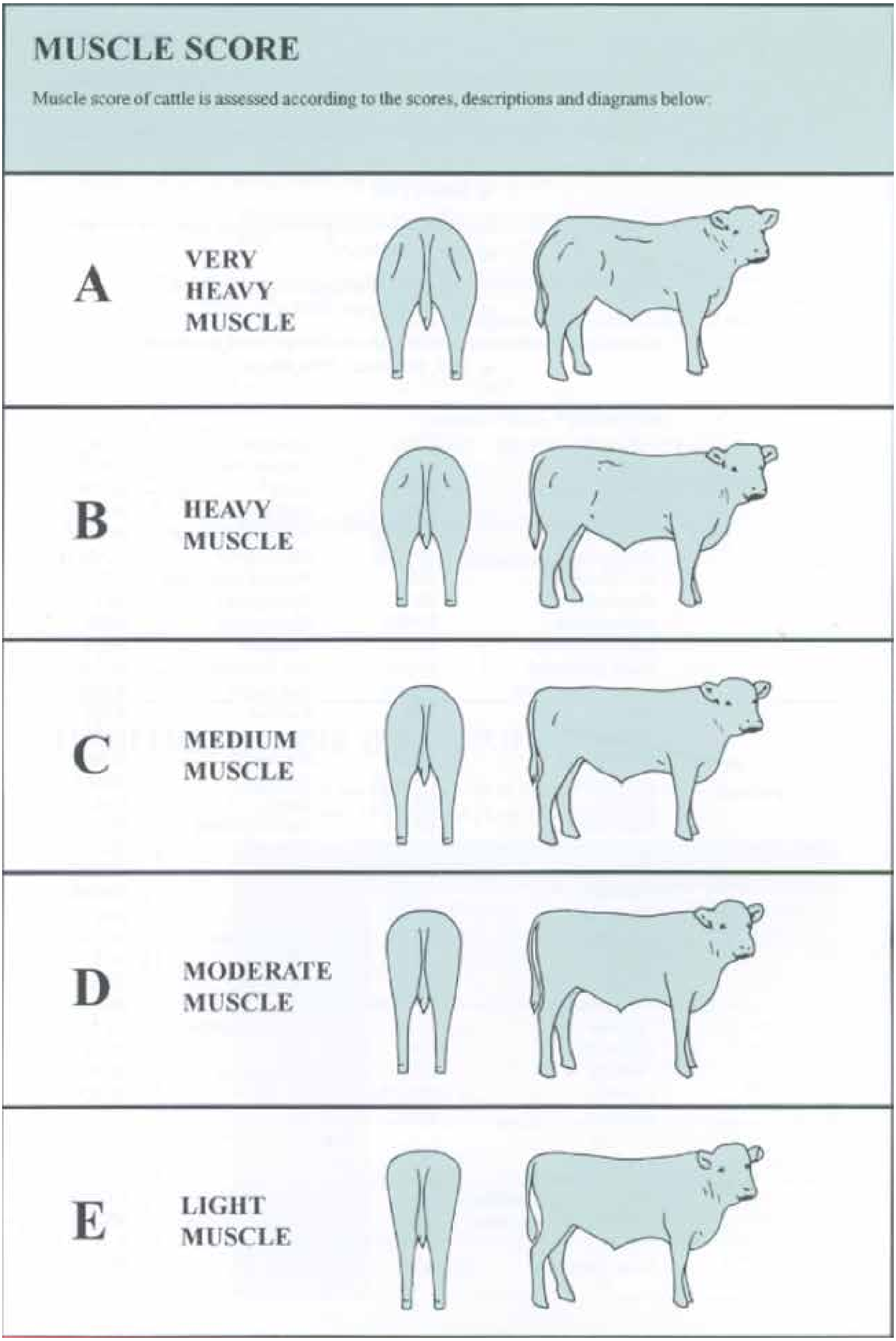
As mentioned in the Fat Score discussion there is some inherent confusion with the northern beef industry BCS or dairy industry condition score systems which do not clearly differentiate fat and muscle. Industry personnel with broad experience in live animal assessment and in training market reporting and other professional assessors strongly advocate that BCS should be replaced by independent fat and muscle score reporting (B. Littler *personal communication*).

This view follows extensive work in muscle and related carcase assessment over a 30 year period by McKiernan and associated researchers. This deserves serious Industry consideration within the language review process. The National Livestock Reporting Service (NLRS) (Anon, 2005) and Auctions Plus assessments (Anon, 2011a) currently utilise the independent fat and muscle score descriptions defined in the livestock language providing further evidence that the approach is practical. The Eastern Young Cattle Indicator (EYCI) (Anon, 2014b) is also based on a subset of these descriptions being vealer and yearling heifers and steers with scores of C2 or C3 and 200kg or above.

Live animal muscle scores are moderately related to carcase yield with coefficients of determination over 60% (Perry et al., 1993a)

The official standards are presented in Figure 4. These scores relate to muscle only and are independent of fatness.

Figure 4: Australian Livestock Language Muscle Score Standard (need a reference)



Further description of cattle typically falling within each muscle score are described in the Auctions Plus Assessment manual and presented for reference in Table 4.

Table 4: Auctions Plus Muscle Score Further Explanation (Anon, 2011a)

The muscle scores could be interpreted as follows:	
Very Heavy	Top European breed – mainly Bulls
Heavy	Top British breed and Tropical crosses, average European cross
Medium	Average British and Tropical breeds, poor European crosses
Moderate	Lower end of British and Tropical breeds
Light	Dairy breeds and crosses

Further consideration might be given to training programs and certification of livestock assessors including producers. Official assessors are evaluated against formal National Competency Standards (NCS) to ensure consistency. Broader provision of assessment courses to producers might be expected to both greatly improve competency and improve understanding of standard language descriptions. Such courses have been very well received and supported in the past. It is also reported (B Littler *personal communication*) that producers who regularly trade cattle on an over the hooks basis consistently develop very high accuracy in relating live assessments to subsequent carcase measures. Extension of live cattle muscle score to the AUS-MEAT "meat" language as a carcase muscle score may be worth consideration due to its' superior estimation of carcase yield relative to butt shape. Perry et.al. (1993a and 1993b) found moderate to high (0.79 and 0.84) correlation between live animal and carcase muscle scores and further an increase of 1.7% in saleable meat and 2.2% in lean meat for each change in live animal muscle score, on a 15 point scale, and 1.9% and 2.4% increases for saleable and lean meat for corresponding carcase based assessments. Improved estimates of saleable and lean meat were obtained with the inclusion of carcase weight, P8 fat, EMA and muscle score in prediction equations (Perry et.al., 1993a and 1993b). The inclusion of either EMA or muscle score in estimates greatly improved accuracy with further marginal improvement by including both.

This would be similar to the EUROP system which also utilises 5 principal muscle categories, often expanded to a 15 point scale by applying + and – within each class. EUROP scores are commonly assigned by camera systems in Irish abattoirs, providing the prospect for effective objective assessment. Results reported by Conroy et.al. (2010) showed that EUROP 15 point carcase classification scores obtained from a mechanical system accounted for 0.73 (meat), 0.67 (fat) and 0.71 (bone) across 662 cattle, these including bulls, steers and heifers of varied description. Consistent results, well beyond the current "meat" language butt shape standards are also possible with trained assessors with this remaining the normal situation in much of Europe.

While subjective muscle scoring may deliver a superior muscle and yield prediction accuracy to current measures (Perry et.al., 1993a) the potential for further improved accuracy from new objective technology must also be noted. Where these technologies are either not sufficiently developed or commercially impractical muscle scoring may be a worthwhile consideration. An attraction of carcase muscle score is that it has been shown to relate to live animal muscling (Perry et.al., 1993a and 1993b) although it's subjective nature and need for assessor training and monitoring may raise concerns. Carcase EMA is currently measured in many carcases using semi-objective means. While the official AUS-MEAT measure is a standard grid on which cm squares are manually counted carcases that are "spencer rolled" by releasing the eye muscle without quartering to allow side chain boning distort this measure. There are also EMA issues with alternate quartering points and a lower relationship to live muscle score; 0.71 (Perry et.al. 2003b) although relationship to saleable meat was similar in both studies.

FRAME SIZE

The language provides for Frame Scores from 1 to 7+ in accordance with Table 5 which utilises a matrix of age versus hip height in cm. The use of age infers that this is known within month by the producer, somewhat at odds with arguments advanced in regard to the use of dentition.

Table 5: Frame size standards in National Livestock Language (Anon, 1994)

FRAME SIZE

Frame size is an indication of maturity pattern and is described either by a frame score, a frame description, or by height in centimetres (cm) at the hips.

SCORE	DESCRIPTION
1	Very small
2 3	Small
4 5	Medium
6 7	Large
7+	Very large

In the associated table below the frame score is calculated by measuring hip height in cm and relating that to age in months for bulls and females with the age relationship static beyond 24 months for bulls while having a further broad category between 25 and 35 months for females at which point the age component is also constant. No relationship is provided for steers.

Figure 5: Need a title and a reference

BULLS

AGE (months)	FRAME SCORE 1	2	3	4	5	6	7
5	86	91	97	102	107	112	117
6	89	94	99	104	109	114	119
7	91	97	102	107	112	117	122
8	94	99	104	109	114	119	125
9	97	102	107	112	117	122	127
10	100	104	109	114	119	124	130
11	102	107	112	117	122	127	132
12	104	109	114	119	124	130	135
13	105	110	116	121	126	131	136
14	107	112	117	122	127	132	137
15	108	113	118	123	128	133	138
16	109	114	119	124	130	135	140
17	110	116	121	126	131	136	141
18	112	117	122	127	132	137	142
24	116	121	126	131	136	141	146
Over 24 mths	120	125	130	133	140	145	150

FEMALES

AGE (months)	FRAME SCORE 1	2	3	4	5	6	7
5	86	91	96	101	106	111	116
6	88	93	98	103	108	113	118
7	90	95	100	105	110	115	120
8	92	97	102	107	112	117	122
9	93	98	103	108	113	118	123
10	95	100	105	110	115	120	125
11	97	102	107	112	117	122	127
12	99	104	109	114	119	124	129
13	101	106	111	116	121	126	131
14	102	107	112	117	122	127	132
15	104	109	114	119	124	129	134
16	105	110	115	120	125	130	135
17	106	111	116	121	126	131	136
18	107	112	117	122	127	132	137
24	110	115	120	125	130	135	140
25/35 mths	112	117	122	127	132	137	142
Over 36 mths	114	119	124	129	134	139	144

While the livestock language employs the standards above these are at odds with those presented in NSW Department of Primary Industries publications (McKiernan, 2005) which present tables of similar, but not identical, measurements for males and females acknowledged as being developed by the University of Wisconsin and further related to Kansas State University sheets, but stated as being applicable to all breeds of cattle. In these tables frame scores extend to 11 with age relationships also extended with bulls and females having further standards at 24, 30, 36 and 48 months of age. These standards are presented in Tables 6 (Males) and 7 (Females). Again the measurement of steers is not clearly defined.

Table 6: Male Frame Scores based on hip height in cm. (McKiernan, 2005)

Age (months)	Bulls—hip height (cm)										
	Frame score										
	1	2	3	4	5	6	7	8	9	10	11
5	85	90	95	100	105	110	116	121	126	131	137
6	88	93	99	104	108	114	119	124	130	135	140
7	92	97	102	107	112	117	122	128	133	138	143
8	95	100	105	110	114	120	125	131	136	141	146
9	98	102	107	113	117	123	128	133	138	144	149
10	100	105	110	115	119	125	130	135	140	146	151
11	102	107	112	117	122	128	133	138	143	148	153
12	104	109	114	119	124	130	135	140	145	150	155
13	106	111	116	121	126	131	137	142	147	152	157
14	108	113	118	123	127	133	138	143	148	154	159
15	109	114	119	124	129	135	140	145	149	155	160
16	110	116	121	126	130	136	141	146	151	156	161
17	112	117	122	127	131	137	142	147	152	157	162
18	113	118	123	128	132	138	143	148	153	158	163
19	114	119	124	129	133	139	144	149	154	160	165
20	115	120	125	130	134	140	145	150	155	160	165
21	116	121	126	131	135	140	146	151	156	161	166
Mature bulls											
24	118	123	128	133	137	142	147	152	157	163	168
30	120	125	130	135	139	145	150	155	160	165	170
36	122	127	132	137	141	146	151	156	161	166	171
48	123	128	133	137	142	147	152	157	162	167	172

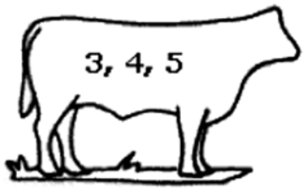
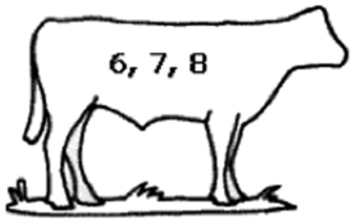
Table 7: Female Frame Scores based on hip height in cm. (McKiernan, 2005)

Age (months)	Females—hip height (cm)										
	Frame score										
	1	2	3	4	5	6	7	8	9	10	11
5	84	89	94	99	105	110	115	120	126	131	136
6	87	92	97	102	107	113	118	123	128	134	139
7	89	94	100	105	110	115	121	126	131	136	141
8	92	97	102	107	112	117	122	128	133	138	144
9	94	99	104	109	114	119	124	130	135	140	145
10	96	101	106	111	116	121	126	131	136	141	147
11	98	103	108	113	118	123	128	133	138	144	149
12	99	104	109	114	119	124	130	135	140	145	150
13	101	105	110	116	121	126	131	136	141	146	151
14	102	107	112	117	122	127	132	137	142	147	152
15	103	108	113	118	123	128	133	138	143	148	153
16	104	109	114	119	124	129	134	139	144	149	154
17	105	110	115	120	125	130	135	140	145	149	154
18	106	110	116	121	126	131	135	140	145	150	155
19	107	111	116	121	126	131	136	141	146	151	156
20	107	112	117	122	127	132	137	141	146	151	156
21	108	113	118	123	128	132	137	142	147	152	157
Mature cows											
24	109	114	119	124	129	133	138	143	148	153	157
30	111	116	121	125	130	135	140	145	150	154	159
36	112	117	122	126	132	136	141	145	150	155	160
48	113	118	122	127	132	137	142	146	151	155	160

Frame score, assessed from age, can be combined with live weight to describe maturity type which is an important descriptor for backgrounding and fattening operators as this establishes the likely and possible carcase end point range for store cattle, allowing appropriate targeting and management from purchase. Maturity type is also an important reference point in breeding herds being associated with age of sexual maturity and with cow maintenance feed requirements.

McKiernan (2005) provides a useful description of maturity type and frame score which adds some explanation as to the use of frame score in assessing the likely potential for a store animal to finish within various market categories as presented in Table 8.

Table 8: Description of Maturity type and Frame Score (McKiernan, 2005)

Maturity type	**Frame type score**
Early maturing—small framed (frame score l and 2): › Generally short in every skeletal dimension. › Short legged and short bodied. › Generally show a tendency towards waste. › Lack rapid growth potential. › Can still show good muscle expression. › Generally reach market potential at low carcase weights, i.e. 150–180 kg carcase weight at 9–12 mm of fat at the P8 site.	
Moderate maturing—average framed (frame score 3, 4 and 5): › Average growth potential rising to good growth for frame 5's. › Generally good length of body and, particularly in British breeds, can have good muscle development. › Generally reach market potential at carcase weights of 200–350 kg with 9–12 mm of fat.	
Late maturing—large framed (frame score 6, 7 and 8): › Much larger cattle with high growth potential, and lean. › Non-continental breeds of this size generally lack muscle expression. › Reach market potential much later at carcase weights of 350–450 kg with 9–12 mm of fat. › Suitable for long feedlot feeding if structurally sound, reasonably muscled and with the potential to marble.	
Very late maturing—extreme framed (frame score 9, 10 and 11): › Huge cattle with extreme growth potential, and usually extremely lean. › It is doubtful if animals of this size will achieve enough fat for any quality market.	

Auctions Plus utilise four alternative frame score descriptions being very large, large, medium and small with description for very large frame being “Very tall and long bodied. Tendency to very late maturity and difficult to finish on some feed types” and for small frame, described as “Short leg and body, early maturing and tendency to over fatness unless killed at light weights” with no height or age based measures which infers a visual rather than measurement based appraisal.

Potential for confusion between visually assigned frame score and that based on measured hip height may need to be addressed in language definitions, assessor training and livestock reporting. The relationship and use of maturity type descriptions also deserves careful consideration to reduce the potential for confusion.

BREED

The language lists 61 beef and 8 dairy breeds each with an abbreviation as shown in Table 6. Crossbreds are described by the breed of sire first, followed by the breed of dam with an example of BRAH x SH given for a Brahman sire over a Shorthorn cow with a second cross example as LIM x (HFD/ANG) being a Limousin sire over a Hereford x Angus cow. Cattle of unknown breeding can be described by the dominant breed such as HFD Cross or a breed within a cross can be specified by the breed percentage such as in 75% BRAH.

A number of issues become apparent in utilising the standard across a range of circumstances. One relates to the use of differing length codes ranging from three to five letters. This requires the use of the additional "x" for cross and brackets and back space to define crossbred parentage. This may raise issues in electronic entry and error checking due to differing field formats and lengths and make the accurate description of more complex crossbred stock particularly cumbersome.

Perhaps of greater concern is that the Australian Breed Codes used in Herd recording systems by ABRI and in analysis by AGBU are different which could create confusion. These are presented in Table 10 for comparison. The Australian Breedplan system utilises two letter breed codes and can accommodate entry of up to 8 digits. Background Breedplan analysis functions apply a percentage for up to six breeds derived from pedigree history (A McDonald *personal communication*).

The international situation is equally diverse with France, for example, utilising two digit numbers for breed coding and others using further alpha combinations so that Angus for example may be AA, AN, ANG or 17 depending on the source reference.

An effort to standardise breed coding within at least Australia should be attempted with the official Breedplan herd recording standard a likely base. The National Association of Animal Breeders (NAAB) in the USA publishes a more extensive breed list (Anon, 1996), all defined by standard two letter codes, that may also be a suitable base for future standardised description, particularly if international equivalence is desired. The definition and categorisation of crossbred stock should be included in any review however to provide an applicable description for a high proportion of commercial cattle. Evolving use of genomic tools may also significantly influence the required language to describe stock in terms of genomics rather than, or in addition to, existing breed conventions.

Table 9: Australian Livestock Language Breed Codes (ref)

BREED

Breeds of cattle and their crosses are written either in full or abbreviated as listed below.

Crossbreds are described by the breed of sire first, followed by the breed of dam.

Progeny sired by a Brahman bull out of a Shorthorn cow is written:

eg. BRAH x SH

Progeny sired by a Limousin bull out of a Hereford-Angus cross cow is written:

eg. LIM x (HFD/ANG)

Cattle of unknown breeding are described by the dominant breed.

eg. Hereford Cross: HFD x

A particular breed in a crossbred is specified by the breed percentage.

eg. 75% Brahman 75% BRAH

BEEF

Africander	AFH	Limousin	LIM
Angus	ANG	Lincoln Red	L/RED
Barzona	BARZ	Luing	LUING
Bazadaiz	BAZA	Maine-Anjou	MANJU
Beefmaker	BFMKR	Mandalong Special	MANSP
Beefmaster	BMSTR	Marchigiana	MARCH
Beef Shorthorn	BSH	Meuse-Rhine-Iyssel	MRI
Belgian Blue	BBLU	Murray Grey	MG
Belmont Red	B/RED	Piedmontese	PIED
Belted Galloway	BGAL	Pinzgauer	PIZG
Black Simmental	BSIM	Poll Hereford	PHFD
Blonde d'Aquitaine	BDAQ	Red Angus	RANG
Boran	BOR	Red Poll	RPOL
Braford	BRAFD	Red Sindhi	RSIND
Brahman	BRAH	Romagnola	ROMG
Bramousin	BRAMS	Sahiwal	SAHW
Brangus	BRANG	Salers	SALS
Braunvieh	BRAU	Santa Gertrudis	SG
British White	BRITW	Shorthorn	SH
Brown Swiss	BSWS	Simford	SIMFD
Charbray	CHABY	Simbrah	SIMBR
Charolais	CHAR	Simmental	SIM
Chianina	CHIA	South Devon	SDEV
Devon	DEV	Sussex	SUX
Dexter	DEXT	Tarantaise	TAR
Droughtmaster	DMSTR	The Highland	HGHL
Flekvieh	FLEK	Texas Longhorn	TEXLH
Galloway	GAL	Tuli	TULI
Gelbvieh	GEL	Welsh Black	WBKL
Greyman	GREYM	Wagyu	WAGU
Hereford	HFD		

DAIRY

Australian Friesian Sahiwal	AFS	Guernsey	GURSY
Australian Milking Zebu	AMZ	Holstein Friesian	HF
Ayshire	AYRS	Illawarra	ILW
Dairy Shorthorn	DSH	Jersey	JRSY

Table 10: Australian Breedplan Breed Codes (source)

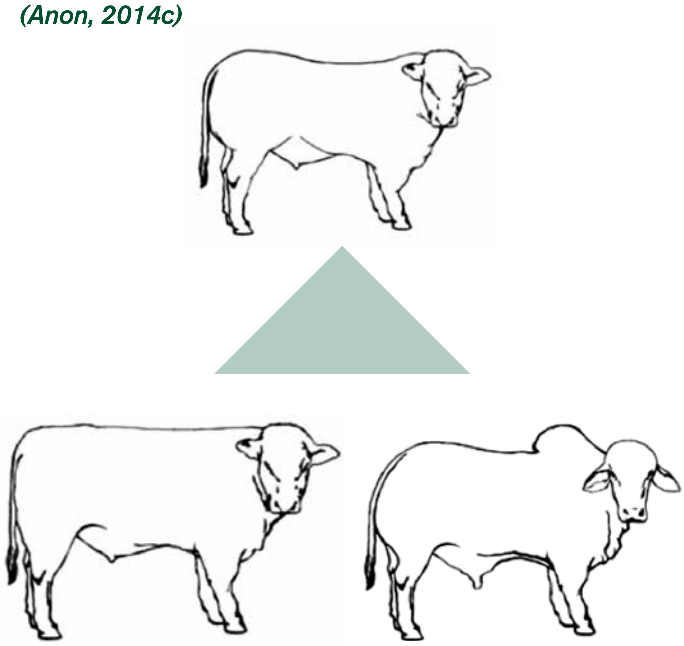
Breed Code	Description
AA	ANGUS
AF	AFRICANDER
AL	AUSTRALIAN LOWLINE
AN	ANGLER
AU	AUSTRALIS (SOUTH DEVON/ANGUS
AY	AYRSHIRE
BA	BLONDE D'AQUITAINE
BB	BRAHMAN
BC	BALI CATTLE (BUNTANG)
BD	BAZADAIS
BE	BRALER
BF	BRAFORD
BG	BRANGUS
BH	BRAHMOUSIN
BJ	BONSMARA
BK	BEEFMAKER
BL	BELGIAN BLUE
BM	BEEFMASTER
BN	BORAN
BO	BEEFALO
BR	BELMONT RED
BU	BUFFALO
BV	BRAUNVIEH
BW	BRITISH WHITE
BZ	BARZONA (COMPOSITE)
CA	CHIANGUS
CB	CHARBRAY
CC	CHAROLAIS (& POLL)
CD	A.C.D.C
CF	CHIFORD
CI	CHIANINA
CN	CANADIENNE
DD	DEVON
DK	DRAKENSBERGER
DM	DROUGHTMASTER
DR	DANISH RED
DS	DAIRY SHORTHORN
DX	DEXTER
FF	HOLSTEIN-FRIESIAN
FS	AUSTRALIAN FRIESIAN SAHIWAL
GA	GALLOWAY (& BELTED)
GC	GASCONNE
GG	GUERNSEY
GM	GREYMAN
GV	GELBVIEH
HH	HEREFORD
HI	HIGHLAND
HV	HAYES CONVERTER
IB	ITALIAN/MEDITERRANEAN BUFFALO
IS	AUSTRALIAN ILLAWARRA SHORTHORN
JJ	JERSEY
LB	LEAN BOS (CHIANINA/SAHIWAL)
LH	LONGHORN (TEXAS)
LL	LIMOUSIN
LR	LINCOLN RED
LU	LUING
MA	MARCHIGIANA
MD	MANDALONG SPECIAL
MG	MURRAY GREY
MH	MASHONA
MI	MUESE-RHINE-ISSEL
MS	MILKING SHORTHORN
MU	MAINE-ANJOU
MZ	AUSTRALIAN MILKING ZEBU
NG	NGUNI
NL	NELORE
NO	NORMANDE
OO	UNKNOWN
PH	POLL HEREFORD
PM	PIEDMONTESE
PR	PIE ROUGE
PT	PARTHENAIS
PU	PUSTERTALER
PZ	PINZGAUER
RA	RED ANGUS
RB	ROTBUT
RF	RED AND WHITE HOLSTEIN FRIESIAN
RO	ROMAGNOLA
RP	RED POLL
RS	RED SINDHI

***Table 10: Australian Breedplan Breed Codes** continued. (source)*

RV	RIVER BUFFALO (MURRAH)
SB	BROWN SWISS
SC	SIMINDICUS
SD	SOUTH DEVON
SE	SENEPOL
SG	SANTA GERTRUDIS
SH	SIMFORD
SI	SIMMENTAL (& FLECKVIEH & BLACK & POLL)
SK	SPECKLE PARK (Canada)
SL	SALERS
SM	SIMBRAH
SN	SAHIWAL-SHORTHORN
SP	SWAMP BUFFALO
SQ	SQUARE MEATER
SR	SWEDISH RED
SS	SHORTHORN (& POLL & BEEF & DURHAM)
ST	SUPERTALER
SU	SUSSEX
SV	SHAVER BEEFBLEND COMPOSITE
SW	SAHIWAL
TA	TARENTAISE
TC	THAI NATIVE - CENTRAL (KO LARN)
TH	THAI NATIVE - NORTH EAST (E-SARN RED)
TI	TULI
TN	THAI NATIVE - NORTH (KAO LAMPOON)
TP	TROPICANA (Mandalong x Red Brahman)
TS	THAI NATIVE - SOUTHERN FIGHTING
TX	TEXON
UR	AUSTRALIAN RED
UU	SOUTH AFRICAN RED
WA	WATUZI
WB	WELSH BLACK
WY	WAGYU
XA	ALEXANDRIA (NAPCO) COMPOSITE
XH	HOTLANDER (SI/BB/SE/RA COMPOSITE)
XK	KYNUNA (NAPCO) COMPOSITE
XM	MOORELLA COMPOSITE
XS	STABILISER (British x Continental)
XT	TAURICUS (SD/RA/BJ red composite)
XX	SUPERBEEFEX (AACO) COMPOSITE
XY	BARKLY (AACO) COMPOSITE
ZE	ZEBU

A potential practical tool for commercial breed description may be that utilised in the BeefSpecs (Anon, 2014c) program. In this application breed inputs are defined in terms of percentage British, Euopean and *Bos Indicus* entered either as % or by moving a cursor within a triangle between the three breed types until the animal silhouette represents the beast in question. Figure 5 displays the pure breed benchmarks and the triangle orientation.

Figure 5: Cattle breed type as defined within BeefSpecs (Anon, 2014c)



PREGNANCY STATUS

The language provides for pregnancy status description in accordance with the status and description shown in Table 11. Further terms of Joined and Un-joined are utilised in Auctions Plus (Anon, 2011a) and also in common industry use indicating that their addition to the livestock language could be appropriate.

Table 11: Livestock Language Pregnancy Status (Anon, 1994)

PREGNANCY STATUS

The pregnancy status of cattle is described as detailed below. Pregnancy testing is performed by a veterinary surgeon or other proficient operator.

STATUS	DESCRIPTION
PTIC	Pregnancy tested in calf
PTNIC	Pregnancy tested not in calf
DEPASTURED/ STATION MATED	Where heifer(s)/cow(s) have been exposed to the bull(s) in the previous ten (10) months (nominate the length of time in months)
NSM	Not station mated, where the heifer(s)/cow(s) have not been intentionally exposed to the bull(s) in the previous ten (10) months
UNKNOWN	Pregnancy status of heifer(s)/cow(s) is unknown or undeclared

The CashCow (Anon, 2014d) project recently reported results obtained by monitoring breeding performance in Northern Australia. The project recorded ~ 78,000 cows in 142 breeding groups from 72 commercial cattle properties. A key finding of the project was the need to develop standard definitions for recording a large range of measures to enable consistent recording, reporting and analysis. The report "identified substantial variation in the definition and understanding of each of these parameters due to variation in both the numerators and denominators used. Attempts to derive annual parameters from over-lapping 18–24 month cycles also cause confusion especially as routine management usually imposes herd re-structures between the mating and lactation phases of reproduction. Even when these parameters are precisely defined, it is often difficult to relate the findings to live weight production and business outcome".

The report included a lexicon of terms with recommended breeding related terminology including:

- Live-weight production
- Live-weight production ratio
- Weaner production
- Pregnant within four months of calving (P4M)
- Calf/foetal loss
- Cattle year
- Closing numbers
- First-lactation cow
- Heifer
- Second-lactation cow
- Lactation rate

These terms should be considered in conjunction with any ongoing language revision. It would also appear prudent to expand discussion to Southern beef breeding systems to ensure that a unified national language could provide suitable standards for use in all Australian locations and circumstances. Formal development of a complete cattle lexicon to define all terms utilised in livestock language and associated descriptions would also provide a useful adjunct to any language review.

HORN STATUS

The livestock language includes standard descriptions as presented in Table 12. A useful minor addition may be a specification for maximum length for tipped horns to align with live export standards. Some form of horn measure might also be desired by processors to assure large horned cattle can be handled through the installed equipment.

Table 12: Livestock Language Horn Status descriptions (Anon, 1994)

HORN STATUS

Cattle are described as:

STATUS	DESCRIPTION
HORNED	Where no portion of the horn has been removed
TIPPED	Where the tip of the horn has been removed
SCURRED	Where scurs are present or where some horn growth has occurred following the dehorning process
DEHORNED	Where the horn has been removed leaving no protrusion of horn from the skull
POLLED	Where there is no evidence of horn growth as a genetic attribute

TEMPERAMENT

Table 13 presents the current livestock language temperament status and related descriptions.

Table 13: Livestock language Temperament Status and Description (Anon, 2011a)

TEMPERAMENT

Temperament of cattle is described as follows:

STATUS	DESCRIPTION
QUIET	Easy to handle singly
MANAGEABLE	Easy to handle in a mob
EXCITABLE	Difficult to handle in a mob

While providing an apparently clear description these terms differ to Auctions Plus (Anon, 2011a) where the terms Quiet, Slightly Stirry and Stirry are used. An effort might be made to adopt common agreed terms to reduce confusion. Flight speed recording has also been advocated and utilised by various research workers as an objective temperament measure. Appropriate standards objectively linked to temperament descriptors might be considered to ensure conformity and clarity.

Growing attention to cattle welfare by external and Industry groups in addition to government agencies may also increase the need for defined measures of stress which might be expected to parallel or relate to temperament scoring. An objective measure of stress pre-slaughter is also a priority research objective of the MSA Pathways Committee (R Polkinghorne, J Thompson, I Lane *personal communication*). A range of blood and urine based measures have been evaluated across multiple trials with further studies planned to consider heart rate, body temperature and retinal scanning in addition to more complex blood and tissue measures. If a suitable measure is established it would be incorporated into MSA grading inputs and as such would need to be referenced in the Livestock and "meat" AUS-MEAT language.

STRUCTURE

The Livestock language incorporates a statement that "Structurally sound cattle do not exhibit visible signs of disease, deformity or injury which might impair mobility, feeding ability and, for breeding cattle, the reproductive function". No measure of assessment or subsequent language term is stated although perhaps "structurally sound" may be implied.

Possibly related terms for breeding quality used in Auctions Plus and for structural soundness within the International Livestock Resources and Information Centre (ILRIC) (Anon, 2014e) together with individual breed type assessment programs are addressed in a later report section.

COLOUR (SKIN/HAIR)

The Livestock language includes advice that "breed colour standards for skin and hair are determined by the appropriate breed society, however for cross-bred cattle the preferred colour(s) is determined by specification". No further standards or descriptive codes are included.

TAIL

Tail status is described in the language as shown in Table 14 and noted as being recorded either individually or as a percentage of the lot or consignment.

Table 14: Livestock Language Tail Status and Description (Anon, 1994)

STATUS	DESCRIPTION
INTACT	Considered natural length (with or without switch)
DOCKED	Where a tail has been subjected to docking at any joint

HIDE CONDITION

The language provides example descriptions for hide condition as follows:

BRAND SIZE	eg. 100mm
NUMBER OF CHARACTERS	eg. 4
LOCATION	eg. Cheek
TYPE	eg. Fire Brands
OTHER FACTORS	eg. Parasites, disease or scratches

No coding or grouping into standard categories is provided for these individual factors although hide grading schemes and related pricing arrangements have been advocated and trialled at various times. Given a 20 year timeframe and the variation in commercial value of raw and processed hides it may be prudent to allow for an expansion of the current language in this area.

Livestock description issues

1. The confusion inherent in use of Body Condition Score (BCS) and Fat Score systems.

2. Disparity between scales and measurement for dairy and beef cattle description.

3. The recommended addition of a 0 Fat Score to assist in description of stock experiencing muscle depletion after fat reserves have been utilised.

4. The difficulty of managing alphanumeric scoring descriptors in electronic systems and statistical analysis.

5. The phasing out of Body Condition Score description and universal application of independent fat and muscle score standards to provide a uniform live animal description base.

6. Possible addition of inputs to facilitate estimates of transit loss and relate weight at assessment to estimated dressed or live weight at delivery.

7. Extension of muscle score to the AUS-MEAT “meat” language replacing butt shape.

8. Definition of Frame Score in months or kg live weight and formal maturity type description.

9. Consideration of standard breed coding to remove existing anomalies and facilitate description of crossbreeds including complex crosses or composite populations while also providing a suitable system to accommodate genomic descriptions.

10. Consideration of BeefSpecs silhouette or base breed type % to describe crossbred commercial cattle.

11. Addition of Joined and Un-joined to pregnancy descriptions.

12. Consideration of CashCow standard descriptions to facilitate analysis and comparison of breeding performance in conjunction with a review of Southern Australian breeding systems and associated terminology.

13. Completion of an agreed lexicon for beef terminology used in the Australian livestock and “beef” language and related commercial and research applications.

14. Standard temperament terminology and provision for addition of a stress measure in language.

15. Measurement standards to define tipped horn length and full horn span.

16. Future provision for inclusion of hide standards within the language.

BEYOND THE CURRENT LIVESTOCK LANGUAGE

While the current livestock language structure incorporates a large number of important livestock description attributes further commonly utilised terms are absent and require consideration if the language is to provide a comprehensive conception to consumption descriptive chain. Major gaps exist in genetic/genomic description, health certification and with detailed structural soundness evaluation. While these aspects have traditionally been largely associated with registered cattle, predicted advances in progeny recording and incorporation of genetic markers in performance estimating tools and MSA grading would generate wider industry application and emphasise the need for common language across the industry and seamless connection of livestock, “meat” and “meals” language sections.

At farm and feedlot level certified compliance to various standard codes including LPA, PCAS, Organic and NFAS are mandatory for many transactions and likely to be expanded to further programs and to issues such as animal welfare or environmental standards.

A number of issues believed to be pertinent, either as language components or in language utilisation within commercial trading systems, follow with the intention of stimulating broader discussion and an ultimate shared vision to refresh current structures, improve inter-sectoral communication and support success in an evolving more technical and dynamic future.

GENETIC/GENOMIC DESCRIPTION

Significant advances in molecular biology over the past two decades have revolutionised livestock genetic evaluation and breeding prediction. While exemplified in Dairy breeding programs where the predominant use of AI and international pooling of production data from daughters is delivering continued global productivity improvement the principles also apply to beef breeding and are being utilised within the stud and breeding services industries. In dairy cattle young sires have initial and moderately accurate breeding values assigned at birth from genomic predictions augmented by conventional pedigree data. These values are weighted over time by actual progeny performance to produce highly accurate breeding values.

In Australia the Beef CRC program extensively pursued genetic marker evaluation and investigated application in commercial breeding. While initial hopes for discovery of simple SNP based gene markers for key economic trait such as growth rate, feed efficiency and marbling proved unsuccessful, with the mechanisms found to be far more complex, significant advances have been made and continue to develop with the growing scientific complexity being mirrored by more cost effective and sophisticated analytical tools, an example being the current routine use of 500k marker chips compared to the original far more expensive 24k chips.

The improvement in prediction accuracy for key economic trait combined with lower cost and commercial incentives is likely to drive extensive utilisation and exponential expansion of genomic application in the future. An example of commercial incentive may be MSA grading with CRC based studies reported by Watson et.al. (2009), Cafe et.al. (2010), Robinson et.al., (2012) and Greenwood et.al. (2013) establishing that the MSA grading result could be substantially changed with different expressions of genomic tenderness measures. Further work Thompson (2011) based on analysis of the MSA research database confirmed that gene marker influence differed by muscle and that differences were detected by consumers. Given that the gene marker status was known at the time of MSA grading it could be incorporated into the grading algorithm and would result in improved consumer prediction and a higher grade result for cattle with the favourable marker(s).

>

A simulation study by Kelly and Thompson (2014) showed that using current prices and premiums tenderness SNPs are unlikely to be profitable unless the mean of the lot was significantly better than the population. The premium in value of the carcase needs to cover the cost of testing which is unlikely to be less than $20/head. At the moment about 50% of the variance in the Pfizer tenderness MVP is accounted for by the 4 tenderness SNPs. If the tenderness MVP was used in a breeding program it would plateau in response after about 4 generations, unless the tenderness MVP was continually updated.

It is suggested that standard descriptions for gene marker status or applicable genomic indicators be investigated and agreed for inclusion in the livestock language. This will require consideration of proprietary systems being, or possibly to be, marketed and definition of what is useful at a commercial livestock production level which might be expected to be significantly simplified to an "expected results" basis from the underlying research level description complexity. This typifies an important issue across language components: where should individual assessment terms and standards be incorporated as livestock language standards versus restricted to use in aligned but independently managed commercial or scientific systems? The lexicon of terms previously raised may be a useful form of standardising communication.

One of the reasons for success of the SNPs in dairy is that the genomic EBVs are continually updated. This is relatively easy for dairy because a high proportion of commercial dairy herds herd test. This may be more challenging for beef where programs to update genomic EBVs would have to be put in place. Incentives for greater data recording and submission by commercial beef producers are canvassed in the following section with further avenues potentially including more developed Beef Information Nucleus (BIN) structures or developments akin to the sheep nucleus flock.

In review and ongoing language administration it is important that points of delineation and connection standards between systems be defined and agreed. For example standard Estimated Breeding Values (EBV's) may be incorporated within the livestock language but their development detail managed within genetic programs.

On this basis the success or demise of certain traits will relate to their accuracy at describing the trait.

Currently (EBV's) are published and extensively used in sale catalogues and registered cattle description within a largely breed society framework. Genomic data is being incorporated within these systems and expanding. The new generation molecular breeding values (MBV's) provide more accuracy than the traditional EBV's as mid parent values are supplemented with genomic inputs. As an example of the improved accuracy progeny from an embryo flush would have identical EBV, due to common parentage, but different MBV values.

While the estimation algorithms are changing to include genomic data the EBV / MBV descriptions such as Milk, 200 day weight, EMA etc remain the same providing continuity in commercial understanding of the terms used. While individual EBV trait, measures used in their calculation and some indexes produced from them, are widely used in commercial herds they are not currently incorporated in the Livestock language. It is suggested that they should be either added to provide a uniform reference point or formal linkage established between the language and their originating source.

Currently the use of EBV's is heavily weighted to registered herds and progeny, principally bull, sales to commercial breeders. Proposed changes under discussion and elaborated in the following section may lead to far more extensive active commercial herd use including application in cross breeding. It is timely that development and incorporation of EBV's and related measures into the Livestock language be considered in concert with these developments.

Existing standards and associated descriptions are also extensively utilised in the production and sale of semen and embryos but again are not within the current Livestock language. Standards associated with identification, breed based straw colour coding, post thaw semen motility, live sperm concentration and sanitary requirements exist for semen with further standards listed for frozen embryos. It would be appropriate for these to be referenced or cross referenced within the Livestock language together with ensuring that breed and other relevant descriptions are consistently applied to reduce confusion in Australian or export sales.

A HERD RECORDING REVOLUTION?

Fundamental changes are currently under discussion in regard to beef herd recording in Australia and may have substantial implication for the rate of adoption and commercial use of recording systems including the collection and analysis of commercial data. Currently while many commercial breeders maintain extensive individual animal, carcase and property data this remains internal and is not utilised in national progeny performance analysis. The vast majority of formal national herd recording remains focussed within individual breeds, controlled by Breed Societies and the province of registered studs. While this structure has served the industry for many years, particularly in selection of sires for commercial herds, it has also imposed restrictions on utilising progeny data and in evaluation of commercial herd progeny or herds, particularly where cross breeding is practised. Due to analysis being on a within breed basis comparisons across breeds or for cross-bred progeny have been extremely restricted.

Explanations for the current structure include a concern regarding accuracy of commercial data, and in particular reporting of cohort management groups, together with a belief that commercial operators are unlikely to adopt herd recording due to cost and time constraints. The veracity of these views may well change in response to commercial incentives including the introduction of value based payment systems or incorporation of genomic, EBV or performance data in payment systems for store cattle or through MSA grading changes. By default MSA commercial grading data currently provides a huge and largely untapped resource to relate carcase and eating quality characteristics to animal data if the linkages were available. The potential for change is illustrated by the fact that from approximately 3.175 million MSA graded carcases in 2015 only 381 had carcase and grading data uploaded to Breedplan (A Ball *personal communication*). Utilisation of the now available data could dramatically improve the accuracy of sire, and dam, EBV's and potentially identify exceptional genetic merit beyond the current system in line with that achieved by the dairy industry. Given that all MSA, and further processor generated carcase data, are currently linked to NLIS individual identification the transition to source animal identification and related history is entirely possible in many circumstances.

Current discussion includes a change to pooling breed based performance data to either a single "cattle" pool or possibly three inter-linked pools for British, European and *Bos indicus* breed types. This change would immediately empower inter-breed and cross-breed analysis, both likely to stimulate commercial breeder interest and wider adoption due to increased relevance. A convincing parallel is provided by the uptake and continued growth in commercial use of the Lambplan system which was established on similar principals to those now proposed for beef. In the short to medium term there may well be breed specific EBVs that are generated but the important thing is that all EBVs can be directly compared, even though they may still use breed specific algorithms. As the understanding of SNP data and analytical procedures improves the need for breed specific algorithms may decrease.

The concern regarding the use of commercial data will need to be addressed and may warrant consideration of alternative data management and screening techniques, similar to those adopted in analysing consumer data which is inherently extremely variable, to filter a much larger volume of data provided by commercial herds directly and from subsequent supply chain sources including backgrounders, grass finishers, feedlots, processors and MSA data. As with dairy the value of extensive multi herd progeny data might be expected to outweigh the value of very limited stud herd information, even if this was of superior accuracy. The value of these data in furthering the utilisation of genomic evaluations and ultimate EBV accuracy is held to be considerable (A Ball *personal communication*) which in turn might be expected to drive a rearrangement of commercial data entry charges to encourage collection and submission, with charging regimes tending to be aligned with outputs rather than record input which may be free.

The implications of these potential developments are fundamentally important and may well prove to be a critical driver of future industry success. To deliver full potential the Livestock language must provide a standardised basis for measurement and input of production, pedigree and >

genomic data together with Industry agreed standards for the outputs. These outputs may include further EBV for carcase or other traits. The formats require urgent consideration and agreement prior to being incorporated into the language. Development of these formats will require active involvement across industry segments together with software providers.

STRUCTURAL SOUNDNESS

While structure rates a heading within the current Livestock language as noted in the previous section no definition or standards are provided beyond "structurally sound cattle do not exhibit visible signs of disease, deformity or injury which might impair mobility, feeding ability and, for breeding cattle, the reproductive function". This description might be more aligned with a health assessment and fall well short of describing individual animal structure in a standard format.

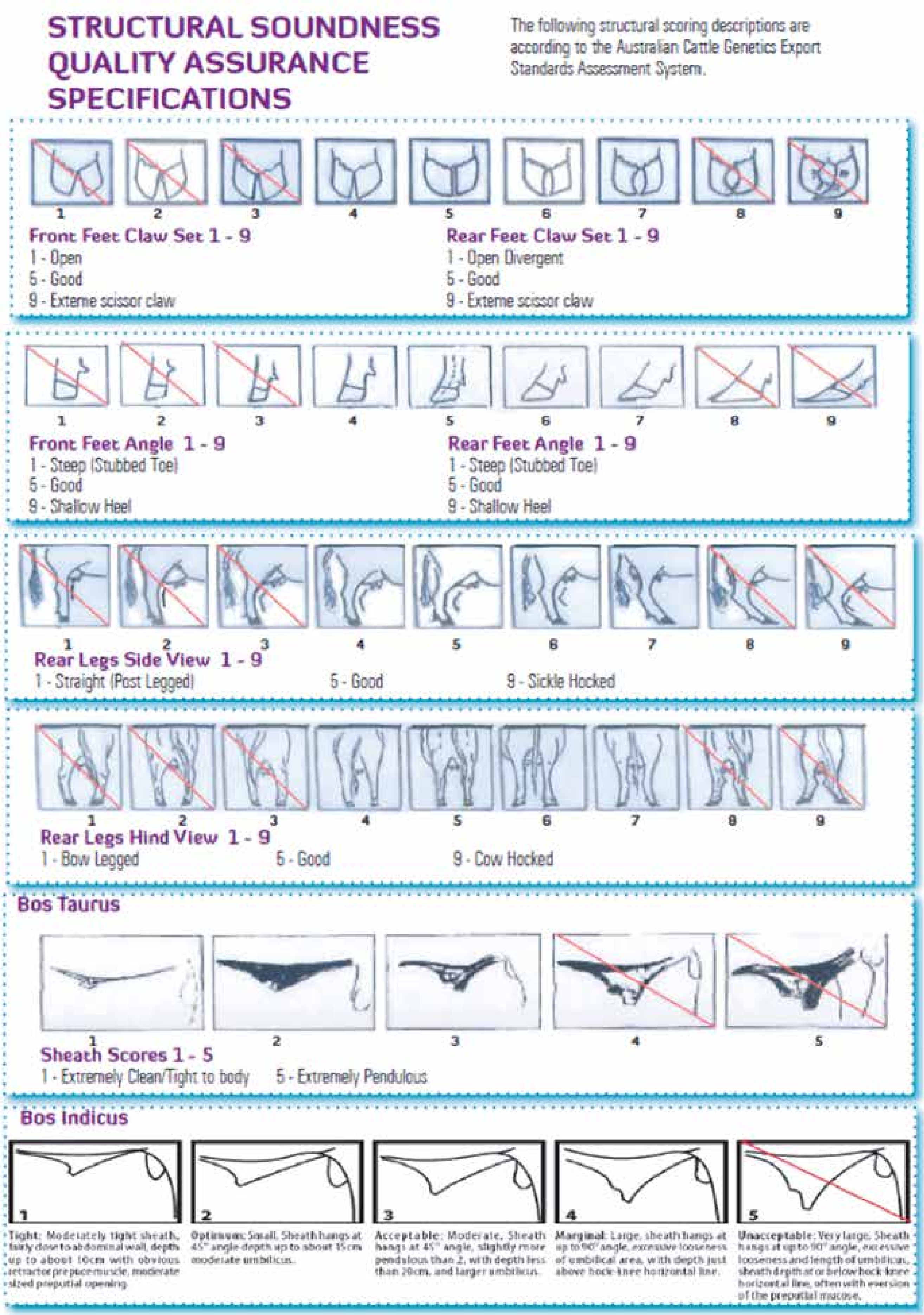
Structural assessment utilising a variety of systems, both formal as in ILRIC appraisal of export breeding stock, and informal as in livestock show judging, is an integral component of livestock appraisal and description. While this is more prominent and formal in stud stock, attributes such as feet and leg soundness or sheath and udder characteristics are extensively used in commercial herd and feedlot sectors. It would appear prudent to develop agreed consistent scoring systems in order to facilitate accurate, unambiguous description, supported by adequate assessment training.

Figure 6 presents the Australian Cattle Genetics Exports Agency (ACGEA), a subsidiary of ILRIC, quality assurance standards for structural soundness which are utilised in certification of exported breeding stock. These may serve as an appropriate base from which to develop standards for inclusion in the Livestock language given that ILRIC membership includes 26 Australian Breed Associations and that the standards have been endorsed by the Registered Cattle Breeders Association (ARCBA), Meat and Livestock Australia (MLA), the Australian Livestock Exporters Council (ALEC) and the Cattle Council of Australia (CCA).

While providing a standard scoring basis for feet, legs and sheath for *Bos indicus* and *Bos taurus* cattle types the ILRIC standards do not provide a description base for scrotal measurement, udders, body capacity, jaw and teeth or pin and hip structure, all of which are variously described by assessors when classing stud or commercial stock. However cattle are required to meet the individual breed type and phenotypic standards. Those described within the ACGEA Australian Genetics Export Standard appear to mostly be of a general nature and related to matters such as coat colour, ears, sheath, horns, hump and mature size with occasional reference to scrotal circumference. This raises a further Livestock language issue in ensuring that any demarcation points regarding language terms, standards or recording between breed society registers and the Australian Livestock language are clearly defined and that descriptions or standards are consistent.

The Auctions Plus assessment manual (Anon, 2011a) states that comment may be made at the assessors discretion regarding feet, teeth, udder and eyes but contains no formal descriptive standards or guidance. These matters should be included in considering any formal assessment of structure within the Livestock language.

Figure 6: ILRIC Structural Soundness Quality Assurance Specifications (Anon, 2014e)



Further specific attributes related to “soundness” or fitness for purpose that might be included in the Livestock language are direct breeding related criteria and recording of animal health and management treatments.

Physical examination of reproductive tracts in females and genitalia in males is widely practiced with both directly measured criteria including scrotal size and observed criteria such as “normal” female reproductive organs and male measures such as serving capacity also utilised. Consideration as to which should be included within the Livestock language and associated standard measures or terminology is warranted.

Other health or market access related treatments are also routinely attached to sale descriptions in various forms. These include vaccinations, drenches, antibiotic or other therapeutic drug use and HGP implantation. A framework for transmission of this information, possibly with suitable numeric or other coding to simplify recording, requires consideration.

STANDARDISED ANIMAL ASSESSMENT?

It is highly desirable that terms and standards used to assess livestock are transportable across stages of growth, markets and also link directly to carcase assessments including provision of any additional information required to estimate subsequent performance both as live cattle, for example during feedlot feeding, or after slaughter in determining carcase yield or ultimate consumer satisfaction through MSA grading inputs. A reverse flow from purchaser to supplier is equally desirable in order to drive improvement through consistent provision of grading, compliance and value based marketing data.

A general overview of the principal sectors in which primary language descriptors are utilised together with sector specific terminology follows as a means to evaluate the degree to which common language elements can be utilised across sectors and to highlight further issues for discussion.

BOBBY CALVES

The bobby calf trade is a very minor aspect of the Australian beef trade but a considerable by-product of the dairy industry. With an annual kill of around 800,000 head however, given an economic incentive, the sector has potential to add appreciably to total beef supply. Given that female dairy cattle numbers are reported at 2.834 million head (Anon, 2014f), including heifers, the reported bobby calf kill may be understated. Under the current circumstances beef language requirements are minimal with a majority of dairy calves sold through local live weight scales at 7 days of age or less. Beef bred bobby calves are thought to principally relate to the splitting of cow and calf units after sale.

Should it become attractive for dairy farmers to grow out bull calf progeny or for specialist calf rearers to enter the market, the production implications are significant with the prospect of a 10% increase in Australian beef supply.

In New Zealand and many European countries the beef industry is already largely a by-product of the dairy industry. Given that the vast majority of dairy cattle are AI bred this sector could rapidly adopt the use of high quality beef sires selected to optimise beef yield or quality. Any development in sexed semen would amplify this impact and lead to extensive utilisation of genetic data, already very familiar to dairy operators. All dairy calves have a known date of birth which may also impact market access.

While the later trading of dairy bred or dairy cross progeny post 6 months or so of age would seem to fit within the standard beef language, if the male calves are left entire as is typical in many countries, it may require further consideration in adequately describing bulls as a significant source of beef, both in livestock and subsequent “meat” language including further development for MSA grading.

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A further issue could be an increased desire for language to suitably describe production potential at 7 days of age. Components of this would relate to genetic potential and to an adequate description of maturity type and associated muscle and fat development patterns.

The desire for genetic indicators may require either extension of current dairy indexes to reflect growth and carcase potential for dairy sires or adaption of beef sire indexes to adjust for dairy breed dams. Further requirements may include a need to develop early life measures for muscle, fat and maturity type with particular relevance to projected development. The existing muscle and fat score standards are claimed to be effective at all stages post around 3 to 6 months of age (B Littler *personal communication*) but have not been studied at younger ages.

BREEDING STOCK

In broad terms breeding stock sales may be viewed as including semen and embryos in addition to bulls and females. Clearly genetic merit is an important component of many sales and not covered within the current livestock language as discussed previously. It is reiterated that any livestock language review should consider the addition of key descriptors utilised in performance and pedigree recording and published as EBV's or GBV's. This should be done in conjunction with existing providers to ensure commonality. Specific fertility measures including indicators such as scrotal size may also be worthy inclusions in the livestock language as may temperament standards.

The existing fat and muscle score standards as described apply to young and mature breeding cattle. The proposed addition of a 0 fat score would ensure a complete range of description in relation to body condition and provide for clear description of targets for breeding in addition to welfare definitions. The CashCow project (Anon, 2014d) has recommended additional standardised terminology to facilitate analysis and comparison of breeding performance in the north. It would be prudent to workshop these with research and extension personnel from southern programs in order to advance standards that can be applied in any Australian environment. A standardised pregnancy status description would assist in clear communication. Reviewed frame scoring and associated maturity type description is also of relevance to breeding cattle language utilisation as would be an enhanced structural assessment system as discussed above. Temperament is also often considered an important criteria in breeding cattle with language clarity desirable as discussed previously.

Standardised coding for animal health treatments within the livestock language could improve clarity and be linked to herd based certification for Bovine Johnes or other industry disease management programs that dictate movement controls.

While language parameters for fat and muscle score, suggested frame score and maturity description and potential structural description are, or can be, defined with pictorial and descriptive standards other less quantified terms are regularly used in commercial marketing. As an example the Auctions Plus assessment manual includes guidance regarding describing breeding quality as shown in Table 15. Consideration is warranted regarding the value of these and other ancillary less clearly defined descriptions within the livestock language. Do they add value or do they detract from more precise description relating to standard fat, muscle and frame terminology? Is it possible to adequately define more general “quality” descriptions and what are the prospects for general adoption if added to the language?

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Table 15: Auctions Plus descriptions for Breeding Quality (Anon, 2011a)

C2 – Breeding quality

These terms can apply equally well to purebred or crossbred stock and should not be affected by condition, ie they mainly relate to the quality of the breeding programme and suitability for their end use.

Indicate the approximate percentage in each category.

Excellent

- Top sires used and top standards of selection and management, ie the small percentage of really first class stock.
- A line with a large culling taken out.

Very Good

- Good quality sires used with heavy culling and selection programme – stock with a reputation for growing out/fattening/producing well.
- A line with a reasonable culling taken out.

Good

- Quality sires used, reasonable selection practices ie average stock.
- A line that has had no culling taken out.

Fair

- Average quality sires used, but otherwise little selection practiced.
- A line that needs a heavy cull taken out.

Plain

- Very poor breeding quality, eg inbreeding, structural or conformation faults expected to limit future growth and/or fattening/production ability.
- Could apply to culls or at best seconds or thirds from a line of stock.

Somewhat intermediate positions appear to be utilised in official market reporting with examples following for USDA Agricultural Market Reporting Service (AMS) (P.Dundon *personal communication*) in Table 16 and Australian NLRS (Anon, 2005) in Table 17. Industry may consider the level of application that is desired or useful in the context of reviewing the Livestock language. The USDA reports inter mix objective descriptions related to weight and price with more generalised terms for pregnancy stage, maturity type and solid mouth. The NLRS report is based on the standard fat and muscle class description but also notes breed type.

Table 16: Example market report for bred heifers and cows. USDA AMS report (Anon, 2015a)

DC_LS755
Dodge City, KS   Wed Jan 21, 2015   USDA-KS Dept Ag Market News

Farmers and Ranchers Livestock Commission Co., Salina, Kansas
Bred Heifer and Cow sale Weighted Average Report for 01/20/2015

Receipts: 2069   Last Month: 2263   Year Ago: 1917

Bred Heifer and Cow Sale: Supply 38 percent first calf; 32 percent bred cows; 29 percent cow/calf pairs; 01 percent replacement heifers.

First Calf Heifers

Bred Heifers Medium and Large 1

Head	Wt Range	Avg Wt	Price Range	Avg Price	
41	1130-1153	1137	2625.00-2685.00	2644.29	2nd trimester
229	1028-1188	1123	2650.00-3000.00	2762.76	3rd trimester
26	1239	1239	2685.00	2685.00	2nd trimester
64	1206-1297	1269	2800.00-3000.00	2894.93	3rd trimester

Bred Heifers Medium and Large 1-2

Head	Wt Range	Avg Wt	Price Range	Avg Price	
32	917-1082	1039	2200.00-2450.00	2245.42	2nd trimester
301	916-1123	1017	2350.00-2585.00	2513.24	3rd trimester

Bred Heifers Medium and Large 2

Head	Wt Range	Avg Wt	Price Range	Avg Price	
28	880-1051	977	1975.00-2185.00	2094.36	2nd trimester

Bred Heifers Large 1

Head	Wt Range	Avg Wt	Price Range	Avg Price	
22	1303-1318	1306	2800.00-2825.00	2820.41	3rd trimester

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Second Calf to Solid Mouth Cows

Bred Cows Medium and Large 1 Middle-Aged

Head	Wt Range	Avg Wt	Price Range	Avg Price	
56	1052-1178	1109	2600.00-2650.00	2609.98	2nd trimester
29	1116-1165	1129	2710.00-3050.00	2926.33	3rd trimester
67	1222-1292	1253	2600.00-2925.00	2779.78	3rd trimester

Bred Cows Medium and Large 1-2 Middle-Aged

Head	Wt Range	Avg Wt	Price Range	Avg Price	
48	1008-1198	1126	2275.00-2575.00	2419.37	2nd trimester
11	1097-1112	1104	2350.00-2500.00	2431.31	3rd trimester
14	1239-1279	1262	2425.00-2450.00	2435.52	2nd trimester
11	1249-1278	1262	2410.00-2525.00	2450.45	3rd trimester

Bred Cows Medium and Large 2 Middle-Aged

Head	Wt Range	Avg Wt	Price Range	Avg Price	
7	877-1124	1018	1850.00-2175.00	2055.02	3rd trimester

Bred Cows Large 1-2 Middle-Aged

Head	Wt Range	Avg Wt	Price Range	Avg Price	
18	1310-1544	1500	2235.00-2425.00	2378.12	3rd trimester

Bred Cows Large 2 Middle-Aged

Head	Wt Range	Avg Wt	Price Range	Avg Price	
10	1372-1403	1388	1850.00-2150.00	1998.32	2nd trimester

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Table 17: Example market report for heifers and cows sold in an Australian store stock sale (Anon, 2015b)

Category Weight Range	Breed	Sub Breed	Muscle Score	Fat Score	Head	Low c/kg	High c/kg	Average c/kg	Low $/head	High $/head	Average $/head
PTIC Heifers											
350-550	Angus		C	3	16	279	279	279	1200.0	1200.0	1200.0
					16	**279**	**279**		**1200.0**	**1200.0**	
PTIC Cows											
400-550	Angus		C	3	10	262	262	262	1360.0	1360.0	1360.0
	Cross Bred		D	2	7	193	193	193	890.0	890.0	890.0
	European Cross		D	2	8	186	186	186	835.0	835.0	835.0
550+	Angus		C	4	10	167	178	171	1100.0	1280.0	1172.0
	European Cross		C	3	11	259	259	259	1450.0	1450.0	1450.0
					46	**167**	**262**		**835.0**	**1450.0**	
Cows & Calves <2 mths											
0-400	Cross Bred		D	1	7	257	257	257	900.0	900.0	900.0
	Cross Bred		D	2	9	293	293	293	1025.0	1025.0	1025.0
400-550	Angus		D	2	3	311	311	311	1275.0	1275.0	1275.0
	Angus		D	3	4	250	250	250	1250.0	1250.0	1250.0
	Cross Bred		C	2	3	338	338	338	1760.0	1760.0	1760.0
	Cross Bred		D	2	5	250	250	250	1250.0	1250.0	1250.0
	Cross Bred		D	3	5	227	259	246	1250.0	1400.0	1340.0
	European Cross		D	2	5	245	245	245	1325.0	1325.0	1325.0
	Hereford		D	2	1	238	238	238	975.0	975.0	975.0
550+	Angus		D	3	19	225	225	225	1260.0	1260.0	1260.0
	European Cross		C	3	3	224	224	224	1525.0	1525.0	1525.0
					64	**224**	**338**		**900.0**	**1760.0**	
Cows & Calves 2-4 mths											
0-400	Cross Bred		D	1	14	266	266	266	985.0	985.0	985.0
400-550	Black Baldy		D	3	4	321	321	321	1670.0	1670.0	1670.0
	Cross Bred		D	1	14	276	276	276	1130.0	1130.0	1130.0
	Hereford		D	2	18	263	263	263	1210.0	1210.0	1210.0
	Shorthorn		D	3	12	315	315	315	1640.0	1640.0	1640.0
550+	Cross Bred		C	3	2	224	224	224	1525.0	1525.0	1525.0
	Cross Bred		D	3	5	254	272	261	1475.0	1550.0	1505.0
	Murray Grey		C	3	5	221	221	221	1500.0	1500.0	1500.0
					74	**221**	**321**		**985.0**	**1670.0**	

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STORE STOCK

Store stock sales are a crucial component of beef production representing the principal income source for many breeders and the principal cost for both grass and feedlot finishers. As such it is imperative that livestock language provide a clear base for valuation and description.

A crucial point is that the true value of a store animal is a mix of its physical characteristics at the point of sale and its potential for subsequent performance. In many situations subsequent performance may account for a greater proportion of value than the initial animal transaction indicating that more attention and associated objective description may be warranted in this aspect.

Existing language components, in particular live weight, fat and muscle score currently provide useful description of the existing animal. Breed is commonly added to this and visual, but rarely a formally calculated, frame score or maturity type factored into valuation. Market reporting utilises the standard muscle and frame score combination within weight ranges following current language standards. Although less commonly utilised, other language descriptions for temperament and a more developed structure description should be relevant.

The strong and consistent use of age, including proxies such as vealer, weaner and yearling, in store cattle description and extremely rare mouthing for dentition appraisal is at odds with the livestock Language use of dentition for category description.

Further descriptive terms are also regularly applied with the Auctions Plus descriptions for condition displayed in Table 18. Further terms such as “sappy”, “fresh”, “good doing” and so on are also in common industry use. A question that needs asking is whether these commonly used descriptive terms are in fact useful or actually detract from the more objective fat and muscle score standards.

If they in fact relate directly should the descriptive terms always be used in combination with the muscle and fat score standard, for example “C2 Store” or “D4 forward store” to reinforce producer understanding of standardised description as used in market reporting? A measure of potential frame score and maturity type may also be useful for the store market. Although it has not been done it is conceivable that an EBV for frame score could be developed.

Currently individual genetic data is rarely available with common terminology often restricted to “xx” bloodline sires and further equally vague descriptors including those within the Auctions Plus Breeding Quality assessments shown previously in Table 15. While potentially important, detail of health history and treatments and prior management practices such as weaning or grazing systems employed are rarely communicated in a coherent or standardised manner. This may be facilitated by including standard codes within the livestock language with accompanying extension to encourage uptake.

An important forward objective could be development of plausible estimates of performance potential incorporating the market specifications that are appropriate for individual cattle, derived from their maturity type and description as presented, indicators of efficiency or time required to reach specification given their current status and genetic potential and a predicted final carcase yield and eating quality.

Research and development of objective tools, with camera and scanning technologies of immediate interest, coupled with streamlined data transfer have the potential to add great value to existing store cattle sale systems and to subsequent sorting into optimised lines post sale for targeted feeding to selected market specifications. This might be considered a high industry priority and a precursor to effective true value based marketing of store cattle.

Table 18: Auctions Plus store stock descriptive terms (Anon, 2011a)

C3 – Condition

Fatness has been estimated in mm or fat score for the slaughter stock assessment. For store stock condition score is also given to indicate strength to travel and expected time to fatten.

Forward to Prime

- Fully cleaned up in coat.
- Large percentage of line killable.
- High development of muscle.

Forward Store

- Rising in condition/nutrition.
- Very light fat cover.
- Showing muscle potential.
- Cleaned up in coat.

Store

- Nil to very light fat cover.
- Bone structure just visible.
- Beginning to clean up in coat.
- Some filling out of muscle.

Backward Store

- Low but strong condition.
- Nil fat.
- Bone structure clearly visible.
- Dry coat.
- Sufficient strength to travel reasonable distances.

Poor

- Very low condition.
- Nil fat.
- Bone structure clearly visible.
- Dry coat.
- Sufficient strength to travel reasonable distances.

Livestock language applied to store cattle must also meet the needs of multiple selling platforms including direct on property sales including those conducted via electronic auctions and traditional saleyard selling. While opinions such as that expressed by McKinna et.al. (2012) summarised in Figure 7 are not uncommon the proportion of store stock sold through conventional saleyards remains significant and the livestock language, including prospective new electronic or other technologies must be configured to operate in all environments.

The issue of estimating weight change during the delivery period also deserves attention and possible incorporation into language definitions. While current saleyard practice does not address this issue formally, and in cases where curfews are imposed may actively aggravate losses, the Auctions Plus (Anon, 2011a) and many feedlot and processor management systems devote considerable attention to predicting and minimising live and carcase weight losses between properties.

Figure 7: Prediction of future livestock selling system development (McKinna et.al., 2012)

In this contemporary environment of computer technology social media and environmental sustainability pressures, the system of selling livestock through saleyards is anachronistic.

- Despite the growth of over the hooks sales, direct selling methods, saleyards still p[lay a mojor role in livestock transactions.
- Saleyards add cost, contribute to animal welfare issues and impact on livestock quality and health.
- Advances in technology including digital photography and acceptance of online trading platforms will reduce the reliance on saleyards, although they continue to play a social function in the short term.

For example Auctions Plus assessors are trained to assess a large number of factors which are combined within software routines to estimate delivered weights and dressing %. The assessed factors are gut fill and transit loss with interactions from feed type, time off feed, time off water, weather, cattle type and breed and class of country (Anon, 2011a).

Aside from direct gut fill and tissue weight loss, change to gut bacteria populations is of particular importance in store cattle transfers due to the direct effect on subsequent adaption to feed, animal health and performance.

Formal market or program access criteria including EU, Organic, PCAS and HGP free are generally communicated on a mob basis and relayed via the National Vendor Declaration (NVD).

LIVE EXPORT

With over 1.3 million head of Australian cattle exported to 23 countries in 2014 (P.Dundon *personal communication*) the Livestock language must provide adequate description for the live export trade. Exports comprise multiple cattle classes including dairy and beef breeding, store and finished cattle. While feeder cattle are by far the greater proportion, breeding cattle return substantially higher prices. All cattle must have NLIS identification when loaded and be managed within Export Supply Chain Assurance System (ESCAS) guidelines following welfare driven concerns.

The basic provisions of the language as discussed appear to readily meet current market specifications for feeder and finished cattle other than for health certification which may be complex and particularly applicable to breeding stock. Calculation of weight as delivered to port and to destination is also an important criteria that may benefit from calculation standards as discussed in the previous section.

Australian export standards for breeding stock are produced by the Australian Cattle Genetics Export Agency (ACGEA), a subsidiary of ILRIC. These specify three categories:

- **Category 1** for purebred stud breeding cattle which require 3 generations of pedigree on both sides with registered sire and dam and month and year of birth certification;
- **Category 2** for registered purebred breeding cattle which may be sired under single or up to 5 sires in group matings plus month and year of birth certification. The dam may be recorded; and
- **Category 3** for unregistered purebred breeding cattle bred from unregistered sires and dams but certified as being true to breed type.

All categories require individual identification by NLIS and/or tattoos and brands and have to be certified as meeting breed true to type phenotypic verification and structural soundness certification. Structural soundness requires scores between 4 and 7 for all the feet and leg trait and 1 to 3 for sheath score as shown in Illustration 6 previously. Livestock inspection compliance standards also include acceptable temperament, acceptable condition and visual health to enable suitability for breeding and be free from excessive warts, ring worm or pink eye scars. These standards should be considered for incorporation or referral within the Livestock language to ensure compatibility.

While current volume markets for feeder cattle may require limited specification beyond weight, sex and breed type buyers place a high value on growth potential, low death rates and high carcase yield with many using property of origin detail as a de-facto guide from past experience (P Dundon *personal communication*). Australian standards specify hornless or tipped horn maximum lengths. A standard to define tipped horn length may be a useful minor addition to horn status as described in the Livestock language. Female feeder cattle mostly require pregnancy testing or speying to ensure they are empty whereas concerns are expressed regarding fertility levels of imported breeding cattle, despite these often relating to feeding after arrival. Each of these concerns indicate that development of further certification or acknowledged standards may be a worthwhile endeavour to reduce potential longer term market damage through poor experience with prior purchases. Any language refinements required in this regard need to be pursued.

SLAUGHTER CATTLE

Ideally livestock assessment and related description of predicted carcase attributes, including those used in marketing and market reporting, should fully align with related description within the AUS-MEAT "meat" language.

A critical and fundamental current issue is the use of dentition and sex to define category within both the livestock and "meat" language sections. While aligned between the two language components, dentition is universally deficient as either an input to eating quality estimates or as an indicator of animal age. Other than for older bulls, sex is also of minor importance in describing eating quality potential (Thompson et.al., 2011a, Dransfield et.al., 2003). While the origin may have reflected a belief at the time that dentition provided a useful and practical basis for segregation this is now discredited and its continual application impedes efforts to more accurately group product. A further significant issue is the inclusion of dentition and sex derived category within a number of legislated export market access agreements. This issue requires serious industry attention and action to reduce and ultimately replace the use of dentition and sex definition of primary category and age.

To this end development of an effective age recording system is a high priority for the livestock industry to facilitate amended market access criteria where age, driven by BSE, is of primary concern. Options to record date of birth, month and year of birth or oldest possible age derived from muster dates should be considered with linkage to the NLIS database a potential mechanism for information transfer. Post slaughter appraisal of skeletal ossification is currently used in eating quality evaluation and remains the most effective measure currently available for that purpose.

A second high impact issue relates to the use of coordinated fat and muscle scoring systems in both live cattle and carcase assessment. The existing livestock language fat and muscle scoring system has been demonstrated to provide superior accuracy as an estimator of carcase yield to butt shape and to provide moderately accurate carcase yield estimates when used in conjunction with P8 fat and EMA measures (Perry et. al., 1993a) Consideration of a common muscle and fat score assessment between livestock and carcases could benefit both sectors via clear communication, accuracy and as a base for the yield component of value based marketing systems. Where objective technology is not available or commercially unattractive this might be achieved by adapting the current EUROP carcase grading format.

Rapidly emerging camera and scanning technologies with related software offer the further promise of accurate and objective technology to determine muscle and fat scores in the live animal and to predict carcase yield prior to and post slaughter both hide on or hide off.

Further development and evaluation of alternative objective systems would seem a high industry priority with the potential to improve prediction and, by doing so, reduce concerns regarding accuracy and transparency in carcase measurements used in over the hooks trading.

In addition to AUS-MEAT livestock and "meat" language standard terms further non- or loosely-defined subjective terms are often employed both in informal communication and semi officially by sellers, buyers and their agents. An example is the carcase quality grade described within the Auctions Plus assessment manual and reproduced in Figure 8. As with the earlier discussion of terminology used in store and breeding cattle the value of these and similar terms should be considered within a framework of whether they add to descriptive accuracy beyond more defined and measured language components or purely add to confusion. While general industry jargon is highly unlikely to change any time soon its' inclusion or exclusion from official language should stem from its' value in effective description.

Figure 8: Auctions Plus Carcase quality grade description (Anon, 2011a)

B2 - Carcase quality grade

These terms are used to describe the expected carcase quality (not necessarily the visual appeal) of the cattle, although they would usually go together.

Incorporate all "quality aspects" including evenness of finish, conformation etc.

Obviously HQ1 will be reserved for really top cattle. Most mobs will be mixed, so specify the approximate break up eg 90% GAQ, 10% FAQ.

Highest Quality 1st – (HQ1)

- This term applies to really top cattle with even fat cover at optimum fat thickness for their market.
- Would have very good weight for age and terms such as "sappy" and "full bloom" would apply.
- Would also be well muscled with at least medium (C) and probably heavy muscling (B) ie well balanced in muscle pattern and "finish".
- They would be handled well with good temperament and be expected to produce high yielding, top quality carcases eg unlikely to experience dark cutting.

Good Average Quality - (GAQ) first grade

- As above only not as exceptional ie the majority of good quality cattle very suited to their trade.
- Perhaps slightly below HQ1 in balance of fat cover, muscling or "bloom".
- May not have weight for age.

Fair Average Quality – (FAQ) second grade

- Cattle lacking a little in trade suitability due to insufficient or uneven fat cover or muscling.
- May be just adequate in fat and muscling, but be a mixed mob, falling in condition, lacking in "bloom" or with poor temperament.

Third Grade Manufacturing – (3MX) third grade

- Cattle with little fat cover and probably towards the lower end of the muscling range eg would suit the manufacturing or grinding meat orders for the USA.

Canner – (CNR)

- Cattle in very poor condition and light weight.
- Usually older cattle from a poor nutritional background.

The transfer of required background production information from supplier, and often from all parties that have managed an animal, to processor is currently a cumbersome task involving multiple paper based information transfers in addition to electronic data for NLIS identification and recent electronic National Vendor Declarations (NVD). Required information currently includes property data relating to veterinary and animal chemical withholding periods, residues and use of HGP's. In addition many transactions require verification of breed or of raising claims via PCAS, organic and NFAS certification and of market eligibility for EU, Saudi etc.

These requirements are likely to increase with further marketing driven programs and potential addition of gene marker inputs to MSA grading and ideally verified animal age. Further work to simplify information collation and transfer with increased electronic data utilisation is highly desirable.

This also needs to be a "two way street" to facilitate transfer of increased information from the store purchaser or meat processor to supplier. Developed systems will provide a base for introduction of value based marketing systems which are likely to be a major stimulus to enhanced industry efficiency. While MSA data is currently assessable electronically considerably greater use of this and additional carcase data could become a principal input for carcase trait in genetic evaluation systems.

A natural progression from improved information transfer coupled with accurate finishing performance, carcase yield and eating quality predictors or direct measures is the evolution of transparent value based marketing systems (VBM). With all industry revenue linked directly to consumer satisfaction and purchased volume it appears logical that payment at any point of the supply chain should ideally reflect the consumer value delivered by that sector (Polkinghorne and Thompson 2010). It can be argued that VBM should be the most powerful driver of industry change and improved profitability in many decades. As stated by Cross and Savell (1994) a functioning value-based marketing system is critical to the economic well-being of the beef industry. Producers must be paid for producing what the consumers demand. Clear signals must come from the consumer to the marketing chain to the producer. They also observe that livestock producers have been frustrated at the apparent lack of monetary differences among market animals with great variation in quality and carcase composition. This position has not changed greatly since 1992 but it should be noted that the Australian industry has made exceptional progress in developing tools and associated systems, including NLIS and MSA, that can facilitate this change.

The replacement of crude and largely inaccurate processor payment grids with accurate value measures can be expected to drive dramatic change in cattle supplied for slaughter. Equivalent potential exists should improved predictors of store cattle performance and end point become commonplace for breeder to finisher transactions.

Using the dairy industry as a benchmark, with milk component payment the equivalent to beef quality and yield, industry response to a clear market signal is likely to exceed expectations. Commercial results reported by Polkinghorne et.al. (2008) indicated carcase value differences between $0.50 and $1.00 per kg at producer level within visually very similar lines of cattle. Given the magnitude of this value range rapid and highly significant gains are possible. A confluence of VBM with improved tools currently under development for genetic evaluation and existing management systems offers exciting potential to dramatically improve beef industry competiveness.

TRUST AND THE TRADING PLATFORM

Trust in description and measurement is a critical base for efficient operation of the beef industry at all levels and in particular at points of ownership transfer or valuation. Precision in use of terms, agreed concise definition, adequate training and monitoring of those making assessments are each important parts of the process. Even with each of these elements fulfilled there may still be distrust where evaluation occurs after delivery and is conducted by the buyer. Inversely the same may be true when the delivered article fails to meet description.

This issue is not unique to Australia with Governmental inspection and grading a feature of many beef grading systems including those used in Japan and USA amongst others. Truly independent third party assessment is however rare in store or breeding cattle transactions although concerns are as common. Comments relating to saleyard buyers being in collusion, to meatworks manipulating assessments, to agents favouring either buyer or seller and live export cattle being infertile are sufficiently common to rate as folklore.

This must improve for the beef industry to be fully competitive with the chicken and pork industries where extensive vertical integration allows a ruthless concentration on total production efficiency. “Knowledge is power” and improved description facilitated by language revision will increase the ability for industry to identify and act to improve efficiency and matching of ultimate product demanded and that supplied. It is essential that structures create trust and encourage cooperation to create a seamless chain of cooperating although independent players. Development of transparent value based marketing systems will assist in clear identification of value creation and reward but may still not address matters of trust in assessment.

Two principal responses to address the issue of trust are to place a high priority on education, to ensure parties are fully aware of specifications and associated measurement, and to prioritise development of objective technologies that can remove the human element. Fortunately a number of these technologies appear to be nearing commercial fruition for greatly improved live animal and carcase assessment.

AUDITED PROPERTY BASED PROGRAMS

A number of property based programs are currently utilised in beef cattle production as requirements for subsequent market access. At the base level there is a universal legislated requirement to register production premises via a Property Identification Code (PIC) and to apply lifetime traceable Radio Frequency Identification Devices (RFID) prior to cattle leaving the property of birth under the National Livestock Identification System (NLIS).

It should be noted that the PIC relates to the property and NOT to the owner of the livestock should this be different such as in agistment or property lease situations. Consequently NLIS tags are ordered and supplied to the property, under State and Territory Government legislation, rather than to the person who may own and control the livestock unless specific arrangements are made with NLIS. In New Zealand a “person in control of livestock” (PICA) basis is utilised which may have merit. The pros and cons of relating PIC to property, of value where issues such as soil borne residues exist, versus the cattle, where concerns relate to administered chemical or other livestock treatments may be worthy of consideration including the incorporation of linking a PICA to the current PIC record.

Lifetime movements associating the PIC and individual animal RFID are recorded by NLIS and enable trace back in the event of animal health or other issues. The RFID devices are routinely read at points of ownership transfer such as saleyards or at feedlot induction and at the point of slaughter where cross checking against a chemical residue database is standard practice. In addition the NLIS identification is widely utilised in property management providing a convenient electronic link to management software and herd recording systems.

Other property based systems include European Union (EU) licensing with associated requirements relating to prohibition of hormonal growth promotant (HGP) use, Organic certification under various certification programs, Pasture Fed Assurance System (PCAS) and the National Feedlot Accreditation System (NFAS) which is a requirement for certification of grain fed beef in export markets. Each of these programs has an associated quality management requirement including record keeping and varying external audit requirements. The Livestock Production Assurance (LPA) program, while operating at a significantly lower requirement level with random auditing, is utilised at a broader level within industry.

Compliance with each of these programs is relayed at points of transfer by the NVD, a paper and more recently electronic, based system that requires the seller to make a legal declaration of compliance. As a single declaration generally applies to a complete consignment of stock such use is manageable but still of consequential impact for larger processors receiving daily shipment from multiple suppliers. This is further complicated where multiple paper forms such as an EU NVD, NFAS and MSA declarations, together with weigh bills in some states and the Northern Territory, are required creating a volume of paper to be checked and collated. Further complexity is added when a single delivery includes two or more classes of stock requiring separate documentation.

It is anticipated that further demands will arise in line with the development of marketing, legislative and commercial developments. Immediate likely additions currently under active discussion include animal welfare and property sustainability standards which may remain optional or become customer specified or legislative requirements. In the welfare area Colditz et.al. (2014) have proposed a property based Unified Field Index (UFI) system to provide a quantitative evaluation system for welfare assessment. They envisage such a system operating at three levels:

- **Level 1:** Assessed within property by the farm manager and supported by training to assure consistent application and recording.
- **Level 2:** Applied across multiple operations with external involvement and use of benchmarking between participants.
- **Level 3:** Externally audited program supplying market assurance to customers.

Further work is being progressed by others in relation to sustainability standards with programs in both this and welfare likely to be progressed in conjunction with major food industry customers including major international and local supermarket groups and food service customers such as McDonalds Corporation. Evidence for this includes current programs by local supermarket groups together with global trends.

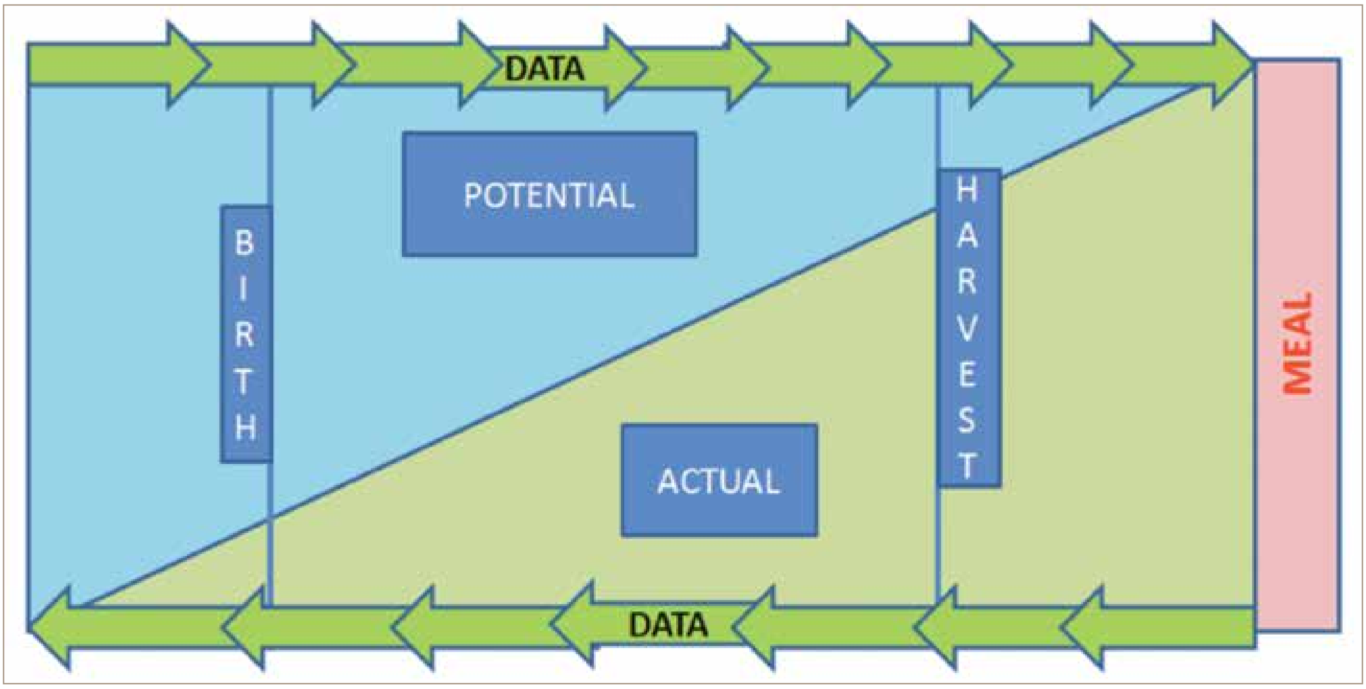
Many of the issues raised in earlier sections, including age verification or gene markers as examples, will also relate to individual animal data rather than to entire mobs or herds. It is unlikely that these demands will be efficiently met by existing NVD related systems. The following section canvasses a prospective solution.

It is also considered likely that future customer or government demands may require a more stringent quality assurance (QA) basis for producer certified criteria more aligned with that expected within the export processing sector and NFAS program. These are likely to specify regular external auditing. To ensure and facilitate acceptance of major new industry initiatives aimed at improved profitability it may be prudent for the producer sector to lead development of a stronger QA culture and systems rather than be pushed externally. The inclusion of training programs within such systems may be highly beneficial in delivering improved knowledge of the total beef to meat chain, associated skills and interpretation of beef language traits. While such suggestions may not be enthusiastically received it may be unrealistic to expect that the producer sector can operate in isolation of the sophisticated QA regimes imposed on all further segments of the food industry.

DATA COLLECTION AND TRANSFER

The need for and value of data from all points between conception and consumption is a consistent theme throughout discussion in all previous sections and in relationship to the livestock language. Another base principle expounded is the concept that value at all points prior to final consumer consumption includes both the physical genetic package, animal, carcase or cut being traded or measured and the potential to transform during subsequent management. Figure 9 provides a simplified representation of this concept.

Figure 9: Language application in defining product at point of sale and future potential.



When purchasing straws of semen or a new sire the value might be seen as predominantly relating to potential. A store stock transaction might be seen as a midway point evenly balanced between the actual animal as viewed and an estimate of future performance and the carcase value as largely actual but also including potential for subsequent consumer products.

It is confidently predicted that the ever increasing collection of comprehensive data coupled with advanced technology for measurement will be utilised to provide relatively accurate estimates of potential performance at multiple points across the supply chain.

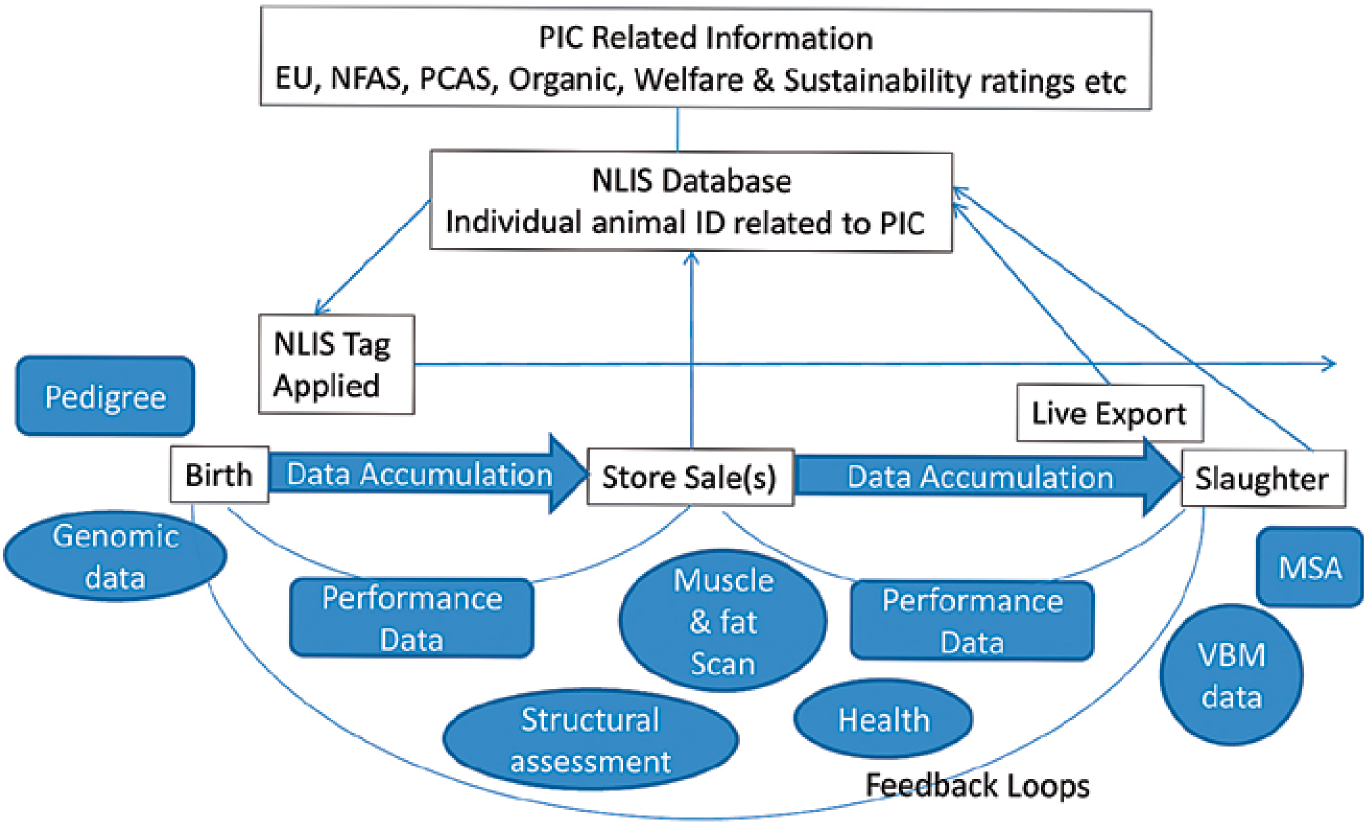
There are numerous existing independent data systems including those held by Breed Societies, AGBU, Genetic services companies, individual property recording systems, MSA data and Processor information systems to name a few. Currently there is minimal connection between the majority resulting in considerable information of potential value either not being shared or transmitted via non-standard and often paper-based formats.

An exception however is that a majority of these independent systems are cross referenced to NLIS individual animal identification. At various times it has been suggested that the NLIS RFID tag should be modified to enable additional information to be "written" to the tag or alternatively that the NLIS database be expanded to collect additional information. Given the proprietary nature of many data sources and challenges regarding data standards and ownership this is considered unlikely.

Date of birth is possibly the principal item that may logically be stored within the NLIS database with alternative detail including actual birth date, month of birth and season of birth – possibly as Month "x" to Month "y". This approach has been considered at an advanced technical level previously raising no substantial technical problems (George Basha *personal communication*).

An alternative proposition may be to simply utilise the mandatory NLIS identification as a key to further data that may be available from multiple independent sources. As an example a particular animal may have genomic data for tenderness, gene markers stored in a genetics database, pedigree data in a breed society system, birth date and weight in a producer management system and live animal scan data in a further system. The existence of such data and access authorisation could be noted in an electronic file including the NLIS identification or simply checked automatically when the NLIS tag is read at various supply chain points. Consequently reading of the NLIS tag could trigger provision of gene marker status, birth date, health records, scan data and breed certification by querying multiple data sources including EU, NFAS etc to add further market eligibility information. This combined data could then be used in MSA grading and to determine eligibility for company brand programs and market access. A loose representation is provided in Figure 10.

Figure 10: Data sources and potential linkages



A recent project conducted by the Victorian Saleyards Association with funding from the Victorian Digital Futures Fund included field trials where a variety of devices including smartphones were used to transmit electronic NVD data. Each system was also tested for the ability to send additional farm level information and interact with the current NLIS database. (Mark McDonald *personal communication*). This general concept might be considered in developing more efficient and simplified information transfer as a necessary component of building more sophisticated customer focused and value based industry trading systems. The MLA Livestock Datalink project may also incorporate elements of a developed industry system. As stated by McKinna et.al. (2014) “there would be many benefits to be gained from exploring a whole of industry RFID and IT based information and management platform”.

ISSUES RELATING TO CRITERIA CURRENTLY NOT INCLUDED WITHIN THE LIVESTOCK LANGUAGE

1. Development of standard terms for commercial reporting of genomic trait.
2. Further definition of the interaction of the livestock language and multiple industry systems. At what level or point do measures or terms used as inputs or outputs become incorporated in the livestock language? Should they be defined in a language lexicon and should standard terminology be agreed to ensure consistent language linkage?
3. Incorporation of Estimated Breeding Values (EBV's) and Genomic Breeding Values (GBV's) in the Livestock language. Standards should be developed in the context of proposed changes to livestock recording systems and greater use of multi-breed and cross-bred formats.
4. Cross referencing or inclusion of semen and embryo descriptions and standards in the Livestock language.
5. Adoption of a standard structural soundness description base within the Livestock language to facilitate clear description.
6. Consideration of standard description or coding for transfer of animal health, therapeutic drug and HGP treatment history.
7. Consideration of performance estimates including beef and dairy sire EBV's/GBV's for dairy and dairy cross calves including assessment standards for maturity type, fat and muscle score at a very young age and the relationship of these to subsequent measures when older.
8. Consideration of standard descriptive language for breeding cattle including the use of broader "quality" descriptive terms.
9. Inconsistency between common use of age and age proxies such as vealer, weaner or yearling and the primary language use of dentition to describe category.
10. Review of terminology for store stock condition and any conflict or ambiguity with livestock language fat and muscle score standards.
11. Priority research and development to prove and introduce systems that provide useful predictions of subsequent store cattle performance to facilitate Value Based Marketing (VBM) and appropriate market targeting.
12. Standard estimating procedures for predicting live and carcase weight losses post assessment under varying conditions.
13. Possible language inclusions to support live export certification schemes.
14. Evaluation of an animal age recording system as a precursor to replacing or reducing the use of dentition as a primary category descriptor.
15. Replacement of P8 fat measurement with whole of carcase fat and muscle scores to improve yield prediction and associated carcase valuation.
16. Accelerated development and evaluation of camera and scanning technologies to predict carcase yield from live animal, hide on and hide off carcase scans.
17. Simplification of information transfer at the point of slaughter via increased use of electronic data transfer both to the processor and return to suppliers and genetic evaluation systems.
18. Facilitation of transparent value based marketing structures via standardised language and more accurate yield and eating quality estimates.
19. The importance of trust, supported by enhanced education to ensure full appreciation of standards and processes, and priority development of objective measurement technologies for live cattle and carcase beef.
20. Potential requirements for more stringent property QA programs and auditing of such programs. Industry may consider leading this development including training in order to stay ahead of customer or government demand and facilitate acceptance of new initiatives designed to improve profitability.
21. Development of an information transfer system, using the NLIS RFID tag as a key, to access multiple data bases and aggregate information of value in livestock transactions throughout the supply chain.

REFERENCES

Anon (1994). *National Livestock Language, Cattle: Bovine* (1st ed). AUS-MEAT Limited, Brisbane.

Anon (1996). *NAAB Electronic Resource Guide. NAAB Uniform Breed Codes.* National Association of Animal Breeders, Columbia, Missouri, USA. (http://www.naab-css.org/guidelines/breed.html). Revised October 2014

Anon (2000). *United States Standards for Grades of Feeder Cattle.* US Department of Agriculture, Agricultural Marketing Services. (http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELDEV3060890)

Anon (2005). *NLRS data collection* (July). Meat and Livestock Australia Limited, Sydney. (http://www.mla.com.au/Prices-and-markets/Market-reports-and-prices/National-livestock-reporting-service)

Anon (2011a). *Cattle Assessment Manual.* Auctions Plus Pty. Ltd. (http://localmedia.auctionsplus.com.au/Doc/CattleAssessmentManual.pdf).

Anon (2011b). *Management of Unfit-to-Load Livestock – Guidelines for persons in charge and veterinarians involved in pre-embarkation live export inspections of cattle and sheep.* Meat and Livestock Australia Limited, Sydney. (http://www.livecorp.com.au/sites/default/files/publication/file/management_of_unfit_to_load_livestock.pdf)

Anon (2014a). *Australian Meat Industry Classification System.* AUS-MEAT Limited, Brisbane.

Anon (2014b). *Eastern young cattle indicator.* Meat & Livestock Australia. (http://www.mla.com.au/Prices-and-markets/Market-reports-and-prices/Eastern-young-cattle-indicator) Accessed 14th August 2014.

Anon (2014c). *BeefSpecs.* (V1.2). NSW Department of Primary industries. (http://beefspecs.agriculture.nsw.gov.au/ accessed 14/7/2014))

Anon (2014d). *Northern Australia Beef Fertility Project: CashCow.* (Project: B.NBP.0382). Meat and Livestock Australia Limited, Sydney.

Anon (2014e). *Australian Cattle Genetics Export Standard.* Australian Cattle Genetics Export Agency. (http://www.ilric.com/pdf/Smaller_ACGEA_Standards_English.pdf)

Anon (2014f). *Statistical review. Key statistics for the Australian red meat and livestock sector.* (July 2013 – June 2014). Meat & Livestock Australia Limited, Sydney. Accessed via (http://www.mla.com.au/Prices-and-markets/Market-news/2014-MLA-Statistical-Review-now-available)

Anon (2015a). *Market News.* US Department of Agriculture, Agricultural Marketing Services (www.ams.usda.gov/mnreports) accessed on February 2nd, 2015.

Anon (2015b). *Market reports and prices.* Meat and Livestock Australia Limited, Sydney. (http://www.mla.com.au/Prices-and-markets/Market-reports-and-prices).

Blackwood IF, Littler B, Siddell J, and Exton S (2014). *Cattle welfare initiatives in low body condition score. Final report.* Meat and Livestock Australia Limited, North Sydney. Access via (http://www.mla.com.au/Research-and-development/Search-RD-reports/RD-report-details/Animal-Welfare/Cattle-welfare-initiatives-in-low-body-condition-score/186)

Blackwood IF, Gaden B, Littler B, Paul A, Prowse K (2010). *Welfare Decisions for Beef Cows.* (Primefact 619, 2nd Ed.) NSW Department of Primary Industry. (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/141079/Welfare-decisions-for-beef-cows.pdf)

Cafe LM, Mcintyre BM, Robinson DL, Geesink GH, Barendse W, Thompson JM, Pethick DW, Greenwood PL (2010). Production and processing studies on calpain-system gene markers for tenderness in cattle: 2. Objective meat quality. *Journal of Animal Science*, 88, 3059-3069.

Colditz IG, Ferguson DM, Collins T, Matthews L, Hemsworth PH (2014). A Prototype Tool to Enable Farmers to Measure and Improve the Welfare Performance of the Farm Animal Enterprise: The Unified Field Index. *Animal* 2014, 4(3), 446–462.

Conroy SB, Drennan MJ, McGee M, Keane MG, Kenny DA, Berry DP (2010). Predicting beef carcase meat, fat and bone proportions from carcase conformation and fat scores or hindquarter dissection. *Animal*. 4(2), 234-241.

Cross HR, Savell JW (1994). What do we need for a value based beef marketing System? *Meat Science*, 36, 19-27.

Dransfield E, Martin JF, Bauchart D, Abouelkaram S, Lepetit J, Culioli J, Jurie C, Picard B (2003). Meat quality and composition of three muscles from French cull cows and young bulls. *Animal Science*, 76, 387-399.

Ferguson D, Matthews L (2011). *Animal welfare objective measures research program – Validation of Body Score as a Practical Indicator of Welfare in Cattle. Final Report.* Meat and Livestock Australia Limited, Sydney. Accessed via (http://www.mla.com.au/Research-and-development/Search-RD-reports/RD-report-details/Animal-Welfare/Animal-Welfare-Objective-Measures-Research-Program-Validation-of-body-condition-score-as-a-practical-indicator-of-welfare-in-cattle/181)

Greenwood, P.L., Cafe, L.M., McIntyre, B.L., Geesink, G.H. Thompson, J.M., Polkinghorne, R., Pethick, D.W. & Robinson, D.L. (2013). Molecular Value Predictions: associations with beef quality, carcase, production, behavior and efficiency phenotypes in Brahman cattle. *Journal of Animal Science*, 91, 5912-5925

Kelly M, Thompson JM (2014). Estimating the economic value of using a panel of tenderness markers to select for improved consumer palatability scores. *Proceedings, 10th World Congress of Genetics Applied to Livestock Production.* (https://asas.org/docs/default-source/wcgalp-posters/393_paper_8869_manuscript_281_0.pdf?sfvrsn=2)

Lawrence TE, Whatley JD, Montgomery TH, Perino LJ (2001). A comparison of the USDA ossification-based maturity system to a system based on dentition. *Journal of Animal Science*. 79, 1683-1690.

McKiernan WA (2005). *Frame Scoring of Beef Cattle.* NSW Department of Primary Industry, Orange. (http://www.dpi.nsw.gov.au/agriculture/livestock/beef/appraisal/publications/frame-scoring accessed on 15/2/2015)

McKinna et al, (2012). *AMPC – Environmental Future Scan – Mega trends to 2030.* Australian Meat Processors Association. Accessed Jan 2015. (http://www.ampc.com.au/site/assets/media/Corporate-Reports/Strategic-Plans/Environmental%20Future%20Scan.pdf)

Perry D, McKiernan WA, Yeates PA (1993a). Meat yield and subjective muscle scores in medium weight steers. *Australian Journal of Experimental Agriculture*, 33, 825-831.

Perry D, McKiernan WA, Yeates PA (1993b). Muscle score: its usefulness in describing the potential yield of saleable meat from live steers and their carcases. *Australian Journal of Experimental Agriculture*, 33, 275-281

Polkinghorne RJ, Philpott JC, Gee A, Doljanin A, Innes J (2008). Development of a commercial system to apply the Meat Standards Australia grading model to optimise the return on eating quality in a beef supply chain. *Australian Journal of Experimental Agriculture*, 48, 1451–1458.

Polkinghorne RJ, Thompson JM (2010). Meat standards and grading. A world view. *Meat Science*, 86, 227-235.

Robinson DL, Cafe LM, McIntyre BL, Geesink GH, Barendse W, Pethick DW, Thompson JM, Polkinghorne R, Greenwood PL (2012). Production and processing studies on calpain-system gene markers for beef tenderness: Consumer assessments of eating quality. *Journal of Animal Science*, 90, 2850–2860.

Thompson JM (2011). The effect of Gene Markers for Tenderness (both as single SNPs and as a tenderness MVP value) on palatability scores using data from the MSA database. *A report prepared for Meat and Livestock Australia Limited and Pfizer Animal Genetics.* Meat and Livestock Australia, Sydney.

Thompson J, Polkinghorne R, Wozniak A, Gutkowskad, K, Wierzbicka A, Wierzbicki J. (2011a). Consumer responses to Polish beef. *A report prepared for Polish Beef Association, Warsaw.*

Watson R, Polkinghorne R, Thompson JM (2009). The effect of gene markers for tenderness on MSA consumer scores. *A report prepared for Meat and Livestock Australia and Pfizer Animal Health Division.* Meat and Livestock Australia. Sydney.

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MEAT & LIVESTOCK AUSTRALIA

APPENDIX C:

THE AUSTRALIAN MEAT LANGUAGE

Author: R. Polkinghorne

Technical papers for the Australian Beef Language
'WHITE PAPER'

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CONTENTS

EXECUTIVE SUMMARY

Language is used across all sectors of the beef industry from genetic selection to final consumer purchase. By far the most formalised and widely used portion of Australian beef language is that directly relating to carcase and cut description. This “meat” section is addressed in this paper while companion papers will cover livestock and consumer language sections. The meat language has been administered by AUS-MEAT since 1987 with application enforced by legislation in export markets.

The language has been continually enhanced and developed to maintain relevance and facilitate trade in meat and meat products. By any measure it has been highly successful and the enormously complex array of beef and veal products traded is testament to the fact. This is not to say that further refinement is not possible or desirable however and the history of innovation and development must continue to maintain relevance.

This paper summarises the principal detail of the existing language and seeks to stimulate discussion over potential areas identified as worthy of consideration. Perhaps the most fundamental issue is to ensure that the language remains flexible and that it can be equally effective as an objective classification tool, reflecting its origins, and in further applying objective elements as inputs to systems that require language to accurately describe a result including carcase yield and consumer satisfaction with cooked individual meal portions.

STRENGTHS OF THE CURRENT LANGUAGE

The outstanding strength of the current meat language is the flexibility that enables objective description of the full range of product traded at any desired level of detail. Beef can be described as purely “beef” or in great detail in regard to the source carcase, cutting lines, visual appearance, production system, packaging and predicted eating quality. This enables virtually any type of beef product desired to be described and successfully traded.

A further significant strength is that it is widely known, understood and utilised across domestic and international markets.

WEAKNESSES OF THE CURRENT LANGUAGE

The current language is based on objective description of observed traits that, by and large, are understood by those trading and reflect their experience and common trading practice. However, if the consumer is regarded as the ultimate customer, language might be judged more by the simplicity and accuracy of performance delivered. On this basis the current language can still deliver but is more conflicted and restricted by a strong orientation toward fundamental description at alternative category level, based on sex and dentition, that has only a poor at best relationship to results whether at the trade level of yield or the consumer level of predictable meal satisfaction.

SUMMARY OF ISSUES ARISING WITHIN SEGMENTS OF THE MEAT LANGUAGE

CARCASE LANGUAGE ISSUES

1. Consideration of changing bull and veal from basic to alternate categories. While requiring federal legislative change this may simplify product description within an enlarged *A* basic category and better relate to prospective production systems now common in other countries while also aligning better with scientific findings in regard to product characteristics.
2. Review alternative means of assessing animal age.
3. Reassess the validity of sex distinction within alternate categories against scientific evidence and current market demand.
4. Monitoring and evaluation of existing and potential technologies that may provide improved accuracy in estimating yield incorporating fat and muscling variation.
5. Review alignment of weight class, fat class and muscling with live animal language.
6. Consider strengthening livestock language to consolidate all live animal information to be carried forward under a single NLIS indexed link with further consideration of implementing farm licensing and auditing.

CHILLER ASSESSMENT ISSUES

A number of issues are evident within the chiller assessment language, standards and application that require evaluation including:

1. Verification of chiller assessment conditions and interaction with colour and marbling measures.
2. Possible current and future technical capacity to utilise objective measurement for key existing or alternative criteria. Examples could be imf% (intramuscular fat%) in lieu of marbling, image analysis evaluation of marbling, meat colour, EMA, rib fat and other measures or electronic meat colour assessment.
3. Graduation of meat colour chips to a linear numeric scale to replace 1a, 1b and 1c.
4. Do we need two marbling systems or should we reduce to the MSA standard?
5. Clarification of the relative roles and benefits of alternative age and maturity measures. This should reflect two separate objectives; the prediction of eating quality, where ossification may be expected to replace dentition given current knowledge, and the assessment of animal age to meet BSE oriented objectives.
6. Validation of hot and cold ossification score relationships.
7. Further research from additional data to improve the accuracy of hump height as a direct MSA model input.
8. Consideration of inherent conflict between alternative category and MSA description and potential solutions including creating an Eating Quality Graded alternative category together with incorporating this in applicable country to country agreements.

CUT LANGUAGE ISSUES

Some issues identified as warranting consideration within the current cuts language structure include:

1. Examination of multiple descriptions, ciphers and symbols for individual cuts or items to identify possible simplification.
2. Consideration of additional H.A.M. codes to facilitate packing of Eating Quality graded product within a cooking method description without mandatory cut identification allowing companies to pack mixed cuts with common eating quality outcomes.

BACKGROUND

While AUS-MEAT Ltd is responsible for quality standards and uniform description of meat and livestock (Anon, 2014) the meat component of the language is by far the most recognised and utilised.

In considering beef language the White Paper is adopting a broader view of language elements starting with genetic data used in sire selection, continuing throughout the live animal phase, linking to conversion to meat and ultimately to final consumer meal description.

In essence this may be viewed as three interlinked language sections: Live Animal, Meat (carcases and cuts) and Meal (consumer).

This background paper addresses the meat language component which in general usage is commonly referred to as "the AUS-MEAT language".

The meat language was established within AUSMEAT in 1987 and has been continually enhanced, with 302 amendments to August 2014 (Anon, 2014b), to serve industry needs in both the Australian domestic and export markets. Further evolution from White Paper recommendations may continue this process.

The language was established to make a deliberate move away from subjective quality assessments such as First Grade, Second Grade etc to a classification basis that facilitated tight objective specification for trading (Polkinghorne & Thompson, 2010). Buyers and sellers could use standard language to describe a product that best met their requirements with Beef *A* at one extreme being a pure undifferentiated species definition. A critical early step was to define and enforce a standard carcase trim to facilitate over the hooks (OTH) trading and reporting. This meant that carcase weights could be compared across different plants and markets without the need to make adjustments for inclusion or exclusion of specific trim items.

Inclusion of alternate categories based on dentition and sex with measures for hot carcase weight (HSCW), P8 fat and bruising were further augmented by the introduction of the Chiller Assessment Language which provided for standardised assessment of marbling, meat colour and fat colour. *The Handbook of Australian Meat* (HAM) (Anon, 2005) further extended language to specify cuts and cutting lines which are utilised within the carcase classification traits to provide the framework for beef cut description and trading. This classification framework provides an excellent base to describe the physical visual characteristics of carcases and cuts and remains the major description used in export trading. The HAM cut descriptions have also been adopted by the UNECE as a voluntary international standard (Anon, 2012).

Industry research based on consumer perception began in the 1990's and grew into the Meat Standards Australia (MSA) grading system. This also utilised the available AUS-MEAT language descriptions plus additional information to predict consumer satisfaction with individual cuts. The new measures have been incorporated into the language as has MSA grade.

While there is some tension between language designed to describe physical visual characteristics and that designed to describe a cooked meal outcome both are within the current language. The White Paper will examine these relationships including areas that are in conflict or complimentary.

CURRENT MEAT LANGUAGE SUMMARY

PRE-SLAUGHTER REQUIREMENTS AND DOCUMENTATION

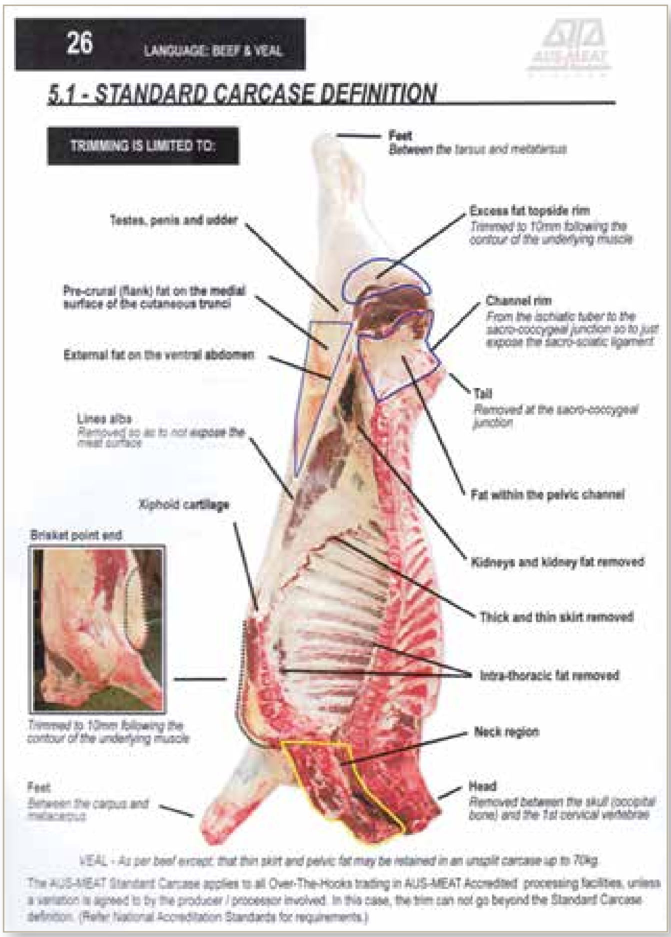
In Australia all cattle must be identified by an RFID device before leaving the farm of birth. Electronic tags must be purchased by the breeder and are registered against the farm of birth within the National Livestock Identification Scheme (NLIS). Each property has a government allocated property identification code (PIC). All subsequent movements of cattle from the property of birth must be recorded within the NLIS to provide lifetime traceability.

A further regulatory requirement is that cattle movements be recorded on a group basis via National Vendor Declarations (NVD) which accompany any cattle movement. The NVD is a statutory declaration utilised to confirm status in regard to market eligibility and status. Other than a summary of the number of head and broad stock type descriptions such as steers or cows the NVD provides information regarding animal treatment withholding periods, exposure to by-product feeds and use or otherwise of hormonal growth promotants (HGP).

Further documentation confirming farm and cattle status is required for European Union (EU) eligibility, National Feedlot Accreditation Scheme (NFAS) eligibility for grainfed cattle, Pasture fed Cattle Assurance Scheme (PCAS) and various alternate organic certifications.

For MSA a declaration regarding tropical breed content (TBC) is required and further breed certification may also be required for specific branding programs. For MSA if the mob being consigned is variable then the highest TBC is stated on the NVD and this is used in the calculation of eating quality.

Relevant data from the above must be aligned with subsequent carcase criteria to establish some meat language descriptions.



CARCASE LANGUAGE

STANDARD CARCASE DEFINITION

In AUS-MEAT licensed plants (only) the language firstly requires a standard carcase trim prior to the scale for cattle sold on an over the hooks (OTH) basis. It should be noted that the standard trim is actually a maximum allowable trim; less may be trimmed if desired to suit alternate specifications. There is no standard trim requirement for processor owned cattle. The carcase must be weighed hot within two hours of slaughter. The diagram on the left illustrates the basic requirements further summarised in the Table 1 (Anon, 2005) on the following page.

Table 1: AUS-MEAT Standard Carcase Definition

HYGIENE REQUIREMENTS	
• Minimum trimming as required by meat inspection services for the carcase to be passed fit for human consumption.	
• Trimming of the neck and neck region may be extended to ensure compliance with "Zero Tolerance" for ingesta contamination, especially where halal slaughter has been performed. This extension of the standard carcase for beef is limited to a hygiene trim and must be controlled by the approved arrangement under the Australian standards.	
STANDARD TRIM REQUIREMENTS	
• Head removed between the skull and first cervical vertebrae.	• Udder, testes, penis and external fat on the ventral abdomen – precural, udder and cod fats.
• Feet between the knee joint and hock joint.	• Fat on the channel rim from the tuber ischi to the sacro-coccygeal junction.
• Tail at the junction between the sacral and coccygeal vertebrae.	• Excess fat on the Topside rim up to 1cm from the underlying muscle.
• Skirts removed (Thin/Thick)	• Xiphoid cartilage and intra-thoracic fat.
• Kidney, kidney fat and fat from within the pelvic channel fat.	• Excess external brisket fat up to 1cm from underlying muscles.

The standard carcase trim, assuming consistent application and use of an unadjusted hot weight, allows direct consistent comparison of hot standard carcase weight (HSCW) and dressing % (HSCW/liveweight) between plants. There are three exceptions however:

- Non AUS-MEAT licensed domestic plants may apply a company specified trim;
- Cattle owned by the plant may be trimmed to any desired specification; and
- Plants utilising vascular infusion (rinse/flush) will elevate HSCW by about 2.5% through the process of pumping a solution through the vascular system immediately post sticking.

The AUS-MEAT standard represents a very heavy trim regime relative to others such as that used in the USA where kidneys and channel fat remain and retention of the tail in many countries and non AUS-MEAT accredited domestic plants. The adoption of a hot weight payment however moved losses from carcase shrink during chilling to the processor. Earlier payment systems were generally based on an estimated cold carcase weight, typically a 2% deduction from hot weight.

To achieve price equity the price paid per kg for a standard trim carcase must be greater than that of a non-standard carcase with a lighter trim or retained kidneys and tail.

Given that processors compete for cattle supply under standard carcase specifications this is assumed to be factored in to pricing.

The standard trim largely supports efficient processing as excess fat and internal organs are efficiently removed on the slaughter chain while the carcase is hot. This is efficient in terms of labour and in reduced refrigeration due to chilling less fat. Also separation of lean and bone is more efficient in hot compared with chilled product. There are a number of further procedures that are more efficiently done on the chain but which may affect HSCW including:

- Hot boning of the neck. This is far easier to do on the hot carcase and can include removal of bone in addition to muscle separation.
- Removal of the paddywack.
- Chining where the cube roll is separated from the feather bones. This results in an improved cube roll shape and easier subsequent boning. The feather bones could also be logically removed at this point.
- Removal of further fat which is far more efficient when done hot with a Wizard rotary knife.

To comply with the standard carcase weight requirements these processes are done post the scale which requires additional space. Many processors also utilise spray chilling systems to reduce carcase weight loss in the chiller.

BASIC AND ALTERNATIVE CARCASE CATEGORY

Current legislation requires all bovine carcases to be assigned to one of three designated categories: Veal *V*, Beef *A* or Bull *B*. The requirements for each are summarised in Figure 2 (Anon, 2005). Approved ciphers and symbols are extensively used in practical language application and can be used in place of, or in addition to, fully written descriptions. When used in trade description ciphers must appear in a set order and are bracketed by asterisk, for example *A* or, for a cut, *SS – RMP* (Anon, 2014). This is of particular value in conserving space in many labelling applications.

Of note is that the veal *V* primary category is principally defined by HSCW being no more than 150 kg and that bull *B* is primarily defined by the presence of secondary sexual characteristics (SSC) rather than testicles. It is possible for a castrated animal to be classified as bull *B* and for an entire male to be classified as beef *A*. This is a cause for concern and will be discussed in later sections.

Within the basic veal *V* category there are optional supplementary classes as follows:

- VEAL – BOBBY defined as weighing no more than 40kg HSCW.
- VEAL – LIGHT VEAL defined as weighing no more than 70kg HSCW with veal meat colour.
- VEAL defined as weighing 70.1 to 150kg HSCW with veal meat colour.

There are also alternative categories to BEEF *A* and to BULL *B* as presented in Figures 3 and 4 (Anon, 2005).

The Beef *A* alternative categories are based on a combination of sex within dentition categories that, for carcases with no more than 7 permanent incisor teeth, allows specification of male only or male and female but not female only. For example *YGS* is steer only whereas *YG* is steer or heifer. Cow *C* relates only to females with 8 teeth whereas steers with 8 or less teeth and females with no more than 7 teeth can be designated *SS*. Carcases can be "packed down" to a lesser alternative category but not up.

Figure 2: AUS-MEAT category requirements

BOVINE – BASIC CATEGORIES (VEAL / BEEF / BULL)

DENTITION	DESCRIPTION	CATEGORY/CIPHER
0	**VEAL** - **Female or castrate or entire male** bovine that: ◆ Has no evidence of eruption of permanent incisor teeth. ◆ Weighs no more than 150kg (HSCW). ◆ In males after SSC assessment shows no evidence of SSC. ◆ Shows youthfulness and Veal colour (Veal meat colour must not exceed the AUS-MEAT Veal colour standard V5).	VEAL * V * Optional Veal classes: Refer Veal section
0 - 8	**BEEF** - **Female or castrate or entire male** bovine that: ◆ In males shows no evidence of Secondary Sexual Characteristics (SSC). ◆ Dentition range for this category is 0 to 8 permanent incisor teeth.	BEEF * A * OR BEEF
0 - 8	**BULL** - Derived from **entire or castrate male** bovine animals showing signs of Secondary Sexual Characteristics (SSC). ◆ (SSC) in bovine are defined by the following well developed aspects: • Muscles on the neck and shoulder. • Inguinal canal and prominent erector muscle • Penis stub. • Pubic tubercle. Exposed area of M. semimembranosus muscle-triangular and, relatively scarce scrotal fat and dark muscle colour.	BULL * B *

: Secondary Sexual Characteristics

*Figure 3: AUS-MEAT alternative categories for BEEF *A**

BOVINE – ALTERNATIVE CATEGORIES (BEEF)

* Chronological age as shown is approximate only

DENTITION	DESCRIPTION	CATEGORY/CIPHER
0	Carcase is derived from **castrate or entire male** bovine that: ◆ Has 0 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	YEARLING STEER * **YS** * * Up to 18 months
0	Carcase is derived from **female, castrate or entire male** bovine that: ◆ Has 0 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	YEARLING BEEF * **Y** * * Up to 18 months
0 - 2	Carcase is derived from **castrate or entire male** bovine that: ◆ Has no more than 2 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	YOUNG STEER * **YGS** * * Up to 30 months
0 - 2	Carcase is derived from **female, castrate or entire male** bovine that: ◆ Has no more than 2 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	YOUNG BEEF * **YG** * * Up to 30 months
0 - 4	Carcase is derived from **castrate or entire male** bovine that: ◆ Has no more than 4 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	YOUNG PRIME STEER * **YPS** * * Up to 36 months
0 - 4	Carcase is derived from **female, castrate or entire male** bovine that: ◆ Has no more than 4 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	YOUNG PRIME BEEF * **YP** * * Up to 36 months
0 - 7	Carcase is derived from **castrate or entire male** bovine that: ◆ Has no more than 7 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	PRIME STEER * **PRS** * * Up to 42 months
0 - 7	Carcase is derived from **female, castrate or entire male** bovine that: ◆ Has no more than 7 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	PRIME BEEF * **PR** * * Up to 42 months
0 - 7	**OX** – Carcase is derived from **female (only)** bovine that: ◆ Has no more than 7 permanent incisor teeth.	OX * **S** * * Up to 42 months
0 - 8	**OX – STEER** – Carcase is derived from **castrate or entire male** bovine that: ◆ Has up to 8 permanent incisor teeth. ◆ Has no evidence of Secondary Sexual Characteristics (SSC).	OX * **S** * or STEER * **SS** * * Any age
0 - 8	Carcase is derived from **female** bovine that: ◆ Has 8 permanent incisor teeth.	COW * **C** * * All ages

*Figure 4: AUS-MEAT alternative categories for BULL *B**

BOVINE – ALTERNATIVE CATEGORIES (BULL)

DENTITION	DESCRIPTION	CATEGORY/CIPHER
0 	Carcase derived from **entire male** not assessed for SSC. ◆ Has no evidence of eruption of permanent incisor teeth. ◆ Carcase weighs more than 150kg *(HCSW).	YEARLING ENTIRE * **YE** *
0 - 2 	Carcase derived from **entire male** not assessed for SSC. ◆ Has no evidence of eruption of more than 2 permanent incisor teeth. ◆ Carcase weighs more than 150kg *(HCSW).	YOUNG ENTIRE * **YGE** *
0 - 2 	Carcase derived from **castrate or entire male** bovine that: ◆ Has no evidence of eruption of more than 2 permanent incisor teeth. ◆ Show signs of Secondary Sexual Characteristics (SSC). ◆ Carcase weighs more than 150kg *(HCSW).	YOUNG BULL * **BYG** *

* (HSCW) Hot Standard Carcase Weight.

While these alternative categories allow accurate description of the specified criteria there appears to be an element of subjective judgement relative to sex related specification, possibly reflecting trade demand or industry opinion, but not scientific evidence. Relevant issues in this regard include:

- The segregation of male sex but not female in young categories in conflict with livestock description.
- The grouping of 8 tooth male carcases in *S* with restriction of females to a maximum of 7 teeth.
- The use of dentition as a proxy for age and applied equally to males and females. If age is the desired outcome total accuracy would be delivered by date of birth with further alternatives ossification in conjunction with sex or recorded joining periods or progressive branding dates.
- The use of dentition as a proxy for eating quality. Scientific evidence (Watson et al., 2008) suggests a very poor relationship between dentition and eating quality with ossification providing a superior estimation input.

The bull *B* alternative categories are defined by dentition and HSCW. Of note is that the first two alternative categories, *YE* and *YGE* apply to entire males where SSC are not assessed and that all three relate only to carcases with two or less permanent incisor teeth. The BYG category can include both entire males and castrates showing SSC.

Some issues of potential relevance include:

- The possibility of *YE* and *YGE* being directly equivalent to *Y*, *YS*, *YGS* and *YG* given no signs of SSC.
- Potential management of young bull carcases produced with table beef as the planned use rather than breeding.
- Uncertain definition of bull for MSA model input.

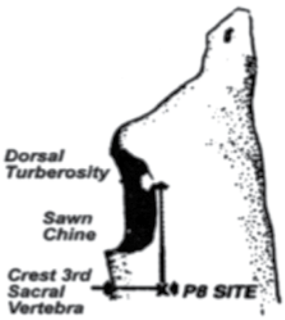
Young bulls are a very common beef production system in some countries including New Zealand and in particular continental Europe where bulls are often more prevalent than steers. Early international studies have found small and variable differences in eating quality in several beef cuts collected from bull and steer carcases (Jacobs et al., 1977; Dransfield et al., 1984). More recent data where animals were sourced from intensive pasture based systems typically producing carcase weights over 350kg at 16 months of age have illustrated little difference to steer equivalents in the same environment (Polkinghorne, Thompson and Watson, unpublished data). Further clarification of entire males without SSC and castrates with SSC in relation to eating quality outcomes is required to clarify appropriate required description.

OTHER CARCASE MEASURES

Other carcase based measures assessed on the hot carcase and used in company specifications and included in producer feedback are:

Mandatory

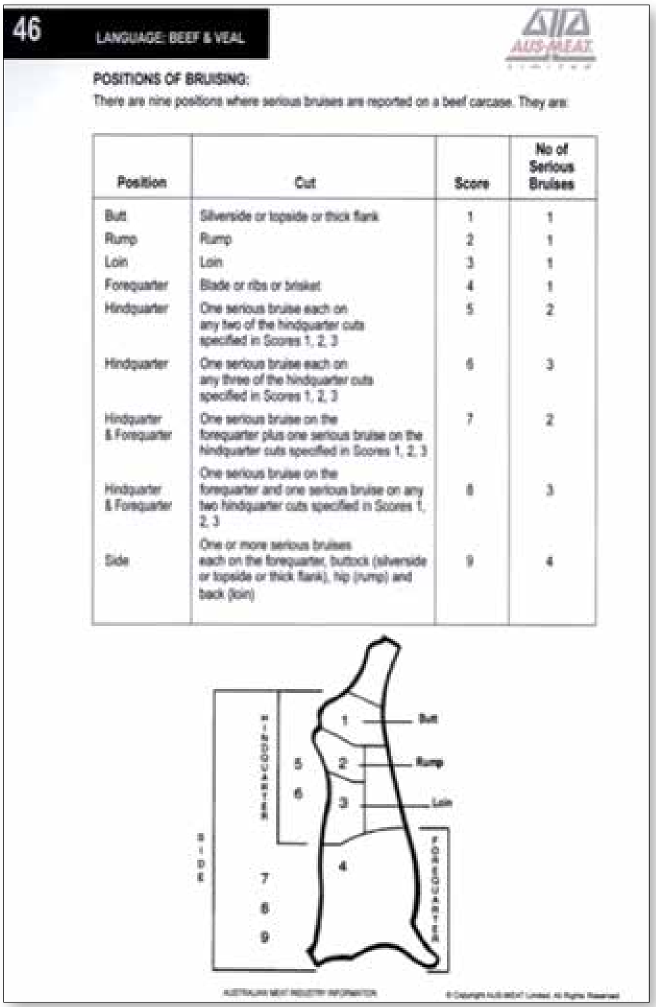
- Hot Standard Carcase Weight (HSCW). Ownership is transferred at the slaughter floor scales for over the hooks (OTH) trading. The carcase weight must be reported.
- P8 fat depth – a measure of external fat thickness at the P8 site (rump). Originally this site was selected from a number of potential sites on the carcase as being a better predictor of percentage carcase yield and having less tearing due to hide puller operation (Johnson and Vidyadaran 1981). However more recent evidence would dispute that there is any less hide puller damage at the P8 compared with the 12th rib site (Hopkins, 1989). The greatest concern is that most live animal assessment of fatness is done at the lumbar site as it is more difficult to assess live animals at the P8 site. This is because at the lumbar site the soft tissue (both fat and muscle) can be palpated against the bone whereas this is not possible at the P8 or sacral site. Better alignment between live animal and carcase would be an advantage in enhancing communication between different sections of the supply chain.



Optional

- Butt shape – assessed against 5 (A, B, C, D and E) carcase silhouettes and adopted as a proxy indication of carcase muscling with implication for carcase yield. A number of researchers have examined the relationship between butt shape and percentage carcase yield (Barton, 1967; Dikeman et al., 1977; Taylor et al., 1990). Without exception these studies have failed to show a relationship between butt shape or conformation and percentage carcase yield.
- Bruise score – A standard bruise reporting system specifies the location of serious bruising in accordance with Figure 5 (Anon, 2014). A bruise qualifies as scorable if; an area of muscle exposed by trimming into the muscle tissue exceeds a 100mm diameter circle or equivalent area or the area is less than 100mm diameter and deeper than 20mm (Anon, 2005).

Table 5: AUS-MEAT Bruise Scoring System (Anon, 2014)



46 LANGUAGE: BEEF & VEAL

AUS-MEAT

POSITIONS OF BRUISING:

There are nine positions where serious bruises are reported on a beef carcase. They are:

Position	Cut	Score	No of Serious Bruises
Butt	Silverside or topside or thick flank	1	1
Rump	Rump	2	1
Loin	Loin	3	1
Forequarter	Blade or ribs or brisket	4	1
Hindquarter	One serious bruise each on any two of the hindquarter cuts specified in Scores 1, 2, 3	5	2
Hindquarter	One serious bruise each on any three of the hindquarter cuts specified in Scores 1, 2, 3	6	3
Hindquarter & Forequarter	One serious bruise on the forequarter plus one serious bruise on the hindquarter cuts specified in Scores 1, 2, 3	7	2
Hindquarter & Forequarter	One serious bruise on the forequarter and one serious bruise on any two hindquarter cuts specified in Scores 1, 2, 3	8	3
Side	One or more serious bruises each on the forequarter, buttock (silverside or topside or thick flank), hip (rump) and back (loin)	9	4

AUSTRALIAN MEAT INDUSTRY INFORMATION

Both P8 fat and butt shape are used as a proxy for yield (saleable meat kg often expressed as a % – kg saleable meat/HSCW) estimates and, while assessed against defined standards, are widely regarded as being deficient due to:

- Overall carcase fat distribution being poorly reflected by the P8 site measurement, sometimes due to site damage but also due to variable distribution.
- Irregular assessment of butt shape between assessors and difficulty in attaining consistent outcomes.
- Saleable meat yield estimates utilising HSCW, sex, dentition, P8 and butt shape proving to have low accuracy, with addition of eye muscle area (EMA) where available providing little improvement.
- Allocation of blame/responsibility for bruising; did it occur on farm, during transport or at the abattoir?

Despite these perceived shortcomings the measures are commonly included within company specifications and payment grids with consequent impact on value. Existing alternatives include the EUROP system which utilises either visual or computerised vision systems to assess total carcase muscling and fat distribution.

Active consideration of alternatives including potential advanced technologies appears warranted.

WEIGHT AND FAT CLASSES

Optional standard carcase weight and fat classes are defined in AUS-MEAT language and may be used to classify carcases or sides, quarters or portions derived from carcases (Anon, 2014). Weight class is expressed as a number being maximum HSCW/10 with, as examples, 4 being up to 40kg HSCW, 7 from 40 to 70kg, 28 from 260 to 280kg and 46 above 440kg.

Fat classes are based on the P8 measurement and range from 1 (up to 2mm P8) to 6 (32mm and higher). Fat classes 2 to 6 may be further subdivided into – and + with, for example, 3- being a P8 of 6 to 9mm and 3+ being 9 to 12mm.

Both the weight and fat class definitions use common values as the upper limit of one class and the lower of the next so that, as used in the preceding example a P8 of 9 could be 3- or 3+. In carcase weight classes a HSCW of 280 could be either a 28 or 30. This should be amended for clarity.

An issue to consider in regard to fat and weight classes is their relationship to live animal language and consistency of descriptions used within NLRS (National Livestock Reporting Service), Auctions Plus, the Eastern Young Cattle Indicator (EYCI) and AUS-MEAT Livestock language. A combination of AUS-MEAT weight and fat class is commonly used in livestock description but far less so in meat trading where specifications are typically more specific as applied at cut level. The weight and fat class system is perhaps more applicable to the carcase trade which has declined in the Australian domestic market. Any increase, including exported quarter beef, may result in wider application and a consequent need to review or confirm the existing standards.

Any examination of carcase trade description might also consider major international systems including EUROP where the E.U.R.O and P refer to muscling and are used in conjunction with a 1 to 5 number to signify fat cover.

ACCELERATED CONDITIONING

An AC symbol may be used in addition to base carcase description to describe alternative accelerated conditioning methods used for other than cow and bull categories (Anon, 2014). Approved methods are electrical stimulation, tender stretched and controlled pH reduction.

AGEING

An AGED symbol and description can be used where the method of ageing is approved by AUS-MEAT, documented and monitored within company quality assurance programs.

FEEDING STANDARDS AND RAISING CLAIMS

Standard descriptions to define grainfed beef have been used for a considerable period and are incorporated in AUS-MEAT language. Early usage in State controlled carcase strip branding schemes is now uncommon but not precluded. The two commonly used grainfed symbols are GF and GFYG with GFD (grainfed domestic) a supplementary specification for purple strip branding (Anon, 2014).

Both categories require a minimum feedlot feeding period and minimum carcase criteria defined by AUS-MEAT base and chiller assessment criteria. While there is no MSA grade requirement a majority of these carcases are routinely MSA graded. This reflects the standards being established prior to the development of MSA and raises questions as to whether the use of days on feed and dentition within the standards might be reviewed and potentially replaced by MSA based eating quality criteria.

Use of the GF and GFYG description is restricted to National Feedlot Accreditation Scheme (NFAS) accredited feedlots. The NFAS is an industry self-regulatory quality assurance scheme administered by AUS-MEAT on behalf of the feedlot industry (Anon, 2014). To be eligible all cattle presented for slaughter must be accompanied by an NFAS delivery docket or agents declaration.

GRAINFED SYMBOL GF SPECIFICATIONS ARE:

- Minimum of 100 days on feed with further specification of minimum ration specification.
- 6 permanent incisor teeth maximum except where carcases have only partially ossified thoracic vertebrae.
- 7 mm minimum P8 fat depth.
- Meat colour score of
- 1a, 1b, 1c, 2 or 3.
- Fat colour score of 0 to 3.

GRAINFED YOUNG BEEF SYMBOL GFYG SPECIFICATIONS ARE:

- Minimum of 70 days on feed for steers and 60 days for females with further specification of minimum ration specification.
- 0 to 2 permanent incisor teeth.
- 5 mm minimum P8 fat depth.
- Meat colour score of 1a, 1b, 1c, 2 or 3.
- Fat colour score of 0 to 3.

PCAS:

A pasture fed cattle assurance scheme (PCAS) has recently been introduced which requires externally audited producer certification of compliance with four mandatory and two optional production based elements. Carcase assessed criteria include Meat Standards Australia (MSA) compliance. The mandatory elements comprise:

1. Identification and lifetime traceability.
2. Non confinement for the purpose of intensive feeding for production.
3. Lifetime pasture fed.
4. Minimum eating quality standards with MSA accreditation.

The optional elements are:

1. HGP free.
2. Antibiotic free.

ORGANIC/BIODYNAMIC:

The Australian national standards for organic and biodynamic production were first introduced in 1992 and are administered by AQIS and implemented by six independent AQIS accredited organisations (Anon, 2015).

The feed and raising claim specifications differ from the previous described language usage in two areas:

1. They require a transfer of certified information with the live cattle to establish eligibility.
2. The NFAS and PCAS systems require additional information from chiller assessment.

PRODUCER INFORMATION REQUIRED ON DELIVERY FOR SLAUGHTER

Currently there are many and diverse livestock related information inputs that may be required at slaughter including the standard National Vendor Declaration (NVD) inputs for HGP use, animal health treatments and access to by-product feeds, EU, NFAS, PCAS or organic eligibility plus breed and other declarations or weigh bills. These are accumulated from multiple sources, often paper based, creating considerable work post arrival and a risk of mistakes. Given that all cattle must carry the NLIS electronic tag the option of utilising this as an index to electronic data that contains other required data may warrant consideration. A further and related consideration could be to strengthen use and consistent application of the livestock language by consolidating all pre slaughter data sources within its jurisdiction, possibly related to on farm auditing and licensing.

PRODUCER FEEDBACK

Where cattle are sold to AUS-MEAT accredited abattoirs mandatory feedback data must be provided to the producer. For all cattle other than cows and bulls, individual carcase data recording hot carcase weight, P8 fat measurement (mm), dentition and bruise score must be provided. For cows and bulls, individual carcase data recording must include hot carcase weight, bruise score, and where P8 fat measurement is used to determine price, P8 fat measurement (mm) and, where dentition is used to determine the alternative category Young Bull *BYG*, dentition (Anon, 2006).

CARCASE LANGUAGE ISSUES

1. Consideration of changing bull and veal from basic to alternate categories. While requiring federal legislative change this may simplify product description within an enlarged *A* basic category and better relate to prospective production systems now common in other countries while also aligning better with scientific findings in regard to product characteristics.
2. Review alternative means of assessing animal age.
3. Review inclusion of butt shape as an indicator of carcase yield
4. Reassess the validity of sex distinction within alternate categories against scientific evidence and current market demand.
5. Monitoring and evaluation of existing and potential technologies that may provide improved accuracy in estimating yield incorporating fat and muscling variation.
6. Review alignment of weight class, fat class and muscling with live animal language.
7. Consider strengthening livestock language to consolidate all live animal information to be carried forward under a single NLIS indexed link with further consideration of implementing farm licensing and auditing.

CHILLER ASSESSMENT LANGUAGE

ASSESSMENT CONDITIONS

Standard conditions are mandated for chiller assessment to facilitate uniform and accurate appraisal. Ribbing and assessment must only proceed after the following post slaughter period (Anon, 2014).

1. 8 hours where the carcase has been electrically stimulated;
2. 18 hours where electrical stimulation has not been used;
3. Other time periods approved under AUS-MEAT controlled pH reduction systems; or
4. Other approved periods.

The carcase must have reached an ultimate pH value prior to assessment with the loin temperature below 12°C. The assessment site must also be free of bone dust and irregularities or damage that may impact assessment. Further conditions relate to lighting via a standard torch, adequate room to assess and positioning of the assessor and torch.

The carcase must be ribbed at least 20 minutes prior to assessment to allow blooming and assessed within 3 hours of ribbing unless the exposed eye has been covered with a film.

Recent research evidence suggests that these conditions achieve the desired pH criteria and in general align with adequate bloom time for colour assessment other than in as yet unexplained circumstances where meat colour remains initially high relative to pH but eventually changes to a normal relationship.

There is also a long-standing observation that marbling results are better after a 48 hour or longer chill suggesting that time and temperature relationships are not as yet fully understood. This was recently investigated in ca. 200 carcases by assessing alternate sides quartered at 24 and 48 hours. Marble score was found to increase 0.8 units over this period (Thompson, J.M unpublished data).

ASSESSMENTS

Chiller assessment language (Anon, 2005) is applied to describe carcases after chilling and quartering, with hump height and ossification also able to be measured on the hot carcase. The basic AUS-MEAT chiller assessment elements may be used alone or augmented by further measures for MSA grading. Chiller assessment language components are:

- **Meat colour** assessed within 9 categories for beef *A* and 5 categories for veal *V*. Whereas the veal colour standards are numbered 1 to 5 with redness increasing with number the beef standards commence with 1a, 1b and 1c then continue as whole numbers from 2 to 7 with 7 being anything darker than the 6 chip. In all cases the standards used (a set of chips purchased from AUS-MEAT for use by certified assessors) represent the darkest colour within the standard.
- **Fat colour** assessed within 10 categories from 0 to 8 in increasing colour with 9 being any colour darker than the 8 chip.
- **Rib fat depth** assessed by measuring the thickness of the subcutaneous fat in mm at a specified rib. The grader can make an adjustment if they observe evidence of fat tearing. This figure has an 'E' after the fat depth estimate.
- **Eye muscle** (*M.longissimus dorsi* muscle) area (EMA) measured using a transparent grid which is placed over the eye muscle and recorded in cm^2.
- **Marbling** assessed under either or both of two systems – AUS-MEAT and MSA. The AUS-MEAT marbling standards (computer generated images of eye muscles with differing levels of marbling) are numeric from 0 to 9 with assessment above 6 requiring assessors to hold a high marbling endorsement. The AUS-MEAT marbling score signifies the amount of visual marbling fat in the eye muscle.

  The MSA marbling standards utilise the same standards but numbered in increments of 100 to 1100. Further subdivision to tenths is applied by the MSA grader who records marbling as 310, 320 etc from 100 to 1190. MSA marbling assessment includes evaluation of the fineness and distribution of marbling pieces. All chiller assessors must pass correlation tests against the computerised AUS-CAP system each 8 weeks.
- **Ossification** assessed against pictorial standards from 100 to 590 in tenths. Individual standards in units of 10 are provided from 100 to 200 with broader divisions between 200 and 590. The ossification scores provide a scale for assessment of physiological maturity of an animal. While the standard ossification assessment is made on a chilled carcase it may also be calculated by adding 10 points to a hot carcase appraisal. With many large processors utilising the hot ossification option the veracity of this relationship should be tested further.

  While ossification scores increase with animal age the rate of increase varies with individual animals related to the environmental conditions under which they were raised and hormone levels associated with pregnancy and HGP use so that while actual age, ossification and dentition all increase they are generally not well correlated.
- **Hump Height** measured in mm and used as a cross check against advised TBC or as a direct estimate of TBC in the MSA model. The cross check calculation was originally designed to check hump height range versus carcase weight and declared TBC% to indentify inconsistencies rather than as a direct estimating tool. The direct estimate of TBC% from hump height is conservative and not accurate (unpublished data Watson, MSA Pathways Committee). Further data are required to establish an appropriate eating quality relationship using hump height as a direct input to MSA grading.
- **Ultimate pH** measured by a calibrated pH meter and recorded to two decimal places with the associated temperature. An upper limit of 5.70 is required for MSA grading. pH is measured as the negative log of the hydrogen ion activity in the muscle. The hydrogen ion activity is a function of temperature. Therefore at warmer temperatures there is a greater concentration of H^+ ions present due to the release of protons from buffers and the pH reading of the muscle will be lower or more acidic than if measured at a cooler temperature when less H+ ions are present due to binding by the buffers. A correction proposed by Bendall and Wismer-Pedersen (1962) is applied so that the pH reading of the muscle is adjusted to 7°C.

MSA GRADE AND SUBSEQUENT CARCASE GROUPING

Where cattle are MSA graded chiller assessment language components (marbling and ossification scores, hump height, ribfat and pH) are utilised together with primary language components of sex, HSCW and carcase suspension plus additional live animal data for HGP, TBC and whether the animal was weaned to calculate the MSA grade (Fail or ungraded, 3*, 4* and 5*). This result is determined at the time of chiller assessment by entering the required data in a DCU (data capture unit) for processing. There is no single carcase grade but rather a current 146 individual cut by cooking method outcomes indicating the predicted consumer satisfaction with each of 39 individual muscles cooked by specific methods. A maximum meat colour score is included as a threshold MSA grade criteria but forms no part of the eating quality prediction.

To facilitate carcase marshalling for boning it is common for various combinations of these cut x cook results to be established as MSA Boning Groups (BG) or plant boning runs (PBR) which are currently replacing the traditional standard MSA boning groups. Carcases are grouped and boned in the assigned runs with the cut descriptions aligned to the broad language and MSA outcomes.

MSA PRODUCER FEEDBACK

Where carcases are MSA graded primary MSA grade inputs must be provided for each carcase via producer feedback together with the grading outcome. These add sex, ossification, AUS-MEAT and MSA marbling, meat colour, hump height and rib fat depth to the mandatory OTH trading measures (HSCW, P8 fat depth and bruise score). Further data may also be provided in MSA feedback and are available via the MyMSA website. The additional measures available are hormone growth promotant (HGP), RFID, hang method, fat colour, milk fed veal (MFV), tropical breed content (TBC%), eye muscle area (EMA), pH and the associated loin temperature, fat distribution, hide puller damage and the MSA Index (Anon, 2007).

CHILLER ASSESSMENT LANGUAGE APPLICATION IN TRADITIONAL DESCRIPTION COMPARED TO MSA

Prior to the introduction of MSA, chiller assessment elements were used in conjunction with alternative category and other descriptions to describe product, with the factors used and related standards determined purely by commercial agreement. A particular cut could therefore be specified as *YGS-Shortloin* MC:1a-3 FC:0-3 MB2-4 with further specification of GF 200 days and so on. This remains current practice in most export trade and is centred on describing product in terms of appearance and assessed factors that in combination the trade believe will meet a market requirement. Early efforts to develop Australian grading standards adopted this approach with the GF and GFYG descriptions reflecting some of these endeavours.

The essential difference with MSA application is that, while most of the same factors are assessed, they are used as inputs to prediction equations for each muscle with the output carried forward as a predicted level of consumer satisfaction. The cut described above might be described as GRL MSA 4* @ 14 days. Consequently the 8 or so inputs, arguably including the cut itself, become irrelevant as they are superceded by a single outcome related result. This can dramatically simplify description while improving the accuracy of a final consumer result. A subtle but significant result of this is that the onus on predicting the final outcome, presumably the critical issue for table meats, moves to industry from the purchaser who under conventional chiller assessment must grapple with the mix of inputs and their interaction to meet a desired standard. This does not diminish the essential value of the traditional chiller assessment system; it remains critical to assess eating quality inputs used in the background for grade calculation and for forward direct customer description in terms of outcome, portion weights, packaging and any desired preparation standards.

It may be noted that while dentition assumes a central role in defining the alternative category it is not utilised in the MSA prediction as it has not proved to be useful. There is often some conflict where MSA grading is applied after grouping carcases on traditional alternative category lines resulting in further carcase marshalling and cut labelling complexity. For example the product above may be described as *YG-SHORTLOIN* MSA with a GRL MSA 4* @ 14 day description. As *YG* reflects dentition it is unrelated to the MSA grade outcome but carcase marshalling must segregate *YG* to ensure truth in labelling. Further there may well be another boning run of *YP* carcases of identical MSA grade description but not able to be mixed unless the *YG* group are “downgraded” to *YP*.

The situation is further complicated where company livestock purchasing grids or customer specifications use a mix of alternative category, chiller assessments and MSA grading and where international access agreements include AUS-MEAT language terminology based on alternative category.

Potential solutions to these complications may include creating a further alternative category of “Eating Quality Graded” which could be used as a substitute for the dentition based ciphers. Where there are no external cipher requirements this can be achieved at present by packing a cut under the primary category of Beef so that rather than a striploin being labelled *PR-STL* MSA it can be labelled STRIPLOIN MSA providing the label also carries the generic Boneless Beef wording.

CHILLER ASSESSMENT ISSUES

A number of issues are evident within the chiller assessment language, standards and application that require evaluation including:

1. Verification of physical chiller assessment conditions and their interaction with colour and marbling measures.
2. Possible current and future technical capacity to utilise objective measurement for key existing or alternative criteria. Examples could be imf% (intramuscular fat%) in lieu of marbling, image analysis evaluation of marbling, meat colour, EMA, rib fat and other measures or electronic meat colour assessment.
3. Graduation of meat colour chips to a linear numeric scale to replace 1a, 1b and 1c.
4. Do we need two marbling systems or should we reduce to the MSA standard?
5. Clarification of the relative roles and benefits of alternative age and maturity measures. This should reflect two separate objectives; the prediction of eating quality, where ossification may be expected to replace dentition given current knowledge, and the assessment of animal age to meet BSE oriented objectives.
6. Validation of hot and cold ossification score relationships.
7. Further research from additional data to improve the accuracy of hump height as a direct MSA model input.
8. Consideration of inherent conflict between alternative category and MSA description and potential solutions including creating an Eating Quality Graded alternative category together with incorporating this in applicable country to country agreements.

CUTS LANGUAGE

Standard cut language is a continuation from carcase language with primary or alternative category linked to common code ciphers and cut descriptions/names. Further specification of cutting lines and preparation detail is detailed within the Handbook of Australian Meat (HAM). One of the undoubted strengths and successes of AUS-MEAT language is the extensive standardised description of cuts as expressed in the HAM, exemplified by adoption of HAM carcase and cut description as a UNECE standard and continued strong demand for copies from many countries (I King, pers.comm.). Further language detail provides for specification of packaging and extensive detail in relation to application and labelling. These language components are extensively and successfully used in all markets.

Further extension into standardised retail cut descriptions via the register of cuts and items has been less extensively adopted and there are many inconsistencies in common cut naming across states, retailers, food service outlets and in export markets.

Key components of cuts-based language include:

THE HANDBOOK OF AUSTRALIAN MEAT (HAM)

The HAM provides a solid reference point for description of carcases, and major carcase portions including quarters, pistola hindquarters, butts and both bone in and boneless cuts together with manufacturing packs. Each HAM product item is assigned a 4 digit numeric code and accompanied by a diagram depicting the source carcase location and a photograph. A written description of cut preparation and points requiring further specification such as minor muscles that may be included or removed from the primal cut is provided.

Related codes that represent different levels of standard preparation from a common primal are mostly assigned closely related codes in a logical order so that a full tenderloin is 2150, a side strap off tenderloin 2160 and a butt tenderloin 2170 for example. Some cuts are assigned two alternative codes under different widely used names, for example Topside 2000 and Inside 2010, reflecting differences in domestic and export terminology.

Provision is also made for combination packs allowing for mixed hindquarter, forequarter or other combinations of cuts under individual product item codes. Further definition is provided for boneless beef manufacturing packs and for trimmings, diced meat, strips and mince with additional provision for agreement between buyer and seller.

Further basic anatomical, skeletal and muscle identification charts including the Latin muscle names are also included to facilitate correct identification. The HAM also provides a chart of estimated weights for key primal cuts related to carcase weight together with basic descriptions of the AUS-MEAT language including basic and alternative categories, chiller assessment language, packaging and labelling. Principal industry programs including MSA are also summarised.

The HAM is also published as an "International Red Meat Manual" and is widely used as a reference in international trade. This adoption has provided value to Australian exporters in establishing standard Australian descriptions as a common language across many markets somewhat simplifying production and labelling complexity.

REGISTER OF CUTS AND ITEMS: BEEF *(ANON, 2014)*

The register of cuts and items: BEEF defines standard cut names, associated HAM codes for bone in beef cuts and items and boneless derivatives, special references where applicable and in most cases a common two to seven length alpha Common Code cipher. For example Blade is a cut description for HAM code 1620 which is a bone in product and also for HAM code 2300 which is boneless. Both are assigned a common code cipher of CLO.

The common code cipher abbreviations are a mix of direct abbreviation of the register cut name; BOL for bolar blade, BKT for brisket and TDR for tenderloin for example and of alternative cut name abbreviations; CLO being shortened from CLOD but named Blade and CT from Chuck Tender but named Blade Roll for example. This reflects multiple names, for example clod and blade, blade roll and chuck tender and fillet and tenderloin where the same cut has multiple different names often reflecting either export and domestic or state by state common usage.

In this respect the common codes are more consistent than the cut names in common usage. This is also true of the special references where a bolar blade (BOL) is derived from a clod (CLO) rather than the alternative Blade (CLO). While initial logic may encourage reduction of these naming inconsistencies to a similar common code equivalent basis, history indicates that this may not be an easy path to pursue.

REGISTER OF CUTS AND ITEMS: VEAL *(ANON, 2014)*

The veal section of the register is aligned with the beef format with two weight ranges for cuts and items derived from veal *V* carcases under 70kg and between 70.1 and 150kg HSCW.

In both the beef and veal register sections there is provision to apply for registration of new cuts and further approved abbreviations for items that do not have common code ciphers, for example FQ for forequarter, HQ for hindquarter and CP/Off for cap off.

MSA MUSCLE AND CUT CODES

The MSA program has evolved through research activity commenced in the early 1990's. For research purposes testing has been conducted at a muscle rather than primal cut level where a conventional primal includes multiple muscles. Some muscles are also present in multiple cuts and some vary in eating quality with position. Standard MSA muscle coding was developed with a three character alpha to designate the standard primal, for example STR for striploin followed by a three digit numeric using the HAM muscle list, for example 045 (M. longissimus dorsi) to describe striploin as STR045. Further portions of the same muscle are described as CUB045 in the cube roll and CHK045 in the chuck. Where muscles are seamed out they may be sold under their individual MSA grade and where several are sold together as a primal cut the lowest rating determines the primal cut grade.

These codes are used in MSA grade application but currently are not disseminated beyond that. Again they differ from common code ciphers in some areas with CUB rather than *CUR* and STR rather than *STL* prominent examples. Further anomalies exist due to MSA positional descriptions which have a notional RMP031, which would align with the *RMP* cipher and 031 HAM muscle number expressed as RMP131 and RMP231 to differentiate two muscle portions or STA and STP to differentiate between anterior and posterior striploin *STL* positions. Further effort to achieve standardised coding should be considered.

A further consideration where product has been MSA graded is the possibility of packing under a cooked quality description rather than being obliged to incorporate cut names. Addition of “EQ beef for stir fry” type codes within the H.A.M system would enable companies to pack multiple muscles from possibly divergent carcases where these all were assigned a standard MSA grade such as SFR 3*.

STANDARD CUT DESCRIPTION AND THE AUSTRALIAN COMMON CODE

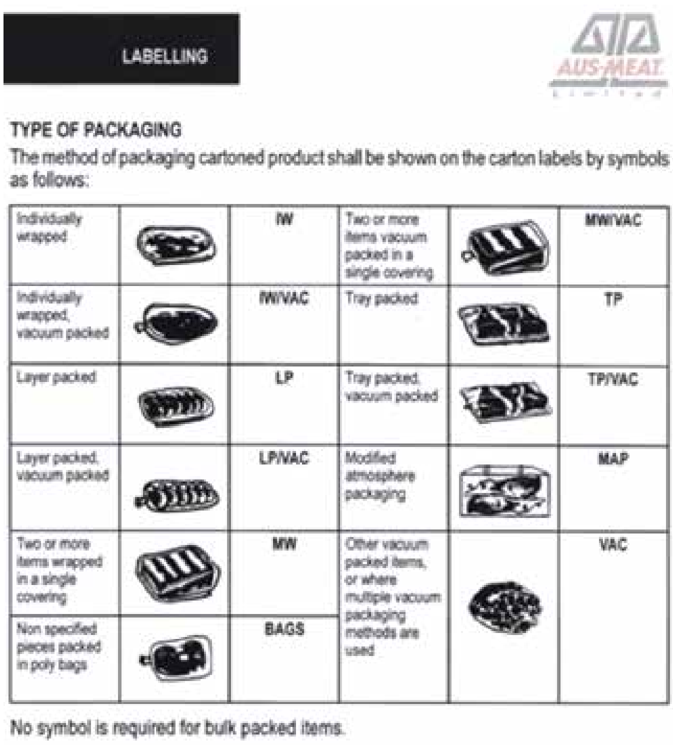
Standard cut description language is in essence a combination of basic or alternative category and the cut and item register name or cipher with further specification delivered by an associated HAM code. Thus a Striploin may be labelled *YG* STRIPLOIN or *YG-STL* and ordered as HAM2140. Due to the inconsistencies noted in naming conventions the common code ciphers offer benefits both in more consistent description of cuts or items and in physical aspects of available space on carton labels.

A further substantial benefit of the cipher applies when exporting product to some countries, notably the USA, Canada and Japan which accept the ciphers as primary description, sometimes simplifying import inspection. An example (Anon, 2014) is that whereas a carton labelled STEER INSIDES requires opening and inspection by USDA inspection to verify that the carton contains steer insides, if labelled *S-INS* inspection is not required.

TYPE OF PACKAGING

The type of packaging must appear on the outside of the carton or package in accordance with Figure 6. No symbol is required for bulk packed product.

Figure 6: Packaging Type Descriptions and Codes


LABELLING

TYPE OF PACKAGING

The method of packaging cartoned product shall be shown on the carton labels by symbols as follows:

Individually wrapped		IW	Two or more items vacuum packed in a single covering		MW/VAC
Individually wrapped, vacuum packed		IW/VAC	Tray packed		TP
Layer packed		LP	Tray packed, vacuum packed		TP/VAC
Layer packed, vacuum packed		LP/VAC	Modified atmosphere packaging		MAP
Two or more items wrapped in a single covering		MW	Other vacuum packed items, or where multiple vacuum packaging methods are used		VAC
Non specified pieces packed in poly bags		BAGS			

No symbol is required for bulk packed items.

FOOD SERVICE DESCRIPTIONS (ANON, 2014)

AUS-MEAT language includes a provision for use of food service terms and some associated general codes that may be used in specification. Examples include Butterfly and medallion, both code Z, Comminuted or Ground, both code X or Portion, code P, and a generic Vale added coded V. While there is no register for these cuts or items the suffix codes can be added to the H.A.M number and cut/item name to create for example BEEF SHORTLOIN STEAKS – 1550Z.

Retail and food service operators also adopt more creative terms without feeling constrained by standard language conventions!

DOMESTIC LABELLING FOR 8 TOOTH CATTLE

When sold in NSW primal cuts derived from animals with 8 permanent incisor teeth must comply with the Budget Beef Selection Program requirements (Anon, 2014) which include three grades;

- BUDGET OX which can be packed from Ox *S* or Steer *SS* with a maximum of meat colour 4 and fat colour 4.
- BUDGET COW which can be packed from Beef *A* or Cow *C*. Meat and fat colour must each not exceed 5.
- MANUFACTURING packed from male or female 8 teeth carcases in *S*, *SS*, *A* or *C* carcases with no further requirements.

The legislative adoption of the Budget Beef Selection Program in a single state adds complexity in packing meat where the final point of sale may not be known.

CUT LANGUAGE ISSUES

Some issues identified as warranting consideration within the current cuts language structure include:

1. Examination of multiple descriptions, ciphers and symbols for individual cuts or items to identify possible simplification.
2. Consideration of additional H.A.M codes to facilitate packing of Eating Quality graded product within a cooking method description without mandatory cut identification allowing companies to pack mixed cuts with common eating quality outcomes.

REFERENCES

Anon (2005), *Handbook of Australian Meat*. 7th Edition, AUS-MEAT Limited, Brisbane.

Anon (2006). *Over the Hooks Trading*. AUS-MEAT Limited. (http://www.ausmeat.com.au/industry-standards/over-the-hooks-trading.aspx)

Anon (2007). *Meat Standards Australia – Standards Manual for beef processing Enterprises*. North Sydney, Australia: Meat & Livestock Australia Limited.

Anon (2012). *Bovine Meat carcasses and cuts: UNECE Standard*. New York, Geneva: United Nations.

Anon (2014). *Australian Meat Industry Classification System*. Brisbane, Australia: AUS-MEAT Limited.

Anon (2014b). *Master index of AUS-MEAT advices*. (Revision 07/08/2014). AUS-MEAT Limited.

Anon (2015). *Organic and Biodynamic Produce: Certification of Organic Produce in Australia*. Australian Government. Department of Agriculture. (http://www.agriculture.gov.au/ag-farm-food/food/organic-biodynamic) Last reviewed 25th Feb 2015.

Barton, R.A. (1967). The relation between live animal conformation and the carcass of cattle. *Animal breeding abstracts*, 35, 1-22.

Bendall, J.R., & Wismer-Pedersen, J. (1962). Some properties of the fibrillar proteins of normal and watery pork muscle. *Journal of Food Science*, 27, 144-159.

Dikeman, M.E., Merkel, R.A., & Magee W.T. (1977). Effects of beef type on bone, fat trim and retail cut yield and distribution. *Journal of Animal Science*, 45, 708-715.

Dransfield, E., Nute, G.R., & Francombe, M.A. (1984). Comparison of eating quality of bull and steer beef. *Animal Production*, 39, 37-50.

Hopkins, D.L., (1989). Reliability of three sites for measuring fat depth on the beef carcass. *Australian Journal of Experimental Agriculture*, 29, 165-168.

Jacobs, J.A., Miller, J.C., Sauter, E.A., Howers, A.D., Araji, A.A., Gregory, T.L., & Hurst, C.E. (1977). Bulls versus steers. II Palatability and retail acceptance. *Journal of Animal science*, 45, 699-702.

Polkinghorne, R.J., & Thompson, J.M. (2010). Meat Standards and Grading: A World View. *Meat Science*, 81, 227-235.

Taylor DG, Meehan DP, Johnson ER Ferguson DM (1990) Shape score of beef carcasses as a predictor of saleable beef yield, muscle and fat content. *Proceedings of the Australian Society of Animal Production* 18:392-395.

Taylor, D.G., Meehan, D.P., Johnson, E.R., & Ferguson, D.M. (1990). Shape score of beef carcasses as a predictor of saleable beef yield, muscle and fat content. *Proceedings of the Australian Society of Animal Production*, 18, 392-395.

Watson R., Polkinghorne, RJ., Thompson, JM. (2008) Development of the Meat Standards Australia (MSA) prediction model for beef palatability. *Australian Journal of Experimental Agriculture*, 48, 1368-1379.

Watson, R., Polkinghorne, R.J., & Thompson, J.M. (2008). Development of the Meat Standards Australia (MSA) prediction model for beef palatability. *Australian Journal of Experimental Agriculture*, 48, 1368-1379.

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