Current usage and future development of the Meat Standards Australia (MSA) grading system

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Abstract. Progress in the development and adoption of the Meat Standards Australia system has encouraged substantial change and an improved consumer awareness at all points of the Australian beef production chain. The system is moving from niche to mainstream market application with the exciting potential to transform many industry practices and build a more direct consumer focus. The system aims to accurately predict consumer satisfaction levels for individual cooked beef portions. This is a major advance on grading systems that classify carcasses into groups of like appearance. A prediction model was developed based on consumer testing and has proved to be useful in categorising a wide range of beef into consumer grades within cooking methods. These provide a basis to ensure a predictable eating quality result for the consumer and a mechanism to align product description and pricing throughout the production chain. When used in value-based marketing systems financial reward can be directly linked to consumer satisfaction encouraging a consumer-focussed industry. Research is proceeding to extend and improve the accuracy of the prediction model encompassing additional cattle types and cooking methods. Several projects in other countries are adding insights into the relative response of consumers from varied cultural backgrounds. It is hoped that further international collaboration will facilitate use of the developed technology to improve consumer value and industry returns through improved product consistency in global markets.

Additional keywords: beef grading, beef quality, value-based pricing.

Current usage: industry adoption

The Meat Standards Australia (MSA) system assigns one of four eating quality grades (unsatisfactory, 3 star, 4 star and 5 star) to 40 individual carcass muscles cooked by up to six alternative methods. In effect, this assigns 137 grades to any carcass, for each number of days aged. The objective is to predict the degree of consumer satisfaction with an individual meal rather than to describe a carcass. As the output is an eating quality result, conventional descriptions such as cut, breed or age can be supplanted by the end result: a 5-star steak or 3-star stirfry for example, if desired.

The grade is assigned by a statistical prediction model, which estimates a composite consumer (MQ4) score on a 0–100 scale for each muscle × cook outcome from inputs of *Bos indicus*%, sex, carcass weight, ossification, marbling, rib fat, carcass suspension method and ultimate pH. The estimation procedure has been developed from analysis of a database recording consumer testing results in relation to recorded cut criteria. The current model reflects data from over 32 000 cuts evaluated by more than 53 000 untrained consumers.

All consumers were screened to recruit only those consumers aged between 20 and 50 who regularly consumed beef and preferred it cooked medium. Detailed product preparation and testing protocols were used to ensure all meat product was cooked to medium doneness and presented in a uniform manner. All consumers were served seven samples, the first a presumed mid-position 'link' product with the following six ranging widely in quality and presented via a 6 × 6 Latin square design that balanced potential halo and order effects. The protocol development is described by Watson *et al.* (2008*b*).

The model development and utilisation process is illustrated in Fig. 1. An MQ4 score scale is derived from consumer testing. Appropriate weightings are derived for tenderness, flavour, juiciness and overall liking scales to produce an MQ4 score. Further analysis determines appropriate MQ4 cut-off scores to separate quality levels. For each of a wide range of cuts derived from varied backgrounds and subjected to alternative treatments, the MQ4 score results from consumer testing were related statistically to the collected data for each cut. This identified grading inputs useful in predicting the MQ4 result. Individual weightings and interactions between nominated inputs are then used in the grading model to predict the consumer MQ4 result for each muscle at a nominated days aging when cooked by a specified method.
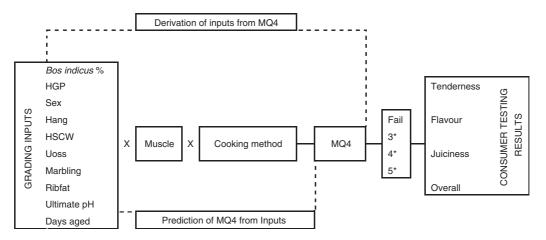
Fig. 1. Representation of Meat Standards Australia model development and application process.

The current model estimates results from steer and female carcasses of any age but does not include bulls. Development of the system has been summarised by Watson *et al.* (2008*a*).

The system can be used at varying levels of complexity and has been licensed on a voluntary basis to Australian processors. The rate and extent of adoption has varied widely across the industry. At the base level, discussion of MSA and an extensive training program has contributed to a greater understanding of eating quality. To date, over 20 000 training modules have been delivered to in excess of 8000 people drawn from the processing, wholesale and retail sectors. This has led to improved practices across the industry and a general improvement in beef eating quality, even where some participants have not formally adopted the MSA procedure.

Training modules address specific areas of operation and have been developed by Meat and Livestock Australia (MLA) and educational providers, principally the University of New England, to address the needs and educational level of target groups. Base-level modules delivered to abattoir employees in areas such as cattle lairage or involved in slaughter floor activity including sticking, electrical stimulation and hide removal are typically very practical in nature and delivered on site in 2–3-h units. Farmer training and licensing workshops are generally delivered locally by extension personnel over a 1-day format. Retail training is delivered at multiple levels commencing at a very basic

system description and progressing to cutting workshops to teach seam boning and more complex application. Other training is delivered at tertiary level over several weeks to those training as graders or in management roles. MLA produces a large number of written and electronic support materials that are freely available by mail or online at http://www.msagrading.com.au. Table 1 summarises training provided by MSA in the period from 2000 to 2008.

A tracking study commissioned by MLA ('Meat Expectations 2003', Millward Brown Australia, consumer research commissioned by MLA, unpubl. data) involving 280 consumers reported that perceptions of beef quality improved in the period from 2000 to 2003 with 38% of those surveyed identifying improved beef quality *v.* 13% believing quality had worsened over the period. Per capita beef consumption also increased by 1.2% to 35.7 kg per person between 2000 and 2006 with the retail value of beef increasing by 59.3% over the same time frame. Two follow-up studies each involving 280 consumers ('Project Angus: Meat Expectations 2005', Stancombe research and planning, consumer research commissioned by MLA, unpubl. data; 'Project Energy: Meat Expectations 2007', The Clever Stuff, consumer research commissioned by MLA, unpubl. data) also indicate improved satisfaction with 45% of respondents in the 2005 study strongly agreeing or tending to agree that 'overall, the quality of beef has

Table 1.   Meat Standards Australia (MSA) training summary

Training package	No. of participants trained	No. of modules delivered	Length of courses
Beef producer workshops	790	790	1 day
Sheep producer workshops	68	68	3 h
Livestock agents and saleyard operatives	753	830	2–3 h
MSA grading	166	166	8 days
Slaughter floor grading	38	38	5 days
Meat science	140	140	5 days
Beef processor training	686	2946	Seven modules, 2–3 h each
Sheep processor training	159	278	Four modules, 2–3 h each
End user training (butchers, chefs or wholesalers)	8266	20 270	2–3 h
Total	11 066	25 526	–

improved over the last 3 years' and the percentage of respondents rating beef quality as 9 or 10 on a 10-point scale increasing from 19% in 2003 to 27% in 2007 (P. Barnard, MLA, pers. comm.). Although it is not possible to partition this increase in both consumption and value, some part is believed to be related to the uptake of MSA grading.

The number of carcasses graded grew from an initial 225 000 in 1999–2000 to 626 000 in 2004–05 and to 786 000 in 2007, representing ~37% of the available national kill (C. Dart, MSA Manager, pers. comm.). MSA projects that some 2.25-million carcasses will be graded annually by 2010–11 (Dart *et al*. 2007). The rate and extent of commercial adoption has varied from limited take-up of specific practices, through basic carcass grading and sale of undifferentiated 'MSA beef', to sophisticated retailing in which product description and pricing is entirely based on graded results without reference to traditional cuts.

Common examples of basic practice modification include reduction of *Bos indicus*% at farm level and attention to pH and temperature relationships on the slaughter floor. Basic adoption of MSA grading is typified by graded carcasses being marshalled into common runs before boning with a limited number of loin cuts collected. These are sold by conventional cut description as 'MSA striploin', 'MSA cube roll' and so on. The product appears in conventional form and is not further divided into alternative grades so is essentially 3 star or better.

The MSA grade has been further used to underpin several branded beef programs where sales promotion typically concentrates on the brand with MSA used in the background to guarantee consistent quality. A further refinement is to separate cuts into 3 star, 4 star and 5 star with differential pricing while retaining traditional description.

Greater sophistication can include the creation of new retail products based on eating quality without reference to source cut or cuts. These products of uniform description and quality may be derived from several different muscles or by seam boning some traditional cuts. The emphasis is shifted from description based on anatomical source to description by expected cooked result.

As experience is gathered, program application becomes more sophisticated with greater potential to improve returns for industry sectors through an improved consumer value proposition. This value proposition is fundamentally based on a guaranteed cooked meal result for a specific portion of beef. Consumer trust is built from demystifying beef purchasing. As the end cooked result is directly described and guaranteed, the consumer does not need any inherent knowledge of cuts and cooking to reliably obtain a 3-, 4- or 5-star result. An accurate value proposition is created by offering guaranteed quality level options at relevant price points. This has not been possible under traditional description systems that have delivered variable quality through a confusing or misleading consumer offer. The potential to improve returns is, however, commensurate with the degree of departure from traditional practice and this presents challenges. Maximum lasting benefits are delivered through value-based supply chains where ultimate consumer value is related to payment and data is shared to enable an optimum response.

Most application to date has applied an MSA eating-quality guarantee to a conventional product description. The removal of beef predicted to be unsatisfactory to the consumer via the grading model has improved product performance and generated premiums within the wholesale and retail trade for beef cuts underpinned by MSA grades. Dart *et al*. (2008) report that pricing survey work conducted by MSA over 9 months in 2005 indicated average retail price premiums averaging $2.18/kg over 10 cuts sold in the capital cities of five states. When calculated back to carcass weight basis, the premium for MSA-graded carcasses was $0.39/kg. The premium at wholesale was $0.29/kg indicating that the additional return was shared across industry sectors.

To date, most graded beef has been marketed as a single product, in essence 3 star or better, rather than being segregated into 3-, 4- and 5-star categories with differentiated pricing. There is an opportunity to increase return by segregating product of different grades, though this would be balanced by additional complexity in managing multiple grade inventories. There is legitimate debate, reflecting the industry's commodity roots, as to the premium that consumers might pay for assured quality, and in turn for assured different quality levels. While tenderloin is universally more expensive than other cuts there is debate as to whether price premiums can be achieved by segregating different graded qualities within common cuts.

Current price premiums are predominantly being generated from an MSA-assured quality being attached to a conventionally described cut. There is further potential to add value in instances where less regarded secondary cuts can achieve the same MSA grade. Examples are upgrading *M. infraspinatis* (oyster blade) to *M. longissimus* (striploin) equivalence, *M. spinalis dorsi* to *M. psoas major* (tenderloin) or grouping *M. gluteus medius* (rump) and *M. rectus femoris* (knuckle) under a common roast description. While described under traditional cut names, it is difficult to raise the price beyond the traditional relationship to that of more favoured cuts. But, in principle, if the consumer agrees that two 4-star cuts have equal eating quality then it follows that pricing should also be equal. Common pricing is more easily achieved by modifying description to represent the cooked result rather than source cut. A 4-star steak is readily understood and easier to price at a common level than upgrading a 4-star graded oyster blade (*M. infraspinatis*) from a traditional price relativity of around one-third of striploin (*M. longissimus dorsi*), despite both having identical eating quality from particular carcasses. Favourable results from a commercial trial applying these descriptions and pricing principles along with application issues are reported by Polkinghorne (2006).

Payments to producers are also greater for graded carcasses in most supply chains with livestock pricing grids adjusted according to MSA grade inputs. The method and sophistication of relating the improved quality to livestock price varies widely and is evolving with experience. Extremes are a $0.20/kg carcass weight premium for cattle that meet an MSA standard to payment based on accumulating the weight and MSA grade for all carcass muscles and linking this to individual retail product pricing.

Carcasses are typically sorted into stratification groups (strats) utilising software within the grading computer which allows pre-set strats to be applied at the point of grading. The strat is constructed by assigning a minimum MSA grade required for a given cooking method and days aged to every cut to be marketed under an MSA grade description. For example, a strat may include

a 5-star tenderloin grill at 7 days aging and a 3-star rump roast specification at 14 days aging. When graded, all carcasses in which the two nominated cuts meet or exceed the specification will be assigned to the strat. Carcasses in the same strat are boned in a common run with cuts derived boxed and marketed with an MSA grade label.

Although stratification is better than using a carcass grading scheme, it falls short of assigning and collecting cuts to their potential eating quality achieved by boning individual bodies. Using strats ensures that specified cuts achieve a minimum grade, but some of the cuts will be better than this minimum grade. As the number of cuts per strat increases, more cuts will exceed the minimum grade. The use of strats is seen as the trade-off between complexity and profit. It has been used by some companies to harvest cuts in a traditional boning room environment; however, it comes with a decrease in efficiency. A little more complexity brings increased profit.

Polkinghorne (2005) used the MSA model to investigate cut relationships within carcasses and reported that as grading inputs changed, the relationships varied widely. This can result in many cuts being identified and sold below their potential eating quality related price, a situation which is compounded by reducing the number of strats used to simplify plant operation.

A more sophisticated system as reported by Polkinghorne *et al.* (2008) was developed to manage individual cuts incorporating individual cut grade and weight data. When allied with a pricing system entirely based on grade this facilitated a true value-based system incorporating quality and yield from the 'farm gate' to retail. To a large extent, the sophistication of usage has tended to increase with experience as commercial entities resolve operational issues relating to changed practices and integrate them with product pricing and description approaches.

Future development

Application potential

Consumer value can be improved via reduced variation, improved quality, and greater confidence in the product. This can deliver greater revenue and build demand. Traditional trade description and pricing systems fall short of providing a clear signal to consumers, often adding to the confusion of purchasing a beef meal. The MSA grade output enables description, and consequently pricing, of each piece of beef in accordance with its final cooked quality. This removes the need for cut or other specialist meat knowledge with the individual grades each offering reduced variation relative to undifferentiated product.

The traditional description system fails to provide the essential information needed to assess value: how will this piece of beef eat when I cook it by a selected method? If the traditional system does not work, why use it? The grading data provides a predicted consumer outcome and further information as to how that might be adjusted with alternative practices. A logical response might be to simply describe all beef at the point of sale according to its cooked consumer quality and to price it accordingly. While this is an elegantly simple concept making both purchasing and retailing easier, it poses challenges in the potential degree of change in both industry thinking and practice. If the transition to description and pricing by cooked result is accepted then strong incentives will

also be created to improve quality at each point and also to upgrade many muscles from their traditional price relativity.

An extension from pricing by cooked result is to extend the practice to 'paying by cooked result' to all production segments providing a transparent value-based pricing structure when combined with yield data. In describing efforts to encourage industry adoption of critical control points to improve consumer satisfaction Miller *et al.* (1996) state that in the United States (USA) a system that impacts beef value based on correct application is not in place, but is required to provide the incentive to make the changes.

At present, application of MSA technology varies widely across the industry. While premiums are being derived at various points by the developing demand for MSA-graded product, they are often not transparent and can be difficult to interpret. Maximum industry gain can be driven by improving the transparency of pricing and using the ultimate cooked result as the base-value parameter. If relayed clearly, this will encourage a processor to tenderstretch a carcass, to seam bone muscles from traditional cuts and to age some muscles longer. It will encourage a retailer to market muscles under cooking styles that optimise their value. At farm level, incentives are created to modify genetics or adapt management practices to turn off cattle at a more desirable weight for age and fatness endpoints.

Each of these actions can assist in transforming beef into a more contemporary meals-based consumer product rather than a somewhat staid traditional raw material requiring specialist knowledge to successfully purchase and cook. While exciting in potential, the challenge is in the degree of change to traditional thinking and practice. This is likely to pose the major challenge to the degree and speed of uptake of MSA technology and also govern the amount of additional value transfer from consumers to industry participants.

It is expected that the technology will be applied in greater detail and further enhance its commercial value, adding significant industry revenue from an increased consumer focus over time as organisations resolve their individual operational issues and the market at large is exposed to consistent product described by cooked result rather than traditional anatomical means.

Improving the prediction model

Further development work is underway to extend the model to accurately grade all beef. New data from Australian and linked international consumer testing has extended the database to over 58 000 cuts as at March 2007, a significant advance over the 32 000 used in developing the current model version as reported by Watson *et al.* (2008*a*). This has added data relating to older animals, particularly cull cows, together with greater numbers of cuts with extreme marbling levels from Wagyu and other cattle. The prediction model will be enhanced and improved as the additional data is utilised.

Improved accuracy should always be sought and will come from further data in many areas. Watson *et al.* (2008*a*) report current model accuracy in relation to comparing model estimates for 72 cut × cook combinations against the consumer observed MQ4 score. In most cases, the average difference was less than 1; and a simple *t*-test indicated a non-zero mean at the 5% level in

Table 2.   Summary of international Meat Standards Australia studies

Country	Cooking methods	Muscles	No. of consumers[A]
South Korea	Grill, Korean barbecue	*M. longissimus*, *M. semimembranosus*, *M. triceps brachii*	720
Northern Ireland	Grill, roast	*M. longissimus*, *M. semimembranosus*, *M. triceps brachii*	720
United States	Grill, roast	*M. longissimus*, *M. psoas major*, *M. biceps femoris*, *M.gluteus medius*	1440
Japan	Grill, yakiniku, shabu shabu	*M. longissimus*, *M. biceps femoris*, *M. serratus ventralis cervicis*	1680
Republic of Ireland	Grill, yakiniku	*M. longissimus*, *M. gluteus medius*, *M. psoas major*, *M. biceps femoris*, *M. triceps brachii caput longum*, *M. semimembranosus*	720

[A]The consumer numbers shown are those from the nominated country. In each case, paired Australian beef samples were also evaluated by Australian consumers.

only 7% of the cells. The standard error for most of the predicted MQ4 scores was less than 1 suggesting that the prediction will mostly be within 2 units of the population mean MQ4 score.

New versions of the prediction model will be developed in response both to additional data or alternative estimation procedures and importantly from consumer standards monitored through the sensory testing program. An important principle is that the model should always target contemporary consumer sensory standards so by definition the target will be modified if consumer preference changes.

At present, there is interest in investigating objective measures to either measure traits that are currently used by MSA, or to measure palatability directly. Techniques such as near-infrared spectroscopy may have application in this area (see Shackelford *et al*. 2005). Any objective technologies that are found to improve prediction, either directly or as an additional or replacement model input, should be incorporated into the model or supplant it if consumer score prediction is enhanced. A challenge is that the model predicts 137 cut × cook outcomes, a more difficult task than sorting a random population of carcasses into 'tough' and 'tender' classes. Consequently, it seems more likely that objective measures found to add accuracy will be applied as a further model input with the model continuing to calculate cut interactions and relativities in response to a comprehensive range of inputs.

The Beef Cooperative Research Centre is currently investigating the role gene markers will play in the Australian beef industry. The MSA beef grading model provides an opportunity to include gene markers as an input variable to predict palatability. This is an ideal conduit to create a 'pull' effect and provide a premium for herds with a high frequency of favourable gene markers.

International application

Of particular interest is the comparison of sensory response from consumers in different countries and the need or otherwise to customise the prediction process to best reflect cattle, production systems and consumers in these countries. A by-product of the international work is greater exposure to alternative cooking styles that offer the potential to achieve higher eating quality outcomes from some muscles and a consequent opportunity for increased value in the Australian and other markets.

Interest in utilising the MSA system in international markets raises a further need to determine whether consumers in other countries have similar sensory responses to Australians. Early work in Korea was encouraging in this regard and has been expanded by further studies in Northern Ireland, the USA, Japan and the Republic of Ireland. The Korean study was reported by Hwang *et al*. (2008), Park *et al*. (2008) and Thompson *et al*. (2008). Data from the later studies are currently being analysed and prepared for publication. Table 2 summarises the international activity.

The work in Northern Ireland was a collaborative study, which involved 720 Irish consumers tasting three muscles cooked by grill and roast methods. Paired Australian samples were utilised in Australia and Northern Ireland to establish linkage between the two consumer populations. The Northern Irish consumers were also served samples from Northern Irish cattle to establish relationships between local consumers and beef. A considerable further body of work utilising the same protocols has been conducted by the local research group comparing doneness, bulls, lairage factors and dairy breeds among other issues.

The USA collaborative study involved 1440 USA consumers in three cities. Grilled and roasted samples from four muscles were tested to provide a wide quality range with paired Australian samples tested in Australia and USA and paired with USA-sourced samples within the USA. The Japanese study involved 1620 Japanese consumers in two cities. In this instance, three cuts were cooked by grill, yakiniku and shabu shabu methods and sourced from an extreme range of marbling levels. Again, paired Australian product was tested in both countries augmented with Japanese sourced samples within the Japanese consumer groups. A total of six muscles were tested in the Republic of Ireland collaborative study utilising the same paired sample approach with grill and yakiniku cookery.

It is hoped to pursue further joint international studies as a basis to sharing data and fostering an efficient collaborative approach to best apply research from various groups in a manner which relates directly to the relevant consumer populations. The better the global consumer is understood, together with local nuances, the better equipped the beef industry is to respond with production systems and products representing improved value relative to competing foods.

Conclusion

The MSA program developed from an initial desire to better understand and meet consumer standards for eating quality satisfaction. Extensive consumer testing and data analysis has led to development of a prediction model used to grade muscles into levels of predicted consumer satisfaction. The model provides a plausible technical base from which to monitor consumer reaction and control beef production inputs to

efficiently produce a contemporary consumer focussed food product.

While adoption of the technology has been variable the Australian industry has become more focussed on eating quality and made substantial changes in response to MSA findings. Industry application ranges from a very basic overlay of MSA output on conventional product production and marketing to intensive application in which conventional practice is largely supplanted. There is still much to be done in improving the model and continually reacting to consumers in various markets but it is believed that the principles used to date continue to be relevant for the future and applicable across global markets.

The MSA grade data provides a means to categorise and describe individual beef portions by expected cooked outcomes. This can supplant traditional cut description and simplify purchasing for the consumer while providing a more predictable result. Potential exists to price product at each step in the supply chain on the basis of eating quality grade. If this were enacted, significant improvement in carcass value may be encouraged as efforts are stimulated to enhance eating quality supplemented by common pricing of equal quality cuts that are conventionally priced differently.

A strong focus on consumers and encouragement of an industry which is rewarded directly according to their level of satisfaction is an exciting idea: an idea which has the power to change perception of the product and from which to build a profitable and progressive industry for the future.

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