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Implementing a palatability assured critical control point (PACCP) approach to satisfy consumer demands

R.J. Polkinghorne

Marrinya Pty Ltd., 70 Vigilantis Rd, Wuk Wuk, Vic. 3875, Australia

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Abstract

A 5-year commercial trial was run to test a new retail-to-farm trading model focused on beef eating quality as assessed by consumers. Retail description and pricing was based on cooked eating quality outcomes, dispensing with conventional anatomical cut description. Eating quality prediction was obtained by extensive use of the Meat Standards Australia (MSA) prediction model, which assigns a palatability score for each muscle from a given carcass when cooked by various methods.

Pricing from the retail store to the boning and fabrication operation and from there to the supplying farmer was based on a % of retail value basis, thereby providing a direct incentive for the entire chain to focus on consumer satisfaction. Extensive yield and quality recording was conducted, providing detailed data to all participants and highlighting the magnitude of true value differences between carcasses, often of very similar type and appearance.

The trial was successful in that sales continued to increase throughout the period and it has continued as an expanding commercial venture. The novel offer of fresh beef and cooked beef meals resulted in balanced carcass disposal and enhanced value to consumers. Systems were successfully developed to manage the process through each segment of the supply chain.

It is believed that the principles demonstrated have broader industry relevance and provide the potential to stimulate substantial innovation and to reposition beef as a more contemporary food category. There are challenges in adopting this philosophy however due to required changes in technical procedures, in educating consumers regarding a new product offer and, more particularly, in changing industry culture.

Keywords: Consumers; Palatability; Beef grading; Value based payment; Beef retail systems

1. Introduction

The objective of this paper is to discuss some of the issues and challenges which arise in seeking to align commercial industry practice with consumer satisfaction by applying meat science knowledge across an integrated supply chain. Ultimately consumers provide all beef industry income. The amount they can be convinced to spend on beef products determines the industry revenue that is available for distribution to all participants from the retailer back to the seed stock breeder. If better value can be delivered via improved quality, consistency or price then revenue might be expected to increase.

Value recognition at consumer level requires accurate, ideally simple, description. It is argued in this paper that traditional retail systems fail to provide this. It is further argued that there has been a similar failure at each other point of supply to the extent that payment and description practices have, at best, a very poor relationship to consumer satisfaction. Traditional average based pricing practices further blur the inherent consumer value differences between individual animals, carcasses, cuts, beef meals and plate ready portions and fail to provide a clear incentive for change.

A case is presented, built on experience from a novel 5-year commercial trial, that significant improvement is possible and that a consumer focused commercial system from the consumer to the cattle producer can be established.

E-mail address: marrinya@net-tech.com.au.

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While the science and technology exists to create such systems in other environments there are significant cultural challenges in stimulating change in industry practices.

2. The consumer base

The consumer desires a "good beef meal" within a selected cooking technique. The level of quality may vary with meal occasion and circumstances. This implies that the most appropriate retail description would be an accurate quality x, y or z within a cooking method. A "gold" quality steak would be priced and eat differently to a "silver" steak and so on. Product performance would accurately reflect the label or branding statement.

Consumer willingness to pay more for higher quality beef has been reported by Huffman et al. (1996), Boleman et al. (1997), and Dransfield (1997) in research environments. Sitz, Calkins, Feuz, Umberger, and Eskridge (2005) also reported consumer value differences for steaks from various countries related to sensory acceptance. In a recent study conducted by Miller and Polkinghorne involving 1520 USA consumers in three cities responses were obtained relating the perceived value of beef at 4 different quality levels – unsatisfactory, good everyday, better than everyday and premium quality. After each tasting seven beef samples which encompassed the entire quality range consumers were asked to select a price per pound which represented appropriate value for each level. Clear, significant price increases ranging from US$2.60 to US$3.19 per pound were recorded for each level with the magnitude between each increased quality level at least equal to that for the one below. At a direct commercial retail level tenderloin is priced, and sells, at a premium price compared to other steak cuts due to its' acknowledged superior eating quality.

The results reported by Huffman et al., Boleman et al., Dransfield and Sitz et al., together with commercial practice suggest that eating quality can be used as a significant value component with a direct price linkage. Further support is provided by Steenkamp and Van Trijp (1989) who reported that, for three out of four meat cuts, the maximum price consumers are willing to pay was significantly influenced by the perceived quality level of the meat cut.

3. Retail product description issues

In contrast to a direct and accurate quality description the retail offer is generally an anatomical cut description. It is assumed that the consumer should "know their cuts' in the sense that they should associate each with an appropriate cooking style and have a base understanding of their relative eating quality. An immediate problem is that any number of anatomical cuts of the one type, even when derived from visually similar cattle or carcasses, can exhibit a range of eating quality. Consumer research by McKinna (1995) also records that the consumer is confused and does not have an extensive cut knowledge.

Further confusion is created by extensive crossover of quality between different anatomical cuts off the range of source carcasses and in many instances by the inclusion of multiple muscles of different eating quality within the one retail cut as sold. In Australia, the United Kingdom and Ireland for example rump steak is a common retail product description for a cut composed of portions of two heads of the *M. gluteus medius*, portions of *M. biceps femoris*, and *M. tensor fasciae latae* together with portions of some other smaller muscles and associated connective tissue and seam fat. From Meat Standards Australia (MSA) consumer testing results, each of these muscles and portions can be expected to eat differently and to further vary with different cooking styles. The consumer is consequently presented with a product description and product that is singularly unhelpful in regard to predicting the eating quality outcome.

The core assertion of this paper is that the consumer interface can be dramatically simplified and enhanced by moving to description and pricing on a more accurate predicted cooked result basis, supplanting cut description. Related propositions involve relaying the consumer value to the entire supply chain to achieve a coordinated consumer value focus and reward system.

4. Wholesale product description issues

At wholesale and abattoir level trading is related to carcasses. The presumption appears to be that carcasses of similar appearance will yield cuts of a similar eating quality and that the eating quality relativity between cuts will be constant across a range of carcasses. Descriptors used in traditional carcass grading systems include confirmation and fat cover (EUROP), skeletal maturity, marbling, meat colour, rib eye area, fat colour and depth (USDA in the USA, JMGA in Japan, and the Canadian and Korean systems). The Australian AUSMEAT system provides for customer specification of any combination of the variables listed over a base dentition and sex description. In each case a common grade is assigned to the entire carcass.

Polkinghorne (2005) presented MSA model based data which refuted the assumption that the relationship between muscles was constant within different carcasses. Using the predictions from the MSA model he reported that as breed, sex, implant treatment, carcass suspension method, marbling, ossification, ageing period and cooking method varied, then so did the relationship between various carcass muscles.

The implication of these findings is that a carcass has no discrete value as an eating quality descriptor other than as a collection of individually assessed components, the relationship of which will be different for any carcass and continue to change in response to ageing period and cooking method choices. The consumer value delivered by traditional carcass grading approaches must therefore be questioned, as must various attempts to use a single muscle measure to value or grade carcasses. The eating quality

component of true consumer value must be derived from accurate individual muscle estimates, which can be accumulated to record a carcass or animal value if desired.

5. Wholesale valuation issues

Conventional management and trading systems rely heavily on averaging and often fail to reflect the degree of variance between animals within common price grid cells. While classification systems such as EUROP make an estimate of yield differences they do not reflect eating quality, which is often addressed in principal by various forms of industry blueprint or retailer specification. The assumption is that all carcasses which are produced within blueprint guidelines and fall within a common yield-based category will be of uniform value, reflected in turn by consistent eating quality of each cut within carcasses from a common grouping. Results reported from the 5-year trial reported in this paper indicate that, even within apparently common groups, there are highly significant differences between the true consumer assessed value of individual animals.

The magnitude of differences reported indicates that significant value improvement could be achieved by utilising accurate consumer eating quality and yield data to encourage a shift in mean performance over time. Such improvement could be facilitated by adopting systems, which relay accurate information in conjunction with a consumer related value payment to each supply chain segment from the producer to the retailer.

Concerted application of meat science research findings would assist in delivering consistent quality products to the consumer. These must be augmented by industry procedures, which can apply the science in a working commercial environment and achieve balanced clearance of all carcass components. The commercial incentive to adopt such changes must come from the adoption of systems, which relay accurate information and directly link price to consumer value at all trading points.

6. Methodology – commercial trial experience

The trial incorporated a complete trading chain from cattle producers to retail sale with every part of the process aimed at optimising eating quality. Eating quality outcomes were derived from extensive use of the MSA grading model which was used throughout the business trading chain to determine the eating quality of any given muscle portion on any day and to assess the impact of possible actions.

The MSA model has been derived from descriptive statistics of consumer trial results conducted over a 10-year period during which over 60,000 consumers have tested in excess of 420,000 beef samples under test conditions. The model provides an estimate of the consumer score for each of 46 muscles cooked by up to six different cooking methods (grill, roast, stir-fry, thin slice, slow cook and corn) from a given carcass. A number of pre-conditions must be met for the carcass to be eligible for grading. These include direct movement from farm to slaughter, a prohibition of mixing cattle from different groups in lairage, a 3 mm minimum rib fat depth and a requirement for the loin to reach pH 6.0 within a defined temperature range (greater than 12 °C and less than 35 °C). Model inputs include *bos-indicus*%, sex, hormone growth implant use, carcass weight, skeletal ossification, marbling, rib fat depth, ultimate pH, carcass suspension method and days ageing by muscle. The direct and interactive effects of the inputs are used to predict individual muscle consumer score outcomes for each cooking method in contrast to a whole of carcass approach.

A predicted consumer points score on a 0–100 scale is produced for each muscle cooked by each different method when aged for a defined number of days. Each muscle portion is allocated to one of four quality grades as determined by the points score.

MSA model prediction scores were used to produce a daily estimate of every individual carcass muscle portion within the business from the point of carcass appraisal to ultimate retail sale. The defining principle was that once a carcass portion had been produced and graded it acquired a grade by cooking method status. The inventory of product could be treated as simply quantities of grills, roasts, stir fry, thin slice and cubes of three eating quality levels with the source cut of no relevance. Consequently, an inventory of "4 star" roasts might contain a mix of material derived from several different muscles with all of equal quality and value as judged by a consumer panel.

7. New retail products and presentation

Retail products were described and priced entirely within a "3 star", "4 star" or "5 star" quality rating within cooking method framework. The grade standards were defined using the MSA identified score ranges with the exception of the lower "3 star" boundary which was increased to provide a threshold above the minimum to achieve a satisfactory rating. Ungraded product was not sold within the store. Any portion which failed to grade was wholesaled externally to the store or converted to mince for use in sausages. Substantial price differentials were established between the three grades offered, with a typical price spread being Au$23/kg for "3 star", $39/kg for "4 star" and $50/kg for "5 star". The "5 star" product was always priced more than double the "3 star".

A number of novel products were created to enable marketing of muscles of unconventional form within their optimal cooking method. For example, small strip shaped muscle portions best grilled were trademarked as Rodz®. Beef which achieved it's highest rating in thin sliced form was trademarked as Shumi®.

The retail store was located in Albert Park, a higher socio economic inner Melbourne suburb. The population included a varied mix of traditional families with children

and working singles and couples. The store was fitted out and branded to differentiate it from a conventional butcher shop using high quality natural materials and utilising a strong direct from the farm high integrity branding theme highlighting natural fresh food. The store included a kitchen which produced fresh meals for reheating at home and a limited range of eat in lunches.

The marketing objective was to position the store as providing a product with a guaranteed cooked result rather than selling a raw material. The product was a meal of a desired quality, not a piece of beef to cook. This philosophy was common to the fresh meat and the cooked meal range. Every product was sold in a ready-to-heat form with value delivered in the form of guaranteed cooked performance, clean safe natural product, no plate waste due to rigorous trim standards and no additional preparation requirements. A complementary range of desserts and adjuncts such as cooked roast vegetables and sauces was also offered.

The retail store was designed to be supplied with retail ready product removing the need for fabrication space, skilled staff or equipment. Preparation from aged primal cuts or seamed muscles into steaks, roasts and other retail products, including hamburgers and sausages, was centralised at a remote fabrication facility. This created a benefit in-store with the development of systems to monitor inventory and costing, while facilitating automated ordering from point of sale data due to the product sold being in the same form as that supplied, rather than requiring conversion from carcasses or cuts.

8. Transfer pricing principles

The change to ordering and supply of units defined as grade by cook products rendered conventional pricing mechanisms ineffective as there was no active external market to compare equivalent product. The '4 star roasts', '3 star steaks' and other retail products could be fabricated from a variety of muscles, conventionally priced differently. The decision was taken to sell to the store at a fixed percentage of the retail sale price. This provided a standard margin for the retail store, subject to management of waste and discounts, while providing a fabrication revenue stream directly related to retail value. As retail value was strictly set by the grade this provided an automatic incentive to maximise eating quality through the fabrication process. Software was created to link point of sale data to automated ordering, stock control and full individual portion traceability.

9. Product fabrication and carcass balance

The direct linkage of eating quality grade to price both from and to the retail store encouraged the use of each muscle portion within its optimum cooking style. This had the effect of encouraging the sale of *M. gluteus medius* and *M. rectus femoris* portions as roasts, *M. semimembranosous* as thin slice and *M. serratus ventralis* as casserole cubes for example. In many cases this contrasted to traditional usage and pricing relativity. Portions which "ate the same" were described and priced identically so that portions of *M. infraspinatis* might be equally priced to equivalent eating quality portions of *M. longissimus dorsi* as grills. The *M. gluteus medius* was separated into two portions along the heavy seam of connective tissue, which was discarded, and the larger portion priced equally to *M. rectus femoris* as a roast as a consequence of equivalent eating quality, but not as grills due to an eating quality difference and so on. These equivalencies were assessed on an individual carcass base as the relative eating quality of various muscle portions varied with hanging method, ossification, marbling, ageing and other model inputs.

A range of cooked meals were used to balance the carcass by developing products which predominantly utilised trim, casserole cubes and thin slice. These products would not sell in natural balance in the raw form, reflecting consumer lifestyle and time devoted to meal preparation. While the Albert Park customer was reluctant to purchase cubes or mince in the natural balance proportion they proved very willing to purchase an Irish stew, Mediterranean beef casserole, rendang curry or cottage pie which utilised the same cubes and mince in a ready to heat high quality meal. This resulted in a balanced disposal of the entire carcass at a substantially value added price. Over the 5-year period virtually no beef was purchased other than as full carcasses/cattle and virtually no cuts were sold externally.

The disposal of a fully balanced carcass was in marked contrast to experience in traditional butcher shops, and more so for those with a higher socio economic customer base. In these areas it is normal for shops to purchase significant quantities of premium grilling cuts such as tenderloin (*M. poas major*), striploin (*M. longissimus dorsi lumborum*) and cube roll (*M. longissimus dorsi* cranial) which can account for the majority of sales. Over the past two decades this pattern has steadily evolved as boxed beef has became available and the trade has moved from having to purchase carcasses. An effect of this has been for the desired prime cuts to increase in price in relation to the less desired secondary cuts which must be absorbed in export or manufacturing trade.

The philosophy of providing a guaranteed consistent eating quality retail product also stimulated substantial innovation within the fabrication area. The direct connection of fabrication income to retail price further encouraged this. Direct examples included seam boning of many traditional cuts to segregate muscles of different eating quality together with differential ageing of individual muscles. The boning principle was to "keep cutting until a uniform eating quality piece of beef was on the table". This led to breakdown of traditional cuts such as rump into the separated heads of the *M. gluteus medius*, the cranial portion of *M. biceps femoris*, *M. tensor fasciae latae* and *M. gluteus profundus*. This separation also removed the heavy connec-

tive tissue seam between the heads of the *M. gluteus medius* and allowed each portion to be cooked, presented and priced appropriately. In this cut a further benefit was the ability to maintain cutting patterns appropriate to the grain direction. Removal of the *M. spinalis dorsi* from the *M. longissimus dorsi* generally resulted in two products of different grade with pricing implications. Removal of heavy connective tissue seams from other muscles such as *M. infraspinatis* also improved uniformity and consumer value and in many instances created product of novel form which were subsequently branded and trademarked as unique products.

Fabrication activity occurred as two distinct functions; the initial carcass boning into primal cuts or muscle portions and later retail product preparation from the primals after ageing. Ancillary functions included production of sausages, hamburgers and preparation of material for kitchen use in cooked meals. An important quality control issue was insistence on the same consumer grade standard for all portions sold to retail or to the kitchen. A "4 star" cube was always prepared from muscle portions with a "4 star" slow cook score, and never from a convenient sized piece of ungraded scrap meat. It is believed that this contributed to the uniformity and ultimate success of the cooked meal range.

10. Fabrication management

Management of this process required a careful pre-boning consideration of the MSA consumer scores for each muscle by cooking method on a carcass by carcass basis with the boning plan developed from this appraisal and cognisant of cooking method and ageing implications over the ensuing 21-day period. Individual cut identification was required to enable optimum use of the muscle portions produced. Extensive software was developed to provide these functions, which had an additional benefit in providing total traceability of every carcass portion. Every portion was weighed at the point of vacuum packing and this weight was linked to the portion ID and predicted consumer scores, which were updated daily by the software to reflect ageing. To enable a complete yield record fat and bone was also weighed from each carcass.

The decision making process used to fill orders from the retail store also required development as, whilst the chiller contained a wide range of identified muscle portions, the store order was for "3 star" steak, "4 star" roasts and "4 star" cubes for example. These could be prepared from a wide range of muscles in varying combinations. This allowed flexibility in matching inventory to demand but required a decision making process. While various individual muscles might provide "4 star" steak on a given day they might each produce different yields and by-products. One muscle may yield over 90% of its weight as steak while another may yield 45% and a combination of cubes, stir-fry strips and trim due to its form and size. The selection of the source cut mix therefore required balancing against the resultant product mix desired, with further consideration of ageing implications for product approaching a use by date, or alternatively about to increase in grade and therefore value. Over the 5-year period procedures were developed and automated by software to facilitate the decision and management process. Individual muscle yields were also recorded with the product produced from every muscle weighed thus enabling detailed yield and costing models to be developed.

11. Carcass value

The combination of complete yield and eating quality data on an individual muscle basis enabled carcasses to be accurately valued on either a wholesale or retail basis. Early analysis highlighted a considerable range in the realised retail value of individual carcasses. Even in groups of apparently similar high quality cattle the combination of yield and grading quality factors regularly produced retail differences of Au$2.50/kg of carcass weight or $700 for a typical 280 kg carcass (Polkinghorne, 2006). The $ per kg carcass weight differences between the highest and lowest value carcass, even in small groups of 20 animals or less, regularly represented 50% of the typical market price. Actual values obtained within a sample group of 399 carcasses are presented in Table 1 with the overall mean value similar to the prevailing average market price for cattle of similar description during the same period. The extent of differences was a surprise and highlighted the degree to which pricing on averages obscured actual value differences.

To encourage and enable improvement at the farm end a novel farmer payment system, directly based on actual retail value, was implemented. Under this system the cattle producer was paid a direct percentage (typically 64%) of the fabrication return for each carcass. As the fabrication section in turn received a similar percentage of the retail value for sales to the store the farmer return was approximately 40% of retail value. For farmer payment the relevant grade of each muscle was assessed at five days ageing. While this could provide an additional return to the boning room, in exchange for the cost of additional ageing, the farmer received full benefit from the boning room dictating aitch bone suspension as a component of its' effort to maximise eating quality and value. The stan-

Table 1
Retail and producer value for 399 carcasses ($/kg carcass wt)

	Minimum	1st quartile	2nd quartile	3rd quartile	4th quartile	Maximum	SD	Average
Retail value	$5.58	$7.13	$7.91	$8.25	$8.61	$9.07	$0.62	$7.98
Producer payment (40%)	$2.23	$2.85	$3.16	$3.30	$3.44	$3.63	$0.25	$3.19

dard days aged approach was adopted to provide a standard basis for price comparison without distortion from varying days of ageing.

The farmer was supplied with detailed information on each carcass including the individual grading model inputs, the % of carcass weight sold as "3 star", "4 star", "5 star", fat, bone and trim and the value paid for each. This had the effect of directly linking returns to consumer value and completed a transparent trading environment in which every participant was rewarded according to their impact on consumer value.

The trial proved to be a success and demonstrated that it was possible to implement a consumer focused system from retail to farm in which pricing was directly linked to ultimate cooked meal satisfaction. Retail sales increased continually over the 5 years with a typical 15% improvement on same week last year result throughout. The system remains as a commercial venture currently expanding to additional outlets supported by planned new commercial scale production facilities for fresh product and cooked meals.

12. Application on an industry basis

The system described and trialed became possible as a direct result of the MSA prediction model which facilitated a shift from the assumption that parts of a carcass had a pre-set reliable inter-relationship to a direct estimate of individual carcass portions differentially aged and cooked. This provided a base for a total paradigm shift in relation to the presentation, description and pricing of beef.

The opportunity to modify description and price within an accurate and consumer friendly framework presents an opportunity to "reinvent" beef and offer a more contemporary product well attuned to the modern consumer, requiring no knowledge of traditional cuts for a successful meal outcome. It potentially addresses many of the consumer issues attributed to a decline in beef consumption over several decades.

We believe, we have demonstrated that the principles arising from the available science can be applied within a commercial environment and that they have been well received by consumers in the test location. Implementation of the system has required development of new software and management approaches, which have been effective at pilot scale level. At a macro-level nothing is different to conventional systems; beef carcasses are boned then fabricated into retail portions and sold. At a micro-level, substantial changes in management approach have been developed and applied to the conventional process. In many respects the challenges to adoption are cultural, requiring a different focus, rather than mechanical.

If the retail offer is perceived as a combination of eating quality by cooking method product lines rather than as a collection of cuts then the process is relatively straightforward and arguably less complicated than conventional methods. In contrast if the new description is superimposed over an existing cut description model then the result is more complicated and arguably confusing due to the same cuts appearing in multiple quality and product forms.

13. Retail application challenges

The key driver should ideally be from retailers. If the consumer is exposed to a product range which accurately reflects value – defined as a price for a product of known and guaranteed cooked performance – then all preceding steps can be readily driven by a related economic signal. Our experience is that the consumer readily accepts and appreciates the clear description but that it can take some time to establish an inherent trust in the system. Beef has often been advertised as consistently high in quality only to perform as something different when purchased. It is the authors contention that traditional advertising and industry practice may often have had a negative effect leading many consumers to believe that "beef just varies", and there is nothing that can be done about it. This view is open to challenge but flows from direct customer contact in a retail environment.

It is a relatively easy proposition to re-brand or name a traditional low price cut to enable it to be sold at a higher price as warranted by a guaranteed eating quality standard. It is a harder task to convince a retailer to drop cut description for a traditional high quality and price item such as tenderloin. One can be done without the other but it is arguably more consistent to present all products under a common eating quality description without reference to the source muscle. This may be resisted for the traditional high price items but arguably this may make substantial price upgrading of traditional low value cuts more difficult. These are issues for marketers and retailers to resolve with a successful outcome being a key requirement for extensive change in industry practice.

The principal is already employed to an extent for products such as mince, stir-fry and casserole cubes where retail product may come from multiple cuts without reference. Traditionally this may often be based on shape, size and availability rather than selection for eating quality but the physical presentation at retail is similar. The concept of segmenting according to perceived quality and cooking style is also well demonstrated in the prepared meal category of many European retailers where multiple levels of quality are further sub-grouped into categories such as Indian, Traditional British, Thai etc. Use of more detailed science such as the MSA consumer score estimate provides a base to both improve the consistent performance of the cooked meal category by improved selection of source material and to introduce similar ranging concepts to the fresh beef category.

14. Fabrication application challenges

In the fabrication area the underlying philosophic change relates to a shift from sorting carcasses into per-

ceived quality groups and maintaining an inventory of boxes of cuts, to tracking individual portions grouped by a cooked quality outcome rather than a carcass or cut derivation. In many respects this transition is consistent with the increased demand for traceability. If eating quality data are associated electronically with traceability codes then a more direct commercial value might be gained from the investment in traceability systems.

At boning room level the management implication is a shift of emphasis from marshalling carcasses to sorting of primals after boning. This overcomes the inherent problem of cuts within individual carcasses having different eating quality relationships. Where all cuts from a run of carcasses are grouped there is an unavoidable increase in the quality range within each cut. This is demonstrated by Polkinghorne (2005) in comparing the eating quality score of the *M. longissimus dorsi lumborum* as a ratio to a number of other cuts across eight sample carcasses. By way of example the ratio of eating quality scores reported between *M. longissimus dorsi lumborum*and *M. spinalis dorsi* ranged from 112 to 171. Where the sorting decision is transferred to the point of packing this issue can be overcome. If desired it is also possible to sort cuts at this point into date by grade outcomes so that a particular pallet of cuts may all be at "4 star grill" level at a particular date, allowing them to be tracked as a group rather than individually if desired.

15. Carcass valuation challenges

A major issue which arose from the reported trial was the value difference between individual carcasses/animals which had all been produced under a common and relatively demanding "blueprint" or specification. The strong implication is that this would also be true of the majority of trade specifications leading to large value variation within trading categories, which are currently applied in the belief that they can achieve consistent quality. Our experience is that this is not so and that even within apparently very consistent cattle lines of common breeding and management history there will be substantial variation in value. These will arise both from yield variation and eating quality shifts across the carcass muscles.

A subtle change in ossification, carcass weight and fatness may result in a major cut, or cuts, moving from one eating quality grade to another, creating a sizeable value difference. Data provided from a sample of 399 carcasses slaughtered over an 18-month period within the trial is presented in Tables 1 and 2. Table 1 displays the actual retail value per kg of carcass weight obtained for these cattle adjusted to a constant retail pricing regime and the producer share of this return at the 40% level. The data are presented by quartile to illustrate the magnitude of difference which might be obtained by moving an industry average by one quartile over a period in response to price or other incentives. Table 2 provides range and average data for key model inputs.

Table 2
Carcase data summary (399 carcasses)

	Minimum	Maximum	Average	SD
Carcase wt (kg)	166	334	241	30
Bos-indicus (%)	0	18.8	1.3	4.8
Ossification (MSA)	110	250	144	24
Marbling (MSA)	190	640	301	61
Rib Fat (mm)	1.0	18.0	6.4	2.6
Ultimate pH	5.3	5.9	5.6	0.1

It is assumed that these differences are likely to be repeated in other supply chains which must raise the question as to the effectiveness of current specification systems and the desirability of changing valuation and payment approaches. Given the range there must be considerable potential to improve overall industry efficiency via improved consumer value outcomes and yield improvement. Improvement however requires the base information to be recorded and transferred to the relevant parties. It is also highly desirable to relate it directly to price signals to encourage full and timely change. This is again a cultural challenge to many in an industry where either seller or buyer may believe they have a trading benefit by keeping such information confidential. Accurate data however remains the key to evaluating and implementing change. If provided with appropriate data the producer can assign economic weights to breeding and management inputs. The abattoir and fabrication sector can evaluate the worth of aitch bone suspension, seam boning and cut ageing. The retailer can offer a clear unambiguous eating quality and value choice to consumers and receive a clear market preference signal in return.

16. Conclusions

It can be concluded that it is feasible to price and present beef to the consumer under a clear and simple eating-quality-by-cooking-method format. This can be argued to be a logical progression arising from the availability of a credible eating quality estimate for individual carcass muscles and its application to provide a simpler and more accurate consumer offer than conventional cut description. Furthermore, the need for such an approach is emphasised by the finding that carcass muscles differ widely in their cooked result when expressed as a ratio within different carcasses. The value of a carcass grade must be questioned given that it cannot be extended accurately to the component parts in any consistent manner. This requires grading at a cut level to provide a useful outcome for consumers.

Improved eating quality and consistency can be attained by managing the boning and fabrication process by grouping muscle portions according to a predicted eating quality outcome rather than on the basis of carcass grouping or cut type. This principally requires a change in management of traditional cutting and packing procedures and would be encouraged by linkage of price to ultimate eating quality outcomes.

Significant carcass and animal value differences are present due to both yield and eating quality variation. The value differences are sufficiently large to drive significant change if the required information is made available and accompanied by a directly related price signal.

The trial reported successfully developed and applied working procedures to create a consumer focused model from the retail offer to the producer. It has continued to function and grow in a commercial environment but represents only a small and isolated situation. The principles are believed to be valid for more general adoption but such adoption will require a substantial effort together with technical and cultural adaption. Critically, full value across the industry can only be obtained by an open trading environment where information is routinely shared and change is encouraged by financial incentives.

References

Boleman, S. J., Miller, R. K., Taylor, J. F., Cross, H. R., Wheeler, T. L., Koohmaraie, M., et al. (1997). Consumer evaluation of beef of known categories of tenderness. *Journal of Animal Science, 75*, 1521–1524.

Dransfield, E. (1997). Beef – what price tenderness? *Meat International, 7*, 24–27.

Huffman, K. L., Miller, M. F., Hoover, L. C., Wu, C. K., Brittin, H. C., & Ramsey, C. B. (1996). Effect of beef tenderness on consumer satisfaction with steaks consumed in the home and restaurant. *Journal Animal Science, 74*, 91–97.

McKinna, D. (1995). In product description and labelling system research summary, Meat Research Corporation Project 360, MLA, Sydney.

Polkinghorne, R.J. (2005). Does variation between muscles in sensory traits preclude carcass grading as a useful tool for consumers? In: *Proceedings of fifty-first international congress of meat science and technology, 7–12 August 2005, Baltimore, USA*.

Polkinghorne, R.J. (2006). Guaranteed eating quality: making it work. In: *Proceedings of Australian beef – the leader! The impact of science on the beef industry, 7–8 March 2006, Armidale, Australia*.

Sitz, B. M., Calkins, C. R., Feuz, D. M., Umberger, W. J., & Eskridge, K. M. (2005). Consumer sensory acceptance and value of domestic, Canadian and Australian grass-fed beef steaks. *Journal of Animal Science, 83*, 2863–2868.

Steenkamp, J-B. E. M., & Van Trijp, H. C. M. (1989). A methodology for estimating the maximum price consumers are willing to pay in relation to perceived quality and consumer characteristics. *Journal of International Food and Agribusiness Marketing, 1*(2), 7–23.