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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

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Abstract. A major trial was conducted to develop, test and demonstrate the application of Meat Standards Australia (MSA) research findings in a beef retailing environment. A new concept retail store was established whereby a mix of raw beef products and pre-cooked meals were merchandised under an eating quality grade defined by MSA palatability scores. Products were presented fully prepared within cooking method with pricing based on the predicted cooked results. Large price differentials were established between the three grades offered, with 5-star product priced at more than double the 3-star product.

The principle of pricing being directly related to eating quality was extended from the retail store sales to fabrication and the purchase of source cattle from producers. This encouraged considerable innovation to optimise eating quality and returns, demonstrating the potential for truly transparent value-based pricing systems to achieve change.

Novel systems were developed to break down and fabricate the carcass into 'retail-ready' product with extensive software development to trace the eating quality, value and location of individual cuts and products. Detailed feedback provided the producer with an accurate measure of value and sufficient data to evaluate possible alternative production strategies.

Results at each level of the supply chain were encouraging with compound annual growth in sales exceeding 12% at retail level and continued innovation through fabrication and on-farm areas combining to improve eating quality and financial outcomes. It was demonstrated that the consumer focus delivered by MSA grades could be applied at a commercial level providing an opportunity to reposition beef as a contemporary consumer product and to implement a value-based system across all sectors.

Introduction

Beef consumption in Australia declined significantly and continuously from the mid 1970s to 2000 (Anon. 2002) and declined 26 kg per capita from 1975 to 1985 (Kingston *et al*. 1987). This decline, also experienced in other countries including the United States, engendered serious concerns within the industry and encouraged major research efforts in several countries to identify the cause and potential remedies. A common finding was that consumers found beef inconsistent in eating quality and confusing to purchase. The decline in consumption was exacerbated by a decline in consumer knowledge and cooking skills in combination with dietary concerns and a perceived lack of convenience (McKinna 1995). Three of six key initiatives in the Australian Meat Industry Strategic Plan (Anon. 1995) focussed on meat eating quality. In the United States, a national beef tenderness conference was convened in 1994 to develop a national beef tenderness plan (National Cattlemen's Association 1994) in response to research that identified that one steak in every four was less than desirable in tenderness and/or palatability.

In Australia, earlier studies (e.g. Kingston *et al*. 1987; Hearnshaw *et al*. 1995) investigated consumer sensory responses to beef and identified differences relating to breeds, fatness and processing. A major new research program was initiated by the Meat Research Corporation in 1994 to evaluate beef by consumer testing to answer two fundamental questions: (i) did consumers agree on beef quality; and (ii) if they did agree, could industry grading systems accurately predict the eating quality of retail beef cuts? This research evolved into the Meat Standards Australia (MSA) research program and, progressively, to the development of a commercial grading system. The research established that consumers did have a reasonable consensus view of beef eating quality and was used to develop a scoring system which utilised a weighted combination of sensory ratings (tenderness, juiciness, like flavour and overall liking) to calculate a composite meat quality score (MQ4) score. Development of the MQ4 measurement was reported by (Watson *et al*. 2008*a*).

Over the past 10 years, MSA consumer taste panels have utilised more than 60 000 consumers who each evaluated seven samples of beef. The MQ4 scores from these taste panels were then used to identify relationships between the MQ4 score and a range of animal, carcass, processing and value-adding factors for individual muscle portions cooked in various ways. The research

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that underpinned the MSA model has been summarised by Polkinghorne *et al*. (2008), and the model building process has been described by Watson *et al*. (2008*c*). The results demonstrated that conventional carcass description and grading systems had a poor ability to predict consumer ratings for all carcass portions (Polkinghorne 2005). It was also found that beef quality did vary widely within traditional descriptions, so that cut and price description offered the consumer neither simplicity nor accuracy in assessing eating quality. Without a reliable eating quality description, the consumer could not make a value judgment of beef offered at different prices.

A principal problem in refining the existing retail descriptions based on cuts was that the relationship of quality between cuts varied among carcasses. Polkinghorne (2005) showed that the striploin (*M. longissimus dorsi lumborum*) did not have a constant relationship to other muscles and was, therefore, a relatively poor predictor of the eating quality of other cuts. Research demonstrated that the relationships of quality between muscles varied according to the following: (i) breed type (Crouse *et al*. 1989; Ferguson *et al*. 2000); (ii) weaning (Watson *et al*. 2008*c*); (iii) hormonal growth promotants (Thompson *et al*. 2008*a*, 2008*b*; Watson *et al*. 2008*b*); (iv) ossification; (v) marbling and carcass weight (Watson *et al*. 2008*c*); (vi) processing with reference to carcass suspension (Hostetler *et al*. 1970; Smith *et al*. 1971; Ferguson *et al*. 1999); (vii) pH/temperature decline (Marsh 1954; Hertzman *et al*. 1993; Simmons *et al*. 1996; Hwang and Thompson 2001); (viii) value-adding factors such as aging (Martin *et al*. 1983; Dransfield 1994; Hopkins and Thompson 2001); and finally, (ix) cooking method (Luchak *et al*. 1998; Neely *et al*. 1999; Park *et al*. 2008). Shackelford *et al*. (1995) raised similar concerns as to the usefulness of using indicator cuts. To a lesser degree, the same issues were evident within commercial cuts due to their multi-muscle composition. Quality variation both between and within cuts could lead to an inconsistent eating experience within a single meal.

Development of the MSA grading model (Watson *et al*. 2008*c*) provided a foundation from which these inherent problems could be addressed. The model estimated, with reasonable accuracy, an MQ4 score for 40 different muscles, aged for a specified period and cooked by up to five alternative methods. The predicted MQ4 score represented a consumer quality taking into account the most important contributing factors. Individual beef cuts were allocated grades of unsatisfactory, 3 star, 4 star or 5 star according to their MQ4 score with grade boundaries set at 46, 64 and 77 MQ4 points. These boundaries were statistically derived optimums with the exception of the unsatisfactory/3-star score, which was increased from 41 to 46 to further reduce the chance of an unsatisfactory experience.

This paper describes the development of a retailing system that uses the MSA palatability score and cooking method to replace the conventional retail approach of just using cut to imply eating quality. The MSA system has the potential to underpin a simple and reliable purchasing system focussed on delivering a specified eating quality to the consumer. If the grade was related to pricing at each point in the production chain then a genuine value-based trading system could also be developed providing a direct relationship between reward and consumer satisfaction.

Retail description and pricing of beef products

The MQ4-based grades were translated to a retail format by presenting raw beef, within-cooking style, described by grade, without reference to traditional cuts. Three retail grades, described as 3, 4 and 5 star, were provided for grilling and roasting, whereas other cooking styles were variously presented as two grades, or reduced to a single grade. In this commercial application of MSA, it was decided that the cut-off score for the lower 3-star grade be increased to 52 MQ4 points, 6 points beyond the 46-point MSA threshold (in itself an increase from the base fail point of 41 points). Assuming a consumer variance of ±8 MQ4 scores (Watson *et al*. 2008*a*), this higher threshold effectively reduced the risk of a sample at the lower end of the 3-star category having a score of less than 46 to ~1 in 5.

Commercial pricing was established with clear and sizeable differences in the order of $15 per kg between grades. A clear decision was made not to offer any cut for sale which did not meet the 3-star minimum MQ4 score (i.e. a MQ4 of >52). All beef was promoted as having an eating quality guarantee backed by replacement of product and return of money paid in response to any unsatisfactory experience.

Pricing levels for each grade were initially developed from commercial market returns for cuts typically of a particular grade. For example, tenderloin benchmarked 5 star and cube roll benchmarked 4 star. An important principle was that all product of a particular grade was priced uniformly despite being sourced from multiple muscles or alternative cuts, which would conventionally be priced differently. In effect, this increased returns for several cuts as the grade price was set from the highest conventional cut in the grade mix. Consumer value at higher price points was created by guaranteeing consistent eating quality within each grade and providing a well trimmed product eliminating plate waste.

New products and branding

A core principle was to provide a guaranteed and uniform eating quality for any product sold. This required many traditional cuts to be fabricated into component muscles. As a consequence, this produced several new products of unconventional appearance. A further principle was to maximise retail value by selling each portion in the cooking style which produced the highest MQ4 score. To differentiate the offer from competitors and conventional displays, several products were trademarked and promoted to build sales and facilitate the desired mix. Trademarks included Rodz (25-mm strips for grilling), Shumi (4-mm-thin sliced beef of specific quality) and Wok Stir (stirfry strips). The retail store was also branded and a brand image developed around core values of an ethical, environmentally sustainable, supply chain direct from the farm, supported by a highly personalised guarantee of consistent quality. The retail offer was communicated as a guaranteed cooked result, rather than a raw material.

Carcass balance

While individual cuts may be bought or sold, there are often financial disincentives relating to either disposal of those in surplus, or premium pricing of those in short supply. It was contended that a by-product of consumer uncertainty in regard to cuts and cooking had been a reduction in the variety of cuts sold with a drift towards tenderloin as a safe reliable high quality option, supplemented by striploin and cube roll at slightly lower price, and ground beef (mince) as a low cost reliable alternative. Those cuts of intermediate quality had tended to move from retail sale to wholesale manufacturing or export commodity markets, a pattern made easier by retail butchers being able to purchase boxes of the higher value primal cuts as a supplement or replacing the traditional carcass trade.

As prime grilling steak cuts represented less than 10% of the carcass, a large value gap was created relative to the remaining 90%. This generated an inherent challenge for many branded product programs as even a substantial premium on the top 10% had a small impact on carcass return in relation to discounts which were often applied to the balance. In this retail model, the objective was to retail the entire carcass at its potential value and in balance, achieving the sale of all carcass components without discounting or external wholesaling of cuts in oversupply.

The substitution of 'grade-by-cook' descriptions such as '3-star grill' or '4-star roast' reduced the number of individual product lines sold and also provided an ability to mix beef of common grade-by-cook description from a range of muscles which formed the traditional cuts. In many instances, this provided an opportunity to improve returns, while reducing retail complexity and assisting carcass balance.

Cooked meals

The aligned principles of marketing a balanced carcass and merchandising each portion within its optimum cooking category introduced constraints on the relative quantities of beef. If steak demand exceeded the appropriate ratio then either carcass balance had to be sacrificed, or means found to rebalance demand. A range of fully cooked, prepared meals, predominantly based on mince, cubes, stirfry and thin slice were developed to increase demand for traditional secondary cuts. In each case, all raw beef was allocated strictly by grade to ensure the meals performed to brand standards and integrity could be maintained. Meals were cooked in an in-store kitchen, which also offered a lunch menu with items designed to encourage trial of new products, such as Shumi. An important element of this strategy was to provide a meals atmosphere and homely cooking odours to further reinforce the impression that the store sold meals, rather than raw materials.

Supply and pricing to the retail store

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. Delivery of product in final retail form simplified store inventory and ordering systems enabling accurate costing and financial analysis. This was in contrast to conventional butcher shop businesses where potential yield variation in fabricating retail product from purchased carcasses or cuts complicated budgeting and financial control. This change also facilitated the employment of food service staff with a cooked meal orientation and no technical meat background.

The change to ordering and supply of units defined as grade-by-cook products rendered conventional transfer pricing mechanisms ineffective because 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, each conventionally being priced differently. To establish an effective transfer price mechanism it was decided 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 tracking of individual meat portions.

Fabrication

The fabrication operation was established to process carcass beef to the retail-ready stage, with the agreed pricing structure used to encourage an enhanced eating experience. The electronic MSA grading file was directly imported and converted to a visual matrix displaying cuts from each carcass within cooking methods. The MQ4 score was also displayed within each matrix cell and adjusted in relation to nominated days of aging. Each grade was colour coded to facilitate evaluation and routines established to adjust the display as aging periods were adjusted. Decisions on initial cutting lines for each muscle and carcass were made from this information with the software producing individual identification labelling to enable muscles to be individually tracked both physically and within an electronic inventory. The MQ4 scores of each muscle and resultant cooking method grades was updated daily in accordance with aging estimates from the MSA model.

The overriding principle at initial boning was to keep separating until the resulting products were of uniform eating quality. This meant that some traditional cuts were seam boned into muscles, a by-product of the process being significant removal of seam fat and connective tissue. The removal of 'tail' or pieces of smaller muscles conventionally left on traditional cuts also generated increased trim. While seam boning created additional work within the boning process and heavy trimming reduced yield, it was believed that the product would have enhanced consumer value and thus justified a higher price. Where seaming resulted in an increase in grade for one or more component portions the increased return was often substantial. Where MSA had documented significant quality variations within a muscle, the final unit was portions of a muscle (e.g. the anterior and posterior striploin).

Each muscle (or muscle portion) plus trim, fat and bone was weighed into inventory creating a detailed yield history connected to MQ4 score for every carcass processed. The electronic record provided traceability of any muscle or trim to a carcass and by using ear tag reference, provided access to individual animal records. This was of value in eating quality control and for food safety, both of which supported the branding position.

Stored primals were retrieved from inventory for fabrication into retail products. The store orders were for 4-star steak, Shumi, Rodz and other products, in effect removing the notion of cuts. Software was developed to facilitate selection of an appropriate mix of muscles best suited to the quality and cooking method required to meet store orders. The inventory was displayed electronically in colour coded formats and sorted into an eating quality × cooking method matrix. Aging was displayed to help make decisions on 'priority' between muscles.

The selected muscle mix was extracted from inventory and the resulting retail product yield and mix also recorded utilising new software that recorded the weight and individual identification of all muscle portions used and all products produced including trim and fat with cutting loss calculated by deduction of products produced from source material. A detailed yield history was established over a 4-year period and used to further develop optimisation techniques. In many muscles, the election of a primary product dictated production of other products due to yield considerations; for example the 'end' left on a muscle, which was too small for steak, might be turned to stirfry or cubes, if of appropriate grade for that cooking style. This created a decision tree hierarchy where the store order mix could prioritise the optimum muscle selection to obtain the desired steak : roast : stirfry : cubes ratio. Prepared products were fabricated to facilitate cooking by accurate unit sizing appropriate to the cooking method. The aim was to enhance consumer value by reducing the opportunity for an unsatisfactory result through poor cooking technique.

Cost of fabrication

Product yield data for each retail primal cut or muscle portion was combined with the retail price and, where applicable, income from other external sales to establish a fabricated value for each primary cut or muscle. Live inventory valuation by item was established from this framework. Alternative yield strategies (determined by the primary retail product sought) for each primal cut or muscle were costed to assist in selection and optimisation of meat products.

For example, the *M. rectus femoris* could be fabricated and sold primarily as either steaks or a roast. Steak preparation typically yielded 78% of the muscle as steaks with 5% sausage trim, 12% fat and a 4% cutting loss. In comparison, an 89% roast yield was obtained with 7% sausage trim, 3% fat and 1% cutting loss. Further yield mixes would apply if the primary objective was stirfry or casserole cubes. The return from the muscle was dependent on the combination of the weight of the primary and secondary products and on their respective prices. The eating quality of this muscle is affected significantly by cooking method (MSA model estimates) with typical results being a 4-star roast but only 3-star steak. As retail pricing was based on grade, the overall return for *M. rectus femoris* from an average carcass was $31.89 when prepared as steak in contrast to $42.25 when prepared as roasts. Consequently, sale as a roast was planned wherever possible to optimise return. A similar decision process was followed for other carcass portions.

A further calculation regime was established to value each individual carcass by extending the recorded cut, fat, bone and trim weights from boning by the average fabrication return for each cut over a nominated period. The cut value was calculated individually for each grade (set by MQ4 score range) as yields were often different due to alternative product mix selections within grades. Returns to the fabrication operation were maximised by pursuing an eating quality goal in conjunction with cut selection. Appropriate aging and use of yield data to align muscle selection with desired product mix resulted in significant increases in value.

Slaughter processes

Slaughtering was contracted with a set of procedures agreed. The philosophy and incentive to enhance eating quality translated to detailed lairage standards, tenderstretch carcass suspension by the pelvic bone and adjustment of low voltage electrical stimulation and chilling to achieve a desired pH-temperature relationship. Carcasses were graded by MSA and the data files were emailed to fabrication (Table 1). Carcass identification used a combination of cattle ear tags and electronic National Livestock Identification System (NLIS) tags.

Livestock purchasing and valuation

To maintain core brand value, all cattle were sourced from producers who could verify age, genetics and detailed management history. Animals that had received a course of antibiotic treatment or a hormonal growth promotant implant were excluded. A group of breeders whose cattle could meet these criteria, and who supported the principle of developing a direct consumer relationship, were recruited to supply the required cattle. Several breeders modified their management systems (i.e. by producing younger, heavier, or fatter carcasses) in order to guarantee supply over several seasons and to improve the eating quality outcomes. Optimum carcass characteristics were defined as 0% *Bos indicus* content, ossification of 120 or less, marbling above 300, a carcass weight of 260–280 kg, with a rib fat depth of at least 6 mm.

Producer payment was set at a percentage of fabrication return, thereby completing a chain of reward that accurately reflected retail value and the potential eating quality delivered to the consumer. An added benefit was the creation of a fixed margin for the fabrication operation and a gross return dependent on the degree to which eating quality outcomes were maximised.

To accommodate occasional purchases from non-core producers, on a fixed price per kg of carcass weight basis, the software was further developed to value the inventory produced by proportioning the purchase price in relation to the true value after deducting actual returns for fat and bone.

Additional software was developed to provide management information to the producer (Tables 1 and 2). The feedback report included detailed MSA model input data (carcass weight, ossification, rib fat, marbling, ultimate pH, hanging method and *Bos indicus* %), the percentage by weight of 3-, 4- and 5-star product plus trim, fat and bone, the dollar return for each component, a gross return for the carcass and an equivalent $/kg of carcass weight return. There was a noticeable difference in value, about $0.50–$1.00 per kg carcass weight, between individual carcasses from cattle within most groups supplied, despite the animals appearing uniform to experienced livestock people.

Table 1. Producer feedback sheet summarising the grading data

EPBI, estimated *Bos indicus* content (0–100 scale); sex, male or female (M/F); HGP, implanted with hormonal growth promotant implant (Y/N); MFV, milk-fed veal (Y/N); saleyard, sold in the saleyard or direct consignment (Y/N); rinse flush, vascular flushing used (Y/N); HSCW, hot standard carcass weight (kg); hang, Achilles hung or tenderstretch by the obturator forum or ligament (AT/TX/TS); hump, hump height (mm); Uoss, USDA ossification score; Umb, USDA marbling score; rib fat, rib fat depth at the 12/13th rib site; Ult pH, ultimate pH of the *M. longissimus dorsi*; Ult loin temp., ultimate loin temperature at the *M. longissimus dorsi*

Kill date: 19 July 2004							No. of head: 14							Supplier: 3972
Works: Abattoir A							Total HSCW: 3260 kg							Invoice no: 2004071901
							Average HSCW: 233 kg							
Ear tag	MSA grading information													
	Body no.	EPBI	Sex	HGP	MFV	Sale yard	Rinse flush	HSCW	Hang	Hump	Uoss	Umb	Rib fat	Ult pH	Ult loin temp.
X376	13	0	M	N	N	N	N	244	TX	45	120	300	5	5.55	2.1
Y059	14	0	M	N	N	N	N	238	TX	40	120	310	5	5.67	2
Y110	15	0	M	N	N	N	N	189	TX	30	110	190	4	5.65	1.7
X220	16	0	F	N	N	N	N	212	TX	30	160	300	4	5.65	1.9
X328	17	0	M	N	N	N	N	221	TX	35	120	220	3	5.61	1.8
X010	18	0	M	N	N	N	N	254	TX	35	120	270	4	5.58	1.8
Y076	19	0	M	N	N	N	N	208	TX	30	120	250	5	5.58	2.0
X274	20	0	M	N	N	N	N	280	TX	30	120	240	5	5.65	1.9
X345	21	0	M	N	N	N	N	247	TX	40	130	270	4	5.68	1.7
X004	22	0	M	N	N	N	N	233	TX	35	120	250	3	5.51	1.9
X212	23	0	M	N	N	N	N	237	TX	45	120	300	5	5.78	2.1
Y055	24	0	M	N	N	N	N	215	TX	35	120	220	5	5.56	1.9
X389	25	0	M	N	N	N	N	227	TX	35	120	210	4	5.55	1.8
X226	26	0	F	N	N	N	N	255	TX	35	190	280	6	5.51	2.0
Total	14							3260 kg							
Overall mean:								232.86 kg		36	128	258	4.43	5.61	n.a.
Supplier mean:		0						240.56 kg		50	166	293	5.3	5.60	n.a.
Co. mean:		0						245.18 kg		50	159	317	6.5	5.59	n.a.

Tables 1 and 2 provide an example of a report to a producer for one group of 14 cattle. Table 1 shows detail of the model inputs for each carcass. In practice, this file was also linked to the radio frequency identification NLIS ear tag for each animal allowing direct electronic porting of data into livestock recording systems.

Fabrication return and its relationship to both carcass yield and eating quality grades of the individual muscles are given in Table 2. The weight proportions shown within the grade columns were calculated by adding all products within each grade (e.g. all 3-star steaks, roasts, cubes and stirfry being grouped together). Carcass payments ($/kg) ranged from $2.74 to $3.67 reflecting the considerable value differences attributed within a single relatively uniform group (Table 2). The producer was paid ~60% of the fabrication return for each product sold, which was derived from the retail product yields for each muscle within each grade. Given that virtually all carcass portions were sold through the retail store, and that fabrication received 64% of retail value, this amounted to ~40% of retail value being returned to the producer, after including external wholesale returns from fat and bone, or occasional sales of cuts or surplus trim.

Market price volatility is a major management challenge for the commercial industry with operating margins affected by weekly livestock prices moving in response to supply and demand which, in turn, are impacted by weather, season and external factors such as currency. This study found the additional variation arising from eating quality grade proportions and overall yield between individual animals to be of similar magnitude to that related to livestock price movement as reported in the Eastern Young Cattle Indicator (Anon. 2005), a published market report providing a weighted weekly average of saleyard prices in eastern Australian markets. Whereas the range from the highest to lowest indicator price over the 2005 year was $0.995 per kg of estimated carcass weight, variances of similar value arising from eating quality and yield were found each week in groups of cattle processed (Polkinghorne 2006). This presents a strong case for moves towards transparent, value-based, payment systems that can stabilise processing margins while encouraging value improvement.

Advantages to the producer of undertaking management and genetic options to give even small increments in marbling and decreases in ossification score are apparent in Table 2, as are the consequences of grade failure from a pH above 5.7 on one animal (ear tag X212) and from excessive fat and high ossification on another (ear tag X226).

Using carcass quality and yield data to maximise carcass value (i.e. to determine economic weights of carcass traits) is a further extension of the scheme. Based on a dataset of 423 carcasses which had been processed and retailed using the above scheme, the value of the carcasses at retail (expressed in $/kg hot carcass weight), ranged from $2.15 to $3.16/kg (A. Doljanin, R. Polkinghorne and J. Thompson, unpubl. data). From this dataset it was estimated that tenderstretch resulted in an

Table 2. Producer feedback sheet showing yield (%) and payment ($) for cuts in the four carcass grade categories

Weights are shown as proportion to facilitate value comparison between carcasses of different weight

Ear tag	Weights as a proportion of hot standard carcass weight								Calculated value of cuts							Payment details	
	Ungraded	3 star	4 star	5 star	Trim	Fat	Bone	Shrink[A]	Ungraded	3 star	4 star	5 star	Trim	Fat	Bones	$/kg	Total
X376	0.008	0.195	0.136	0.012	0.287	0.134	0.221	0.006	10.14	270.28	303.08	46.25	229.44	0.85	11.58	3.57	871.61
Y059	0.005	0.194	0.119	0.013	0.316	0.128	0.218	0.007	5.92	254.33	276.31	46.76	244.93	0.79	10.95	3.53	839.98
Y110	0.006	0.246	0.086	0.015	0.301	0.123	0.217	0.006	6.16	238.28	141.18	42.65	185.51	0.61	8.78	3.30	623.18
X220	0.024	0.261	0.065	0.014	0.304	0.134	0.185	0.012	7.55	255.00	158.14	45.34	211.09	0.74	6.86	3.23	684.72
X328	0.005	0.237	0.081	0.014	0.301	0.116	0.236	0.010	5.81	266.51	155.71	47.92	217.65	0.67	11.44	3.19	705.71
X010	0.014	0.194	0.118	0.013	0.316	0.123	0.211	0.010	19.05	272.48	299.28	51.45	261.35	0.82	11.74	3.61	916.17
Y076	0.004	0.201	0.112	0.014	0.326	0.125	0.210	0.009	4.39	244.18	221.81	44.55	221.00	0.67	9.25	3.59	745.86
X274	0.007	0.207	0.116	0.013	0.282	0.147	0.219	0.010	11.10	333.55	308.40	56.90	257.90	1.07	12.63	3.51	981.54
X345	0.006	0.212	0.114	0.013	0.307	0.132	0.209	0.007	8.37	301.42	267.31	47.06	248.45	0.85	10.33	3.58	883.78
X004	0.005	0.200	0.129	0.013	0.316	0.108	0.218	0.011	6.63	258.54	293.23	45.92	239.90	0.65	10.58	3.67	855.46
X212	0.000	0.157	0.078	0.013	0.407	0.138	0.199	0.007	0.00	189.10	152.55	0.00	321.69	0.85	9.54	2.84	673.73
Y055	0.030	0.247	0.091	0.014	0.283	0.129	0.197	0.010	10.87	279.17	169.04	45.45	198.79	0.72	7.41	3.31	711.44
X389	0.027	0.232	0.091	0.013	0.311	0.121	0.188	0.017	11.14	274.33	175.36	46.83	230.15	0.71	7.35	3.29	745.86
X226	0.058	0.230	0.059	0.006	0.286	0.149	0.196	0.017	34.33	254.50	141.58	19.49	238.28	0.99	9.62	2.74	698.79
Total																	10937.83
Overall mean	0.014	0.215	0.100	0.013	0.310	0.129	0.209	0.010	10.10	263.69	218.78	41.90	236.15	0.79	9.86	3.35	781.27
Supplier mean	0.016	0.195	0.111	0.013	0.312	0.129	0.214	0.011	11.69	247.31	250.86	42.01	245.46	0.81	10.43	3.36	808.57
Co. mean	0.015	0.193	0.111	0.013	0.293	0.155	0.210	0.011	11.64	248.28	256.39	44.21	234.46	0.99	10.43	3.29	806.39

[A]Shrink is the difference between cold recovered weights and hot carcass weight.

increase of \$0.27/kg. Sex (i.e. whether the carcass was from a heifer or a steer) resulted in a \$0.12/kg advantage for heifers. Both the tenderstretch and sex differences in carcass value were due solely to differences in eating quality and were not affected by carcass yield. Perhaps of more interest were the economic weights of those traits which the producer can change by either management or breed. For this dataset, an increase in 100 units of ossification score resulted in \$0.15/kg decrease in value. This effect was independent of carcass yield. For marbling a 100-unit increase in USDA marbling score resulted in a \$0.07/kg increase in carcass value and this increased to \$0.09/kg when variation in carcass yield was taken into account. This arose as while an increase in marbling was associated with increased quality, it was also associated with decreased yield. At the same carcass yield, the effect of marbling on value was greater. Fat depth at the 12/13th rib had a negative effect on carcass value with a 1-mm increase in fat depth associated with \$0.018/kg decrease in carcass value. As expected, the negative effect of fat depth was largely associated with decreased carcass yield.

This analysis provides clear market signals for the producer to implement either genetic or management programs to change carcass traits. Clearly, the price of a new bull to increase marbling in slaughter progeny should be judged against the expected change in value of these progeny using a transparent marketing system. Similarly, if cattle were being sold into this system it would be easier to calculate the economics of feedlotting if the impact of changes in marbling, fat depth and ossification on carcass value could be predicted.

Conclusions

A change in retail focus to an eating quality × cooking method matrix required some time to communicate to consumers but, once understood, was well accepted. The value position of premium pricing against guaranteed cooked meal outcomes succeeded with same week sales on a year-to-year basis, consistently tracking 10–20% higher. In this retail location, a high proportion of demand centred on the 4-star product range despite an average \$15 per kg premium above the 3-star product.

The retail mix was such that carcass balance was essentially achieved with the entire carcass marketed to its best eating quality outcome. Important components in achieving this balance were the move to outcome description rather than cuts and the offer of new branded products and precooked meals. The percentage of cuts from higher quality carcasses sold within steak and roast categories and their average pricing was increased beyond that obtained under conventional description systems without compromising eating quality. This was achieved by transferring some traditional secondary muscles to higher value descriptions. For example, the *M. rectus femoris* from the knuckle primal was typically marketed as a 4-star roast and separated from the lesser quality *M. vastus lateralis* located in the same primal. The utilisation of traditional secondary cuts within cooked meals, which optimised their eating quality, also added substantial value. This was of particular relevance for trim, which was substantially value added by conversion to several popular cooked meal lines.

Results at other points of the chain also demonstrated the power of linking payment to consumer value. Incentives driven by this philosophy triggered the development of unique fabrication techniques and novel software to facilitate management. When aitch bone carcass suspension resulted in over \$60 of additional return through improved cut grades it became a processing requirement, overcoming resistance to the additional work in the abattoir and initial apprehension as to changes in the cutting lines and shape of some hindquarter cuts. Development of individual cut inventory and traceability systems was stimulated by income responses to aging and the ability to select product for cooking styles which achieved a greater return.

At farm level, changes in management and rapid improvement in value was driven by a mix of accurate and useable information coupled with a directly related payment structure. Short-term changes included more accurate assessment and management of fat cover. Longer term breeding management responses arose from progeny values attributed to individual sires.

The results demonstrate a potential to reposition beef to the consumer by providing a guaranteed quality consistent product, sold under a simplified description reflecting the predicted eating quality of the product when cooked in turn directly related to product pricing. The trial involved significant innovation to convert the base consumer estimates produced by the MSA model to a working system. This system was successfully developed and implemented throughout the supply chain demonstrating the potential for value-based marketing approaches within the beef industry to be directly linked to consumer satisfaction.

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