"How can farmers be rewarded for producing better eating quality beef?"

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Executive Summary

This paper focuses on how the Meat Standards Australia (MSA) grading system was developed, the underlying science behind it and the relevance to the Welsh beef industry.

The Australian beef industry identified the fact that it faced a number of significant challenges with falling domestic beef consumption due in part to a variable quality product. The response was to develop a new way to assess the quality of the beef produced in Australia and how this communicated to consumers to increase sales and value.

The MSA grading system was launched in 1999/2000 and to date has cost an estimated AU$85m in research and development. Some studies however have suggested that by 2007/08 it had already produced AU$300m of economic benefit based on improved retail prices for the beef supply chain.

The MSA model is built on agricultural best practice and meat science; combined with a detailed understanding of consumers' preferences for beef palatability. This allows the model to predict the eating quality of 135 different beef cuts by cooking method, taking account of 12 different variables in a complex dynamic model.

The challenges faced by the Welsh beef industry are different to those in Australia but for any farmer, processor or retailer seeking a blue print to develop a supply chain focused on delivering guaranteed, high quality, eating experience for its beef customers, the MSA model would appear to have no rival.

Background

In 2010 Rob Cumine returned home to Pembrokeshire to establish his own consultancy business with a view to starting his own beef marketing business. The idea was to develop a producer group, to market beef based on its eating quality, using genetics from his small herd of Aberdeen Angus and Wagyu cattle.

This led him to question what was involved in producing the very best eating quality beef and how might farmers might be rewarded for producing a better quality product. Initial desk based research on the Australian Meat Standards Grading (MSA) system resulted in an application for a HCC scholarship to go and find out more.

Scholarship Objectives

There were four basic objectives to the study:

1. What factors influence beef quality?
2. How can the eating quality of beef be verified?
3. How can you communicate this to consumers?
4. How can a farmer be rewarded for eating quality of the beef they produce?

Australian Beef Industry

In order to set the MSA grading system in context it is important to understand the scale and economic significance of the Australian beef industry.

Domestically…..

- Australians eat an average 35.7 kg of beef per person, per year
- Total consumption of beef in Australia is projected to rise in 2010 to 760,000 tonnes, and is projected to rise 4% over the next five years
- During 2010 Australians spent an estimated $6.4 billion on beef

On the world market……

- Australia exported 927,000 tonnes of beef and veal in 2009, worth $4.3 billion. The major export markets for beef and veal are Japan (38%), the United States (27%) and Korea (12%).
- Australian live cattle exports in 2009 were worth $665.5 million – predominantly exporting to Indonesia (72%), China (11%) and Israel (3%).
- Australia is the second largest beef exporter in the world (behind Brazil).

National Beef Herd

New South Wales (NSW)		South Australia (SA)	
Herd	5.9 million	Herd	1.2 million
Victoria (VIC)		Tasmania (TAS)	
Herd	3.9 million	Herd	700,000
Queensland (QLD)		Northern Territory (NT)	
Herd	12.3 million	Herd	1.7 million
Western Australia (WA)		Australian Capital Territory (ACT)	
Herd	2.3 million	Herd	6,000

The gross value of Australian cattle and calf production is $7.46 billion-a-year

NSW:	$1,491	WA:	$557
VIC:	$1,308	TAS:	$170
QLD:	$3,366	NT:	$303
SA:	$254	ACT:	$2.5

Beef grading system

Table 1 taken from a paper produced by Rod Polkinghorne shows the range of different beef grading systems used around the world and the factors they take into consideration. It clearly highlights the gap that exists between the EUROP grid system used in Wales and the more complex measures used elsewhere to assess and value a carcass.

Table 1

Country	Canada	Europe	Japan	South Korea	The Republic of South Africa	USA	Australia	
Scheme	**Canada**	**EUROP**	**JMGA**	**Korea**	**South Africa**	**USDA**	**AUS-MEAT**	**Meat Standards Australia**
Grading unit	Carcass	Carcass	Carcass	Carcass	Carcass	Carcass	Carcass	Cut
Classification	Yes	Yes	-	-	Yes	-	Yes	-
Quality grade	Yes (4) + (5)	-	Yes (5)	Yes (5)	-	Yes (8)	-	Yes (3)
Yield grade	Yes (3)	-	Yes (3)	Yes (3)	-	Yes (5)	-	-
Pre slaughter	-	-	-	-	-	-	Grainfed	*Bos indicus%* HGP implants
Slaughterfloor	Carcass weight	Carcass weight	Carcass weight	Carcass weight	Carcass weight	Carcass weight	Carcass weight	Carcass weight
		Sex			Definition		Dentition	Sex
	Sex	Fat cover	Sex	Sex	Rib fat	Sex	P8 fat	Electrical stimulation
	Conformation	Conformation			Sex		Sex	Hang
							Butt shape	
			Marbling score					
			Meat colour	Marbling score		Marbling		
	Marbling score		Meat brightness	Meat colour		Ossification score		Marbling score
	Meat colour		Fat colour	Fat colour		Meat colour	Marbling score	Ossification score
Chiller	Texture	-	Fat luster	Firmness		Meat texture	Meat colour	Meat colour
	Fat colour		Fat texture	Texture		Ribfat	Fat colour	Hump height
	Fat thickness		Fat firmness	Lean maturity		EMA		Ultimate pH
			EMA	EMA		Kidney and perirenal fat		
			Rib thickness	Fat thickness				
			Fat thickness					
Post chiller	-	-	-	-	-	-	-	Ageing time
								Cooking method

MSA grading

In 1999 the MSA grading system was established and it represented a new approach to beef grading offering consumers a prediction as to the eating quality of beef. It was based on taste panel responses from untrained consumers. The database which now contains responses from over 80,000 consumers from 8 countries, ranking 560,000 beef samples from 56,000 individual cuts. The second important part of the system is the use of a Total Quality Management approach that recognises all the critical control points along the supply chain that can influence the eating quality of beef.

The system was developed by quantifying the relationship between the animals traits (the genetics, growth rate, marbling and ossification scores (physiological age of the animal)), lairage (ultimate pH), processing (pH, temperature decline and hanging method), value adding (aging or conditioning of the cut post mortem) and cooking methods (grill, roast, stir fry, slow cook and corning (brined joint normally boiled)) with consumer palatability for the beef.

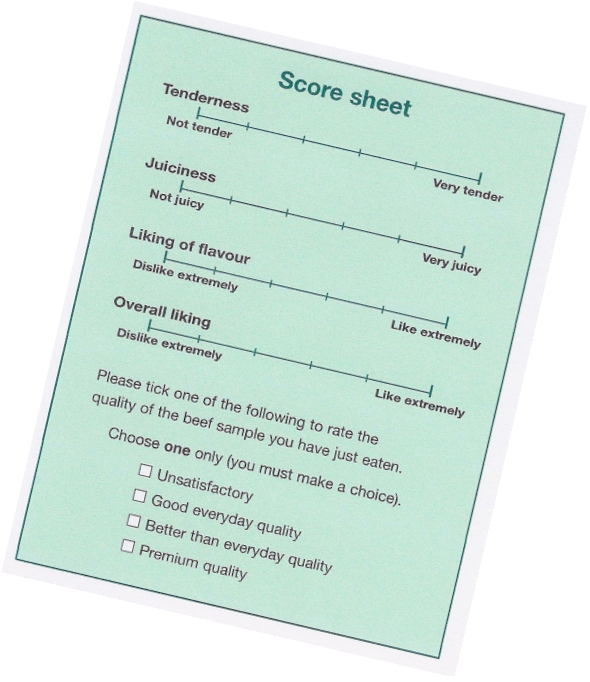
The aim was to develop a tool that could be integrated into a supply chain that could be used as a procurement and retailing model to deliver a guaranteed eating quality outcome to the consumer. This is in contrast to the EUROP grid that simply allows meat processors to trade with farmers and has very little meaning the further away you get from the farmer along the supply chain towards the end consumer.

Eating Quality

Eating quality is the interaction of the attributes of beef that result in an enjoyable eating experience. MSA scores individual cuts of beef out of 100 based on:

- Tenderness 40%
- Flavour 10%
- Juiciness 20%
- Overall Liking 30%

The illustration shows the standard MSA score sheet.

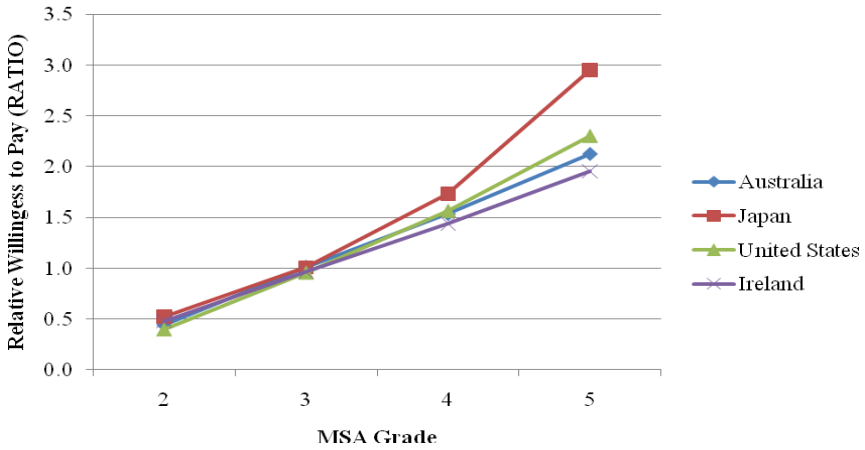


Customers' willingness to pay

MSA established 4 grades: 2 star (unsatisfactory), 3 star (good everyday), 4 star (better than everyday) or 5 star (premium). The taste panel responses from the 80,000 consumers, from the 8 different countries has also given those that developed the system, a unique insight into what consumers in these countries are willing to pay for different grades of beef.

The chart opposite taken from a paper produced by Rod Polkinghorne clearly illustrates the willingness of consumers to pay for better eating quality beef around the world. It shows that some consumers are willing to pay almost double for 5 star quality beef verses 3 star, and in Japan almost 3 times the value.

Figure 1. Willingness to pay (expressed as a ratio to 3 star grade) for Australia, Japan, United States, and Ireland, adjusted for demographic and meat consumption habits



Value of MSA grading to the Australian Beef Industry

The Centre for International Economics estimated the total R&D costs for the development of the MSA system is in the region of AU$85m to date. It is estimated in one economic study that cumulative retail-level economic benefit of the MSA system to 2007/08 to be AU$300m. This basically means that price premium achieved in retailers for MSA graded beef since it started is worth AU$300m which would represent quite a good return on investment.

Various studies have sort to quantify how this increase in value/MSA premium is apportioned along the supply chain and perhaps the simplest way to relate it to the UK market is by using percentages. The difference between an ungraded carcass (not meeting MSA grade) and an MSA grade 3 carcass was estimated at between 4 - 6.8% for the whole carcass at retail sales value with the range, due in part to market fluctuations in beef supply. The share of this market premium broke down into 19% for retailer, 38% wholesaler and 44% for the farmer. E.g. if a beef carcass had retail value of £2,000 in the UK and consumers were willing to pay a 5% premium for MSA graded beef that would be worth an additional £100. Based on work done in Australia this would be broken down into £19 for retailer, £34 for wholesaler and £44 for the farmer.

It is very difficult to draw direct comparisons with the UK and simply apply the same percentages without understanding a little bit more about the factors that influence beef eating quality, to establish the relative eating quality of UK beef verses Australian beef.

Factors that Influence Beef Eating Quality

On Farm

Genetics

Nearly all farmers have an opinion on which breed they think produces the best beef, yet in reality whilst some breeds on average produce better quality beef, there is as much potential variation in eating quality within a breed, as between breeds. This statement is based on the fact that within any genetic population

you have extremes. What has been confirmed by scientists is that on average Native British breeds have higher palatability scores for tenderness, juiciness and succulence than Continental breeds.

In Australia their biggest challenge was determining the amount of Bos Indicus (tropical humped cattle like Braham) genetics within an animal which was discovered to have a direct impact on the eating quality of the beef. The MSA grading system takes account of this by measuring the height of the hump on the carcass which is closely correlated to the percentage of Bos Indicus genetics. Due to the challenges of improving the eating quality of Bos Indicus cattle many beef producers have become more involved in cross-breeding programs to try and maintain the Bos Indicus ability to survive in certain environments, with the eating quality of Bos Taurus (British and Continental breeds).

Perhaps the most exciting contribution to improving and predicting the eating quality of beef is the application of DNA technology. A DNA marker is a piece of the DNA molecule that is close to a gene or chromosomal region. During a meeting with Dr Heather Burrow, CEO of the Cooperative Research Centre (CRC)for Beef she explained just how fast the science was moving and the enormous potential of this research. In 2006 the bovine genome sequence became publically available and scientists predicted that five to ten DNA markers would collectively account for around 50% of the genetic variation of each economically important trait.

In 2008 this led to the release of the first commercially available tests for tenderness, marbling and meat yield from companies such as Pfizer and Merial based on just a small number of DNA markers. However Dr Burrows explained that contrary to their belief it is now evident that hundreds, even thousands of genes have a small influence on complex traits that are important for production; including feed efficiency, growth, meat and carcass quality, reproductive performance and adaptation traits. She also explained how the cost of testing was falling rapidly, with a 50kSNP test costing US$250 in 2008 now costing less than AU$100 per animal and she expects this to fall further in the coming years.

Dr Burrows still considered the current commercial tests a very useful tool and the trials conducted by CRC beef scientists have certainly validated a number of these commercially available tests including the tenderness which she explained seemed to work across beef breeds.

The MSA team is currently considering how to incorporate gene markers into the grading system having validated the value of the tenderness markers in terms of meat quality in recent trials. The challenge they face is how to commercially validate the DNA profile of an animal without incurring the cost of individually testing each of them.

Beef DNA markers for tenderness have been available now for several years. They are marketed by Pfizer Animal Genetics and have been validated and included in BREEDPLAN EBVs. By June 2012, prediction equations for growth, feed efficiency, carcase and beef quality and female reproduction attributes based on high density SNP panels (>50k SNPs) will be delivered to BREEDPLAN. These DNA panels are expected to explain at least 15% of the genetic variation in each trait.

CRC economic analyses suggest that DNA markers accounting for either 15% or 50% of genetic variation for traits in a breeding objective will result in an economic benefit to the broader beef industry of $1.108 billion (15%) or $1.930 billion (50%) in net present value over the period 2006-2030.

During a tour of the Rissington Breedline Angus cow herd in New Zealand they talked about how they were already incorporating DNA markers into their breeding program. The US Angus, GAR-EGL Protege has been used as their main AI sire for the last 2 years and was the first Angus bull to have both a conventional Estimated Breeding Value and DNA EBV.

GAR-EGL Protégé

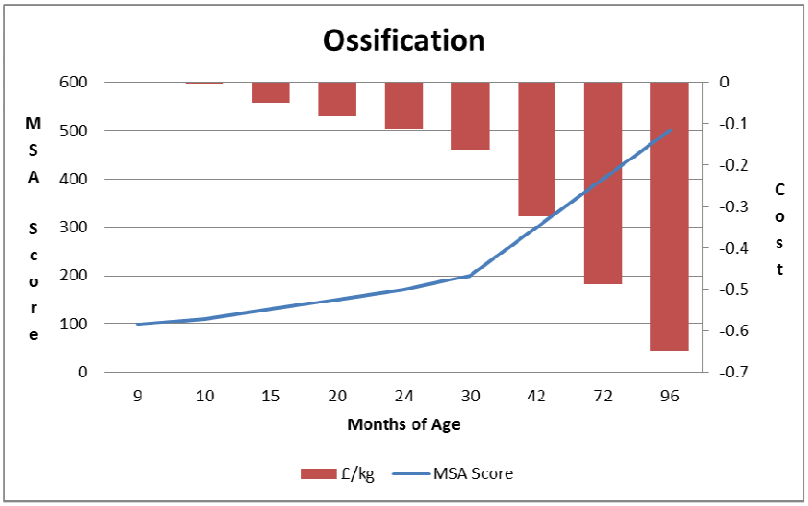
	CED	BW	WW	YW	ADG	DMI	NFI	CEM	MA	CW	FAT	REA	MS	TND	$B/$MVP^{FL}
EPD	6	1.1	66	106	-	-	-	5	22	21	0.01	0.34	0.67	-	65.23
ACC	0.6	0.87	0.81	0.61	-	-	-	0.25	0.27	0.23	0.31	0.41	0.35	-	-
EPD % Rank	**45**	**25**	**2**	**5**	**-**	**-**	**-**	**70**	**40**	**50**	**23**	**15**	**5**	**-**	**1**
MVP	6.5	-1.4	54	-	0.43	-0.23	-0.47	1.3	16	33	-0.03	0.33	0.86	-0.66	211
MVP % Rank	**30**	**15**	**1**	**-**	**15**	**30**	**6**	**70**	**50**	**7**	**8**	**15**	**3**	**20**	**1**

GAR-EGL Protégé has a high ranking $MVP^{FL}, the industry's first DNA-based economic index that helps producers select seedstock based on their profit potential for genetic merit in feedlot and carcass traits. While he has an exemplary EPD profile, the MVPs provide accurate predictions earlier in life. With $MVP^{FL}, producers can identify at an early age bulls with the greatest potential to add profitability to their operation.

MSA research has also linked genetic variations in cattle temperament to meat tenderness, with quieter animals producing more tender meat.

Animal Maturity

Younger cattle are generally more tender because they have less connective tissue in their muscles. Under the MSA grading scheme they use ossification as the term for the measure of the physiological maturity of the beef carcass by examining the development of the spinal vertebrae. The chart opposite is based on figures produced by Rod Polkinghorne for the economic value/cost of ossification on eating quality based on MSA grading scores. These are expressed as approximate animal ages.



The chart shows that the value, in terms of eating quality between an animal that is 9 months and an animal that is 8 years old is 65p/kg dead weight based on the current Australian dollar exchange rate. The chart illustrates the value of slaughtering animals at less than 30 months of age with the cost of keeping them in terms of loss of eating quality doubling in the next 12 months from 16p/kg to 32 p/kg verses a 9 month old animal.

Nutrition plays a significant role in the ossification scores of cattle with animals fed a poor diet likely to have increased levels of ossification. In the UK this might be a result of "storing" the animal over winter. Health may also affect ossification and chronically sick or injured animals showing higher rates.

The key to managing ossification therefore is to maintain good growth rates throughout the animals' life and avoiding major health challenges.

Nutrition

It was clear under Australian conditions that grain feeding cattle in feedlots had become the norm when trying to produce a quality beef product. The time animals spent on a finishing ration varied dramatically dependent on the target market. On Australian Country Choice feedlot heifers destined for Cole's Supermarket might be fed for between 35 – 90 days with a target carcass weight of 220kg. On the Rangers Valley Feedlot owned by a Japanese company they fattened Wagyu cattle on a finishing ration for over 350 days.

Even short feeding periods were considered important to ensure animals had adequate fat coverage and glycogen levels. The fat coverage was to avoid the risk of very lean carcasses cooling too rapidly and resulting in cold shortening which caused beef to become tough. The higher glycogen levels or energy reserves, also allowed animals to more easily cope with any pre-slaughter stress which is discussed in more detail later in this paper.

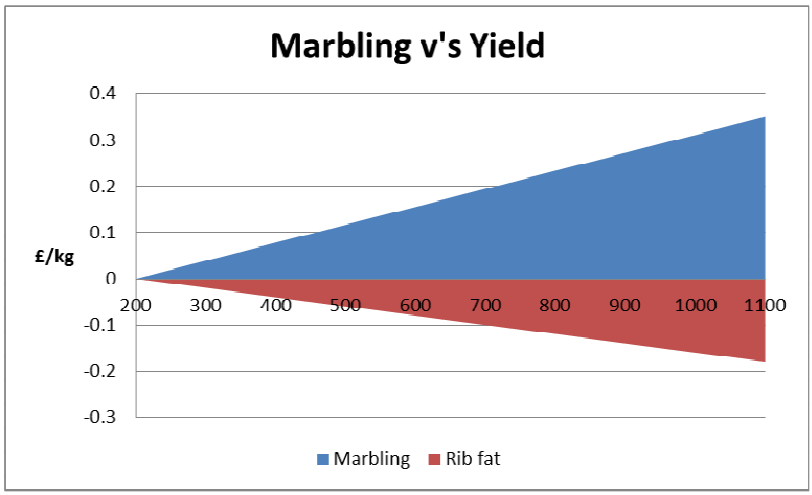
In New Zealand better grass growth meant this was not seen as an issue but they were conducting research into fat colour as grass fed cattle exhibited a more yellow fat which was seen as negative attribute in many Asian markets.

Very little research had been conducted on the influence of forage based diets on flavour in Australia compared with the large amount of research carried out on tenderness. This is partly due to the fact that the majority of consumers consider tenderness and juiciness to be more important than flavour. This is reflected in relative weighting of each within the MSA model with flavour given a weighting of just 10% verses tenderness 40% and juiciness 20%.

MSA can measure fat colour but this is only done to satisfy a customer specification and was not taken into account as part of the prediction of eating quality. Fat colour was considered to have no influence on eating quality despite grass fed cattle clearly having more yellow fat seen on my visit to the Australian Country Choice abattoir in Brisbane. Further desk based research is needed to convince myself that the commonly held belief in the UK that a forage based diet results in more "beefy" flavour is a complete fallacy.

Marbling

Marbling is the intramuscular fat which appears as fine flecks within the muscle. It's more prominent in forequarter cuts and decreases as you move along the animal towards the hind quarter. Work conducted in Australia has shown that marbling has a very positive effect on the eating quality of prime cuts. The effect is greatest in the high value loin



cuts although it is not clear to what extent this relationship is due to improved tenderness or juiciness.

Research has clearly shown that marbling is influenced by the animal's nutrition and genetics. Higher marbling scores are normally associated with higher levels of external rib fat as it's the last type of fat to be laid down. Although certain individual animals that are more prone to marbling can be selected to minimise rib fat while maximising Intramuscular Fat (IMF). The chart above is based on figures taken from work conducted by Rod Polkinghorne and shown in £/kg dw at current exchange rate.

The chart shows the estimated yield loss due to increases in rib fat verses the value of increased marbling. This shows the potential benefit of finding animals with the genetic potential to produce high levels of IMF combined with low rib fat. Based on the figures represented in the chart an animal with the maximum marbling score under the MSA model estimated to produce beef that is worth 35p/kg dw more based on eating quality than an animal with no marbling.

The table below shows the breeding values for the top selling Aberdeen Angus AI bull, in Australia in 2010 based on registered progeny. Ardrossan Admiral is a bull we've also used in the UK with semen available from Genus he is promoted on the strength of his growth and carcass figures. But based on discussions with Australian Angus breeders an important part of his success domestically has been the fact he is also a trait leader for IMF.

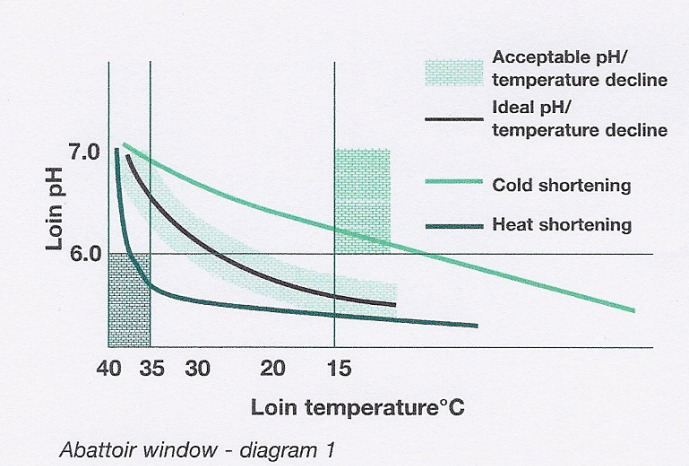
It's also worth noting the Docility trait, something that has yet to be measured in the UK.

May 2011 Angus GROUP BREEDPLAN																		
	Calving Ease Dir (%)	Calving Ease Dtrs (%)	Gestation Length (days)	Birth Wt. (kg)	200 Day Wt. (kg)	400 Day Wt. (kg)	600 Day Wt. (kg)	Mat. Cow Wt. (kg)	Milk (kg)	Scrotal Size (cm)	Days to Calving (days)	Carcase Wt. (kg)	Eye Muscle Area (sq.cm)	Rib Fat (mm)	Rump Fat (mm)	Retail Beef Yield (%)	IMF (%)	Docility (Trial)
EBV	-4.2	-7.2	**-5.5**	+8.1	**+59**	**+103**	**+134**	+135	**+17**	+1.2	-4.3	**+81**	**+7.6**	-1.4	-1.3	+1.1	**+2.3**	+25.2
Acc	93%	87%	98%	99%	99%	99%	99%	96%	96%	98%	79%	94%	88%	93%	93%	87%	86%	83%
Breed Avg. EBVs for 2009 Born Calves Click for Percentiles																		
EBV	+0.0	+0.4	-2.6	+4.5	+37	+69	+89	+81	+12	+1.3	-2.7	+49	+3.1	-0.1	+0.0	+0.3	+0.9	+2.3

Pre-Slaughter Stress

Once an animal is killed glycogen stored in the muscles is turned into lactic acid which can be measured by monitoring the pH of the meat. If the animal is stressed or has a low glycogen level prior to slaughter this will result in low levels of lactic acid being produced giving rise to high pH meat that has a darker more purple colour and is heavily discounted. This is often referred to as a dark cutter.

The relationship between meat pH is fully investigated later in the report but it clearly has a major influence on eating quality and as such is a key measure in the abattoir. It is not simply an absolute either that beef is either dark cutter or ok with degrees of difference. MSA grading allows for a range in the final pH from 5.3 to 5.7 but attributes a different score.



Abattoir window - diagram 1

The majority of meat business in Australia appeared to prefer to source finished cattle

direct from feedlots and not via sale yards to reduce the risk of potential dark cutter due to stress.

At the Abattoir

pH Temperature Curves

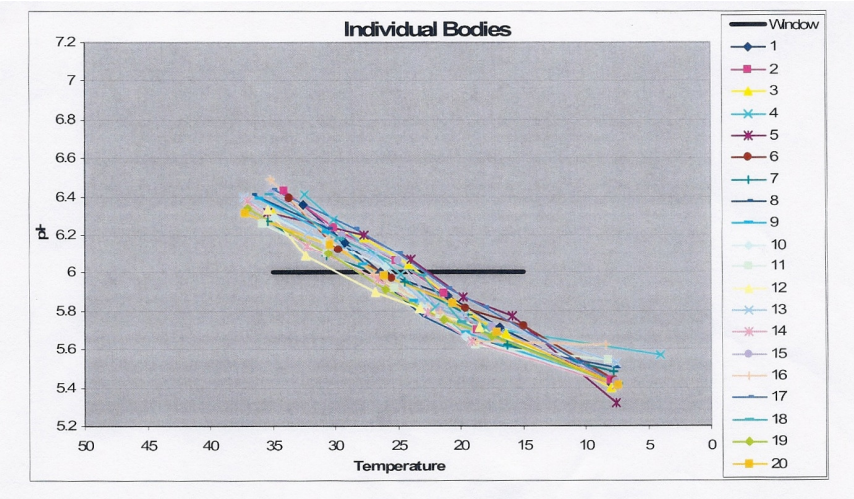
Abattoirs in Australia and the UK are aware of the issues of chilling carcasses too rapidly following slaughter something which is referred to as cold shortening.

The other potential issue is known as hot shortening that is a result of excessive electrical stimulation which results in glycogen being broken down too rapidly and turning to lactic acid. The chart taken from an MSA document shows the accepted pH/temperature curve. The issue of achieving this is made harder by a number of variables that influence the curve for any given carcass:

- Glycogen levels in the muscle
- Size of carcass
- Fat cover
- Level of electrical stimulation

Other variables such as the chilling regime and type of hanging method used will also have an influence on the curve but should be consistent within the same abattoir. The key factor in MSA grading is that it requires abattoirs to test and record the pH of every carcass to validate the potential eating quality of the beef.

Electrical Stimulation



Electrical stimulation of the carcass speeds up the rate of glycogen degradation and pH decline. It is an important tool for beef processors but traditionally only two types were available low voltage or high voltage with all carcasses normally receiving the standard time and voltage for that particular abattoir. At the Australian Country Choice abattoir in Brisbane they shared the results they were now achieving with their new intelligent electrical stimulation developed in New Zealand that varied the time and voltage carcasses received based on electrical resistance.

The chart opposite shows the cooling curves for 20 individual animals and clearly shows the benefits of the new technology with all the carcasses tightly clustered despite variations in the live animals.

Method of hanging

There are two methods of hanging carcasses; by the Achilles tendon or by the H-bone known as Tenderstretching in Australia. There are a number of economic and operational benefits to hanging carcasses by the Achilles that has traditionally been the norm. Following research on how muscles change during the critical 24 hour post slaughter period, a new best practice was developed in the USA that re-hung the carcasses once they were split into sides on the H-bone. The table shows the impact this has on the eating quality of various cuts verses Achilles hanging.

Cut	Achillies		Tenderstretch	
	MSA score	MSA grade	MSA score	MSA grade
Cube roll	62	3	68	4
Striploin	52	3	60	3
Rump	50	3	58	3
Tenderloin	77	5	73	4
Eye round	47	3	47	3
Topside	43	ungraded	52	3

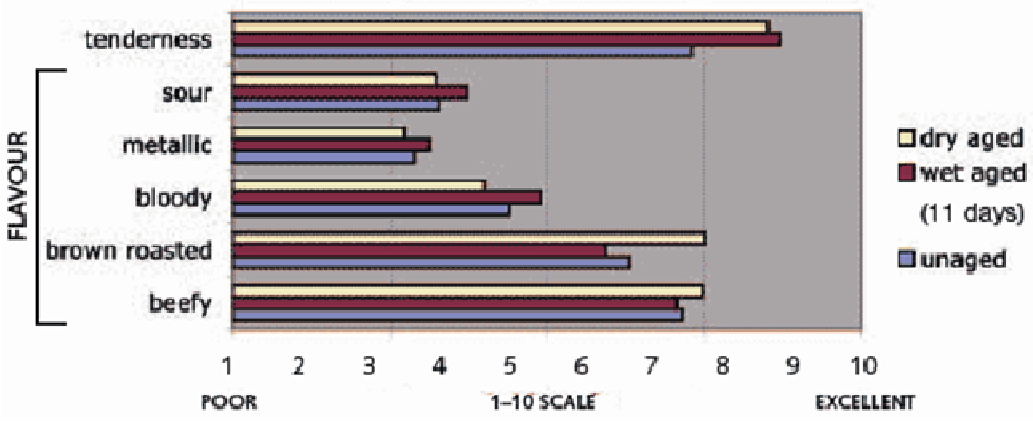
Aging (maturation)

It's widely accepted that aging beef or maturing it improves eating quality to a point. MSA grading takes account of the eating quality of different cuts at different days of maturation.

Days Aged	Cube roll	
	MSA score	MSA grade
5	62	3
14	64	4
35	68	4

There are also two basic ways to mature beef on the bone and in vacuum bags with the traditional on the bone sometimes referred to as dry aging. The beef "purest" will claim that dry ageing produces a superior tasting product although a number of scientific studies have shown that the majority of consumers can't distinguish between wet and dry aged beef. In fact work commissioned by Quality Meat Scotland show that some consumers actually consider it a negative.

The benefits of wet aging are reduced weight loss and improved bacterial counts that improve potential shelf life of the product allowing beef to be kept for up to 12 weeks under refrigerated conditions vacuum packed. Holding meat in trays rather

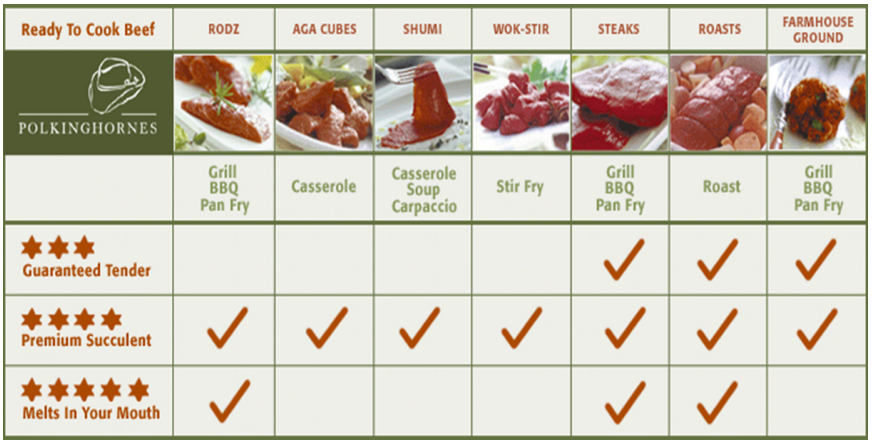


than on the bone in carcass form also dramatically reduces the refrigeration space required to mature beef.

Based on personal experience the biggest impact of dry aging beef is on the flavour and the development of a more intensive beef flavour although under some conditions the beef fat can take on some rancid taints.

Butchery

The MSA model takes account of 135 different cuts of beef and 6 different cooking methods for each. So rather than simply considering the rump as a single muscle it actually takes account of the 5 different muscles that make up the rump and how the eating quality of each would affected by the 6 different cooking methods. This has resulted in more seem butchery being used in Australia to allow a wider range of cuts to be sold. The concept was taken a step further by Rod Polkinghorne who sold beef in his Melbourne butchers shop by MSA grade and cooking method rather than in the form of traditional cuts.



Packaging

UK retailers' shelves are dominated by trays of bright red beef which consumer perceive as a sign of freshness and quality. This packaging format is known as modified atmosphere packaging (MAP) with the gas composition (80% O; 20% CO). The high-oxygen content gives the beef a stable bright red oxymyoglobin colour that is desirable to consumers at the moment of purchase and the addition of 20-30% CO prolongs the shelf life by inhibiting bacterial growth.

There is however a move both in the UK by some retailers and in all the Australian supermarkets towards vacuum and skin packaging. A number of studies have shown that the high level of oxygen promotes oxidation of both proteins and lipids, giving an inferior product compared with packaging systems that exclude oxygen. MAP systems for beef steaks were found to negatively influence shear force and water-holding capacity as well as the sensory attributes, tenderness, meat flavour and juiciness, compared with beef steaks packaged in skin pack or vacuum.

There are issues of consumer perception of skin and vacuum packed products but the science clearly shows that they result in a better eating quality product than the conventional MAP packing used in many UK retailers.

In the Kitchen

During the development of the MSA grading model it became very apparent that direct links need to be developed with how the customer cooked the meat. The cooking method is ultimately one of the most important factors influencing the eating quality of a piece of beef. MSA offered customers a range of cooking methods and using the same quality grades show the impact on the eating quality of the particular cut. The table below taken from an MSA document clearly shows that rump was better utilised as a roast, stir fry or thin slice. Whilst roasting tenderloin (Fillet) would have a detrimental impact on the eating quality.

Cooking method	Eye rump		Eye of knuckle		Tenderloin	
	MSA score	MSA grade	MSA score	MSA grade	MSA score	MSA grade
Grill	53	3	47	3	77	5
Roast	62	3	60	3	76	4
Sir-fry	60	3	55	3	79	5
Shabu shabu	60	3	58	3		
Slow cook			48	3		
Corned						

Application in the UK

The science and work on consumer preferences that sit behind MSA grading model are clearly applicable anywhere in the world. The key question is the potential impact it might have in the UK and to understand this you need to contrast the farming systems that exist in both countries.

	Australia	Wales
Genetics	Bos Indicus cattle were an issue that MSA grading has helped to over come	No breed issues
Nutrition	Issue of droughts and ranching systems making it difficult to control animal nutrition.	Potentially improvement in management of cattle being sent direct for slaughter direct off grass at certain times of the year. No real issues of cattle having to deal with long store periods and majority of animals sold before 30mths of age
Pre-slaughter	Long journey times and heat stress coupled with poor nutrition were historically major cause of dark cutters	Trend towards cattle travelling further and fattening bulls might cause some issues but considered to be minor
Post slaughter/Chilling	Best practise and good science are understood around the world but MSA focuses beef processors on outcomes and validates their systems	
Butchery	High demand for steak	Opportunities to move away from

	cuts and Asian cultural influences has resulted in butchery innovation	very traditional approach
Cooking	Consumers understanding of beef and most appropriate cooking methods	

The introduction of MSA grading had a major "quick win" in Australia identifying the percentage of Bos Indicus genetics which had resulted in part in the inconsistent eating quality of beef. In practice cattle in Australia are either MSA graded or not with no differentiation as to the yield of 3, 4 or 5 star grade meat on farmers price. If the system was applied in Wales in the same way given the differences in farming systems and environment the vast majority of cattle would meet the MSA grade. It could therefore be argued that there is little to be gained from the introduction of MSA grading for farmers.

This however, ignores the fact that we suffer from some of the same issues; inconsistency in the eating quality of beef produced, falling domestic consumption and the consumer who lacks understanding of how to cook beef. Many of the larger beef processors in the UK serving multiple retailer customers have a very good understanding of the meat science involved in producing good quality beef, although some smaller abattoirs in Wales might have some technical gaps in their understanding.

These larger abattoirs have adopted many of the MSA practises such as H-bone hanging and pH measurement as means of improving the eating quality of the beef they produce. The focus in multiple retailers has been very much on using breeds and maturation as the differentiator of quality for the consumer.

Conclusion

The adoption of MSA grading in the UK could help to increase beef consumption and consumers' willingness to pay for guaranteed eating quality. Farmers however, have little influence at present over the quality of beef that reaches consumers and therefore are primarily rewarded for meat yield and any additional consumer benefits such as specific breeds or farm assurance standards specified by their customer.

If farmers are to be rewarded for producing better eating quality beef they will have to make a direct link with the end consumer or a technical innovation in production that results in a step change in the eating quality of the beef. It seems likely that the advances in genomics will result in such a step change at some point in the future and early adopters could benefit.

The MSA standards provide a blue print for any farmers or farmer group seeking to build a quality beef supply chain or brand. It highlights the value of marbling for example which is rarely seen on UK retailers' shelves, yet is proven to have a direct influence on the eating quality of beef. Although there are some obvious trade-offs between what the consumer likes to eat; buying with their eyes and concerns over fat in their diet, that might limit the potential to develop a market for highly marbled beef in the UK.

In conclusion, it is clear that in the future we will need to continue to measure meat yield, perhaps more objectively than the EUROP grid currently allows. The electronic systems now in operation like VIA scan

could be used in conjunction with the MSA grading system. The combination of both has the potential to reward farmers for both meat yield and eating quality.