Carcass Grading Schemes – USA/Japan/Australia How and why do they differ?

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Abstract. Over the past thirty years there has been increasing pressure for the establishment of a grading system in Australia. During this time, many and varied options have been proposed and comparisons have often been made with the United States Department of Agriculture (USDA) and the Japanese Meat Grading Association (JMGA) systems. Australia has now developed a grading system that is driven by the consumer – Meat Standards Australia (MSA). Although some years (70 plus) behind the USDA the Australian model has the opportunity to deliver a product guaranteed to deliver eating quality every time.

While this paper evaluates the three systems and their specific operations both the USDA and JMGA systems are compared to the potential performance of the MSA systems applied on a cut by grade by cooking method basis.

Introduction

Over the past thirty years there has been increasing pressure for the establishment of a grading system in Australia. During this time, many and varied options have been proposed, some trialed, some developed and not applied others trialed and not adopted. During all this the comparison has often been made with the United States Department of Agriculture (USDA) and the Japanese Meat Grading Association (JMGA) systems. At different stages it has even been proposed that either of these systems be adopted as an Australian system, in some cases as they stand and in other cases with variation.

The difficulty in this however being that both the USDA and the JMGA systems work commendably well in their respective environments. However, when applied across the vast and variable production systems of Australia, both fail to deliver an effective differential trading system as they do in their parent countries. In addition neither is able to provide consistent or accurate signals to the Australian consumer on product quality variation.

Applied as they were designed, within the confines of the two countries production systems, they not only provide useful trading signals but also send reasonably accurate (although limited) eating quality performance signals to consumers.

Australia, on the other hand, has developed a grading system that is driven by the consumer – Meat Standards Australia (MSA). Although some years (70 plus) behind the USDA the Australian model has the opportunity to deliver a product guaranteed to perform every time.

While this paper evaluates the three systems and their specific operations both the USDA and JMGA systems are compared to the potential performance of the MSA systems applied on a cut by grade by cooking method basis.

The Three Grading Systems

1. USA

The USA has an established grading system which was developed and is administered by the USDA. This system has been in existence for over 70 years and attained a well-earned status as the world benchmark. It was originally conceived as, and largely remains, a system to group carcasses with similar visual characteristics as a basis for trade.

Over 95% of the US steer and heifer slaughter is graded.

Some of the characteristics used to assign a quality grade also relate to eating quality and as such convey a measure of eating quality assurance within the grades. Yield grades can also be applied in conjunction with the quality grades. Yield and quality grades are not required however to be coupled and can be applied separately if required.

The system has been periodically amended to reflect changes in market or science but remains true to its' original intent. Grading is only performed by licensed USDA government graders who attain high skill levels through extensive training and continual correlation. Standards applied between graders are commendably consistent and the system integrity of the highest order. This has led to USDA grades becoming the *de facto* international standard for higher quality beef trade.

Yield grades are applied on a scale from 1.0 to 5.9 with 1.0 having the highest yield and 5.9 the lowest. Factors used to make the yield grade calculation are:

- Rib Fat Thickness
- Fat distribution
- Rib Eye Area
- Carcass Weight
- Kidney, Pelvic and Heart Fat

Yield grades are calculated by a mathematical equation in the following steps:

- A preliminary yield grade (PYG) which is Total Rib Fat in CM, added to 1.0, adjusted for total carcass fatness.
- An adjustment for rib eye area in relation to carcass weight.
- An adjustment for kidney, pelvic and heart fat as a percentage of carcass weight.

Yield grades are stamped on the carcass (with or without the quality grade) and reported in whole numbers only – 1 to 5.

To assign a USDA quality grade the carcass is evaluated after chilling and ribbing at the 12/13-rib point. The grader evaluates the colour and texture of the exposed eye muscle, the amount, distribution and type of marbling present and the degree of ossification of the backbone. Bulls are excluded from the higher grades.

The meat colour and ossification score are combined to assign a USDA maturity score which is then in turn related to the marbling score to assign a grade.

The grades in declining quality order are:

- **Prime**
- **Choice** - often divided into High, Average and Low Choice
- **Select** - previously called Good
- **Standard** - sometimes divided into High Standard and Low Standard
- **Commercial**
- **Utility**
- **Cutter**
- **Canner**

In practice the Standard grade and below represents manufacturing beef only with the majority of retail product ranging from Select to High Choice. Prime grade represents a low percentage of carcasses but is highly valued for specific top end food service use.

Prime, Choice and Select grades each have an absolute maximum maturity cut-off (300 for Prime and Choice, 200 for Select). Beneath this maturity cut off an increasing marbling score is required to attain the same grade as maturity increases.

Figure 1 illustrates the trade off between marbling and maturity where the combination of the two is used to calculate the final grade.

In effect the striploin is graded although the entire carcass, or all the individual cuts, receive the same grade. Any correlation from grade to eating quality expectation is therefore heavily reliant on an assumed knowledge of cut relativity. Commercially this results in trade on a 'cut by grade' basis with 'Choice Chuck' priced very differently to 'Choice Striploin' or 'Choice Tenderloin'.

2. Japanese Meat Grading Association (JMGA)

Founded in 1975 the JMGA commenced services grading pork and beef in 1976. Initially both beef primals and carcasses were graded. Up until 1988 beef yield and quality grades were evaluated as one score however the current system of reporting has been applied since then. In Japan, similarly to the US, all meat graders are independently employed; in Japan's case, by the Japanese Meat Grading Association (JMGA).

For the 1999 calendar year the JMGA graded 985,000 carcasses or 74.4% of the national kill.

All beef carcasses are assessed for both yield and quality grade score. No uncoupling of grades is allowed. Both a yield and

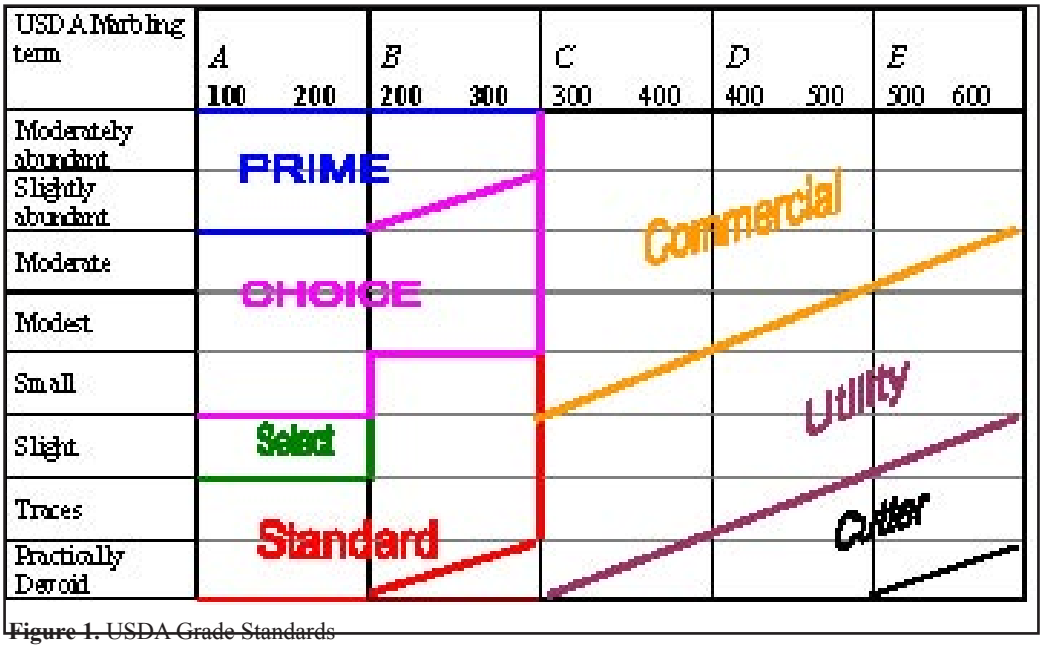

Figure 1. USDA Grade Standards

Table 1. Japanese Quality Grading System Based on MB, MC, FC, Firmness / Texture

Grade	BMS (Marbling)	BCS (Meat Colour)	BFS (Fat Colour, lustre & quality)	Texture / Firmness
5	8-12	3-5	1-4	v. good / v. fine
4	5-7	2-6	1-5	good / fine
3	3-4	1-6	1-6	average / average
2	2	1-6	1-7	below av. / below av.
1	1	1-7	1-7	inferior / coarse

quality grade are assigned. In addition to yield and quality grading a designation of defect or damage may also be applied. Each carcass is given a score for yield – grade A, B or C, and a score for meat quality – grades 1 – 5 (Table 1).

The final grade is reported combing the two scores from independent quality and yield grade assessments – B2, for example.

Ribbing is standardised at 6/7 rib and yield and quality are assessed at this site.

Meat Quality is assessed in terms of:

- Marbling – Beef Marbling Standards 1 - 12
- Meat colour and brightness – Beef Colour Standards 1 - 7
- Firmness and texture of meat – Grades 1 - 5
- Colour, lustre and quality of fat – Beef Fat Standards 1 – 6.

Overall meat quality is expressed as the lowest grade of the four quality attributes. For example, if the following scores were applied to a carcass, the quality grade would be 3.

Beef Marbling 4
Colour / Brightness 4
Firmness / Texture 3
Fat Colour, lustre & quality 4

Yield score **is determined as an estimated percentage by the multiple regression equation that includes four carcass measurements:**

- Rib eye area in cm
- Rib thickness in cm
- Cold left side weight in kg
- Subcutaneous fat thickness in cm.

The equation for yield estimation:

Estimated percentage (%) = 67.37+ (0.130 x Rib eye area cm) + (0.667 x Rib thickness cm) + (0.025 x Cold left side weight kg) + (0.896 x Subcutaneous fat thickness cm)

The Classification of the Yield Score into 3 grades, A, B and C as follows (Table 2):

The yield score may be adjusted downward for excessive intramuscular fat, inferior muscling or lack of proportionality between forequarter and hindquarter.

As with the USDA system the JMGA grading system is largely a carcass trading mechanism. As can be seen from the impact on palatability of marbling though, both the USDA and the JMGA do in fact segregate carcasss on eating quality to an extent.

3. MSA

The MSA system has a much more demanding ambition, expressed by the promise that:

"this piece of beef, cooked as labelled, will eat as described, every time, everywhere".

This promise is seen as being necessary in the current age due to the decline in product knowledge by consumers who no longer understand cuts, their relativity to each other or their

Table 2. Classification of Yield Score

Grade	Yield Estimated Percentage	Specification
A	72% and above	Yield of total cuts is above average
B	69-72%	Average Range
C	Under 69%	Below Average Range

performance under different cooking methods.

To deliver the MSA promise then it is necessary for the MSA label to define, and guarantee, an eating quality result for a nominated cooking method. Any adjustments or calculations required to provide an accurate label must be incorporated in the grading process rather than left to consumer knowledge.

The MSA consumer-testing program is the largest ever conducted. Extensive data has been collected on over 35,000 cuts and linked to sensory results. Analysis of this data provides critical knowledge as to relationships to eating quality.

Subsequently the MSA grading system has been developed using all available knowledge, some known, but mostly developed, to deliver the MSA promise. The result of this has been a grading system that delivers to the consumer a guaranteed eating experience every time. In achieving this however, the system is not simple to apply but delivers the simplest result, grade by cooking method.

Combining all the information that contributes to the MSA grade results requires more extensive information than both the USDA and JMGA systems as can be seen in the later table.

All traits that contribute to eating quality are assigned either a variable or an absolute value. Marbling for example has an increasingly positive effect as it increases; ossification on the other hand has an increasingly negative effect as it increases. pH however has an absolute maximum of 5.70 where anything above this level is ungraded. Other factors such as handling and processing have absolute requirements where they are either met or the product is ineligible for grading.

All contributing traits are assessed or recorded and fed into a series of equations that calculate all values from a base point (an average animal from all those tested). Traits impact differently on individual cuts with marbling for example having a greater impact on a striploin than on a topside. Additionally individual cuts also vary due to the amount of connective tissue. Traits are also interactive where for example ageing rates by cut vary for Tenderstretch carcasses or Achilles hung carcasses.

The result therefore is a set of grade values for each cut by each cooking method on a consumer point scale of 0-100.

Carcasses can be grouped on outcomes similarly to the USDA or JMGA systems however instead of a carcass being assigned an absolute grade value, MSA carcasses are grouped on the outcome achieved across all cuts meeting a minimum value. This then means that each MSA carcass in all probability will have a full range of potential product uses – 3,4 and 5 star product with all cooking methods.

The MSA system has single-mindedly pursued the objective of guaranteeing consumer evaluated eating quality as a sole objective. As a consequence issues such as grouping carcasses of similar type only apply to the extent that such a grouping assists prediction. Given that the system concentrates on the result rather than the process, it follows that a number of alternative process/product combinations may achieve a common result.

This was reflected in MSA pathways that allowed cattle from different production systems to achieve a common MSA grade. It also follows that 'cut', while a critical element in estimating eating quality, becomes redundant as a retail description. The consumer is assured the steak is a '4-star grill'. Whether it achieved '4-star' due to being a Tenderloin from a poorer quality carcass or a Blade from an excellent carcass is not an issue for the consumer. The MSA grade represents a common eating quality. This may result either from the same cut derived from similar carcasses or different cuts sourced from dissimilar carcasses.

Systems Variation Comments

The USDA system, via price signals, has heavily influenced the American beef industry to produce to common end points. The critical difference to MSA however is that these are visual carcass appearance points, in reality marbling and maturity levels, rather than necessarily eating quality end points. Thus while two Prime grade Tenderloins, both from carcasses with very high marbling scores, may eat '5-star', the Tenderloin from a very young low marbling milk calf of identical eating quality as measured by consumers, may be graded Standard.

The market strength of the USDA system, coupled with industry cost structure, has resulted in a much more uniform production system and higher eating quality product than in Australia. Virtually all American table beef is derived from young cattle finished in feedlots to achieve moderate to high marbling levels. This is a good product.

It is also a relatively efficient product in the US environment where the severe winters demand that livestock must be mechanically fed for a reasonable period of the year in many regions. The reverse is true in Australia where cost of feedlot gain ranges from equal to the store cattle price at best to more than double.

The economic circumstances and grading system imposed targets have successfully encouraged the American cattle industry to produce a relatively uniform appearing product of similar carcass weight, age and fatness. This has provided processing and distribution efficiencies and, on average, high eating quality.

One downside however has been the incentive to produce high fat levels which have become a marketing negative. The other major weakness is that the system does not reflect eating quality well at consumer level across the full grade spectrum. This arises from a wide eating quality variation within each grade, further exemplified if considered across cuts.

This is hardly surprising, as the USDA grading process does not consider many factors proven by MSA and other research, including a large volume from American scientists. Consequently the factors which contribute to the MSA grade results are more extensive than both the USDA and JMGA system.

The factors considered for quality grading, by the USDA, JMGA (Japanese) and MSA grading systems are summarised

Table 3. Factors considered in quality grading

	USDA	JMGA	MSA
Ossification %	X	X	Yes
Growth	X	X	Yes
Hanging Method	X	X	Yes
Cut	X	X	Yes
Marbling	Yes	Yes	Yes
Ossification	Yes	X	Yes
Meat Colour	Yes	Yes	Yes
Fat Colour	X	Yes	X
Meat Texture	Yes	Yes	X
pH	X	X	Yes
pH/Temperature Relationship	X	X	Yes
Ageing	X	X	Yes
Cooking Method	X	X	Yes
Weight	X	X	Yes
Sex	Partial	X	Yes
Breed/other factors	X	X	Yes

Table 4. Consumer Results by USDA Grade

CUT	USDA Grade	No	%Fail	%3-star	%4-star	%5-star
Strip Loin	Prime	12	0.0	16.7	41.7	41.7
	High Choice	38	0.0	13.2	39.5	47.4
	Av. Choice	158	3.8	20.3	50.0	25.9
	Low Choice	492	9.8	29.3	45.1	15.9
	Select	2239	17.9	42.0	33.6	6.6
	High Std	3910	27.4	41.2	26.8	4.6
	Low Std	1894	34.6	43.5	19.9	2.1
	Commercial	14	28.6	35.7	21.4	14.3
	Utility	416	40.6	38.0	19.7	1.7
	Cutter	84	39.3	41.7	17.9	1.2
	Total Cuts	9277				
Brisket	Prime	7	42.9	28.6	28.6	0.0
	High Choice	17	29.4	58.8	11.8	0.0
	Av. Choice	44	39.1	45.7	15.2	0.0
	Low Choice	88	38.6	46.6	12.5	2.3
	Select	123	57.7	30.1	11.4	0.8
	High Std	201	69.7	20.9	9.0	0.5
	Low Std	99	50.5	35.4	12.1	2.0
	Utility	33	63.6	27.3	3.0	6.1
	Cutter	6	0.0	66.7	33.3	0.0
	Total Cuts	620				

in the Table 3.

Critical USDA and JMGA omissions are cut, cooking method, *Bos indicus* %, hanging method and carcass pH/temperature/time parameters. These are all components of the MSA system and contribute to its' superior performance on a cut by cut basis.

Every carcass collected for MSA consumer testing is also graded accurately to USDA specification. The two tables that follow (Tables 4 and 5) present the MSA consumer evaluated eating quality on a USDA grade basis. The first (Table 4) reports Striploins as this is the indicator cut graded and briskets to demonstrate the degree of variation. The USDA assumption would most likely be that the consumer/retailer should have the knowledge to adjust for cut and cooking.

While low numbers for some grades should be noted the general pattern of higher grades having higher CMQ4 scores and lower failure rates is evident. Also evident however is the wide spread of scores within each grade. This spread becomes greater at the lower grade levels with Select and Standard trending toward an even distribution between failures, 3-star and 4-star.

This is in line with earlier pre MSA studies, which concluded that while USDA grades performed credibly on high marbling cattle they were largely ineffective on typical Australian domestic product.

Given that the MSA collections represent a fair subset of the Australian domestic product the high percentage graded USDA Select or Standard (90%) strongly supports this view. From the table it can be seen that these USDA grades provide little consumer guidance.

The second table (Table 5) presents a harsher picture by reporting eating quality performance of all cuts by USDA grade.

Table 5 demonstrates the expected position of cut variation adding to the spread of MSA consumer eating quality grade within each USDA grade. For example, where 'Prime' Striploins were spread evenly between 4 and 5-star, additions of further cuts leads to 22% failures within the Prime grade.

This underscores the challenge for MSA to genuinely deliver the promise of predicting eating quality of each cut by cooking method. The task is made even more difficult by the huge and unique range of cattle types and production systems predominant in Australia.

Whereas the USA has a highly uniform feedlot product and Japan has a reasonably consistent supply of cattle type through the two main production systems, the Australian

Table 5. Consumer Results by USDA Grade – All Cuts

USDA Grade	No. Cuts	% By Grade	Av. CMQ4	St. Dev	Range		% Distribution By MSA Grade			
					Low	High	%<46.5	%3-star	%4-star	%5-star
Prime	165	0.62	60	16.1	21	95	23.6	30.9	29.7	15.8
High Choice	407	1.53	61	15.4	20	93	18.4	36.6	28.5	16.5
Av. Choice	1304	4.89	61	15.2	14	94	19.0	36.0	30.6	14.3
Low Choice	2236	8.38	60	14.7	10	95	18.4	36.1	33.8	11.7
Select	5217	19.55	57	14.3	10	95	22.5	41.3	29.2	7.0
High Standard	9673	36.25	56	15	7	96	27.2	38.8	27.1	7.0
Low Standard	5748	21.54	56	14.2	9	90	26.3	42.1	26.3	5.4
Commercial	36	0.13	64	16.2	34	92	19.4	25.0	33.3	22.2
Utility	1545	5.79	53	15.3	10	91	33.2	38.6	23.5	4.7
Cutter	354	1.33	55	14.7	18	90	33.9	36.7	24.0	5.4
TOTAL	26685	100	57	14.8	7	96	25.2	39.5	27.9	7.5