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MEAT STANDARDS AUSTRALIA

Meat Standards Australia sheepmeat information kit

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Meat Standards Australia sheepmeat information kit

The Meat Standards Australia sheepmeat information kit has been written for stakeholders in the lamb and sheepmeat industry. This kit is for use by individuals and enterprises who seek to optimise the eating quality of their sheepmeat product.

contents

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MSAS1 MEAT STANDARDS AUSTRALIA

What is MSA sheepmeat?

Meat Standards Australia (MSA) is a valuable asset to the Australian sheepmeat industry, providing opportunities to differentiate products in the market. MSA sheepmeat is a supply chain management program designed to improve the eating quality of all sheepmeat categories (lamb, hogget and mutton).

A complex series of factors, which all affect the eating quality of sheepmeat are taken into account during the production process. This solves the long-standing consumer problem of selecting sheepmeat and choosing an appropriate cooking method.

In 1997, an Australia-wide audit of retail lamb showed that 20% of loins were unacceptably tough.

Today consumers expect quality – attributes such as flavour, juiciness, tenderness and overall liking should not fall below a minimum value.

In 2000, Meat & Livestock Australia (MLA), with the support of research partners and the industry, designed a Sheepmeat Eating Quality (SMEQ) research program to define best practice procedures through the identification of critical control points for eating quality. This research covered all aspects of the supply chain on behalf of producers, processors, retailers and foodservice operators. The results provided tools to monitor and improve product quality and match customer requirements in a practical and cost-effective way.

Consumer research

A total consumer focus has been the foundation of SMEQ research and development. The target has been to accurately establish and satisfy consumer-set standards. Since 2000, more than 90,000 consumer taste tests of sheepmeat products, involving 9,000 cuts of meat and 15,000 consumers have been conducted.

The tests required consumers to score samples based on tenderness, flavour, juiciness and overall liking on a 1 to 100 point scale. Consumers also scored products into eating qualty grades as either unsatisfactory, good every day or better than every day eating quality.

Key points

- MSA sheepmeat involves all sectors of the production supply chain, from farm to plate, to manage the critical control points that impact on eating quality.
- MSA sheepmeat standards are created from the analysis of 90,000 consumer test results, combining tenderness, juiciness, flavour and overall liking scores.
- MSA sheepmeat labels advise the correct cooking method for every cut of sheepmeat and assures an eating quality result.

Reducing variability

Sheepmeat production in Australia is comprised of a variety of breeds raised under variable climatic conditions. While sheep have remarkable biological mechanisms to cope with and minimise the effects of drought, flood, heat, cold, and fly strike, the risk of compromised and variable eating quality is always present.

Variables throughout the supply chain include:

- stress caused by mustering and the time between mustering and slaughter
- processing procedures such as slaughtering and chilling
- conditions under which sheepmeat is stored and displayed to customers.

By understanding and controlling these factors through the identification of eating quality critical control points, and the translation of these control points into practical steps, the industry has the potential to improve average eating quality and reduce variability.

Reduced variability and a more consistent and improved eating quality in sheepmeat products will result in increasingly effective competition with other protein products. This does not mean that all sheepmeat will end up the same. Rather, different products – lamb loins, hogget legs, mutton racks – can achieve their optimum

quality and individually contribute to increased industry returns.

Furthermore, suppliers can make more informed choices about where to position their product for consumer satisfaction, risk, price and quality.

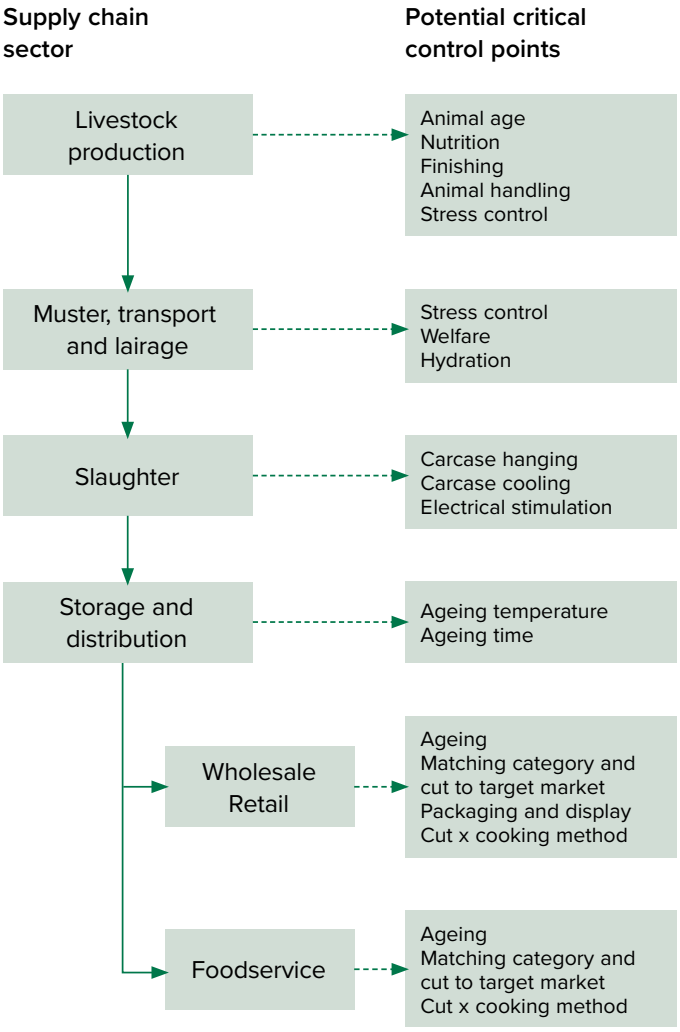
Sheepmeat eating quality critical control points

Research was based on identifying where critical control points occur in the supply chain (see figure 1) and where they impact on eating quality outcomes. By minimising the impact in these areas, improvement in eating quality of sheepmeat products is achieved.

Industry participants should benchmark their own processes against the critical control points to determine whether their current practices could improve to meet the eating quality needs of customers.

MSA licensed participants of the MSA program are required to measure and monitor some of these factors such as pH.

Figure 1: Potential critical control points for eating quality.



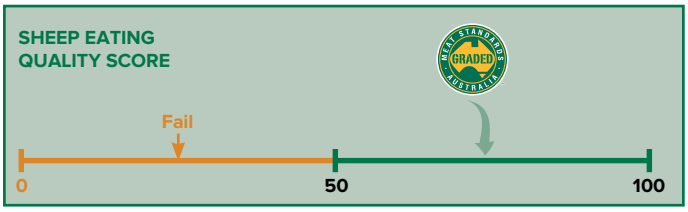
How is the MSA score calculated?

The MSA score, out of 100, is calculated by adding a percentage of the individual consumer scores for each sensory component as follows:

Tenderness	20%
Juiciness	10%
Flavour	30%
Overall liking	40%

These percentages have been established from statistical analysis of consumer taste test results.

When a resulting eating quality score is 50 or above, the cut can be labelled and sold as MSA, providing a minimum of 5 days ageing is met prior to selling to consumers.



Purchasing MSA sheepmeat

The carton label provides trade (wholesaler, retail and food service) with MSA eating quality information including recommended cooking methods and ageing requirements. This is all the consumer or enterprise needs to know to purchase and prepare sheepmeat products with confidence.

For more information

Visit www.mla.com.au/msa or contact MSA 1800 111 672.

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The effect of nutrition and growth on sheepmeat eating quality

Nutrition and finishing

Good nutrition and finishing are critical in defining sheepmeat eating quality in the period leading up to slaughter. Given the potential for good eating quality cuts from all sheepmeat categories (lamb, hogget and mutton), it is important those animals are well nourished and managed.

During periods of active growth, the 'turnover' of collagen in the body (the structural protein that dominates connective tissue) increases. For this reason, the hardening of connective tissue is slower and the background toughness in meat will be reduced.

Growth and weight gain

For best eating quality, animals should be gaining weight up until slaughter. The growth rate in the two weeks prior to slaughter should be a minimum of 100g per day and aiming for 150g per day for Merino sheep and lambs. Good nutrition is particularly important in the two weeks prior to slaughter.

Good finishing optimises the amount of muscle and intramuscular fat leading to more tender meat and resulting in increased flavour and juiciness. Muscle tissue comprises soft muscle fibres surrounded by stronger connective tissue fibres, which increase in toughness as the animal ages. Poorly nourished animals that are losing weight will use muscle fibres and intramuscular fat to nourish the rest of the body, but the connective tissue fibres remain unchanged. Consequently, poorly finished sheep are likely to produce tougher meat.

Selection for more muscular and leaner animals has been shown to reduce eating quality and highlights the need for careful monitoring of breeding programs to maintain high lamb eating quality.

Key points

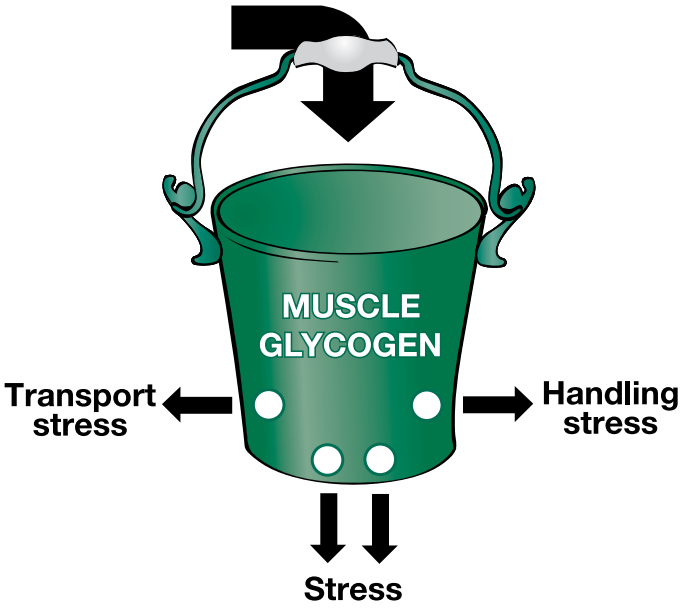
- For optimum eating quality results, lambs should be gaining at least 100–150g/day 2 weeks prior to consignment.
- Lamb and sheep should be finished to a minimum fat score of 2.
- The type of finishing system has little effect on eating quality, provided that sheep are gaining weight before slaughter.
- Diets that result in weight loss in the weeks before slaughter cause meat quality problems.
- Stress prior to slaughter can reduce levels of muscle glycogen.
- Reduced glycogen will increase muscle pH and cause dark cutting meat.

Good finishing optimises muscle glycogen

Glycogen is blood sugar and is held in reserve for vigorous muscular activity. Optimising glycogen is a combination of good pre-slaughter nutrition and reducing stress in the immediate pre-slaughter period.

Every animal has a certain amount of energy contained in its muscles in the form of glycogen. Once the animal is dead, the muscle glycogen is converted to lactic acid, which causes pH to fall. The glycogen bucket diagram in figure 1 shows this relationship.

Figure 1: Glycogen bucket



Nutrition provided for the animal is the energy that goes into the bucket. The holes in the bucket represent the factors that use up energy, such as exercise or stress. These factors will always be present in some form, but it is important to minimise their impact. That is, to keep the 'holes' in the bucket as small as possible.

Low levels of muscle glycogen in the live animal cause high pH meat (above 5.70), which has an unattractive dark colour, is tougher, takes longer to cook, and has a reduced shelf life.

Good nutrition reduces the risk of slaughter animals developing high pH. Nutrition, sufficient to reduce the risk of the high pH condition in sheep, can be defined as a weight gain of at least 100g per day (150g per day for Merinos) and results in a high and normal concentration of glycogen in lean muscle tissue. The normal and ideal concentration in sheep is around 1.5g/100g of lean muscle weight.

If the concentration of glycogen in lean muscle tissue falls below a threshold concentration (around 0.8g/100g), the pH of the resulting meat becomes higher than normal.

Poor nutrition and stress as a result of poor handling during mustering, yarding and transport will increase the rate of glycogen loss.

The effect of finishing on eating quality

Research has shown that the type of finishing system has little effect on eating quality, provided sheep are gaining weight before slaughter and they are finished to a fat score of 2 or above. This will ensure adequate intramuscular fat (IMF) for effective juiciness and flavour.

Animals with higher IMF% levels will produce meat that is more acceptable for consumers. The preferred range in lamb is between 4% and 6%.

IMF% is a strong driver of consumer sensory scores of all attributes. The highest impact is on juiciness.

Good quality pasture is just as effective as concentrate-based diets for producing high quality meat. Diets that are very high in cereal grains, fed for prolonged periods, may cause eating quality problems such as off flavours and soft fat.

Using genetics to optimise eating quality

Eating quality breeding values allow for selection of traits that cannot be visually selected in a live animal. They can be used in a breeding program to improve the performance of future generation, or to purchase stock that are likely to be more productive and have better eating quality.

Intramuscular fat (IMF) and shear force (Tenderness) are current research breeding values that are available and relate to eating quality.

IMF, often referred to as marbling, has a moderate to high heritability and high negative correlation with shear force. That is, high IMF will increase tenderness.

Shear force relates to the force required to cut through the loin muscle of lamb, an indicator of tenderness. This trait has a moderate-high heritability and a moderate correlation with tenderness in lamb. The preferred value for lamb is 3kg or less. More negative breeding values indicate genetic potential for more tender meat.

For more information

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MSA requirements for handling sheep

How sheep handling can affect eating quality

An important element contributing to predictable eating quality is the management of sheep on farm or at a feedlot prior to slaughter. For this reason MSA has produced guidelines to optimise the eating quality potential of the animal.

The long period of care and investment in producing an animal with high eating quality potential is most at risk in the two weeks prior to slaughter and the first few hours post slaughter. Optimum eating quality can be reduced to low quality, unacceptable product by inappropriate handling preslaughter.

The damage is caused by changes in muscle glycogen (blood sugar) levels. Glycogen is the energy reserve of the muscle. The glycogen level in muscle is increased by feeding (a process taking several days) and rapidly reduced by stress (which may only take minutes) or activity in the live animal. After stunning, the glycogen in muscle is converted to lactic acid that steadily decreases the pH of the muscle.

When there is insufficient glycogen in the muscle at the point of slaughter, inadequate lactic acid is produced and high pH meat can result. High pH meat is often referred to 'dark cutting' due to its unattractive dark colour and is often tough, cooks inconsistently and has a reduced shelf life.

Reduce stress pre-slaughter

Poor handling in the days and hours prior to slaughter can compromise the eating quality of even the best finished animals. Sheep and lambs are susceptible to stress and this must be minimised between mustering and slaughter.

Some ways to consider reducing stress include:

- Minimising the use of dogs during mustering prior to loading.
- Adjust transport times to match favourable weather conditions. Dramatic changes in temperature during transport, such as a cold snap or heavy rain, will cause undue stress.

Key points

- Unweaned or sucker lambs are more susceptible to stress caused by handling than carryover lambs.
- Allow a minimum of two weeks off shears before slaughter.
- Minimise the time between mustering and slaughter.
- Allow a minimum of two weeks at consignment property before dispatch.
- Total time off feed must not be greater than 48 hours (for on farm curfew, transport and lairage), before slaughter for MSA eligibility.
- Minimise stress during curfew, transport and lairage.
- Access to water should be available during on farm curfew and lairage.

• For product consistency from saleyards, producers and processors should aim to reduce the time between muster and slaughter, where practical. Transport and lairage principles for meat quality focus on two factors – minimising stress and reducing the time until slaughter.

A compromise between minimising carcase weight loss in transport and processor requirements for clean stock should be made. A minimum of two weeks between shearing and slaughter is required to manage stress occuring as a result of the shearing process.

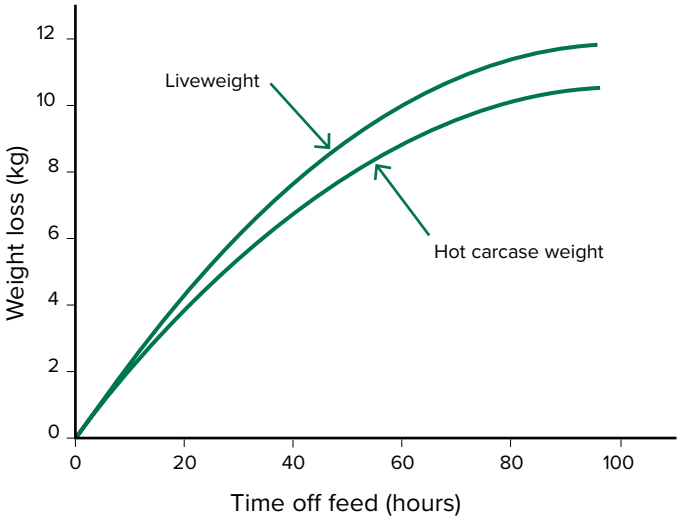
Reduce dehydration pre-slaughter

Dehydration can reduce muscle weight and eye muscle area, with preliminary data suggesting a possible 3% loss in carcase weight. Therefore, to maintain quality, it is important to ensure stock have access to water during curfew, transport and lairage periods.

Maintain carcase weight

Once sheep are taken off feed they have the potential to lose carcase weight and condition. Losses are not immediate because many hours pass before the digestive system is food free. However, the longer the period between mustering and slaughter, the greater the chance that losses in carcase weight will occur (figure 1).

Figure 1: Weight loss with time off feed



Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

Pre-slaughter curfews

Processors may require that sheep be held off feed for a minimum of 12 hours before being presented for slaughter, as animal excreta contains immense concentrations of microbes, which present contamination risks during trucking, lairage and the preliminary stages of slaughter.

To accommodate food safety concerns of processors and minimise the impact on eating quality, animals destined for MSA are held for a minimum of 12 hours or up to a maximum of 48 hours without access to feed before slaughter. The minimum time will depend on feed type, weather, and processor food safety requirements.

Requirements from processors vary in each state. Producers, stock agents and transporters should contact processors prior to transport to understand their individual curfew requirements.

Time in lairage

It is recommended that slaughter take place between 4 and 24 hours after the start of lairage. Sucker lambs have been shown to suffer pH problems from tailgate slaughtering (straight from truck to slaughter floor), so it is recommended that these lambs have a short resting period pre-slaughter. Tailgate slaughter for carryover lambs and older sheep is not detrimental.

Lairage should be limited to 24 hours to minimise carcase weight loss and meat pH problems. A decline in carcase weight, as shown in Figure 1, can result in lower carcase value.

For more information

Visit www.mla.com.au/msa or contact MSA 1800 111 672.

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The effect of breed and age on sheepmeat eating quality

The effect of breed on eating quality

Research shows sheepmeat eating quality is not greatly affected by breed. Due to the historical success of the wool industry, around 70% of Australian sheep genetics are Merino. Other breeds are increasingly promoted for meat production because they generally have better growth rates, better reproductive performance and more heavily muscled carcases which are better suited to meat production.

The key factors to optimised eating quality from all breeds is good nutrition and stress minimisation prior to slaughter.

It should be recognised that while the eating quality of Merino lamb and sheepmeat can be as good as other breeds, they do require more careful pre-slaughter management than other breeds, with key factors being good nutrition and stress minimisation prior to slaughter.

The Merino breed has an increased sensitivity to stress, which also extends to Merino crosses. This is further explained in figure 1 where the loss of muscle glycogen between farm and post-slaughter is compared between two cuts for three genotypes handled under identical conditions. Merinos lost more glycogen than crossbred lambs, with the first cross being affected proportionately, which subsequently resulted in higher pH meat. In low-stress pre-slaughter conditions, Merino lambs can perform as well as crossbreds with no differences in glycogen, meat colour or pH.

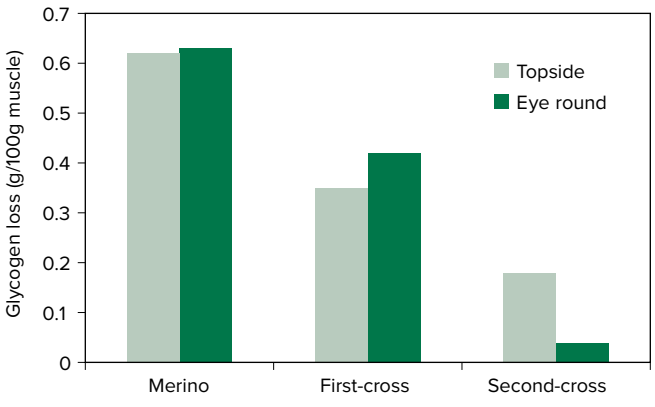
Provided that nutrition is adequate and animals are finished to a minimum fat score of 2, the intramuscular fat concentration of Merinos is either the same or higher than that of other breeds.

There is also some evidence that some genes for increased muscling may lead to a significant reduction in eating quality through reduced tenderness. More information on the requirements for reducing stress when handling sheep can be found in other components of MSA Tips & Tools.

Key points

- Sheepmeat eating quality is not greatly affected by breed.
- An increase in the proportion of Merino genes increases an animals sensitivity to stress prior to slaughter.
- Research has shown that processing regimes can improve eating quality and consistency of all classes of sheepmeat.
- Lamb has the best sheepmeat eating quality when comparing like-for-like (eg same cuts, same processing method, same cooking method).
- Mutton loin can have a similar eating quality to hogget loin.

Figure 1: Loss of muscle glycogen between farm and slaughter for Merinos and crossbreeds.



Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

The effect of animal age on eating quality

The eating quality differences between lamb, hogget and mutton are based on:

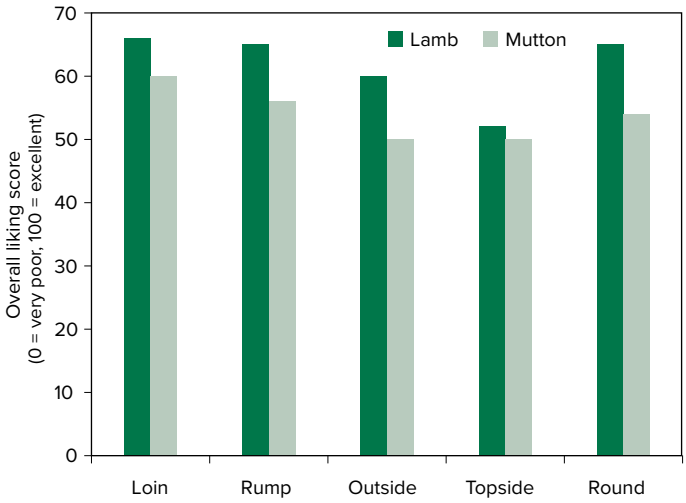
- the toughening of connective tissue
- adverse flavours accumulating in fat as a result of age
- the darkening of meat colour with age.

Connective tissue is visible as sinew, 'silverskin' and 'gristle' within meat. As the animal ages, this invisibly permeates muscle. In older animals, 'tougher' connective tissues do not melt as easily with cooking, so are more easily detected as the 'background toughness' in meat.

This effect is shown in figures 2 and 3, which summarises data from large numbers of Australian consumers who tested grilled cuts from lamb and mutton. Better cuts of meat, like eye of loin, have less connective tissue but these also become tougher as sheep get older.

Hogget loin cuts, when processed under optimal conditions, have only slightly lower eating quality than lamb loins.

Figure 2: 'Overall liking' of eating quality of five grilled cuts from lamb and mutton.

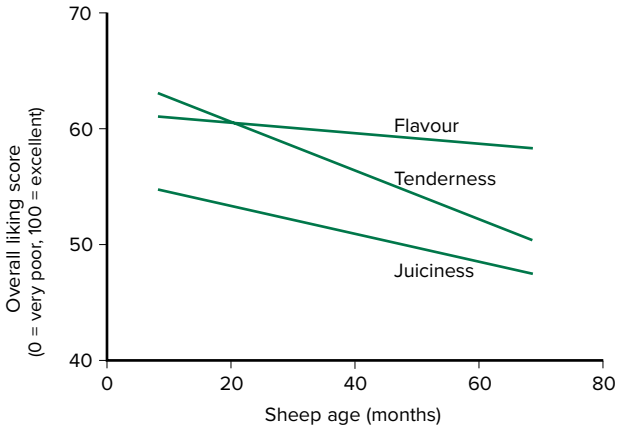


Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

Note: Optimal processing used: electrical stimulation + 5 days ageing; no stimulation + 10 days ageing; or tenderstretch + 5 days ageing.

Research found that lamb remains the premium product and has the best sheepmeat eating quality when comparing like-for-like (eg same cuts, same processing methods). Some cuts of hogget and mutton also show potential for high eating quality.

Figure 3: Change in eating quality attributes with sheep age.



Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

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The effect of pH on sheepmeat eating quality

The effect of muscle glycogen on pH

Every animal has a certain amount of energy contained in its muscles in the form of glycogen. Once the animal is dead, the muscle glycogen is converted to lactic acid that causes the pH to fall. If there is not enough glycogen available in the animal, insufficient lactic acid will be produced and the pH will remain high, resulting in dark cutting. The main point to consider is that adequate glycogen levels need to be maintained to deliver the ultimate pH required for good eating quality.

If the concentration of glycogen falls below a threshold concentration (around 0.8g/100g) because of poor nutrition or other factors such as poor handling and stress, the pH of the resulting meat becomes higher than the normal 5.7 (figure 1) and will result in high pH and dark cutting.

No matter how well lambs and sheep are prepared by the producer, poor practice in the days and hours leading up to slaughter can cause dark cutting. Dark cutting sheepmeat is characterised by a darker colour, coarse texture, reduced tenderness and a stronger flavour. At the retail level, consumers are likely to reject this meat on the basis of appearance. At higher pH levels, bacteria grow more rapidly and the meat will have a shorter shelf life.

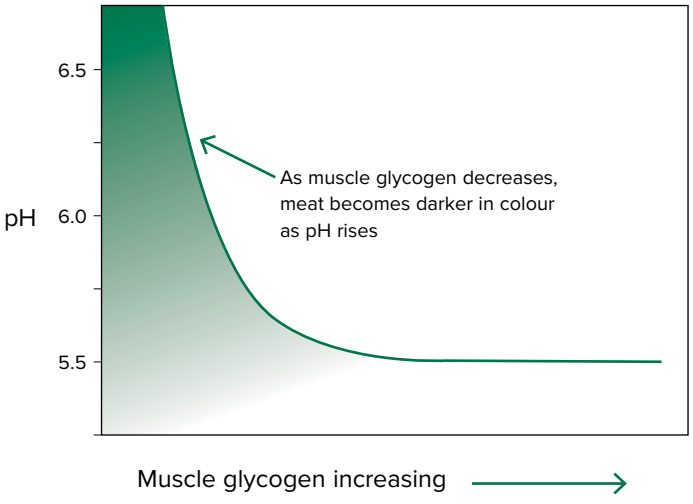
pH decline

The temperature at which a carcase enters rigor (pH 6) can significantly affect meat quality. If the carcase temperature falls too quickly before the carcase enters rigor (pH 6), then cold shortening may result, often leading to toughness.

Key points

- Glycogen levels prior to slaughter will determine the ultimate pH and eating quality outcomes.
- Electrical stimulation can be used to ensure carcases enter rigor (pH6) at the desired temperature.
- Tenderstretch carcases hung by the pelvis have a wider temperature window and can enter rigor between 8°C and 30°C, in combination with five days ageing.
- Aggressive chilling regimes (ie high air speed, low temperature) can increase toughness.

Figure 1: Muscle glycogen and pH of resulting meat.

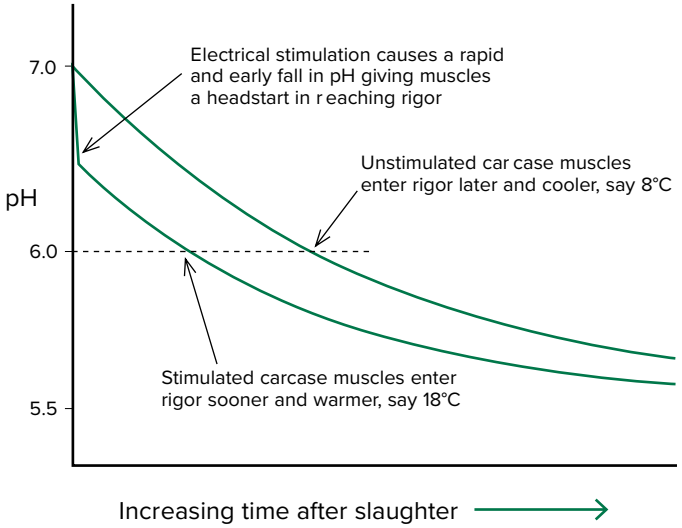


Electrical stimulation

Electrical stimulation provides a method for accelerating the fall of pH. When properly applied, electrical stimulation will ensure muscles enter rigor (pH 6) at a temperature that will avoid cold shortening and hence maximise eating quality. It will guarantee better consistency in all sheepmeat categories.

The electrical current stimulates the conversion of glycogen to lactic acid so that muscle pH drops rapidly during current application (figure 2). Electrical stimulation of carcases causes an early and rapid fall in pH so that muscles enter rigor (pH 6) sooner and at a higher temperature.

Figure 2: The effect of electrical stimulation on pH.



Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

Key principles of electrical stimulation

- Electrical stimulation is a useful tool for processors to control rigor onset. For continuous effectiveness, it is critically important that stimulator systems are monitored and that treated product is temperature-pH measured.
- Electrical stimulation is not necessary if meat is aged for at least 10 days before consumption and a temperature window of 8–18ºC at rigor is achieved.
- There are no adverse eating quality effects from correctly applied electrical stimulation. However, if incorrect electrical stimulation results in carcase rigor above 35ºC, then drip loss and meat colour stability problems may occur.
- Electrical stimulation of sheepmeat does not increase or decrease contamination of carcases by microorganisms. Electrical stimulation can in fact improve shelf life by enabling more rapid chilling.
- pH/temperature measurements are made at various times after slaughter and results are assessed to determine the temperature at which the eye of loin pH reaches 6.0, the pH at which rigor develops.

Carcases cooled too quickly

If carcases are cooled too quickly, temperature decline exceeds the pH decline and follows the upper line shown in figure 3. This is called cold shortening.

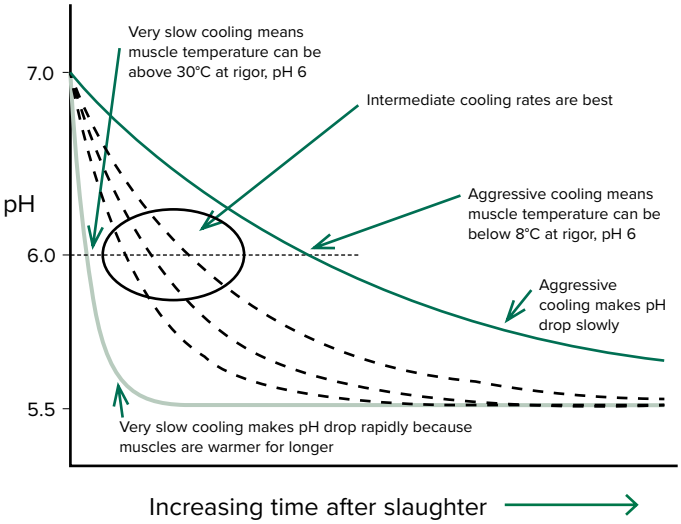
In extreme cases, fast cooling leads to permanent toughening and, at the very least, it causes slow ageing. The ideal balance is to cool carcases between the two extremes; this is illustrated by the three dashed curves in figure 3. However some processors, when considering specific markets, may choose to operate to the lower or upper curve.

Carcases cooled too slowly

If carcases are cooled too slowly (e.g. because of inadequate chilling capacity), muscle pH falls rapidly (see the lowest line in figure 3) because the chemical reactions in the muscle will have accelerated. This is called heat shortening.

If the temperature of the muscles is above 35°C at the onset of rigor (pH 6), the muscles will be inclined to heat shorten. This can cause quality problems such as toughness, excessive drip and pale meat colour.

Figure 3: Impact of carcase cooling on pH.



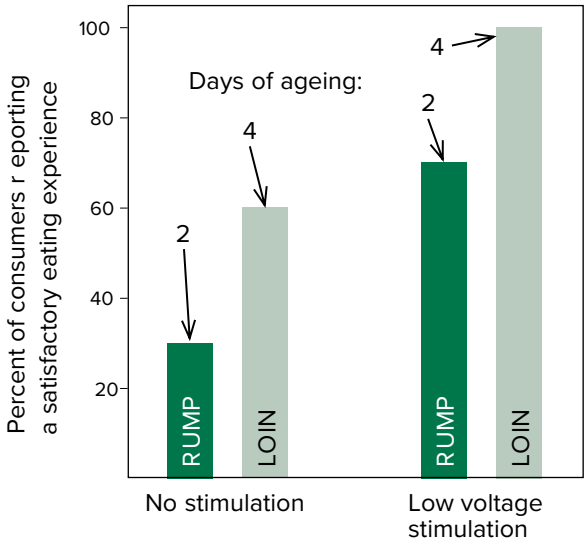
Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

Effect of stimulation on eating quality

Figure 4 shows that electrical stimulation maximises the frequency of satisfactory eating experiences particularly when products are eaten soon (two days) after slaughter. However, further ageing in all treatments will continue to improve eating quality.

Under any treatment, the importance of sufficient ageing time for the development of optimum eating quality cannot be overemphasised. For this reason, all MSA sheepmeat products must be aged for 5 days before sale to the consumer.

Figure 4: Effect of electrical stimulation on overall eating experience.



Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

Types of stimulation

When purchasing or upgrading electrical stimulation equipment, consideration should be given to the newer types of lower cost, low voltage/high frequency systems. These are as effective as high voltage systems. Medium voltage systems can be installed to operate during the bleeding process or, alternatively, post evisceration.

Researchers consider the time and processes between stunning and chilling to be the most crucial element in eating quality. Sheepmeat eating quality can be maximised for individual situations by using a combination of processing tools as follows:

- electrical stimulation
- hanging method
- temperature at which the carcase enters rigor (pH 6)
- minimum ageing period.

Table 1 summarises the processing and ageing recommendations for optimum eating quality relevant to specific markets.

There are specific processing regimes known to optimise the consistency and eating quality of all classes of sheepmeat for any market.

Table 1: Processing and ageing conditions for optimum eating quality in different markets.

Target market	**Domestic chilled trade**		**Domestic or export chilled trade**
Hanging method	Tenderstretch	Achilles	Achilles
Electrical stimulation needed	No	Yes	No
Enter rigor (pH 6) at:	8–35°C	18–35°C	8–18°C
Minimum ageing period	5 days	5 days	10 days
Storage temperature	1°C	1°C	1°C

Optimum conditions for preslaughter pH management

Glycogen levels prior to slaughter will determine ultimate pH. The following points list optimum conditions for reducing animal stress therefore maintaining glycogen levels prior to slaughter.

1. Livestock receival

- Unloading areas are easily accessible to transport operators.
- Trucks move immediately to unloading area and are unloaded without delay.
- Trucks arrive in good condition, with non-slip flooring and at recommended loading densities.
- Trained stockmen are used to unload animals.
- Use of electric goads and dogs are minimised. Flappers or other goads used.
- Sheep are moved directly to lairage pens.
- 'Downer' or injured sheep are assisted to their feet prior to unloading and treated accordingly.
- There are no obstructions in the unloading operation.
- Familiar sheep are left in their groups, and not mixed as they arrive.
- Ramp facilities are of a correct design.

2. Lairage facilities and livestock

- Animals are inspected by trained handlers upon arrival. Injured sheep are separated and treated accordingly.
- Sheep are placed in the same lairage pen, which will house them for the entire period before slaughter.
- Trained stockmen are used to move or redraft animals.
- Canvas or leather flappers, soft polythene pipes or rattlers are used in preference to electric prodders.
- Pens are situated well away from unloading area to minimise disturbance to resting sheep.
- Animals are maintained in their consignment group.
- Lairage pens are well drained, sheltered and/or shaded.
- Sheep are given adequate time to rest in lairage prior to slaughter.
- Clean fresh water is available in the pens.

3. Assembling for slaughter and pre-slaughter practices

- Sheep move easily into laneways without disturbing other pens of sheep.
- Laneways are wide enough to avoid pushing and interaction between sheep.
- There are no sharp corners, obstructions or distractions in laneways and races.
- Trained stockmen are used to draft and move sheep through laneways, races and ramps.
- Non-slip flooring is used.
- Grooved stair steps are used on concrete ramps.
- A level surface is provided at the top of the ramp prior to the stunning restraint entry.
- There are no sheep on ramps during breaks and stoppages.
- Electric prodders are only used on animals which are baulking and have a clear path ahead.

4. Stunning

- Fully trained personnel with sheep handling skills are used for stunning
- The entrance to the stunning area is inviting to sheep. Goads are used appropriately for entry into the restrainer.
- The stunning restrainer is solid underfoot and quiet in operation.
- The restrainer uses a well-designed head restraint.
- The stunning device provides an effective stun and is easily positioned.
- There are no distractions to the sheep in the stunning restraint.
- Stunning is not delayed, nor sheep held in the restraint during stoppages or breaks.

5. Monitoring of individual lots through lairage

Individual lots are assessed in the following areas to ensure best practice for optimal eating quality outcomes:

- Consignment number and number and type of sheep
- Source (place, private/saleyard)
- Time and date of arrival
- Unloading process (difficulties, downers, delays and dogs or other goads)
- Ease of movement to pen (drafting required, goads used)
- Conditions in pen (conducive to settling, boggy, other stock mixed in same pen, access to watering points)
- Ease of movement along laneways (drafting required, goads used)
- Movement up ramp to slaughter floor (time on ramp, goads used)
- Movement into restrainer (ease)
- Time of stunning
- Time interval between stunning and sticking
- pH temperature declines performed as routine monitoring.

For more information

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MSAS6 MEAT STANDARDS AUSTRALIA

The effect of hanging method on sheepmeat eating quality

Traditionally, sheepmeat carcases are suspended or hung from the Achilles tendon. An alternative hanging method that can improve eating quality performance is the 'tenderstretch' method. For achieving sheepmeat of good eating quality, tenderstretch hanging provides an alternative. It is particularly beneficial for improving the tenderness of loin and hindquarter cuts.

Key points

- Tenderstretch hanging improves eating quality of the loin and hindquarter cuts.
- Tenderstretch can be used as an alternative for electrical stimulation to optimise eating quality.
- Achilles hung carcases destined for the domestic market will generally require electrical stimulation.

Achilles hanging method

The traditional method of hanging sheep or lamb carcases is by gambrels inserted behind the Achilles tendon. In the Achilles-hung carcase, the spine is curved and the hindquarter muscles have less tension on them. As a result, when these large hindquarter muscles go through rigor mortis they can contract. When this occurs, the muscle fibres overlap resulting in slightly tougher meat.

If Achilles-hung meat is cooled to achieve the pH/temperature target of 18–35°C, and the meat is stored for five days at 1°C before retail sale, the eating quality of all cuts will be consistently good when they are cooked in the recommended way. The best way of attaining this pH/temperature target is with electrical stimulation which would be suitable for a processor selling lamb, hogget or mutton into the domestic market.

Tenderstretch hanging method

Tenderstretch hanging involves sheep carcases being suspended by the pelvic or aitchbone, so that the leg drops down at a 90° angle. As a result, a number of muscles are held in a stretched position so they cannot contract during rigor mortis. Tenderstretch is most effective in the hindquarter and has a varying effect on each cut.

Figure 1: Conventional Achilles hanging (left) and tenderstretch hanging.

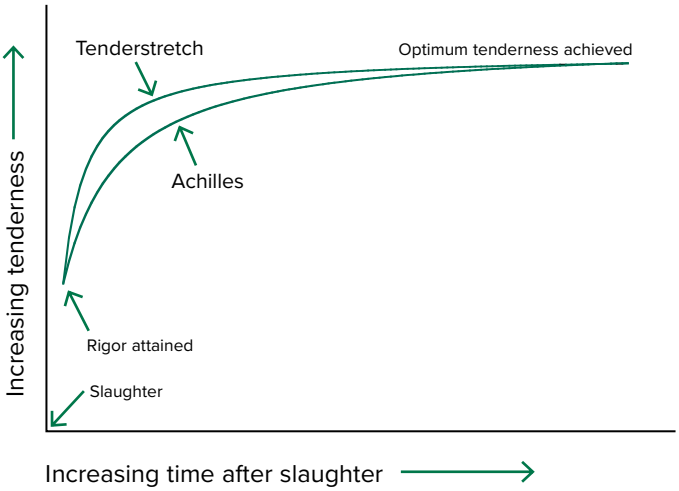
Advantages of tenderstretch hung carcases

When tenderstretch hung, hindquarter muscles assume a more 'life-like' posture. Muscle shortening is prevented and improved eating quality will be attained. Although tenderstretch hanging requires some additional labour, it does have some significant advantages to eating quality:

- Ageing will occur more rapidly in tenderstretch carcases compared to Achilles-hung equivalents (Figure 2)
- Eating quality is improved for loin and most leg cuts, when compared to Achilles hung carcases.

Figure 2 compares the tenderisation kinetics of Achilles hung with tenderstretch carcases. Tenderstretch clearly yields acceptably tender meat more quickly, although, when given sufficient ageing, Achilles-hung sheepmeat ultimately achieve the same degree of tenderness.

Figure 2: Tenderisation kinetics during ageing for Achilles hung and tenderstretch carcases.



Source: Improving lamb and sheepmeat eating quality – a technical guide, 2006.

The tenderstretch effect varies for each muscle according to the muscle's position in the carcase and the degree of stretching. Although the tenderstretch effect on eating quality is slightly negative in the tenderloin (which is stretched in an Achilles-hung carcase), it is strongly positive in most other hindquarter cuts and largely neutral in forequarter cuts.

Another advantage of tenderstretch lies in the uniformity of eating quality between cuts. If older sheep are Achilles hung, there are marked differences in quality between the different cuts, to an extent not seen with lamb. However, if older sheep are tenderstretch hung, the differences between cuts are minimised.

It should be noted that tenderstretch hanging will alter the shape of several of the leg cuts (see figure 3). Cuts are more evenly distributed around the bone than in Achilles-hung carcases. This even distribution is well suited to the foodservice industry and the 'evenness' of the eating quality throughout the leg cuts is a bonus for consumers. However, adoption of tenderstretch hanging requires changes to operations that will not suit everyone.

Figure 3: Tenderstretched hindquarters.

Tenderstretch hanging provides an alternative to electrical stimulation for achieving sheepmeat of good eating quality. It is particularly beneficial for improving the eating quality of loin and hindquarter cuts. This method is well suited to the domestic market where rapid tenderisation is important and electrical stimulation is not a valid option.

For more information

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MSAS7 MEAT STANDARDS AUSTRALIA

The effect of cut and cooking method on sheepmeat eating quality

How cooking method affects eating quality

The cut and cooking method combination is a vital factor in optimising sheepmeat eating quality. The various muscles of a carcase will have different recommended cooking methods.

Muscle is made up of muscle fibre groups surrounded and supported by connective tissue, which contains collagen fibres. Collagen fibres form cross-links to stabilise and strengthen muscles. Different muscles have varying amounts of connective tissue related to the muscle position and function within the body.

For example, muscles that are used constantly will have a high connective tissue content. The collagen and connective tissue can be partially broken down through casserole (wet) cooking methods using low heat and moisture over a period of time. This cooking method will optimise the eating quality of these cuts.

Muscles that do little to no work will contain almost no connective tissue and are therefore inclined to be more tender. An example is the loin, which is situated along the spine. Loin cuts would not be suitable for the casserole cooking method, as the structure would be completely broken down. These cuts would be best suited to pan frying, grilling or roasting.

Key points

- The eating quality of grilled cuts is (in descending order): loin > round and rump > silverside > topside.
- Recommended cooking methods can optimise eating quality.
- There is some potential for mutton loin products to be marketed as a good quality grilling meat although its eating quality will be more variable than that of lamb and hogget loin.
- To avoid pronounced mutton flavours, heavily trim the fat (denude) from the meat of older animals.

Table 1: 'Overall liking' score for grilled and roasted cuts from lamb and mutton.

	Lamb		Mutton	
Cut	**Grill**	**Roast**	**Grill**	**Roast**
Loin	66	68	60	54
Knuckle	70	65	54	59
Rump	65	68	56	56
Silverside	60	60	50	unsatisfactory
Topside	52	59	50	unsatisfactory

The MSA score, out of 100, is calculated by adding a percentage of the individual consumer scores for each sensory component (tenderness, Juiciness, Flavour and Overall liking). Consumer survey results have shown that an eating quality score below 50 is considered an unsatisfactory eating experience. All lamb and sheepmeat sold as MSA has a score of 50 and above.

Eating quality of different cuts from lamb, hogget and mutton

Table 1 shows the 'overall liking' score for grilled cuts of lamb and mutton after optimal processing and ageing. The higher the eating quality score, the lower the risk of a poor eating experience.

In table 1 it can be seen that for lamb, all grill cuts – except topside – scored highly. When grilled, lamb cuts clearly outscored the mutton cuts, as would be expected. It can be concluded that when grilled, and with the exception of the topside, lamb performs well across all cuts.

Also in table 1, all lamb cuts score highly when roasted. In comparison, mutton silverside and topside cuts, when roasted, fail to satisfy consumer expectations. However, cuts such as mutton knuckle and rump, although not scoring as highly as lamb, can deliver a satisfactory eating experience when roasted. There is also opportunity to successfully market mutton loins as grilling cuts.

Recommended cooking methods

Collective research has provided cooking recommendations for MSA sheepmeat cuts by category. These recommendations provide a basis for product labelling. The chances of disappointment can be significantly reduced when appropriate cooking methods are applied.

Table 2 demonstrates the application of recommended cooking methods to various cuts.

Category	Cut				
	Loin	Rump	Silverside	Topside	Hindshank
Lamb	Grill Roast Stirfry	Grill Roast Stirfry Casserole	Grill Roast	Stirfry	Casserole
Hogget	Grill Roast Stirfry	Grill Roast Stirfry Casserole	Grill Roast	Stirfry	Casserole
Mutton*	Grill Roast Stirfry	Grill Roast	Grill Roast	N/A	N/A

* Mutton should be denuded of fat

The following cooking methods are recommended as part of MSA sheepmeat. Where MSA is used to underpin a brand, that brand can have its own cooking label but the corresponding cooking method for the cut must be displayed.

CASSEROLE

Casserole or 'slow cook'
Cuts displaying this cooking method should be cooked in sauce or gravy on low heat for two hours. The product is prepared in 20mm cubes.

GRILL/PAN FRY

Grill (BBQ/pan fry)
Cuts displaying either of these symbols are suitable for cooking in a pan, grill or BBQ. They are best cut at minimum 15mm thickness.

ROAST

Roast
Cuts displaying this symbol are suitable for roasting in a moderate oven (180°C). accurate cooking is best determined using a meat thermometer. Internal temperatures should be as follows for the different degrees of doneness:

Rare 60°C
Medium 65–70°C
Well done 75°C

When the roast is removed from the oven, allow it to rest for 10 minutes prior to carving.

STIR FRY

Stir-fry
Cuts suitable for this cooking method should be cut into strips approximately 6mm wide and 75mm in length. The product is cooked in small batches on high heat.

For more information

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MSAS8 MEAT STANDARDS AUSTRALIA

How to supply sheep to MSA

Consumer taste tests have determined the factors that affect eating quality resulting in accurately established standards. The factors that affect eating quality are set as minimum requirements and recommendations for MSA. These recommendations address the critical control points along the production chain that can impact on eating quality. Producers supply lamb and sheep following the minimum requirements as outlined in *MSA Tips & Tools: MSA requirements for handling sheep.*

Sheep are consigned to an MSA licensed abattoir to be slaughtered within 48 hours of animals being off feed. MSA trained operatives check details on the Livestock Production Assurance National Vendor Declaration (LPA NVD) prior to sheep being processed at the abattoir.

The following steps can assist with supplying lambs and sheep to meet MSA requirements and improve your understanding of MSA.

Step 1

To supply MSA sheep, through the saleyards, direct to a processor or through an MSA underpinned brand, you must be registered as an MSA producer. The easiest way to become registered is to use the online registration program at **www.mla.com.au/msa**. Following a short training program, you will have instant access to MSA electronic vendor declarations.

Step 2

Alternatively, a registration form can be downloaded from **www.mla.com.au/msa**. When registering by paper-based form, allow two weeks to receive your registration number and producer pack containing information.

Step 3

Check that you meet the list of requirements detailed in *Tips & Tools: MSA requirements for handling sheep.* Once you have received your MSA producer registration number and are satisfied you meet the MSA requirements, you can consign lambs and sheep through the MSA system, providing you also have access to Livestock Production Assurance National Vendor Declarations (LPA NVD). MSA also provide free information sessions to lamb and sheep producers regarding the impacts of production systems and management techniques on eating quality. Contact MSA to find a suitable workshop.

Key points

- Producers wishing to supply lambs or sheep for MSA must be registered.
- A Livestock Production Assurance National Vendor Declaration (LPA NVD) must accompany the animals to the MSA licensed abattoir.
- The LPA NVD contains information about the animals that can impact on their compliance to the MSA requirements.
- Ensure your MSA producer registration number is included in Part A, question 7, on the NVD
- Ensure transporters complete Section B of the NVD with details of when transport commenced.
- Sheep to be processed no later than 48 hours off feed (including on farm curfew, transport and lairage).

Table 1: MSA sheepmeat carcase specifications.

Category	Dentition	Approximate age	HSCW (kg)**	Fat score	GR***
Sucker lamb (milk fed) or Young lamb *YL*	0	Up to 5 months	≥ 16kg	≥ 2	≥ 6mm
Lamb *L*	0 permanent incisor teeth in wear.	12 months	≥ 18kg	≥ 2	≥ 6mm
Hogget *H*	1 but no more than 2 permanent incisor teeth in wear.	10–18 months	≥ 18kg	≥ 2	≥ 6mm
Mutton *M*, *W*, *E*	1 or more permanent incisor teeth in wear.	Over 10 months	≥ 18kg	≥ 2	≥ 6mm

** HSCW – Hot Standard Carcase Weight

*** GR – Fat measurement taken at the standard site, 110mm from the midline over the 12th rib.

Step 4

The MSA website lists all MSA licensed abattoirs. If you are supplying through a MSA underpinned brand or to a MSA licensed abattoir make sure you are familiar with the purchaser's specifications. Table 1 details the MSA carcase specifications, however MSA does not take yield parameters into account and has a wide acceptance of weight and fat ranges. Many processors will have tighter specifications. Carcases outside their nominated specifications may be discounted regardless of their MSA compliance result.

Step 5

You should liaise with the abattoir to ensure sheep are processed within 48 hours of being off feed. You should also consider any condition that may impact on the eating quality of the animals such as climate and pre-slaughter stress. For more information on the importance of these measures, see *MSA Tips & Tools: MSA requirements for handling sheep.*

Step 6

Fill in the Livestock Production Assurance National Vendor declaration (LPA NVD) to accompany the consignment to the abattoir or saleyard. It is important that all the details are filled in correctly. The abattoir uses the information from the vendor declaration to determine eligibility of the livestock for MSA. If details are missing or inaccurate the animals may not be eligible for the MSA program.

The following sections of the LPA NVD need to be completed to ensure MSA eligibility:

- Address and PIC of property
- Month of shearing (included in Part A – Description)
- Time off feed
- MSA registration number (included in Part A – Question 7)
- Ensure transporters complete Section B of the NVD with details of when transport commenced.

Step 7

Ensure you receive your carcase feedback sheets from the abattoir. Check your compliance to MSA and/or company specifications. Note any common factors in the noncompliant carcases. MSA producer workshops can assist in providing information on the impact of live animals and carcase attributes on eating quality.

Step 8

Talk to other MSA producers to share the knowledge they have gained from using the system. At times of seasonal risk you may want to discuss strategies for minimising pH and stress risk (see *MSA Tips & Tools: The effect of pH on sheepmeat eating quality*). Link other sources of information into your production objectives. EDGEnetwork® workshops, your state department of agriculture or Primary industries, local or preferred consultants can all assist in improving your management system to improve your product.

Step 9

Ensure you retain all feedback for comparison purposes. Compare each consignment with the previous one, particularly where production changes have been made in an effort to improve compliance. A small management change can significantly improve compliance without the extended generation time associated with genetic improvements.

For more information

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