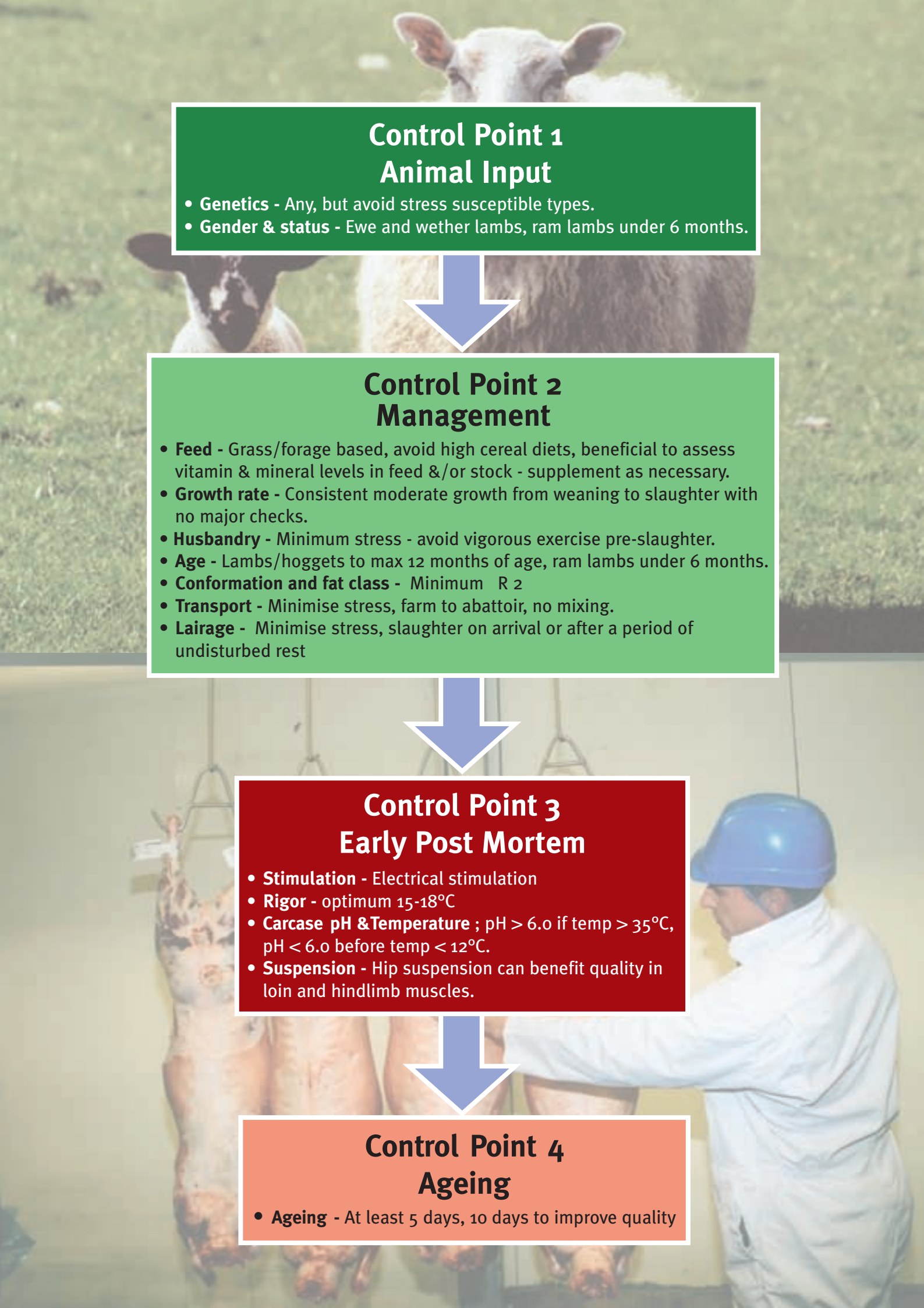
# Lamb Eating Quality
# Summary of Good Practice

QUALITY MEAT SCOTLAND
representing the Scottish red meat industry



## Control Point 1
## Animal Input

- **Genetics -** Any, but avoid stress susceptible types.
- **Gender & status -** Ewe and wether lambs, ram lambs under 6 months.

## Control Point 2
## Management

- **Feed -** Grass/forage based, avoid high cereal diets, beneficial to assess vitamin & mineral levels in feed &/or stock - supplement as necessary.
- **Growth rate -** Consistent moderate growth from weaning to slaughter with no major checks.
- **Husbandry -** Minimum stress - avoid vigorous exercise pre-slaughter.
- **Age -** Lambs/hoggets to max 12 months of age, ram lambs under 6 months.
- **Conformation and fat class -** Minimum R 2
- **Transport -** Minimise stress, farm to abattoir, no mixing.
- **Lairage -** Minimise stress, slaughter on arrival or after a period of undisturbed rest

## Control Point 3
## Early Post Mortem

- **Stimulation -** Electrical stimulation
- **Rigor -** optimum 15-18°C
- **Carcase pH &Temperature** ; pH > 6.0 if temp > 35°C, pH < 6.0 before temp < 12°C.
- **Suspension -** Hip suspension can benefit quality in loin and hindlimb muscles.

## Control Point 4
## Ageing

- **Ageing -** At least 5 days, 10 days to improve quality

# Control Point 1

## Animal Input:

- **Genetics** - Breed related differences, particularly for sensory quality are small and inconsistent. The Soay lambs are reported to produce tougher meat than Welsh Mountain and Suffolk animals (1, 2), and Herdwick at 8 months of age was reported more tender than Suffolk at 6 months of age (3). There may be breed related differences in protein content, and fatty acid and mineral composition (4). Genotype based differences in tenderness have been reported (5,6), but carcase composition may be more important than genotype (6).

Fine wool producing breeds especially the Merino tend to be highly stress susceptible (7, 8) – leading to reduction of glycogen, high pH and poor meat quality.

Carriers of the callipyge gene (CLPG) should be avoided. CLPG is associated with greatly increased muscle mass in the hind quarters and loin, but there is also a general increase in toughness (9, 10), although not in all cases (11). Post mortem processing methods may influence tenderness (12,13) but not in all muscles.

Breed differences in physiological maturity or muscularity are reflected in carcase characteristics and may be important in selecting at slaughter weight (14, 15).

# Control Point 2

## Animal Management:

- **Gender & status** – Ewe and wether lambs produce good quality meat. Ram lambs will also produce tender meat but abnormal flavours may occur around 30 weeks of age (16) so for quality, rams lambs should be less than 5-6 months old.

- **Handling & Stress** - Careful management to reduce stress is important and improves productivity and welfare (17). Low stress management helps to ensure the maintenance of muscle glycogen levels (7, 8) and hence meat quality. Exercise stress (e.g. 5 mins exercise using a dog, 30sec rest, 5 mins exercise) preslaughter can lead to glycogen loss, high ultimate pH and increased drip loss (18).

Physical damage to animals may appear as bruising on

the carcase and may also cause stress leading to a loss of muscle glycogen.

- **Feed** – Diet has a predominant effect on flavour, but little or no effect on tenderness.

  Grass or forage fed lamb has a more intense lamb flavour than grain fed lamb which was preferred by British sensory panellists (19, 20).

  Grass feeding increased muscle n-3 polyunsaturated fatty acid concentrations, improved lamb flavour and increased the overall liking score of grilled lamb (1). In contrast, concentrate feeding increased scores for 'abnormal flavours' probably due to low n-3 and higher n-6 polyunsaturated fatty acid concentrations (1). Diets containing high levels of cereals can lead to off flavours and soft fat. If cereals are used they should be used whole not rolled or processed (21, 22).

  Vitamin E is provided by grass but supplementation with vitamin E may be important where grain is also fed. Grass fed lamb has similar vitamin E levels to those in lamb fed a concentrate diet with 150 IU/kg supplemental vitamin E (22). Estimated maximum vitamin E concentrations would be an intake of 584 IU of total vitamin E/d, supplementation above that level does not further influence concentrations in meat (23). Feeding concentrate diets with 300 IU vitamin E/kg for 7 or 21 d before slaughter can increase concentrations in meat (23) and hence extend shelf life.

  Increasing weight through the use of barley/fish meal or fish meal diets had no effect on fat depth or tenderness (24).

  It has been suggested that 12 hrs feed withdrawal prior to slaughter may benefit eating quality (7, 8, 25).

  Feeding 15 or 17% crude protein has little effect on daily gain or gain:feed. A level of 15% crude protein with supplementary soyabean meal for 25-40kg growing Finn-Dorset lambs has been recommended (26).

- **Growth rate**- Selection of stock on the basis of average daily gain gives double the economic response compared with selection for feed conversion ratio or total feed intake. This may be a good method for indirectly improving efficiency of gain in lambs (27).

  Provided nutrition is adequate and stress levels are low, supplementary feeding to enhance growth rates does not give any tenderness over the lower growth rates achieved from grass (28). Weight gain should be maintained up until slaughter (7,8), even short periods (2 weeks ) poor nutrition before slaughter can affect levels of intramuscular fat in lambs (7,8).

  Meat quality differences between animals raised with high (238 g/d) or moderate (185 g/d) growth rates from birth to slaughter were minimal (29), although collagen degradation rates and hence implied tenderness was greater in lambs with high (>250g/d) than low (<25g/d) growth rates (30) .

- **Age** – Age has been perceived by producers and processors as an important factor in lamb (31) but the data are contradictory. The ultimate tenderness of loin has been shown to increase as slaughter age of lamb increases from 2-10 months (32), but slaughtering at live weights between 12 and 36kg showed no effect on toughness (33). Australian studies have shown that eating quality of lamb is maintained during tooth cutting (during eruption but not in wear) (7).

  In a North American study, although 125 d old winter lambs (born 1/1 -15/2 and raised in a feedlot) showed better growth performance, the older (260d) spring lambs (born 15/4-30/5 and raised on pasture) were leaner with higher leg conformation and carcass quality scores (34).

  Work in the USA suggests that wether lambs 14-15 months old produce acceptable quality meat providing the feeding is appropriate (35).

  **Conformation and Fat class** - There is little information on conformation, but muscular carcases reflecting growth rate are likely to give best eating quality. Recent Australian work shows that if there is less than 2% fat within the muscle the meat may be rated as dry by consumers (8). Subcutaneous fat will give some protection against cold shortening (36). Finishing lambs to a minimum of fat class 2 will give ~4% fat in the meat. Short period (eg 2 weeks) of poor nutrition before slaughter can reduce the fat level in the meat (8).

- **Transport** - Good handling of lambs is important to maintain eating quality (37). Animals should be subjected to minimum stress, no mixing of unfamiliar groups. Stocking density should be as low as possible.

- **Lairage** – Good handling to minimise stress in lairage is important. Lambs should be moved with minimum of force, to preserve muscle glycogen and hence aid the production of good meat quality.

  Evidence suggests that the impact of the length of time spent in lairage may depend on the age of the lamb; meat may have a higher pH if lambs just off their mothers are held for short (<4hrs) periods prior to slaughter (8).

# Control Point 3

## Early post mortem:

- **Carcase pH & temperature -** The relationship between pH and temperature is very complex and involves the rate of fall (38, 39). The temperature of rigor onset can influence meat quality, if the temperature falls too rapidly the muscle will cold shorten and the meat will be tough, but if the cooling is too slow hot shortening can occur.

  Due to the small size of lamb carcases and the rapid heat loss post slaughter, lamb muscle is particularly susceptible to cold shortening, which can be marked in loin. Subcutaneous fat can play an important role in insulating against a too rapid fall in temperature.

  Australian studies suggest different optimum temps depending on the stimulation, suspension and ageing strategies and time to market (8).
  Considerate chilling can produce tender meat - the long standing premise is that no part of the carcase should be below 10oC within 10 hrs of slaughter (40) , more recently it has been suggested that carcase temperature should not fall below 10°C before the pH has reached 6.2 ( 41) .

  The rate of pH decline should not be too rapid in relation to carcase cooling (42). Meat with a high ultimate pH is tough. Very fast chilling, (down to 0°C in the core by 5hrs after slaughter), can lead to tender meat (43), but results are inconsistent and if it fails rapid chilling leads to cold shortening. Cooling to 2°C straight after slaughter results in tough meat (44).

  Based on these data a general recommendation is pH > 6.0 if temp > 35°C, pH < 6.0 before temp < 12°C. It may be good practice to record both pH and temperature and adjust processing practices to meet optimum.

- **Stimulation** – Electrical stimulation (ES) causes muscle contraction which uses up the muscle energy supplies (ATP and glycogen) and so accelerates pH fall and the onset of rigor. ES allows more rapid chilling. High voltage ES (HVES) may improve the tenderness, through accelerating ageing or causing physical damage to the muscle fibre (45, 46). Low voltage ES (LVES) must be applied when the nervous system is intact. LVES tends to prevent cold-shortening (47), but can cause hot shortening. The precise timing and nature of ES is very important. Different muscles will respond differently.

  If ES achieves a carcase temperature at rigor of 25°C or less, there is no effect on shelf life or colour, but if rigor happens at above 25°C there may be problems with both colour and drip loss (8).

  Australian studies indicate that the use of stimulation may be varied depending on suspension, ageing and time to market (8).

  Electrical stimulation may improve some meat from callipyge animals (11).

- **Rigor** - a rigor onset temperature of 15-18°C has greatest beneficial effects on tenderness. Rigor above 20°C will usually lead to hot shortening (48). Shortening during rigor development can cause toughening in lamb (49).

- **Suspension** – The value of altering the relative posture of the carcase has been recognised for a considerable time (50, 51). The type of suspension used influences tenderness because muscle length appears to have a direct effect on meat tenderness. Suspension of the carcase from the hip bone acts to maintain tension in a range of hindlimb muscles and prevent muscle shortening.

  Shortening appears to be the main cause of background toughness, and ageing is the main determinant of tenderness in lamb loin (31). Australian work suggests that hip suspension can be used instead of ES with Achilles hanging for good eating quality, and that ageing benefits for tenderness are more rapid in hip suspended than achilles hung carcases (8).


# Control Point 4

## Ageing

- **Ageing -** Ageing is a major determinant of tenderness in lamb loin (31). Post mortem ageing is dependant on the activity of proteolytic enzymes which breakdown protein, the activity of these enzymes falls with time at 4°C (52, 53). Ageing time can be affected by other factors such as ES, and suspension.

  Tenderness increases with ageing at 1°C from 2-10 days (31). 80% of the tenderisation in lamb occurs within 8d post slaughter at 1°C (54). A minimum of 5 days ageing should be used; 10 days should provide good quality.

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