Hybu Cig Cymru
Meat Promotion Wales

Beef Producers' Handbook

From gate to plate

www.hccmpw.org.uk

About HCC

Hybu Cig Cymru - Meat Promotion Wales (HCC) is the organisation responsible for the development, promotion and marketing of Welsh red meat. We work with all sectors of the Welsh red meat industry - from the farmers through to the retailers, to develop the industry itself as well as develop profitable markets for Welsh Lamb, Welsh Beef and pork from Wales.

This booklet forms part of a series of publications produced by HCC's Industry Development team.

The Industry Development team undertake a range of activities that include:

- Technology Transfer
- Research and Development
- Market Intelligence
- Training
- Benchmarking

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Introduction

In this booklet, we have set out a series of guidelines on the selection of stock for the market that look at all aspects of the supply chain.

These begin with information on how to improve your livestock so that they best meet what the market demands, followed by how to assess that demand (using classification as a basis for the specification of market requirements), and how to target your production through good stock selection.

Good Carcase Selection opportunities for farmers to improve their returns when marketing finished cattle and sheep are being made available through the Cattle and Sheep Selection for Slaughter Training Programme.

These training events are free to all producers in Wales and provide practical demonstrations and 'hands on' experience at an abattoir, assessing live animals through to assessment of carcases.

Contents

Breed Improvement

The factors that influence livestock performance can be divided into those that are due to an animal's breeding potential as determined by its genes, and those due to the environment in which it is reared.

It is important to get both of these aspects of production right. This makes the selection of breeding stock extremely important.

It is not possible to select superior breeding stock by eye alone. Performance records and genetic markers provide an essential tool in assessing breeding potential.

Estimated Breeding Values (EBVs) which help to identify breeding stock with superior genetic potential are now widely available.

EBVs are calculated for the following characteristics:

- Gestation Length
- Calving Ease
- Birth Weight
- 200 Day Milk
- 200 and 400 Day Growth
- Muscle Depth / Area
- Fat Depth

Breeding Indexes are then calculated using these EBVs to rank animals according to their overall breeding potential. Breeds recorded by Signet are ranked on their Beef Value, Calving Value and Maternal Value. Breeds recorded by ABRI are ranked using a Terminal Sire or Self Replacing Index.

These Breeding Indexes enable the animal's potential financial benefit to be established, making it easier for commercial producers to identify the most profitable sires.

Trials show that producers can improve the financial performance of their herd by at least £30.00 per calf through the selection of breeding stock with high indexes. Select bulls with good EBVs for muscle depth (muscularity), to improve the muscularity of carcases and therefore increase saleable meat yield.

For more detailed information see Technical Note 1, page 25.

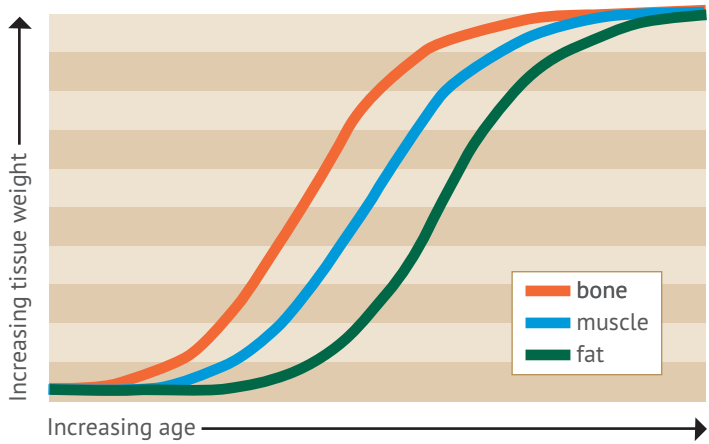
Growth / Muscle Development

The development of lean muscle and fat

The main purpose of rearing beef cattle is the production of meat for human food. Meat comprises lean muscle with associated bone and fat.

As an animal grows, the tissues grow and mature at different rates. Of the important components of the carcase, bone grows first, followed by muscle and then fat.

Growth of animal tissue



This means that the energy intake of an animal is first directed to bone growth and then to muscle growth. Once the demands of these two tissues are met, excess energy is stored as fat.

Knowing when to market your animals is important to avoid costly overfeeding.

Allowing animals to become overfat is costly from a feed (and forage) point of view and because of the penalties that may be incurred in the abattoir.

Carcase Classification

Systems of classification were principally set up as a means of improving the efficient operation of the market. Today they remain as basic aids to the more efficient and transparent trading of livestock and meat, forming the basis for the deadweight sale of cattle and enabling beef carcases to be traded using a common language.

Classification has also been shown to be a very good indicator of meat yield (which is the total percentage of saleable meat from a carcase, not to be confused with killing out percentage which is the carcase weight as a percentage of the live weight).

An R4L carcase will have a meat yield of about 71%, with yield rising by about 1% for each move up a conformation class or down a fat class, and falling by 1% for each move down a conformation class or up a fat class.

EU classification legislation

Abattoirs slaughtering over 75 cattle a week are required to classify carcases to the EUROP grid. The application of the carcase classification is monitored and enforced by the Rural Payments Agency (RPA) on behalf of government.

The basis of beef classification

CONFORMATION

The conformation class is determined by a visual appraisal of shape, taking into account the blockiness of a carcase and the development of muscle in the hind quarters (the round), loin and the shoulder. No adjustment is made for the influence of fatness on overall shape.

There are five main classes: E, U, R, O, P. (where E = excellent conformation and P = poor conformation). In Great Britain classes P, O, and U are sub-divided into – and +.

FATNESS

The fat class is determined by a visual appraisal of external fat development. There are five main classes ranging from 1 (very lean) to 5 (very fat). In the UK, classes 4 and 5 are sub-divided into L (leaner) and H (fatter).

The conformation class is described first, followed by the fat class (e.g. R4L).

15 POINT SCALE

To further enhance the classification grid some abattoirs have adopted a '15 point' grid, in which each conformation and fat class is sub-divided into three, these are low (-), medium (mid) and high (+); this allows a more precise description of the carcase.

Classification using the EUROP grid

- The carcase weight (derived from a nationally agreed and verified carcase dressing specification)
- Visual appraisal of conformation and fatness (as defined in the centre of this publication)
- Category (sex)- steer, heifer, cow, young bull, mature bull
- Age

Example of an R3

Target your Markets

In order to obtain the best returns, producers need to:

- Identify the market(s) for their cattle
- Understand what the market needs
- Assess their cattle against market needs and manage accordingly

Seasonal variation

The beef market is affected by seasonal demand. Returns improve when producers match production to market demand. This may require adjustments to breeding and feeding policies.

Market information is vital and can be accessed online at www.hccmpw.org.uk

Selecting for the market

The ability to assess cattle both visually and by handling is an essential skill for a beef producer. It provides vital feedback to monitor the progress of animals, spot ailments and adjust feeding regimes. By regularly weighing and recording, in order to monitor how animals are progressing towards finish, it is possible to adjust feeding regimes to bring stock to market at the best time.

Typical market requirements

Increasing fatness →

Improving conformation ↑

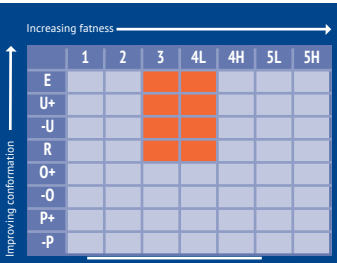
	1	2	3	4L	4H	5L	5H
E	+5	+10	+10	+5	-15	-50	-50
U+	base	+5	+5	base	-15	-50	-50
-U	base	+5	+5	base	-15	-50	-50
R	-5	base	base	base	-15	-50	-50
O+	-10	-5	-5	-10	-20	-60	-60
-O	-20	-15	-15	-25	-40	-70	-70
P+	-30	-25	-25	-35	-40	-80	-80
-P	-30	-25	-25	-35	-40	-80	-80

Example of payment grid

The target classification for different markets is highlighted below. For example, an R4L carcase of 280 to 300 kg cw (carcase weight), would attract the supermarket **base price** and would be acceptable for all markets.

Supermarket
Weight: Min 280kg cw, max 380kg cw
Conf: E,U+,-U,R (some include 0+)
Fat: 3,4L

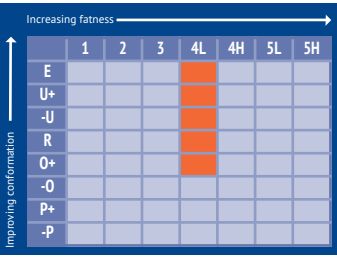
Steers, heifers and young bulls are acceptable. Steers and heifers are usually finished under 24 months old (but 30 months are becoming more acceptable). Bulls are usually finished under 16 months old.



While there are markets for all types of cattle, too much fat creates problems for buyers.

Traditional Butcher
Weight: Many prefer lighter carcases, 250 to 320kg cw
Conf: E,U+,-U,R,O+
Fat: 4L (some 4H)

Heifers are often preferred. Some will avoid bull beef.



Export
Specifications tend to vary from country by country, with demand growing for whole sale cuts rather than the whole carcase.

Cull cows
A range of conformations are acceptable (R, O+ and -O), but fat levels should be 3 or 4L. For the export trade with the better conformation and fat class 3, 4L cull cows, the demand is primarily for 'pistola' cut hindquarters and boneless cuts. For poorer quality cull cows the demand is predominantly for manufacturing beef.

Selecting Stock for Slaughter

Visual appraisal

To the trained eye, general appearance gives some guide to an animal's level of finish. As lean cattle walk, muscles visibly ripple. These muscles are less visible with higher levels of fat cover, making cattle appear smoother.

A wide, deep brisket projected well forward also indicates fatness.

Today, most of the trade requires lean, more muscular cattle with straight to convex profiles in the round (hind quarter), loin and shoulder. Weight and visual appraisal are general guides to market condition, but to ensure accurate selection, handling is essential to ensure the best estimate of the level of finish.

Three key points give the best indication of fat class. The handling points for fat assessment are shown below. Other handling points, e.g. flank, cod and brisket, may be used, but they tend to be less reliable, or less accessible.

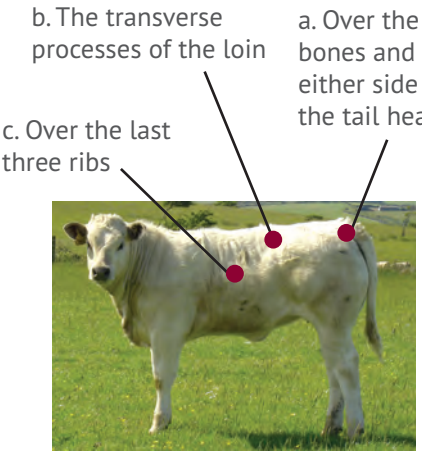
Fatness assessment

You should handle animals on the left side as seen from behind. Kidney fat, which is attached to the underside of the loin on the right hand side, can mislead the handler when assessing fat cover. Use just the tips of fingers, to feel fat depth over the underlying muscle and bone, at each of the handling points.

As animals get fatter, the ends of the transverse processes over the loin and the pin bones, as well as shoulder blade ridge, become more rounded. The hollows between ribs and shoulders fill up completely at the highest fat levels.

Hide thickness varies with breed. Consider this when assessing fatness, particularly over the tail head, loin and ribs. Use the descriptions opposite to predict carcase fat class with reasonable accuracy, in the live animal. Further information and practical training on how to assess live animals are available through HCC.

Cattle should carry an even degree of finish; the fatter an animal the softer it becomes to the touch.



Key handling points to assess fatness for beef cattle

Key handling points to assess fatness for beef

TAIL HEAD

Fat class

1 & 2	Skin is tight. Area around root of tail and over the pin bones is firm and unyielding.
3	Indicated by a very thin fat cover which yields slightly to moderate pressure.
4L	Thin layer of fat felt when skin on either side of tail head is pinched between fingers and thumb. Thin soft layer is felt over the pin bones.
4H	Looks slightly puffy; soft layer of fat felt using light pressure. Surface area around pin bones is soft and the fat tends to spread back towards the tail head.
5L	Looks puffy and feels spongy. Moderate fat cover over pin bones is felt as distinct soft layer.
5H	Looks very puffy and feels very spongy. Thick and sometimes patchy layer of soft fat over the bones.

LOIN

Fat class

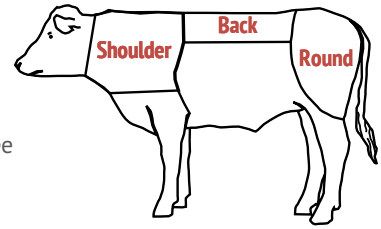
1 & 2	Ends of transverse processes of vertebrae very prominent. Individual bones felt as deep corrugations.
3	Ends of transverse processes prominent. Individual bones are felt as corrugations.
4L	Ends of transverse processes slightly rounded by fat, felt with light pressure.
4H	Ends of individual transverse processes are felt only with moderate pressure.
5L	Transverse processes are felt only with firm pressure.
5H	Individual transverse processes cannot be felt.

RIBS

Fat class

1 & 2	Ribs are prominent, clearly visible and are felt as deep corrugations.
3	Some fat cover is detectable over the bones but individual ribs are felt easily as corrugations.
4L	Thin layer of fat is felt over the bones. Individual ribs felt with light pressure.
4H	Distinct layer of soft fat is felt over the bones. Individual ribs are felt only with moderate pressure.
5L	Thick soft fat covers ribs. Individual ribs are felt only with firm pressure.
5H	Rib cage is smooth to the touch with a tendency to patchiness. Individual ribs cannot be felt.

Conformation assessment



Assessing conformation takes account of depth and thickness of the round, fullness of loin and chine (the back) and thickness of fleshing over shoulders.

Remember, carcase classification is an assessment of three areas: round, back and shoulder. When the three parts differ, the classification for two of the three is applied.

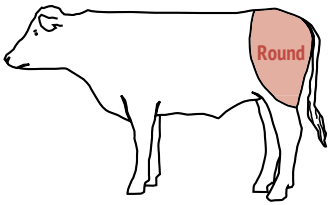
Cattle of good conformation have a full outline. Lean cattle of good conformation have thickly fleshed, well-rounded contours. Viewed from the rear, they stand wide with a convex round - wider than the back. From the front they are wide between the legs and thick through the shoulder.

Cattle of poor conformation have a relatively straight or, at some points, hollow appearance. They are often bony and angular, although excess fat may disguise this to some extent.

If an animal lacks muscle thickness, its overall appearance may be improved by additional feeding, but much of the extra gain will be fat. So, it is important to handle for fatness before assessing the extent to which conformation indicates a lean or fat beast.

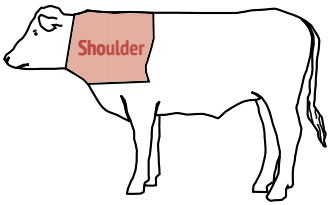
ROUND

E	Very rounded
U	Rounded
R	Well developed
O	Average to lacking development
P	Poorly developed



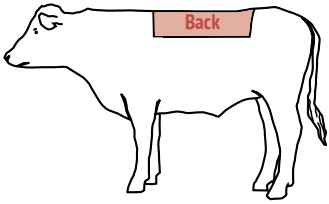
SHOULDER

E	Wide and very thick up to the shoulder
U	Wide and thick up to the shoulder
R	Still thick but less width at the shoulder
O	Average to lacking thickness
P	Narrow with bones visible



BACK (LOIN)

E	Very rounded
U	Rounded
R	Fairly well developed
O	Average development to almost flat
P	Flat with bones visible



Handling animals with care

Good handling is vital for animal welfare and avoids:

- Carcase damage (bruising) and wasteful trimming
- Stress, which leads to the risk of dark cutting meat

Damage to carcases always reduces value so careful handling of live cattle is important.

Effective handling also improves the safety of those working with livestock. The good design of animal handling facilities will improve farm operations, as people will be able to handle stock safely and efficiently.

Poor handling leads to less cooperative animals which increases the risk to animals and staff and reduces efficiency.

Carcase damage

Bruising and abscesses lead to wasteful trimming or even partial condemnation of carcases. Bruising is best avoided by:

- Handling cattle in layouts with smooth walls and no sharp corners, nonslip floors and gradual ramps
- Avoiding use of sticks and goads
- Using vehicles that avoid overcrowding with internal partitions to restrict movement
- Using clean injection needles to avoid infection

Dirty hides

Cattle in a dirty condition will not be accepted for slaughter. A dirty hide is worth less than a clean one and it can contaminate the carcase and this can give rise to public health problems. Handling yards should always be kept clean.

The Food Standards Agency (FSA) enforced clean livestock policy uses scores in categories 1-5 (where 1 is very clean and 5 is extremely dirty) to assess animals. Animals with scores of 3, 4 or 5 will not be accepted for slaughter.

Clean livestock

FSA score 1 and 2 are acceptable, 3, 4 and 5 are unacceptable.

Making Marketing Decisions

In order to maximise returns, when cattle are reaching the condition ideal for the target market being considered (i.e. local butchers, domestic supermarkets or export), the producer needs to:

- Monitor market signals e.g. comparative daily, weekly, regional, deadweight/liveweight price reports
- Consider the route to the market. Whether selling direct to the abattoir or via an auction market, each route will incur different costs. These marketing costs need to be understood if the best returns are to be achieved.

Target Markets

Most outlets, whether export or domestic (supermarkets or local butchers), produce weekly payment schedules using carcase classification to define the key attributes of product required.

Food Chain Information

Since 1st January 2010, when cattle are sent for slaughter, providing Food Chain Information (FCI) has been a legal requirement.

The 'minimum elements' of FCI consist of statements to confirm that:

a. The holding is/or is not under movement restriction for bovine tuberculosis (TB)

b. Cattle and calves on the holding are not under movement restrictions for other animal diseases or public health reasons

c. Withdrawal periods have been observed for all veterinary medicines and other treatments administered to the animals while on this and previous holdings

d. That the livestock, as far as the producer is aware, are fit and healthy and not showing any signs of a disease or condition that may affect food safety.

Currently these are most commonly appended to the movement licence and will accompany the animals when they are being transported. It is good practice however, to send the information before the animals are consigned so as to pre warn the abattoir and its official veterinarian of any issues to watch out for (especially important if the animals have been injured prior to consignment).

In specific instances additional information may be requested.

Market Signals

HCC provides extensive marketing information on a daily, weekly and annual basis. Information can be obtained from the following sources:

- Website — www.hccmpw.org.uk
- Printed information — e.g. Market Bulletins direct from HCC
- Text messages — Market price information sent to your mobile phone from HCC
- Industry meetings — HCC staff available to disseminate latest market information

Armed with the knowledge of the quality of stock they produce, market requirements and pricing schedules, producers can then develop market strategies which maximise their returns.

Terms & Conditions
and other factors that can affect returns

Killing out percentages and carcase weight

The killing out percentage (KO%) is the amount of a live animal that ends up as carcase (including muscle, sinew, fat and bone), but it is not an indicator of quality.

Slaughterhouse operators/butchers often refer to 'meat yield'. This is the proportion of saleable meat from the carcase.

Factors which affect carcase weight

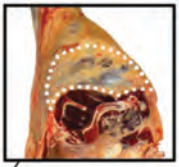
Beef carcase dressing specifications
Abattoirs may choose from three recognised dressing specifications, these are:

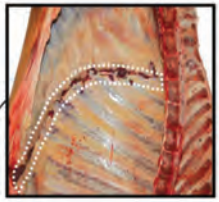
- Standard Specification
- EC Reference Specification
- UK Specification

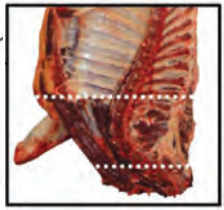
Current Name (Previous name) **As % of carcase weight**	**Cod / Udder Fat 1.5%**	**Crown Fat 0.3%**	**Bed Fat *0.4%**	**Brisket Fat *0.2%**	**Thin Skirt 0.4%**
Standard Specification (MLC Standard Conditions)	ON	ON	ON	ON	ON
EU Reference Specification (Old EC Specification)	OFF	OFF	ON	ON	OFF
UK Specification (EC Specification)	OFF	OFF	OFF	OFF** (trimmed to leave a covering of fat)	OFF

** Assuming fat class 3*
***Note: the UK specification differs from the previous "EC specification" in that the brisket is trimmed to leave a covering of fat and the flank edge must not be trimmed.*

Processers have to adhere to the following during carcase trimming







Bed Fat

The fat deposit within the flank area is removed.

Trimming must not expose the muscle and must be confined to the area identified on the illustration.

There must be no 'dropping' of the flank edge muscle.

There must be no perforation, damage or cutting through of the outer carcase/muscle.

Crown Fat

The heavier fat deposited on the inside of the topside is removed.

Trimming must not expose the muscle and must be confined to the area identified on the illustration.

Cod/Udder Fat

The cod or udder fat is removed in its entirety.

Trimming must not expose the muscle at any point and must be confined to the area identified on the illustration.

Thin Skirt

The fleshy part of the thin skirt is removed back to the ribs at the division between the thorax and abdomen.

Trimming must be confined to the area identified on the illustration - no further trimming of the abdominal membrane is permitted.

Any fat on the inside of the pleura, between the ribs, must be left attached.

Brisket Fat

The brisket must be trimmed to leave a covering of fat, the muscle tissue must not be exposed.

Trimming must be confined to the area identified on the illustration.

Neck Trim

The 'sticking' must be done in such a manner that the neck muscles are not damaged.

The jugular vein and its adjacent fat must be removed.

Fat removal must not extend horizontally below the joint of the third and fourth cervical vertebrae, or above or behind the first rib.

There must be no removal or trimming of the neck muscle.

Carcases are hot if weighed within one hour of slaughter. The hot weight must be recorded to the same calibration as indicated on the scale with no rounding applied.

When carcases are weighed hot, the cold weight is determined by reducing the hot weight by 2%.

As a guide the average carcase weight will reduce between each of the specifications by the following;

- Standard to EC Reference – males 1.2% and females 1.7%.
- EC Reference to UK specification – all categories 0.8%.

The majority of the Welsh kill is through a small number of abattoirs that use the UK Specification. To accurately compare the price from one abattoir to another it is important to know the dressing specification as it will have an effect on the carcase weight and price.

Other factors affecting carcase weight / killing out percentage (KO%)

Different breeds carry varying hide weights:

- Limousins have a thin, light hide.
- Welsh Blacks have a thicker, heavier hide.
- Heifers tend to have a lower killing out percentage (KO%) due to increased levels of internal fat.
- Dairy breeds have larger organs and digestive tract, and more internal fat than beef breeds, leading to lower KO%.
- Production systems/seasonal variation affect KO%. Forage fed cattle tend to develop a proportionately larger gut than cereal fed cattle – resulting in, on average, a lower KO%.
- Stomach content at live weighing also affect KO%. An empty stomach gives a higher KO% and reduces the risk of contamination at the point of gutting when the cattle are being dressed.
- Cattle of a higher fatness level will, on average, produce a higher KO% than leaner cattle; but any increase in return from a higher carcase weight may be mitigated by penalties for the cattle being over fat.
- Cows, because of age, proportion of gut and udder development (which is removed before weighing at slaughter) generally produce a lower KO% than 'clean' (not bred) cattle.
- It is extremely important that a farmer understands the terms and conditions being offered by the abattoir for the purchase of livestock (e.g. dressing specifications, deductions and insurance) and not rely on the quoted headline base price as being indicative of the best returns.
- Bruising through poor handling or carcase damage through infected needles, will reduce the carcase weight as trimming will occur.

Eating Quality

Why is eating quality important? – The Consumer View

Purchasing decisions are based on price and visual appeal appearance. Repeat purchases, and hence the profitability of the industry are reliant on the product giving a satisfactory eating experience.

Consumer research on beef eating quality has shown that the most important attributes in determining acceptability is tenderness and flavour. Tenderness is the most important but where tenderness is less variable, flavour increases in relative importance.

Pre-slaughter factors influencing eating quality

Breed
Research has demonstrated that breed effects on eating quality are small. Although not all breeds have been fully evaluated, where clear differences have been identified they are mainly in purebred animals. There is some advantage in using a single breed if a consistent supply is possible and there is a marketing advantage.

Sex

- There is no eating quality difference between steers and heifers.
- Young bull beef is generally tougher than that from steers and heifers at the same age, and requires particular attention to post slaughter handling to enhance tenderness.

(For more information see Technical Note 2 on page 26).

Age/seasonality
In general, older cattle produce tougher meat. Some would recommend an upper age limit for the production of prime beef at 30 months for steers and heifers, to protect against the toughening effects of animal maturity. For bulls a cut off date of 15/16 months is more appropriate.

However, meat from older animals tends to have a more intense flavour than meat from younger animals, and some markets prefer some cuts of beef to come from older cattle (e.g. French market for ribs of beef from older cows).

In general, it is better to finish animals as young as possible within a given production system, which will also minimise the cost of production and environmental impact.

Diet
Diet can influence beef flavour, with the stronger flavour of grass fed beef being generally preferred by UK consumers.

Vitamin E in the diet of cattle (at 1000IU per day for 100 days), can extend shelf life and protect flavour in beef fed on conserved forage or concentrate diets low in antioxidants.

Feed withdrawal pre slaughter should be limited to avoid 'dark cutting meat'.

Fatness and conformation
In recent years consumers have sought to reduce their fat intake through seeking leaner cuts of beef. However, at very low levels of intramuscular (or marbling) fat, the eating quality of beef is less satisfactory. The rearing of cattle to give a minimum fat level of fat class 3 , provides protection against very low intramuscular fat levels. In terms of conformation, O+ is widely accepted as a minimum.

Pre slaughter handling/transport
Careful handling of livestock prior to slaughter reduces the risk of stress. Stressed cattle use up their muscle energy reserves prior to slaughter. As a consequence of this the meat can be very dark, making it unattractive, of poor flavour and more prone to bacterial growth, thus reducing shelf life.

A similar problem can arise if cattle are underfed prior to slaughter. To avoid stress;

- Always handle cattle quietly
- Avoid mixing cattle from different groups
- Take special care with bulls, as they are more susceptible to stress than steers or heifers
- Provide clean, dry bedding and access to drinking water in the pen/lairage.

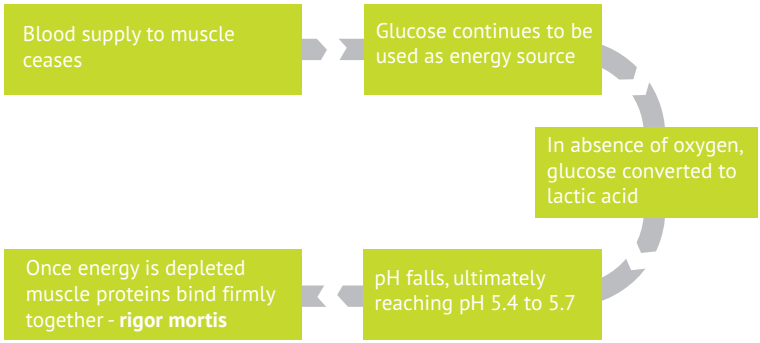
(For more information see Technical Note 2 on page 26).

Post slaughter factors influencing eating quality

Stunning and slaughter
Cattle are usually stunned by the use of a captive bolt pistol that fires a bolt into the brain. Alternative methods include electrical stunning (head to back) and percussion stunning. After stunning, cattle have to be stuck (bled) within 60 seconds for penetrative captive bolt stunning, within 30 seconds for non penetrative captive bolt and within 10 seconds for electrical head to back.

The stunning and sticking method does not have an important influence on meat quality, if carried out improperly, the resulting traumatic stress can lead to the problems with the meat. Electrical stunning should be carried out with great care, and abattoir operators need to monitor pH/temperature relationships post-slaughter to avoid hot-shortening issues.

The conversion of muscle to meat
Following slaughter, muscle undergoes a number of changes that are important in determining visual appeal and ultimate meat quality. These changes are illustrated in the following diagram.

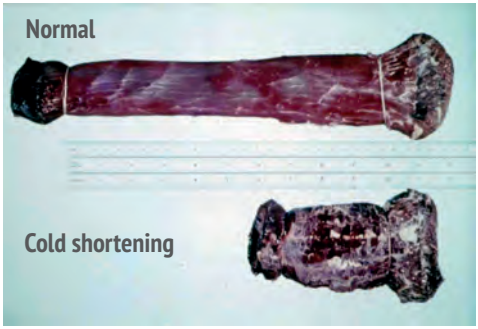


The rate at which a muscle goes into rigor mortis is influenced by a number of factors:

- Energy stores within muscle when the animal leaves the farm
- The depletion of energy stores during transport and lairage
- Stimulation of the metabolic processes via pre-slaughter stress
- Stimulation of muscular activity during slaughtering
- The rate at which the muscle is cooled

(For more information see Technical Note 3 on page 27).

Chilling regimes
The excessive contraction of the muscle prior to rigor mortis ("shortening") results in increased meat toughness. As a general rule, when chilling, avoiding a temperature below 10°C in any muscle within 10 hours of slaughter will prevent cold shortening. The use of High Voltage Electrical Stimulation (HVES) can mitigate this and allow more rapid chilling.

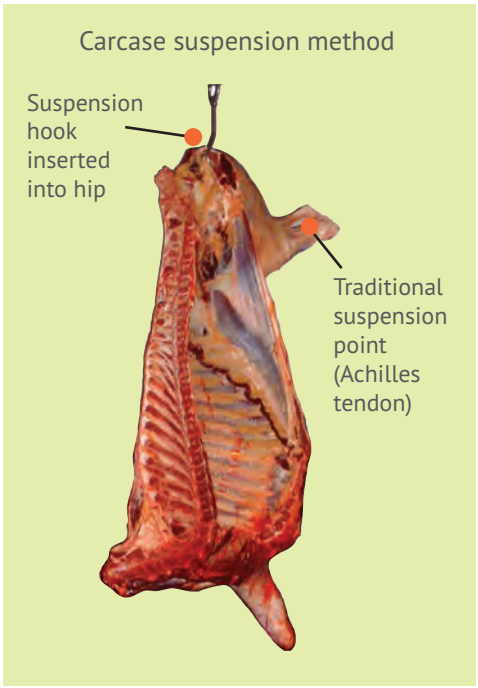


Electrical stimulation
Electrical stimulation is used in some abattoirs to improve eating quality. An electrical current is applied to the carcase after slaughter. This stimulates the muscles to contract and hence use up energy. This accelerates the onset of rigor mortis enabling chilling to take place earlier. HVES increases tenderness more than low voltage but is not as effective in improving tenderness as hip suspension.

(For more information see Technical Note 3.2 on page 28).

Carcase suspension method
The tenderness of the leg and loin muscles are increased by suspension of the carcase from the hip rather than the Achilles tendon. This is the result of the stretching of muscles, avoiding contraction prior to rigor mortis.

(For more information see Technical Note 3.3 on page 29).



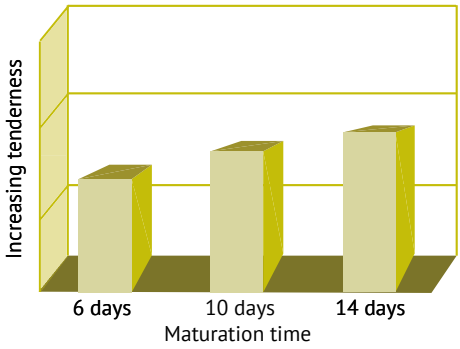
Hip bone suspension

Maturation (ageing)
Ageing tenderisation occurs as enzymes, that are naturally present within the meat, break down the protein. Beef grilling and roasting cuts benefit from ageing for up to 21 days. This can be done either on the bone (a suspended whole or part carcase), or in the bag (deboned vacuum packed primal cuts), or through a combination of both.

Where beef is only aged on the bone (sometimes referred to as dry ageing), there will be an accompanying weight loss, caused by evaporative loss and the discoloration and drying of externally exposed muscle that will result in greater trimming.

(For more information see Technical Note 3.4 on page 29).

Effect of ageing on tenderness of beef loin



Cooking
It is important to cook meat with a suitable method. Cuts higher in connective tissue benefit from moist cooking methods. When using dry methods (grilling, frying and roasting) overcooking can result in drying out and toughening of meat.

The flavour of meat develops during cooking, as a result of the effects of heat on the proteins, fats and sugars present in muscle and fat. The chemical reactions that cause this are complex, but during cooking, the number and speed will increase if cooking temperature is raised and the internal temperature of the meat increases. This effect is why well-done steaks and joints have more intense flavour than those that are lightly done.

However, too high a temperature for too long a period will affect the tenderness of the meat. Searing steaks on the outside quickly at high temperatures, is one way of intensifying flavour and retaining tenderness within meat that has tenderness attributes – cooking is a skill, a science and an art!

Butchery / Meat Yield

Whether selling live or dead weight, producer returns are ultimately reliant on the value of the carcase. This value is directly related to the yield and the distribution of saleable meat.

Fat content has a significant impact on carcase meat yield.

Given the preference of most consumers for leaner meat, in order to meet consumer requirements, over-fat carcases need to be trimmed. Trimming of excess fat reduces meat yield and increases processing costs.

A typical beef carcase (R4L) produces approximately 68 to 71% saleable meat (depending upon the butchery technique). Reducing the fat to class 3 increases the meat yield by approximately 1.5%. Increasing the fat to class 4H decreases the meat yield by approximately 1.5%.

It may not always be possible to remove all excess fat from individual cuts, if there is an excessive amount of marbling.

Even after trimming, cuts from fatter carcases may still have a higher than desirable fat content and as a consequence, be visually less appealing to the consumer.

Conformation has less impact on meat yield compared to fatness, due to the need to trim excess fat from over fat carcases.

The main influence of conformation is the distribution of meat within a carcase. Better conformation carcases will have more of their meat in the higher value hindquarter cuts.

(For more information see Technical Note 4 on page 30).

8% Fat Trim
24kg

13% Fat Trim
39kg

Technical Notes

1. Breed Improvement
Whether you are a commercial beef producer or a pedigree breeder, Estimated Breeding Values (EBVs) are an essential decision making tool when developing a breeding policy.

The objective of Beef Values are to produce animals which have shorter gestation length, easier calving, higher growth rates or carcase weights, better carcase shape and less fat.

The chart on the right provides an example of EBVs on the performance of two different bulls:

Bull B has the best overall carcase EBVs and this is reflected in the Beef Value (30). It has significantly higher growth and muscle EBVs and is leaner than Bull A.

In contrast, Bull B's offspring will be more difficult to calve than Bull A. Birth weights are predicted to be heavier and gestation lengths longer, resulting in more difficult calvings.

EBVs are important decision making tools, but it is still important to check the animals' structural soundness and health status prior to purchase.

EBVs	Bull A	Bull B
Gestation length (days)	+1.7	+2.1
Calving ease	+0.8	-2.6
Birth weight (kg)	+1.5	+3.2
Calving value	+3	-6
200 day milk (kg)	+4	+1
200 day growth rate (kg)	+20	+32
400 day growth rate (kg)	+45	+61
Muscle depth (mm)	+0.1	+1.5
Fat depth (mm)	+0.2	-0.8
Beef value	24	30

2. Pre-slaughter factors influencing eating quality

Pre-slaughter handling/transport
If the energy reserves of the muscle are depleted prior to slaughter, the degree of glycolysis which can occur is diminished and the ultimate pH (pHu) will not be as low as in normal muscle with higher energy reserves. If the pHu is greater than 6.0, the muscle will have a dark and dry appearance with a firm texture. This condition is termed Dark Firm Dry meat (DFD) or sometimes 'dark-cutting' meat.

One of the attributes that consumers use to select meat is colour and appearance, and they will often avoid very dark meat.

A combination of reduced oxygen penetration into the meat and lower light reflectance results in less visible red oxymyoglobin pigment and hence the dark appearance. The dryness is thought to be a consequence of the higher pH leading to a higher water holding capacity of the myofibrillar proteins. DFD meat is normally found to be more tender, but the higher pH also leads to a better environment for the growth of spoilage bacteria and consequently a poorer shelf-life.

Example of a bruised hind quarter

3. Post-slaughter factors influencing eating quality

Before slaughter the muscles of the animal are generating energy through biochemical pathways that use oxygen. Following bleeding out there is no longer a blood supply to the muscles. This has two effects:

- There is no longer any oxygen
- The products of metabolism cannot be removed via the bloodstream and therefore accumulate in the muscle.

In the absence of oxygen, the muscle attempts to maintain cellular energy (ATP) levels. Muscle is capable of producing ATP from glucose without the need for oxygen (glycolysis). This anaerobic metabolism produces lactic acid. The acid accumulates and gradually reduces the pH of the muscle from about 7.2 in a normal resting live muscle to an ultimate pH (pHu) of about 5.4 to 5.7 in normal meat. Muscle can generate energy from glucose until all the glucose is used up or until the accumulation of acid in the muscle destroys the metabolic processes.

This ability to generate energy even after slaughter means that muscle can continue to contract for a considerable time (e.g. in response to an external electrical stimulation) after the animal's central nervous system is dead. Different muscles, or even different muscle fibre cells within a muscle, can continue to function for varying lengths of time.

The main bulk of the muscle is made up of the proteins myosin and actin. When all of the available energy is exhausted, the myosin and actin molecules bind firmly together and the muscle loses its extensibility and flexibility. This is rigor mortis.
Mae'r rhan fwyaf o'r cyhyr yn cynnwys dau brotein, sef myosin ac actin. Pan fo'r holl egni sydd ar gael wedi'i ddisbyddu, mae'r moleciwlau myosin ac actin yn glynu'n dynn wrth ei gilydd ac mae'r cyhyr yn colli ei natur estynadwy ac ystwythder. Dyna yw rigor mortis. ŵThe rate at which a muscle will go into rigor mortis can be influenced by a large number of factors, key ones are:

- Energy stores available when an animal leaves the farm
- The extent to which these stores are depleted during transport and in the lairage
- The stimulation of the metabolic process via pre slaughter stress

3.1 Chilling regimes
Muscle will contract (shorten) naturally as it goes into rigor mortis if it is not restrained from doing so. Most muscles are under tension when the skeleton of the carcase is in its normal standing posture. If muscle is restrained it will develop tension as it goes into rigor but will not be able to shorten in its overall length. The extent to which muscles are able to shorten depends on the remaining energy (ATP) available, the load on the muscle and the temperature of the muscle when these events occur. Shortened muscle is usually significantly tougher because of the overlapping muscle fibres which are densely packed. The response depends on the degree of shortening.

There is an important effect of temperature on the ability to shorten during rigor. There are two types of shortening. For shortening to be minimised rigor should occur at about 15°C. This can never be achieved in practice for all muscle fibres because of the different rates of cooling in different locations of the carcase and the different rates of rigor development in different fibres. It is however a useful guideline.

Cold shortening occurs if the muscle is exposed to low temperature (<10°C) prior to the development of rigor. Under these conditions the muscle spontaneously contracts and, since it does so at higher levels of ATP and pH than rigor shortening, the degree of contraction (and toughening) can be considerable.

Hot shortening is the shortening that occurs with rigor above 20°C. This occurs as the energy supply is being exhausted and it is generally quite weak. Hot shortening has the potential to affect meat quality but its importance is still debated. It can occur if high voltage stimulation, used to improve tenderness is too rigorous.

The level of pH is a good indication of the onset of rigor and the combination of muscle temperature and pH can predict cold shortening toughness problems.

3.2 Electrical stimulation (ES)
Electrical stimulation (ES) can be used to improve tenderness of beef. ES was developed primarily to allow rapid chilling without the risk of cold shortening. The electrical current applied stimulates the muscles to contract and hence use up energy. This accelerates the onset of rigor mortis enabling chilling to take place earlier. It also appears that High Voltage ES (HVES) has additional benefits to tenderness, perhaps through accelerating the ageing process or direct physical damage to the muscle fibre structure. In beef, however, these effects are not as great as the effect of hip suspension.

If low voltage electrical stimulation (LVES) is used it must be applied whilst the nervous system is still intact. In practice this means immediately after bleeding. Good contact (i.e. electrode positioning) and timing are critical for LVES to be effective. This means that it is

a less reliable approach than HVES. There is also the risk of a toughening effect of LVES due to hot shortening. Where LVES is effective it seems to simply prevent cold shortening.

HVES does not depend on an intact nervous system. It is applied later on the slaughter line and therefore electrode contact is easier and the high voltage makes positioning less critical. Because it is applied later the carcase has cooled to an extent where hot shortening is less likely, although this can occur in the deep muscles of a beef carcase.

3.3 Carcase suspension method
It is clear from the section on chilling that the state of contraction of muscles is a significant factor in determining eating quality. Muscular contraction post-mortem is moderated by the attachment of the muscles to the skeleton. The tension imposed on any individual muscle in the carcase depends on the position of the skeleton. Hip suspension stretches the muscles of the leg and loin yielding tenderness benefits.

In the UK the use of the aitch bone has largely been replaced by the ischium (an alternative position in the pelvic region) for safety reasons. In terms of the tension on the muscles, this achieves the same effect.

3.4 Maturation (ageing)
The action of enzymes that damage or destroy proteins (proteolytic enzymes) in post-mortem muscle is a highly significant source of variation in the tenderness of meat. The enzymes primarily responsible for the tenderisation process are a family of calcium activated enzymes, called the calpains, and their inhibitor calpastatin.

Generally proteolytic degradation and hence tenderisation is considered to occur more quickly in white fibres, and muscles made up predominantly of these, than in red fibres/muscle. This is reflected in differences in the rate of tenderisation (and hence optimum ageing time) between muscles within a carcase and between the species.

The enzymes are more active at nearer neutral pH and at higher temperatures, therefore their greatest level of activity is around the time of rigor when sufficiently high levels of calcium may become available.

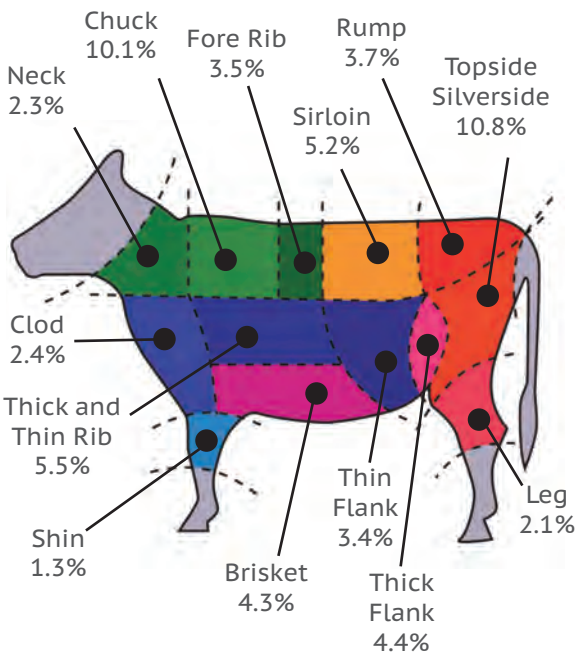
4. Butchery / Meat Yield

Most beef is sold boneless. Bone-in beef, which today only represents approximately 2% of sales in a typical outlet, is mainly rib roasting joints and T-bone steak.

The removal of bones and trimming excess fat means that only around 70% (depending on the butchery technique) of an average beef carcase is sold as retail/catering cuts or products.

The basic butchery principal of removing bone and trimming fat to an acceptable level is the same whether the product is being prepared in a large abattoir packing for supermarkets, or a butcher's shop. In butchers' shops, where time is available between customers, the practice of traditional boning is often used. This approach often involves the removal of individual vertebrae and the careful separation of the meat from them in order to maximise yield.

Yield - Traditional Beef Cuts
Average yield of prepared bone in cuts and joints as a percentage of the carcase.



Yield - Traditional Beef Cuts

	% Yield
Shin	1.3
Clod	2.4
Neck	2.3
Brisket	4.3
Thick Rib	4.3
Thin Rib	1.2
Fore Rib	3.5
Chuck and Blade	10.1
Lean Trim	4.3
Forequarter Saleable Cuts	**33.7**
Leg	2.1
Thick Flank	4.4
Topside	5.5
Silverside	5.3
Rump	3.7
Sirloin	5.2
Thin Flank	3.4
Fillet	1.3
Lean Trim	3.5
Hindquarter Saleable Cuts	**34.4**
Total Saleable Cuts	**68.1**
Fat trim	10.6
Bone and waste trim	21.3
Total	**100**

In the major abattoirs, where maximising efficiency is key, sheet boning is commonly used. With this approach vertebrae are removed as a block and less time is spent removing flesh from the bone.

Whether adopting traditional or sheet boning, the level of fat in the carcase has a significant impact on the proportion of saleable meat. Most consumers require a product with the minimum amount of fat. With an increasing proportion of meat being purchased in retail packs from self-service multiple retailer display cabinets, consumers are able to be selective. Product with unacceptable levels of fat will often remain on the shelf.

Excess fat therefore needs to be removed during the butchery process, this adds to processing costs.

Better conformation carcases will have a higher proportion of saleable meat in the higher value hindquarter cuts. High value cuts, which include sirloin and rump grilling steaks and topside/silverside roasting joints represent approximately 40% of the carcase.

The fillet, which is the highest value cut, only represents approximately 1.5% of the carcase.

Further information

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For further information on this brochure or the work of HCC please visit www.hccmpw.org.uk