



RESEARCH REPORT

The relationship between meat yield from beef carcasses and their classification on the EUROP grid

Executive Summary

Beef sides from carcasses selected to represent a range across the classification grid were broken down by commercial primal butchery. Regression analysis was carried out to establish the yields of primals by classification class. Both fat class and conformation class have significant effects on the yield of saleable meat from the carcass with a difference in yield of 11% of the side weight when moving from U-2 to O-4H for example. For an average carcass weight from this sample (289.2kg) this represents a difference of 31.8kg. Even on a cautious assumption that all the additional weight is trim, at a wholesale value of £3.30 for 93% VL trim (commercial price as at April 2011) this represents £104.94 per carcass.

Fat trim makes up the majority of difference in saleable yield between sides of different classification scores.

While visual carcass classification has some disadvantages, these results clearly show that it remains a useful tool for the assessment of carcass value.

This project has given an improved understanding of the link between classification and yield. This will help industry assess the value of carcasses and enable abattoirs to better reward for those carcasses that have higher inherent value (and penalise those that have lower value). This information also informs the discussion on the value of other carcass assessment methods (e.g. VIA) by providing a benchmark against which any added value of other methods can be compared.

Contents

Executive Summary.....	1
Contents	2
Background	4
Objectives.....	4
Materials and Methods	4
Carcase sampling	4
Carcase yield assessment	5
Trimmed primal yield.....	5
Data analysis.....	5
Results and discussion	6
Overall Carcase Break Down	6
<i>Table 1. Overall average of side break down (unadjusted means) for an average side weight of 144.6kg</i>	<i>6</i>
Yields across the classification grid.....	7
<i>Table 2. Overall percentage yield of saleable meat across the classification grid for an average side weight of 144.6kg</i>	<i>7</i>
<i>Table 3. Overall percentage yield of trimmed primals across the classification grid for an average side weight of 144.6kg</i>	<i>7</i>
<i>Table 4. Overall percentage fat trim across the classification grid for an average side weight of 144.6kg</i>	<i>8</i>
Benefits.....	8
Annex 1. Carcase selection	9
Target selection.....	9
Actual selection achieved.....	9
Annex 2. Detailed cutting specification	10
Cutting specification	10
Forequarter cuts.....	10
<i>Shin.....</i>	<i>10</i>
<i>Clod and Neck (Sticking).....</i>	<i>10</i>
<i>Brisket.....</i>	<i>10</i>
<i>Thin and Thick Ribs (Jacobs Ladder, LMC).....</i>	<i>10</i>
<i>Chuck and Blade/Feather</i>	<i>10</i>
Hindquarter cuts.....	11
<i>Fore Rib</i>	<i>11</i>
<i>Loin</i>	<i>11</i>
<i>Fillet</i>	<i>11</i>
<i>Leg of Beef.....</i>	<i>11</i>
<i>Rump</i>	<i>11</i>
<i>Topside</i>	<i>11</i>
<i>Thick Flank.....</i>	<i>11</i>
<i>Silverside</i>	<i>11</i>
<i>Pistola Flank</i>	<i>12</i>
Trimming to boneless primal cuts.....	13
<i>Shin.....</i>	<i>13</i>
<i>Clod and Neck.....</i>	<i>13</i>
<i>Brisket.....</i>	<i>13</i>
<i>Jacobs Ladder (Thick and Thin Ribs).....</i>	<i>13</i>
<i>Fore Rib</i>	<i>13</i>
<i>Chuck and Blade.....</i>	<i>13</i>

<i>Leg of Beef</i>	13
<i>Thick Flank</i>	13
<i>Topside</i>	14
<i>Silverside</i>	14
<i>Pistola Flank</i>	14
<i>Rump</i>	14
<i>Fillet</i>	14
<i>Sirloin</i>	14
<i>Lean trim</i>	14
Annex 3. Butchery of flanks from subset of carcasses	15
Summary of results	15
Effects of carcass characteristics on flank yields	15
Annex 4. Summary of main statistical analysis.....	15
References	16

Background

Carcase classification provides a description of a carcass to facilitate trade. This is linked to the commercial value of carcasses, based on an assumed relationship with yield of saleable meat for specific market requirements.

A considerable amount of work was undertaken in the early 1980s relating conformation and fat class to carcass lean meat percentage and yield (see, for example, Kempster (1986) and Kempster *et al* (1986)). An objective assessment of the relationship between classification scores and meat yield has not been undertaken, however, since that time. In the intervening period market requirements have changed, in particular in relation to trimming specifications. Furthermore, the type of cattle produced has been changing.

It is therefore considered necessary to undertake an evaluation of the relationship between carcass classification (both fat class and conformation score) and carcass yield. Of particular relevance to assessing the commercial value of conformation is the yield of trimmed primals.

Objectives

To assess carcasses across the classification grid for meat yield (at the primal level).

Materials and Methods

The work was carried out in a commercial cutting facility in collaboration with an industry partner. An abattoir/cutting plant business was identified where it was possible to have individual sides of beef broken down by a single butcher to a single specification.

Carcass sampling

Overall, 149 sides were selected as detailed in Annex 1. This was short of the original target of 210, and there was particular difficulty in obtaining cattle from the extremes of the classification grid. A good representation of carcasses in the central portion of the grid (-U2 to -O4H) was achieved, however.

The selection grid was drawn up based on the distribution of prime beef in the grid in England in 2007, with those cells with 2% or more of the population forming the basis of the selection. The target can be compared with the carcasses actually selected in the Annex.

Sides were selected at slaughter and held for 24 hours (occasionally up to 72 hours for business reasons) before quartering and primal butchery.

Carcase yield assessment

RHS (some LHS were used when poorly split or damaged RHS) from selected carcasses were used for yield assessment. Prior to starting butchery actual cold side weight was recorded.

Butchery was carried out by the same person (plant boning hall manager). Eblex staff, under the supervision of the Meat Technologist, undertook recording of weights and other information.

Quartering was carried out as follows:

- The forequarter was separated between the 6th and 7th rib by sawing between these ribs and then cutting between the ribs to leave a pistola hindquarter which has the extended loin (ie including the fore rib).
- The plate of beef was left attached to the flank.
- The short fore quarter was weighed.
- The pistola flank (described on page 11) was removed as described in Annex 2 and weighed, including the flank fat.
- The hind quarter was weighed.
- The flank fat was removed and weighed.

Flanks are not trimmed at the plant so a subset, selected at random, was purchased and trimmed by the EBLEX Meat Technologist in order to establish the trimmed primal yield of flanks.

The plant's normal cutting specification was used throughout with the same specification used for all sides. Details are given in Annex 2.

Trimmed primal yield

The following was recorded for each primal:

- trimmed primal weight
- weight of lean trim
- weight of fat trim
- weight of bone and waste

The plant's normal dressing specification is the UK specification. In a minority of cases, where an alternative specification has been used (ie EU specification), to calculate consistent yield percentages, side weight has been corrected to the UK dressing specification and total fat trim adjusted accordingly, using the coefficients published in Annex III of Commission Regulation 1249/2008.

Data analysis

To enable regression analysis to be undertaken, EUROP classification scores were converted to a 15 point conformation score and estimated subcutaneous fat percentage according to the relationship published by Kempster (1986).

The yield of lean from the flank was calculated from the subset of 18 carcasses from which flanks were taken for butchery. These were used in regression analysis to establish the relationship between carcass characteristics (weight, conformation and fatness) and lean proportion in the flank. This was then used to calculate the lean from the flank for all carcasses in order that the total saleable yield could be estimated.

Regression analysis was used to find the relationship between conformation score, fat class and side weight, and yield parameters (see Annex 4).

Results and discussion

Overall Carcass Break Down

The overall average breakdown of all sides in the study is shown in Table 1.

Table 1. Overall average of side break down (unadjusted means) for an average side weight of 144.6kg

	Average percentage of side
<i>Forequarter trimmed primals</i>	
Shin	1.5
Clod	2.3
Neck	3.8
Brisket	2.4
LMC	3.5
Chuck	4.6
Feather/blade	1.9
Forerib	4.5
Total forequarter trimmed primals	24.5
<i>Hindquarter trimmed primals</i>	
Sirloin	4.7
Fillet	1.8
Leg	1.4
Heel	1.6
Topside	6.4
Silverside	5.7
Thick flank	3.9
Rump	3.8
Rump tail	0.3
Total hindquarter trimmed primals	29.5
Total trimmed primals % (ex flank)	54.0
Total lean trim (including flank) %	16.4
Total saleable yield %	70.4
Total fat trim %	9.6
Total bone and waste %	20.0

Using regression equations derived from the data, yields of primals were estimated for all classification classes using an Excel spreadsheet which will be made available on the Eblex website. It should be noted that this will only approximate to yield for any particular side depending on the specific characteristics of the carcass and the exact butchery specification used. Particular care will be needed when extrapolating to classification scores outside the range used in the study.

Yields across the classification grid

Table 2 shows the total yield of saleable meat (trimmed primals plus lean trim) across the portion of the classification grid for which sides were collected for the study. It can be seen that both fat class and conformation class have significant effects on the yield of saleable meat from the carcass with a difference in yield of 11% of the side weight when moving from U-2 to O-4H for example. For an average carcass weight from this sample (289.2kg) this represents a difference of 31.8kg. At a wholesale value of £3.30 for 93% VL trim (commercial value in April 2011) this represents £104.94 per carcass.

Table 3 shows the yield of trimmed primals and Table 4 the fat trim across the grid. It can be seen that fat trim makes up the majority of difference in saleable yield between sides of different classification scores.

Table 2. Overall percentage yield of saleable meat across the classification grid for an average side weight of 144.6kg

Conformation score	Fat class					Overall
	2	3	4L	4H		
U-	76.5	73.8	71.7	70.4		73.1
R	74.8	72.1	70.0	68.7		71.4
O+	73.1	70.4	68.3	67.0		69.7
O-	71.7	69.0	66.9	65.6		68.3
P	70.8	68.1	66.1	64.7		67.4
Overall	74.1	71.4	69.4	68.0		70.7

Table 3. Overall percentage yield of trimmed primals across the classification grid for an average side weight of 144.6kg

Conformation score	Fat class					Overall
	2	3	4L	4H		
U-	58.8	56.9	55.4	54.4		56.4
R	57.4	55.4	54.0	53.0		54.9
O+	56.0	54.0	52.5	51.6		53.5
O-	54.8	52.8	51.4	50.4		52.3
P	54.1	52.1	50.6	49.7		51.6
Overall	56.8	54.9	53.4	52.4		54.4

Table 4. Overall percentage fat trim across the classification grid for an average side weight of 144.6kg

Conformation score	Fat class				
	2	3	4L	4H	Overall
U-	4.9	8.4	11.1	12.8	9.3
R	5.2	8.8	11.4	13.2	9.6
O+	5.5	9.1	11.7	13.5	10.0
O-	5.8	9.4	12.0	13.8	10.3
P	6.0	9.5	12.2	14.0	10.4
Overall	5.3	8.9	11.5	13.3	9.8

While visual carcass classification has some disadvantages, these results clearly show that it remains a useful tool for the assessment of carcass value.

Benefits

An improved understanding of the link between classification and yield is available to help industry assess the value of carcasses.

This knowledge will enable abattoirs to better reward for those carcasses that have higher inherent value (and penalise those that have lower value). This information also informs the discussion on the value of other carcass assessment methods (e.g. VIA).

Annex 1. Carcase selection

Target selection

	1	2	3	4L	4H	5L	5H	Any fat class	Overall
E								10	10
U+									
-U		10	10	10	10				40
R		10	10	10	10				40
O+		10	10	10	10				40
-O		10	10	10	10				40
P+								40	40
-P									
Overall	0	40	40	40	40	0	0	50	210

Actual selection achieved

	1	2	3	4L	4H	5L	5H		Overall
E									1
U+		1							
-U		4	9	7	1				21
R		9	9	10	10				38
O+		9	10	10	10				39
-O		8	10	10	5				33
P+	1	5	6	3					17
-P		1	1						
Overall	1	37	45	40	26	0	0		149

Annex 2. Detailed cutting specification

Cutting specification

The quarters were separated to leave a pistola hind, with the plate (flank end of brisket) and the fore rib attached to the hind quarter.

Forequarter cuts

Shin

To remove the shin from the forequarter, the knife was held at right angles to the working surface and cut from the elbow. The cut then followed the contour of the shin bone passing through the joint and cutting across the muscle.

Clod and Neck (Sticking)

This was removed by holding the knife at right angles to the working surface with the cut following the posterior edge of the clod bone to the blade bone joint. This cut was extended in a straight line to the dorsal edge of the forequarter.

The neck contained no more than 6 cervical vertebrae.

The separation of the clod was completed by cutting, with a knife held at right angles to the working surface, from the point where the initial incision was made for the removal of the shin parallel to the edge of the brisket. This point is also the anterior removal point of the Brisket.

With the vertebrae uppermost, the Clod and Neck were divided by cutting through the natural seam, which lies under the muscles attached to the ventral surface of the cervical vertebral bodies, to the exposed ventral edge of the large fat deposit containing the prescapular lymph node. Then, with the knife held at right angles to the working surface, a cut was made from this edge along a line at right angles to the posterior cut surface.

Brisket

This was removed by cutting along a line from the posterior edge of the 6th rib to the anterior removal point (defined under "clod and neck" above).

Thin and Thick Ribs (Jacobs Ladder, LMC)

Holding the knife at right angles to the working surface, a straight cut was made from a point on the posterior edge of the 10th rib measured from the ventral tip of the eye muscle a distance of half the length of the eye muscle, to the 1st rib, 5cm from the ventral edge of the vertebral body.

A cut was made along the posterior edge of the 5th rib separating the Thick Rib from the Thin Rib.

Chuck and Blade/Feather

The 6 bone primal joint is the remaining portion of the forequarter.

Hindquarter cuts

Fore Rib

This was removed by cutting at right angles to the mid line and along the posterior edge of the 10th rib.

Loin

The loin was removed at the last lumbar vertebra leaving the whole fillet attached.

Fillet

The head of the fillet was loosened from the rump while hanging and then the whole fillet was removed from the loin after separation from the quarter.

Leg of Beef

This was separated from the top piece by cutting through the stifle joint and then removing the tibia bone. The leg or hind shin was removed leaving the heel (gastrocnemius) attached to the top piece.

Rump

This was boned while hanging and later prepared as a "D" cut rump primal.

Topside

The aitchbone was removed, avoiding cutting into the topside. From the posterior cut surface of the top piece, cutting followed the natural seam between the second and third muscle layers. This seam was followed carefully to the round bone and cut around this bone to remove the topside.

Thick Flank

Holding the knife at right angles to the working surface, cutting commenced at the ventral edge of the cut surface of the aitchbone. The cut followed the contour of this bone to the ventral edge of the round bone (femur) and then in a straight line to the stifle joint following the edge of the bone with the point of the knife.

The muscle was freed from the bone by cutting carefully along and under the round bone until the natural seam, which forms the ventral surface of the silverside, was reached.

This seam was followed to the lateral surface of the top piece, where the thick flank was removed without incising surrounding muscles.

Silverside

The round bone (femur) was carefully removed from the remaining muscles, which form the Silverside. The heel was removed and weighed as a unit.

Pistola Flank

A cut was made in a straight line from the ventral tip of the rump muscles on the posterior cut surface to a point on the anterior edge of the 7th rib a distance equal to half the length of the eye muscle from its ventral tip.

Trimming to boneless primal cuts

Shin

The bone was removed and all associated tendons, ligaments, exposed blood vessels, excess fat and ragged edges.

Clod and Neck

The clod and neck were boned out and all associated tendons, ligaments, surface blood vessels and discoloured tissue removed. Excess fat was trimmed so that the two primal cuts contained around Min. 95% VL

Brisket

All the bones and intercostal muscles were removed in one piece, the bones were trimmed of excess meat. Any external fat was trimmed to a maximum of 10mm, and any exposed connective tissue, surface blood vessels and discoloured surfaces removed. The brisket was trimmed of the majority of its internal fat. (min of 95% VL)

Jacobs Ladder (Thick and Thin Ribs)

The large muscle block (LMC) was removed as a primal joint; the rest of the Jacobs Ladder was boned and used for mince (VL 93%).

Fore Rib

This was kept as a bone in primal, with no bone trimming. The blade tip was not removed. This was trimmed to a maximum external fat of 10mm

Chuck and Blade

All the vertebrae and ribs were removed in one, avoiding cutting into the surrounding muscle. These bones were trimmed of excess lean tissue. The blade bone was removed; the blade and feather steaks were removed and weighed together but separate from the chuck. External fat was trimmed to a smooth surface with a maximum depth of 10mm.

Leg of Beef

The bones, tendons and ligaments were removed by squaring off the ends and excess fat removed. The resulting primal joint contained no more than 7% separable fat (min 93% VL).

Thick Flank

The knee cap (patella) was removed with associated tendons and ligaments by a straight cut parallel to the anterior surface. All external fat was trimmed. Excess intermuscular fat was removed together with any exposed ligaments and exposed connective tissue. The resulting primal was free of any skirt or adhering lean tissue.

Topside

Any exposed ligaments, connective tissue, excess intermuscular fat and any discoloured tissue was removed. External fat was trimmed to a smooth surface with a maximum depth of 10mm. The resulting primal was free from any loosely adhering pieces or ragged edges.

Silverside

Any exposed ligaments, connective tissue (including the silverwall) and excess intermuscular fat were trimmed. The heel was removed as a primal. Any external fat was trimmed to a smooth surface to a maximum depth of 10mm.

Pistola Flank

All bones were removed together with the membrane and the thick sheet of connective tissue, which lies beneath the first muscle layer. External and intermuscular fat were trimmed so that the finished primal had a VL of 90%.

Rump

The goose skirt and tail were removed to produce a "D" cut rump. The external fat of the rump was trimmed to a smooth surface with a maximum depth of 10mm. Any large deposits of intermuscular fat were removed. The resulting primal was free of any exposed connective tissue, loosely adhering tissue or ragged edges.

Fillet

The fillet was trimmed of all fat and any exposed blood vessels removed together with any discoloured surface tissue. The psoas minor and the tail of fillet was left on.

Sirloin

All bones were removed in one without causing damage to the surrounding muscle. The bones were trimmed of excess lean tissue. Any exposed connective tissue was removed and the backstrap trimmed away. A cut was made 40mm from and parallel to, the ventral tip of the eye muscle removing the flap. Any external fat was trimmed to a smooth surface with a maximum depth of 10mm.

Lean trim

Lean trim had a VL of approximately 93%. Any surplus fat was separated into the fat trim.

Annex 3. Butchery of flanks from subset of carcasses

Summary of results

Flanks prepared (n)	18
Average weight (kg)	23.1
Average % of side	15.4
Lean trim yield (%)	62.4
Fat trim yield (%)	18.3
Bone and waste (%)	19.3

Effects of carcass characteristics on flank yields

To enable prediction of flank yields for the full analysis, regression has been carried out using the C15 conformation and SFe fat class conversions described above.

$$\text{flank \% lean yield} = 92.2 - 0.106 \text{ adjCSW} + 0.526 \text{ C15} - 2.66 \text{ SFe} \quad (p=0.003)$$

$$\text{flank \% fat trim} = -27.2 + 0.170 \text{ adjCSW} - 0.240 \text{ C15} + 3.38 \text{ SFe} \quad (p<0.001)$$

$$\text{flank \% bone/waste} = 35.0 - 0.0646 \text{ adjCSW} - 0.285 \text{ C15} - 0.718 \text{ SFe} \quad (p=0.037)$$

These regressions have been used to estimate these parameters for incorporation into the main analysis.

In the prediction of lean and fat yields SFe has the largest effect and by combined regression the only significant effect. The effect of fat class on % lean yield from flanks, estimated by Analysis of Variance ($p=0.001$) is shown below:

Fat class	% lean trim in flank
2	69.3
3	67.6
4L	59.3
4H	47.6

Note: The small number of carcasses mean that the analysis of data from the flanks is less reliable.

Annex 4. Summary of main statistical analysis

The following regression analyses were derived at a constant side weight of 144.6kg.

Yield of trimmed primals

$$\text{shin \% of carcass} = 1.72 - 0.0134 \text{ C15} - 0.0257 \text{ Sfe} + 0.000348 \text{ adjCSW}$$

$$\text{clod \% of carcass} = 2.31 + 0.00377 \text{ C15} - 0.0332 \text{ Sfe} + 0.00158 \text{ adjCSW}$$

$$\text{neck \% of carcass} = 3.36 - 0.00364 \text{ C15} - 0.0551 \text{ Sfe} + 0.00588 \text{ adjCSW}$$

$$\text{brisket \% of carcass} = 2.55 + 0.0279 \text{ C15} - 0.0310 \text{ Sfe} - 0.00092 \text{ adjCSW}$$

LMC % of carcass = $3.02 + 0.0105 C15 - 0.0336 Sfe + 0.00426 adjCSW$

chuck % of carcass = $4.47 - 0.00730 C15 - 0.0277 Sfe + 0.00248 adjCSW$

feathers/blade % of carcass = $2.06 - 0.0168 C15 - 0.0319 Sfe + 0.000695 adjCSW$

fore rib on bone % of carcass = $4.87 + 0.0217 C15 + 0.0258 Sfe - 0.00478 adjCSW$

FQ Primals % = $24.4 + 0.0228 C15 - 0.212 Sfe + 0.00956 adjCSW$

sirloin % of carcass = $4.60 + 0.0996 C15 + 0.0449 Sfe - 0.00553 adjCSW$

fillet % of carcass = $2.30 + 0.0229 C15 - 0.0334 Sfe - 0.00313 adjCSW$

leg % of carcass = $1.71 - 0.00031 C15 - 0.0296 Sfe - 0.000635 adjCSW$

heel % of carcass = $2.08 + 0.0196 C15 - 0.0335 Sfe - 0.00289 adjCSW$

topside % of carcass = $7.55 + 0.0984 C15 - 0.130 Sfe - 0.00564 adjCSW$

silverside % of carcass = $6.21 + 0.120 C15 - 0.142 Sfe - 0.00178 adjCSW$

thick % of carcass = $4.67 + 0.0352 C15 - 0.0875 Sfe - 0.00287 adjCSW$

rump % of carcass = $3.91 + 0.0554 C15 - 0.0278 Sfe - 0.00197 adjCSW$

rump tail % of carcass = $0.266 + 0.00232 C15 + 0.00164 Sfe - 0.000105 adjCSW$

HQ Primals % = $33.3 + 0.453 C15 - 0.437 Sfe - 0.0245 adjCSW$

Other carcass components

Total lean trim % = $18.6 + 0.0903 C15 - 0.259 Sfe - 0.00716 adjCSW$

Total saleable yield % = $76.2 + 0.566 C15 - 0.909 Sfe - 0.0221 adjCSW$

Total fat trim % = $- 1.89 - 0.111 C15 + 1.18 Sfe + 0.0308 adjCSW$

Total bone and waste % = $25.4 - 0.449 C15 - 0.267 Sfe - 0.00968 adjCSW$

Total fat trim % = $- 1.89 - 0.111 C15 + 1.18 Sfe + 0.0308 adjCSW$

Loss % = $0.235 - 0.00616 C15 - 0.00529 Sfe + 0.00101 adjCSW$

These regressions were used to determine the yield for the grids presented in tables 2 to 4. The dissection loss was included in bone and waste.

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