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Report Title: Beef primal cut weight prediction from diverse breed crosses

Prepared by: Pitchford, W.S.

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Executive Summary

The focus of the current trial was to quantify saleable meat yield variation between breeds and sires within breeds (Ewers *et al*. 1999). This has also been used for pricing carcasses (Pitchford *et al*. 2020). The focus on the current report is to use the same data set to predict primal weight cut. Given the extremely diverse breeds, this provides some guidance as to what traits are likely to be important for beef cut weight prediction as DXA systems are implemented.

The aim of this analysis is to test how much various measures add to prediction of cut weight and whether they can sufficiently describe breed differences to prevent needing to know breed which would aid processors. The hypothesis is that simple measures will not be sufficient and a measure of shape reflecting muscularity will be important especially for hind quarter cuts.

The results demonstrate that measurement of saleable meat yield adds just small additional accuracy in predicting cut weights. It is assumed this will also be the case for measurement of lean meat yield. Thus, the value proposition for DXA needs to be through additional value that can be captured.

The specific hypothesis that initiated this analysis was that a measurement of bone weight would aid description of cut weight variation from diverse breeds. However, this did not prove to be the case which suggests that a measure of carcass “shape” should be unnecessary in addition to more standard measures.

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Introduction

The focus of the current trial was to quantify saleable meat yield variation between breeds and sires within breeds (Ewers *et al*. 1999). This has also been used for pricing carcasses (Pitchford *et al*. 2020). The focus on the current report is to use the same data set to predict primal weight cut. Given the extremely diverse breeds, this provides some guidance as to what traits are likely to be important for beef cut weight prediction as DXA systems are implemented.

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Methods

Data set

The data set comprised 241 carcasses from steers of 10 breed combinations specifically chosen for diversity in marbling and yield and including purebred Jersey, Limousin and Hereford, Limousin x Jersey, Jersey x Hereford, Wagyu x Hereford, Angus x Hereford, South Devon x Hereford, Limousin x Hereford and Belgian Blue x Hereford.

The weight of 17 cuts (brisket, thick flank, intercostal, chuck, chuck tender, blade, oyster blade, cube roll, rib eye, striploin, tenderloin, rump, topside, eye round, outside flat, knuckle and shank) was recorded after trimming to a 6-mm fat depth, and bone, fat and trim were also recorded for each cut. Chemical lean content of trim for each carcass was measured using microwave and trim weights were proportionally adjusted to 85% chemical lean before calculating saleable meat yield (SMY, %) as the sum of all trimmed saleable cuts and total trim. Calves were born over a 2-month period and the bone-out trial was conducted over a 1-month period, so the range in ages on a kill day varied from 32 to 72 days and maximum across the trial was 108 days.

The mean carcass weight was 330kg ranging from 204–436kg with saleable meat yield averaging 67.7% and ranging from 59.5 – 76.7% (Table 1). There was a large range of eye muscle area (41–124cm^2) and P8 fatness (2–32mm). The coefficient of variation in cut weight ranged 16–26% and was greater than for carcass weight (side weight 14%), reflecting the large variation in both fat and muscle.

Analysis

For each cut, two models were compared (traits in fitted order and using type 1 sums of squares):

1. Side weight plus breed; and
2. Side weight, P8 fat depth, eye muscle area (EMA), saleable meat yield (SMY), bone percent, breed.

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Table 1. Summary of carcass traits and primal cuts.

Trait	Mean	Min	Max	CV (%)
Side wt (kg)	164.9	102	218	14
P8 rump fat depth (mm)	14.7	2	32	36
Eye muscle area (cm^2)	74.9	41	124	22
Saleable meat yield (%)	67.7	59.5	76.7	5
Bone percent (%)	18.6	14.8	26.1	8
Fat percent (%)	13.4	5.7	21.7	24
Topside (kg)	8.5	4.1	13.2	20
Outside flat (kg)	6.1	3.5	9.7	22
Eye round (kg)	2.3	1.2	4.4	26
Knuckle (kg)	5.4	3.1	8.2	19
Rump (kg)	6.0	3.1	8.9	17
Striploin (kg)	6.1	3.2	8.9	16
Tenderloin (kg)	2.5	1.5	3.7	17
Rib set (kg)	3.6	2.1	5.5	16
Chuck (kg)	9.4	4.9	14.0	16
Chuck tender (kg)	1.3	0.8	1.9	18
Blade (kg)	8.1	4.4	11.0	16
Thin flank (kg)	8.4	4.3	12.9	18
Point-end brisket (kg)	3.6	1.0	6.7	24
Navel-end brisket (kg)	5.5	2.9	8.7	18
Shank (kg)	4.5	2.6	6.4	18
Shin (kg)	2.8	1.5	4.3	18
Intercostals (kg)	1.5	1.0	2.6	19

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Results and Discussion

As expected, side weight explained the majority of variation in all traits except for intercostals (Table 2, Figure 1). This was extremely high (>80%) for the rump, chuck and blade. It was lower (<70%) for the eye round, rib set, brisket and shin.

Breed effects were large (>10%) for the topside, outside flat, knuckle, rib set, chuck tender, navel-end brisket and especially large (22.2%) for the eye round reflecting the impact of the myostatin or double muscling gene.

P8 fat explained significant variation (>3%) in the topside, outside flat, eye round, knuckle, rib set, chuck tender and shank.

Eye muscle area was associated with variation in cuts of the same muscle (Rib set 10.1% and Striploin 4.4%), the eye round (7.8%) and also topside and outside flat.

Variation in cut weight associated with saleable meat yield was tested after P8 fat and eye muscle area were already in the model which would have removed some of the variation. However, it was still strongly associated (>6%) with variation in topside, outside flat, eye round, knuckle and shank. I was also associated with variation in tenderloin (5.5%) and chuck tender (4.7%) weights.

A specific hypothesis was tested to see if bone weight would be associated with cut variation in addition to traits easier to measure. Surprisingly, bone weight was very highly associated with navel-end brisket weight (10.6%). As expected, it was associated with shin and shank weights. However, it accounted for very little of the variation in most cuts except the loin (striploin 1.6% and rib set 1.0%).

Breed effects on cut weights were large for many cuts. However, after accounting for P8 fat, eye muscle area and saleable meat yield, breed effects were only significant (>3%) for the eye round, rib set, thick flank, point-end brisket and intercostals. Generally, P8 fat, eye muscle area and saleable meat yield explained a large proportion (>80%) of the breed variation in cut weight beyond that accounted for by carcass weight. High value cuts that were exceptions to this are the rump, striploin and rib set.

For cuts of significant value, the model accounted for a large proportion (>80%) of the variation in cut weight.

The results demonstrate that measurement of saleable meat yield adds just small additional accuracy in predicting cut weights. It is assumed this will also be the case for measurement of lean meat yield. Thus, the value proposition for DXA needs to be through additional value that can be captured.

The specific hypothesis that initiated this analysis was that a measurement of bone weight would aid description of cut weight variation from diverse breeds. However, this did not prove to be the case which suggests that a measure of carcass "shape" should be unnecessary in addition to more standard measures.

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Table 2. Proportion of variation (%) in cut weight explained by carcass traits.

Trait	Side wt	Model 1 Breed	P8 fat	EMA	SMY	Bone	Model 2 Breed	Residual
Topside (kg)	73.8	14.4	5.8	4.0	7.6	0.3	0.8	7.8
Outside flat (kg)	77.3	13.3	3.2	3.7	7.5	0.0	1.6	6.7
Eye round (kg)	61.4	22.2	5.8	7.8	10.0	0.1	3.0	11.8
Knuckle (kg)	74.0	14.0	5.4	2.4	6.7	0.8	1.7	8.9
Rump (kg)	83.8	3.2	0.0	0.3	1.3	0.2	1.8	12.5
Striploin (kg)	74.9	4.4	0.1	4.4	0.2	1.6	1.5	17.2
Tenderloin (kg)	74.7	8.0	2.6	1.3	5.5	0.7	1.5	13.7
Rib set (kg)	65.1	13.8	3.9	10.1	1.5	1.0	4.3	14.1
Chuck (kg)	81.9	1.8	0.4	1.3	0.1	0.0	1.7	14.5
Chuck tender (kg)	70.8	10.5	6.6	1.0	4.7	0.9	1.5	14.6
Blade (kg)	84.5	2.0	0.0	0.1	0.7	0.3	1.6	12.8
Thin flank (kg)	57.7	8.1	2.6	1.4	0.1	2.4	5.1	30.6
Point-end brisket (kg)	53.1	5.9	0.0	0.5	0.1	0.0	5.6	40.7
Navel-end brisket (kg)	52.3	10.4	34.4	0.0	1.4	10.6	1.9	32.3
Shank (kg)	72.9	14.5	6.5	2.0	6.6	2.7	1.1	8.1
Shin (kg)	68.9	7.1	1.5	0.5	2.9	3.6	2.2	20.4
Intercostals (kg)	35.3	7.3	0.0	0.2	0.0	0.4	8.3	55.8

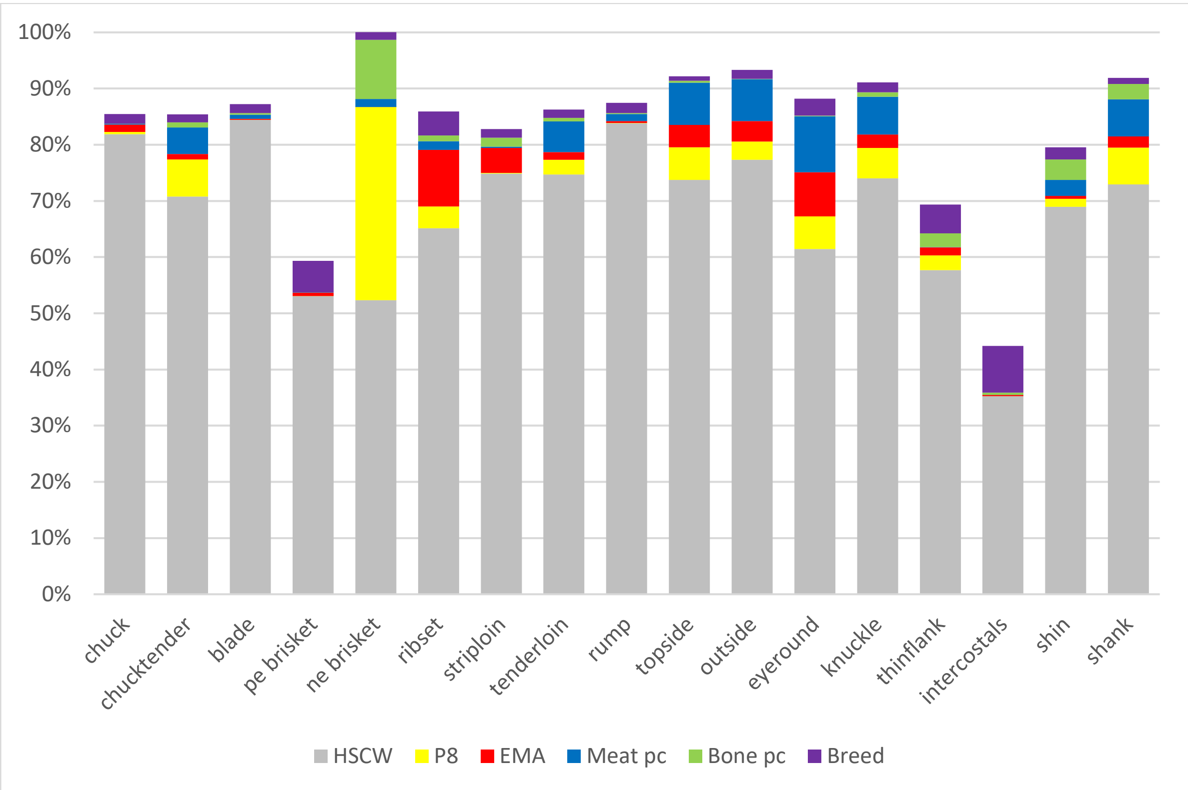

Figure 1. Proportion of variation (%) in cut weight explained by carcass traits.

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