PE4.17 Objective measures of saleable meat quality and yield on commercial cattle ¨C preliminary findings 59.00

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***Abstract* - Value-based marketing based on robust objective measures of meat quality and meat yield will address issues of product consistency and contribute to a price mechanism where consumers and producers operate on a value-for-money / money-for-value basis on an industrial scale. Objective measures of meat yield and meat quality are integral to such a system. In the present study, objective measures by Visual Image Analysis (VIA) on striploin and pistola were used to investigate the ability to predict the sirloin and fillet steak yield. The VIA data on striploin and pistola were collected on 135 commercial cattle of different breeds. Preliminary analysis suggests that VIA striploin and pistola weight estimates were statistically significantly associated with the mean weights of complete sirloin, fillet, boned sirloin and trimmed sirloin in individual animals. Therefore, VIA data may be useful in predicting the saleable meat yield in both sirloin and fillet steak and hence it could be useful to incorporate the VIA measures into a value based marketing system.**

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***Index Terms* - Beef, Processing, Value-based marketing, Video image analysis**

I. INTRODUCTION

VALUE-BASED marketing of beef and lamb has long been seen as a preferential way of rewarding farmers on the saleable meat yield and saleable meat quality attributes of their animals[1]. However such a system must overcome some hurdles before it can be viable, particularly in the ability to predict the fit between consumer desirability and objective, on-line measures of meat yield and meat eating quality. Video Image Analysis (VIA) and Visible-Near Infrared (Vis-NIR) spectroscopy are two technologies that show potential to achieve this[2,3]. Several types of VIA equipment exist that are able to report against the EUROP grid and estimate saleable meat yield[2,4].

The objective of this research was to investigate the ability of VIA to predict sirloin and fillet weights under commercial operating conditions as an important precursor to a value based marketing (VBM) strategy.

II. MATERIALS AND METHODS

A. Animals

Between March and May 2009, 135 commercial cattle below 30 months of age were selected for inclusion in the trial at the point of grading in an abattoir where a commercial video grading installation was operating on-line. In each week, eight Charolais cross (CHX), eight Limousin cross (LIMX) and eight Dairy Cross (DAX) animals were selected. Furthermore, four steers and four heifers were selected per week except in the dairy cross group, where young bulls were substituted for heifers. Age of individual animal on the day of slaughter was recorded. The samples were obtained in six batches. This survey yielded carcass data for detailed analysis of a variety of yield and meat quality attributes.

B. Abattoir protocol

Video grading and yield estimations for striploin and pistola weight were recorded on the right hand sides of carcasses while relevant data were retrieved for the animals of interest from abattoir records. Actual weights were recorded at the quartering stage (48 h post-mortem) from full sirloins (including fillet, bone, lean and fat), fillets, boned sirloin and trimmed sirloin (fat and bone removed to commercial specification). Quartering took place at the 9th/10th rib, where a 40 mm section of trimmed sirloin was also recovered for NIR, pH and Lab-Spec colour analysis on site.

C. Statistical analysis

To achieve normality in the response data, appropriate transformations were carried out. A logarithmic transformation (base 10) was applied to the complete sirloin weight and fillet weight while a square root transformation was applied to the boned sirloin weight and trimmed sirloin weight.

To evaluate the effect of different factors that might be associated with the actual weight of meat samples, a linear mixed model was employed. The parameters in the models were estimated using the restricted maximum likelihood method and the modified F-statistic[5] was used to assess the significance of different main and interaction effects of predictor variables on response variables.

The striploin or pistola weight (VIA data) and the age of individual animal were included as covariates in the model. All covariates were centred by redefining them as deviations from the respective means. The breed and sex of the individual were included as fixed effects in the model. The model considered different orders of interaction effects of VIA data, age, breed and sex. The batch of sampling was included as a random effect in the model. Initially, all possible fixed effects were incorporated into the model, and predictor variables or their higher order interactions were assessed for statistical significance via the modified F-statistic.

To measure the proportion of explained variation by each linear mixed model, the R^2 value for each model was estimated as specified by Xu (2003)[6]. To estimate R^2 of the selected model, the 'null' model was defined as the model that included an overall mean and a random batch effect.

All statistical analyses were carried out in GenStat 11th Edition[7].

III. RESULTS AND DISCUSSION

Descriptive statistics of complete sirloin weight, fillet weight, boned sirloin weight and trimmed sirloin weight (in original scale) and the hot carcass weight are presented in Table 1.

Trait	N	Mean	Range (Min, Max)	SD	SE (Mean)
Complete sirloin weight	135	15.29	(9.2, 21.8)	2.32	0.20
Fillet weight	135	3.42	(2.3, 4.84)	0.54	0.05
Boned sirloin weight	135	8.31	(4.2, 12.74)	1.55	0.13
Trimmed sirloin weight	135	7.20	(3.48, 11.39)	1.36	0.12
Hot carcass weight	135	332.0	(236.2, 475.4)	48.05	4.14

Table 1. Descriptive statistics of complete sirloin weight, fillet weight, boned sirloin weight, trimmed sirloin weight and hot carcass weight in original scale. All values are recorded in kg.

Table 2 presents the estimated effects of continuous variables (VIA striploin weight and age) and estimated means for the breed and sex factors along with the associated 95% confidence intervals.

The VIA striploin weight was statistically significantly associated with the complete sirloin weight, fillet weight, boned sirloin weight and trimmed sirloin weight (all P<0.001). The results showed that a unit increase in VIA striploin weight relative to the population mean contributed to an increase in complete sirloin weight (on log scale) by 0.047, fillet weight (on log scale) by 0.045, boned sirloin weight (on square root scale) by 0.188 and trimmed sirloin weight (on square root scale) by 0.178 (Table 2).

		Complete sirloin weight [Mean (CI)]	**Fillet weight [Mean (CI)]**
Effects	R^2	86%	79%
VIA striploin		0.047 (0.042, 0.052)	0.045 (0.038, 0.051)
Age		0.00005 (0.000003, 0.0001)	0.00005 (-0.00001, 0.0001)
Breed	CHX	15.1 (14.4, 15.8)	3.4 (3.3, 3.5)
	DAX	15.1 (14.4, 15.9)	3.3 (3.2, 3.4)
	LIMX	14.9 (14.2, 15.6)	3.4 (3.3, 3.5)
Sex	H	15.2 (14.5, 16.0)	3.4 (3.3, 3.5)
	S	15.2 (14.5, 16.0)	3.4 (3.3, 3.5)
	YB	14.7 (14.0, 15.4)	3.2 (3.1, 3.4)
		Boned sirloin weight [Mean (CI)]	**Trimmed sirloin weight [Mean (CI)]**
Effects	R^2	83%	80%
VIA striploin		0.188 (0.166, 0.211)	0.178 (0.155, 0.201)
Age		0.0001 (-0.0001, 0.0004)	0.0002 (-0.0001, 0.0004)
Breed	CHX	8.1 (7.6, 8.6)	7.1 (6.7, 7.5)
	DAX	8.3 (7.8, 8.8)	7.1 (6.7, 7.6)
	LIMX	8.1 (7.6, 8.5)	7.1 (6.7, 7.5)
Sex	H	8.6 (8.0, 9.1)	7.3 (6.9, 7.8)
	S	8.2 (7.7, 8.7)	7.1 (6.6, 7.5)
	YB	7.6 (7.1, 8.1)	6.9 (6.5, 7.4)

Table 2. Estimated effects (95% lower, upper confidence interval) for VIA striploin and age for complete sirloin, fillet, boned sirloin and trimmed sirloin weights (on transformed scale) and estimated means (95% lower, upper confidence interval) of those response variables (on original scale) for different levels of breed and sex. The R^2 values indicate the amount of variation accounted for the corresponding models.

Models that included VIA striploin weight also showed a statistically significant effect for the age of the animal on complete sirloin weight (P=0.038). The mean effect of age on complete sirloin weight was in a positive direction, indicating that complete sirloin weight tended to increase as the age of the animal increased. The effect of age was not statistically significant for fillet weight, boned sirloin weight and trimmed sirloin weight.

The effect of sex was statistically significant on boned sirloin weight (P=0.012). The breed effect was not statistically significant for any of the four response variables when VIA striploin weight was present in the model. There was no evidence in the present analysis that different second and higher order interaction effects were statistically significant.

Models for complete sirloin weight, fillet weight, boned sirloin weight and trimmed sirloin weight with VIA striploin as one of the predictor variables explained 85.9, 78.8, 83.1 and 81.0% of variation (R^2) respectively (Table 2).

Table 3 presents the estimated effects of continuous variables (VIA pistola weight and age) and estimated means for the breed and sex factors along with the associated 95% confidence intervals.

In a similar fashion to VIA striploin weight, VIA pistola weight (which includes the back leg and the striploin) was also statistically significantly associated with the complete sirloin weight, fillet weight, boned sirloin weight and trimmed sirloin weight (all P<0.001). The results showed that a unit increase in VIA pistola weight relative to the population mean contributed to an increase in complete sirloin weight (on log scale) by 0.0038, fillet weight (on log scale) by 0.0037, boned sirloin weight (on square root scale) by 0.0146 and trimmed sirloin weight (on square root scale) by 0.0139 (Table 3).

		Complete sirloin weight [Mean(CI)]	**Fillet weight [Mean(CI)]**
Effects	R^2	88%	82%
VIA Pistola		0.0038 (0.0034, 0.0042)	0.0037 (0.0032, 0.0042)
Age		-0.00001 (-0.00006, 0.00004)	-0.00001 (-0.00007, 0.00005)
Breed	CHX	15.2 (14.5, 16.0)	3.4 (3.3, 3.5)
	DAX	14.8 (14.1, 15.5)	3.2 (3.1, 3.3)
	LIMX	15.1 (14.4, 15.9)	3.4 (3.3, 3.5)
Sex	H	15.6 (14.8, 16.4)	3.4 (3.3, 3.6)
	S	15.0 (14.3, 15.8)	3.4 (3.3, 3.5)
	YB	14.5 (13.8, 15.3)	3.2 (3.1, 3.3)
		Boned sirloin weight [Mean(CI)]	**Trimmed sirloin weight [Mean(CI)]**
Effects	R^2	81%	79%
VIA pistola		0.0146 (0.0128, 0.0165)	0.0139 (0.0120, 0.0158)
Age		-0.00009 (-0.00033,0.00150)	-0.00006 (-0.00030,0.00018)
Breed	CHX	8.2 (7.7, 8.7)	7.2 (6.8, 7.7)
	DAX	8.0 (7.5, 8.5)	6.9 (6.5, 7.3)
	LIMX	8.2 (7.7, 8.7)	7.2 (6.8, 7.6)
Sex	H	8.7 (8.2, 9.3)	7.5 (7.0, 8.0)
	S	8.1 (7.6, 8.7)	7.0 (6.5, 7.5)
	YB	7.5 (7.0, 8.1)	6.8 (6.4, 7.3)

Table 3. Estimated effects (95% lower, upper confidence interval) for VIA pistola and age for complete sirloin, fillet, boned sirloin and trimmed sirloin weights (on transformed scale) and estimated means (95% lower, upper confidence interval) of those response variables (on original scale) for different levels of breed and sex. The R^2 values indicate the amount of variation accounted for the corresponding models.

The models that included VIA pistola weight showed that the sex of animal had statistically significant effect on complete sirloin weight (P=0.018), boned sirloin weight (P<0.001) and trimmed sirloin weight (P=0.016). Results showed that the heifer had the highest while the young bull had the lowest mean complete sirloin weight, boned weight and trimmed weight (Table 3). This was in line with expectation since the pistola weight estimation includes the rump of the animal which also contains the backfat. It was observed that heifers have a tendency to carry more fat than young bulls and steers. The effect of age was not statistically significant for these response variables. Breed had a statistically significant effect on the mean fillet weight (P=0.034). The results showed that LIMX had the highest mean fillet weight while the DAX had the lowest mean fillet weight. There was no evidence in the present dataset that different second and higher order interaction effects were statistically significant.

Further research may be required to determine if VIA estimation of saleable yield would need to be calibrated to reflect individual plant requirements. This would entail testing the technology under the operating conditions of various abattoirs, or benchmarking against CT scanning as an alternative to dissection[8].

It is also part of our plan to augment the current dataset with objective measures of eating quality. For this purpose, further data were collected on NIR spectra and Slice-Shear Force tenderness measures on the same animals. Future work will aim to include both VIA and NIR into objective models for various value-based marketing scenarios. If adopted and incorporated into a quality assurance scheme, value-based marketing holds the potential to address product consistency issues of table beef and enhance rural profitability by aligning farming objectives with consumer demand via a price, value-for-money mechanism on an industrial scale.

IV. CONCLUSION

The present study showed that VIA striploin and pistola weights were statistically significantly associated with the mean weights of complete sirloin, fillet, boned sirloin and trimmed sirloin as recorded from individual animals. The models presented here accounted for 78 to 88% of the explained variation. Hence the VIA measurement, when incorporated as a predictor variable, has potential to allow the red meat industry to objectively predict the weights of beef sirloin and fillet entering the chillers.

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