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Mechanical Grading of Beef Carcasses

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Contents

MECHANICAL GRADING OF BEEF CARCASSES

Authors:

Paul Allen B.Sc. M.Sc. Ph.D.
The National Food Centre, Dunsinea, Castleknock, Dublin 15

and

Nicholas Finnerty
Department of Agriculture, Food and Rural Development,
Kildare Street, Dublin 2

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Teagasc 19 Sandymount Avenue Ballsbridge Dublin 4

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SUMMARY

Three beef carcass classification systems that use Video Image Analysis (VIA) technology were tested in two trials at Dawn Meats Midleton, Co. Cork. The VIA systems were BCC2, manufactured by SFK Technology, Denmark, VBS2000, manufactured by E+V, Germany, and VIAscan, manufactured by Meat and Livestock Australia. The first trial, conducted over a 6-week period in July/August 1999, calibrated the VIA systems on a large sample of carcasses and validated these calibrations on a further sample obtained at the same time. The second trial, conducted in the first two weeks of March 2000, was a further validation trial. The reference classification scores were determined by a panel of three experienced classifiers using the EUROP grid with 15 subclasses for conformation class and 15 sub-classes for fat. In the first trial the accuracy of the VIA systems at predicting saleable meat yield in steer carcasses was also assessed.

In the first trial, the VIA systems predicted the conformation scores of the reference panel to within 1 subclass for 93%, 91% and 97% of the carcasses for BCC2, VIAscan and VBS2000 respectively. BCC2, VIAscan and VBS2000 predicted the fat class scores of the reference panel to within 1 subclass for 80%, 72% and 75% of the carcasses respectively. The performance of all three VIA systems was clearly superior for conformation class than for fat class. There were some biases (systematic over- or under-scoring) either overall or within certain classes for both conformation class and fat class. There was also variation in the accuracy within classes for all three VIA systems for both conformation class and fat class. All three VIA systems predicted saleable meat yield with a high accuracy (RSD between 1.1 and 1.2%).

The calibrations were refined using all the data from the first trial. These new calibrations were then tested in a second trial at the same location in March 2000. The results were either similar to or slightly better than the first trial. The percentage of carcasses predicted to within one subclass of the reference panel score was 97%, 94% and 95% for conformation class and 80%, 76% and 74% for fat class for BCC2, VIAscan and VBS2000 respectively. Given that the spring sample (trial 2) was fatter on average and the fat was less yellow

than the summer sample (trial 1), this result indicates that the calibrations were reasonably robust to this type of variability. However, some biases were still evident in the second trial, particularly for conformation class, with all VIA systems tending to underscore classes R and U.

Several conclusions can be drawn from these trials which were the first comparative trials in the world of any VIA beef carcass classification systems and the first time that any of the VIA systems had been tested on Irish carcasses. Firstly, the differences in accuracy between the VIA systems were relatively small, with a range in the second trial of about 3% for conformation class and about 6% for fat class. Secondly, the accuracy for conformation class was much higher than for fat class for all three VIA systems. Thirdly, even after recalibration there were some important biases that would be of concern to the industry. Finally, all three VIA systems were able to accurately predict saleable meat yield.

The final conclusion is that none of the VIA systems would be likely to pass the criteria proposed by the EU for approval of mechanical grading systems. If the biases that were evident in the results could be reduced then it is possible that one or all of the three VIA systems could pass the criteria for conformation class. However, based on these results, none of them would be likely to pass the first criterion for fat class, namely that at least 88% of the predictions should be within 1 subclass of the reference panel score. These criteria will need to be modified if the industry is to exploit the potential of these mechanical grading systems. The authors are not aware of any other technology that would be likely to meet the currently proposed criteria for authorisation.

INTRODUCTION

The McKinsey Report (Enterprise Ireland, September 1998) and the Report of the Beef Task Force (Department of Agriculture, Food and Rural Development (DAFRD), June 1999) recommended that the Irish beef industry should move towards a mechanical carcass classification system as soon as possible. This could then form the basis of a quality-based payment schedule agreed between producers and processors.

Beef carcasses are classified by DAFRD classifiers according to the official EUROP scheme (EC 1208/1981) for conformation (E, U, R, O, P) and fat cover (1, 2, 3, 4, 5). In Ireland, fat class 4 is subdivided into Low (L) and High (H) and conformation class P is subdivided into 3 subclasses. Some countries subdivide each class into 3 to give 15 subclasses each for conformation and fat class. In addition to being used as the basis of a payment schedule to producers, the scheme is used for price-reporting purposes and to determine eligibility for intervention.

Because the scheme depends on human judgement, it is criticised by some as being subjective and inconsistent. This lack of confidence in the scheme makes it difficult to agree quality-based payment schedules that reflect the true value of carcasses to the industry. A lack of effective incentives to produce quality carcasses has undoubtedly contributed to a decline in carcass quality, particularly the higher percentage of overfat carcasses (Keane, 1999). Machines that can automatically classify carcasses would be more acceptable as the basis of quality-based payments. Such machines should command the confidence of all parties provided they can be shown to be at least as accurate as the present system.

Machines have been developed to classify carcasses, using technology known as Video Image Analysis (VIA). These have been described by Allen (1999). VIA takes images of a carcass with one or more cameras, extracts data such as lengths, areas, volumes, angles and colours, then processes these data to estimate the conformation class and fat class. Two of the machines, BCC2 and VBS 2000, project striped light onto the carcass and measure its curvature to gain information about the 3-dimensional shape. Since the process is automatic, once the machines have been calibrated they should be more consistent than well-trained classifiers.

A further advantage of the VIA systems is that they can predict the saleable meat content of a carcass. This is of interest to the processor because yield is closely related to the realisable value of a carcass. Visual classification also gives an indication of the saleable meat yield but previous tests have shown that the VIA systems are able to predict saleable yield with greater accuracy than classifiers (Borggaard *et al.*, 1996; Sonnichsen *et al.*, 1998).

Two trials were conducted with the objective of testing the accuracy of three of these VIA systems for predicting EUROP classification scores and saleable meat yield. VIAthe systems have been tested previously in separate trials (Ferguson *et al.*, 1995; DMRI, 1996; Borggaard *et al.*, 1996; Tong *et al.*, 1997 and Sonnichsen *et al.*, 1998), but this was the first time that more than one VIA system was tested in the same trial and the first time that any VIA system was tested on Irish carcasses. The results have been reported in more detail by Allen and Finnerty (2000).

METHODS

The following VIA beef carcass classification systems were evaluated:

- BCC2, manufactured by SFK Technology, Denmark;
- VBS2000, manufactured by E+V, Germany;
- VIAscan, manufactured by Meat and Livestock Australia.

These were installed side by side on the line at the Dawn Meats plant at Midleton, Co Cork. Reference classification scores were determined by a panel of three experienced DAFRD classifiers, using the EUROP grid with subclasses (15 x 15 grid). The first trial ran for 6 weeks in July/August 1999. Images of 7,247 carcasses were captured and stored by all three VIA systems. Reference classification scores for 60% of these carcasses (calibration set) were used to calibrate the VIA systems for Irish carcasses. Predictions were then made by the VIA systems for the remaining 40% of the carcasses (validation set).

The left sides of a sample of 386 steer carcasses were boned-out to a standard specification to determine the saleable meat yield. These were also divided into calibration (253) and validation sets (133). The primal yield was calculated by subtracting the lean trim and flank weight from the saleable meat yield.

The validation results were in line with those previously published for these VIA systems but there was evidence that the calibrations were not optimised for the test population. The VIA systems were recalibrated using all the data from the first trial. These new calibrations were then tested in a further trial on 2,226 carcasses also at Dawn Meats, Midleton in the first two weeks of March 2000.

RESULTS AND DISCUSSION

Results of the first trial (July/August 1999)

The sample population of beef carcasses

The distribution of carcasses with respect to conformation class and fat class is shown in Table 1. The distribution of carcasses in the national kill (1999) is shown in Table 2 for comparison. The main difference between the two was the total lack of carcasses of E conformation (v 0.05% of national kill) and the smaller percentage of U conformation carcasses in the trial sample (1.2% v 4.5%).

With respect to sex category, the trial sample had a higher percentage of cow carcasses (27% v 21%) and a smaller percentage of heifers (16% v 24%) than the national population. The calibration and validation sets were well balanced with respect to conformation, fat class and sex (data not shown).

Conformation class predictions

Between 91% and 97% of the carcasses were predicted to within one subclass (1/3rd of a full class on the 5-point scale) of the reference classification (Table 3). VBS2000 had the highest percentage of predictions in agreement with the reference panel.

Table 1: Number (%) of carcasses by conformation class and fat class for the full data set (First trial).

	Conformation class				
Fat class	U	R	O	P	Total
1	6 (0.1)	18 (0.2)	74 (1.0)	490 (6.8)	588 (8.1)
2	13 (0.2)	58 (0.8)	209 (2.9)	275 (3.8)	555 (7.7)
3	30 (0.4)	162 (2.2)	638 (8.8)	415 (5.7)	1245 (17)
4	37 (0.5)	563 (7.8)	2286 (32)	546 (7.5)	3432 (47)
5	4 (0.1)	251 (3.5)	1054 (15)	118 (1.6)	1427 (20)
Total	80 (1.2)	1052 (15)	4261 (59)	1844 (25)	7247 (100)

Table 2: Distribution (%) of carcasses by conformation class and fat class for the national kill in 1999 (data from DAFRD).

	Conformation class					
Fat class	E	U	R	O	P	Total
1	0.01	0.1	0.1	0.4	2.9	3.5
2	0.01	0.2	0.7	1.8	3.0	5.8
3	0.02	0.8	4.4	8.1	3.8	17.1
4	0.01	2.9	20.8	28.8	4.6	57.1
5	0	0.6	5.8	9.3	0.8	16.5
Total	0.05	4.5	31.9	48.4	15.2	100

Table 3: Percentage correspondence with the reference grading panel for conformation class for three VIA systems (First trial).

	VIA system		
	BCC2	VIAscan	VBS2000
% correctly classified	39.9	45.0	56.3
% overscored by 1 subclass	5.5	30.9	21.7
% underscored by 1 subclass	47.4	15.1	18.5
Total	92.8	91.0	96.5

Predicted conformation scores were highly correlated with the reference panel scores (r = 0.93, 0.92 and 0.91 for BCC2, VBS2000 and VIAscan respectively) (Table 4). The residual standard deviations (RSD) were less than a whole subclass for all three VIA systems (between 0.7 – 0.8 of a subclass).

There were some inconsistencies in the performance of the VIA systems across the classification grid (data not shown). BCC2 performed better for carcasses with poorer conformation, whereas the performance of VIAscan and VBS2000 was poorer for U carcasses. All three VIA systems performed best

Table 4: Correlation coefficients (r) and residual standard deviations (RSD) between predicted and reference conformation scores for three VIA systems (First trial).

VIA system	r	RSD
BCC2	0.93	0.70
VIAscan	0.91	0.80
VBS2000	0.92	0.75

for fat class 1 carcasses with little variation in performance across the other fat classes. All VIA systems performed best for cows and worst for steers, but the differences were small for VBS2000 (Table 5).

All VIA systems performed better for light than for heavy carcasses and the difference was greater than 10% for all systems (Table 6).

Fat class predictions

Between 72% and 80% of the carcasses were predicted to within one subclass of the reference panel classification, with BCC2 having the highest percentage in agreement (Table 7).

Predicted fat class scores were highly correlated with the reference panel scores (r = 0.94, 0.92 and 0.92 for BCC2, VIAscan and VBS2000 respectively) (Table 8). The RSD values for predicted fat class scores were between 1.1 and 1.4 of a subclass.

There were no large average biases (tendency to overscore or underscore) for any of the VIA systems but all systems had biases within some fat classes (data not shown). BCC2 and VIAscan performed above average for very fat and

Table 5: Percentage correspondence with the reference grading panel for conformation class for each VIA system within three sex categories (First trial).

		VIA system		
		BCC2	VIAscan	VBS2000
Steers	% correctly classified	76.2	77.2	84.7
	% overscored by 1 subclass	2.1	18.5	6.9
	% underscored by 1 subclass	21.0	4.2	8.0
Cows	% correctly classified	84.6	85.5	88.8
	% overscored by 1 subclass	1.3	11.5	7.4
	% underscored by 1 subclass	13.4	3.1	3.3
Heifers	% correctly classified	79.0	85.1	86.9
	% overscored by 1 subclass	0.9	8.2	5.1
	% underscored by 1 subclass	19.2	6.8	7.5

Table 6: Percentage correspondence with the reference grading panel for conformation class for each VIA system within two weight categories (First trial).

Weight category		VIA system: BCC2	VIAscan	VBS2000
Light	% correctly classified	85.2	90.3	90.5
	% overscored by 1 subclass	0.4	3.9	3.0
	% underscored by 1 subclass	14.0	5.8	5.8
Heavy	% correctly classified	72.9	69.5	79.6
	% overscored by 1 subclass	6.5	25.1	10.7
	% underscored by 1 subclass	19.3	5.5	9.1

Table 7: Percentage correspondence with the reference grading panel for fat class for three VIA systems (First trial).

	VIA system		
	BCC2	VIAscan	VBS2000
% correctly classified	34.4	28.0	29.4
% overscored by 1 subclass	19.3	22.1	23.9
% underscored by 1 subclass	26.7	21.9	21.3
Total	80.4	72.0	74.6

Table 8: Correlation coefficient (r) and residual standard deviation (RSD) between predicted and reference panel fat class scores for three VIA systems (First trial)

VIA system	r	RSD
BCC2	0.94	1.14
VIAscan	0.92	1.38
VBS2000	0.92	1.38

very lean carcasses, whereas VBS2000 was more accurate for fat class 4 carcasses than for carcasses of other fat classes. Sex category had little effect on the performance of the VIA systems, though BCC2 tended to underscore steers while VBS2000 tended to overscore cows and heifers (Table 9). BCC2 tended to underscore light carcasses and VBS2000 tended to overscore both light and heavy carcasses while VIAscan tended to overscore heavy carcasses (Table 10).

Prediction of saleable meat yield

The validation set was representative of the total sample (mean saleable meat yield = 76 ± 2.2% v 76 ± 1.8% and mean primal yield = 53 ± 2.6% v 52 ± 2.4% for the validation set and full set respectively).

There was little variation in saleable meat yield across fat classes (from 75.5% for fat class 1 to 76.8% for fat class 5). In contrast, the variation across conformation classes was larger (from 74.2% for P conformation to 78.6% for U). The fact that the saleable meat yield increased rather than decreased with increasing fat class reflects the fact that the specification used did not involve heavy trimming of fat, particularly for the flank (Table 11).

Table 9: Percentage correspondence with the reference panel score for fat class for each VIA system within three sex categories (First trial)

		VIA system		
Sex category		BCC2	VIAscan	VBS2000
Steers	% correctly classified	72.1	67.2	70.1
	% overscored by 1 subclass	9.7	17.1	14.8
	% underscored by 1 subclass	17.1	15.7	14.6
Cows	% correctly classified	70.9	67.8	66.4
	% overscored by 1 subclass	12.5	13.5	20.4
	% underscored by 1 subclass	15.3	17.4	11.5
Heifers	% correctly classified	71.3	64.2	71.0
	% overscored by 1 subclass	13.3	21.3	18.2
	% underscored by 1 subclass	14.5	14.3	10.0

Table 10: Percentage correspondence with the reference grading panel for fat class by each VIA system within two weight categories (First trial)

Weight category		VIA system BCC2	VIAscan	VBS2000
light	% correctly classified	71.4	68.9	69.7
	% overscored by 1 subclass	7.1	15.6	18.7
	% underscored by 1 subclass	20.7	14.5	9.3
heavy	% correctly classified	73.9	67.6	68.4
	% overscored by 1 subclass	12.3	21.2	23.0
	% underscored by 1 subclass	12.3	11.2	8.1

The three VIA systems did not differ in their accuracy of predicting saleable meat yield, with RSD values of slightly over 1% (Table 12). While these results compare favourably with those of other published trials (Ferguson *et al.*, 1995; Borggaard *et al.*, 1996; Sonnichsen *et al.*, 1998), the VIA systems

Table 11: Mean saleable meat yield percentage (number of sides) by conformation class and fat class

Fat class	Conformation class U	R	O	P	Total
1	-	77.8 (3)	74.7 (9)	75.4 (1)	75.5 (13)
2	77.2 (1)	77.7 (7)	76.0 (32)	73.9 (24)	75.4 (64)
3	78.7 (10)	78.2 (33)	76.2 (44)	74.2 (20)	76.7 (107)
4	78.9 (14)	78.1 (36)	76.4 (71)	74.4 (23)	76.8 (144)
5	76.8 (2)	77.3 (18)	76.6 (46)	-	76.8 (66)
Total	78.6 (27)	77.9 (97)	76.3 (202)	74.2 (68)	76.5 (394)

Table 12: Correlation coefficient (r) and residual standard deviation (RSD) for the prediction of saleable meat yield by three VIA systems (N = 133).

	VIA system		
	BCC2	VIAscan	VBS2000
r	0.84	0.85	0.87
RSD	1.20	1.20	1.12

were no more accurate at predicting saleable meat yield than were the classification scores of the reference panel (RSD = 1.2%, Table 13). This is in contrast to Borggaard *et al.*, (1996) who found that the BCC2 was more accurate than classifiers at predicting saleable yield.

Conformation score was the best single predictor of saleable meat yield (RSD = 1.23), fat score and/or carcass weight adding little to the precision (Table 13).

Table 13: Prediction of saleable meat yield from models using reference grading panel classification scores and half carcass weight (r = correlation coefficient, RSD = residual standard deviation).

Model	r	RSD
Weight	0.58	1.84
Conformation score	0.84	1.23
Conformation score + weight	0.85	1.21
Fat score	0.31	2.14
Fat score + weight	0.60	1.81
Conformation score + fat score	0.84	1.23
Conformation score + fat score + weight	0.85	1.21

The poor relationship of fat score with saleable meat yield (r = 0.31) was due to the small amount of variation in saleable meat yield across fat classes.

Prediction of primal yield

Removing the flank and trim from the saleable meat yield to obtain primal yield had the effect of increasing the range across fat classes and reversing the trend with respect to fat class. The relationship between primal yield and fatness was in the expected direction, primal yield being highest for fat class 1 (54.7%) and lowest for fat class 5 (49.8%) (Table 14).

The three VIA systems predicted primal yield with similar accuracy, with RSD's of around 1.5 (Table 15).

Reference classification scores were more accurate (RSD = 1.44) at predicting primal yield than the three VIA systems (Tables 15 and 16). Reference panel conformation score was the best single predictor of primal yield and fat class was a good co-predictor.

Table 14: Mean primal yield percentage (number of sides) by conformation class and fat class.

	Conformation class				
Fat class	U	R	O	P	total
1	-	55.9 (3)	54.4 (9)	53.1 (1)	54.7 (13)
2	54.8 (1)	55.4 (7)	53.6 (32)	51.2 (24)	52.9 (64)
3	55.0 (10)	54.7 (33)	52.3 (44)	50.4 (20)	52.9 (107)
4	53.5 (14)	52.8 (36)	50.9 (71)	48.8 (23)	51.3 (144)
5	50.5 (2)	50.3 (18)	49.6 (46)	-	49.8 (66)
Total	53.9 (27)	53.3 (97)	51.5 (202)	50.2 (68)	51.9 (394)

Table 15: Correlation coefficient (r) residual standard deviation (RSD), slope coefficient and constant for the prediction of primal yield by three VIA systems (N = 133).

	VIA system		
	BCC2	VIAscan	VBS2000
Correlation	0.82	0.80	0.80
RSD	1.50	1.54	1.56
Slope	0.80	0.98	1.05
Constant	10.5	1.80	-2.15

Table 16: Prediction of primal yield from models using reference grading panel classification scores and half carcass weight (r = correlation coefficient, RSD = residual standard deviation).

Model	r	RSD
Weight	0.01	2.59
Conformation score	0.60	2.07
Conformation score + weight	0.73	1.77
Fat score	0.36	2.41
Fat score + weight	0.50	2.24
Conformation score + fat score	0.83	1.44
Conformation score + fat score + weight	0.83	1.44

Results of the second trial (March 2000)

The sample population of beef carcasses

The distribution of carcasses with respect to the classification grid is shown in Table 17. Almost 4% of the carcasses were classified as U and E conformation, which is nearer to the national average than was the case in the first trial (Table 2). Very lean carcasses were underrepresented in the sample with only 5 of fat class 1$^-$ (lowest subclass of fat class 1). There were only 6 bull carcasses in the sample and a larger percentage of steer carcasses (70% v 56%) than in the first trial. Cows and heifers were almost equally represented, as was the case in the first trial.

Conformation class predictions

Between 49% (VIAscan) and 58% (BCC2) of the predictions from the VIA systems agreed with the reference panel scores, with between 94% (VIAscan) and 97% (BCC2) being within one subclass of the reference panel score (Table 18). The tendencies for VBS2000 to overscore and BCC2 to underscore compared to the reference panel were again apparent. There was no apparent overall bias for VIAscan.

Table 17: Number (%) of carcasses by conformation class and fat class (Second trial)

	Conformation class					
Fat class	E	U	R	O	P	Total
1	0	1 (0.0)	1 (0.0)	8 (0.4)	49 (2.2)	59 (2.7)
2	0	4 (0.2)	9 (0.4)	29 (1.3)	72 (3.2)	114 (5.1)
3	1 (<0.1)	14 (0.6)	87 (3.9)	257 (11.5)	159 (7.1)	518 (23.3)
4	1 (<0.1)	45 (2.0)	288 (12.9)	685 (30.8)	190 (8.5)	1209 (54.3)
5	0	19 (0.9)	92 (4.1)	179 (8.0)	36 (1.6)	326 (14.6)
Total	2 (>0.1)	83 (3.7)	477 (21.4)	1158 (52.0)	506 (22.7)	2226 (100)

Table 18: Percentage correspondence with the reference panel score for conformation class for three VIA systems (Second trial).

	VIA system		
	BCC2	VIAscan	VBS2000
% correctly classified	58.3	48.7	52.2
% overscored by 1 subclass	16.3	23.4	29.0
% underscored by 1 subclass	22.5	22.2	14.2
Total	97.0	94.2	95.4

All VIA systems tended to overscore poorer conformation carcasses and to underscore carcasses of good conformation (data not shown). These biases balanced out for VIAscan, but resulted in an overall negative bias for BCC2 and a positive one for VBS2000.

Fat class predictions

The percentages correctly classified for fat class and within 1 subclass of the reference panel score are shown in Table 19. Between 30% (VIAscan) and

Table 19: Percentage correspondence with the reference panel for fat class by three VIA systems (Second trial).

	VIA system		
	BCC2	**VIAscan**	**VBS2000**
% correctly classified	34.8	30.2	30.8
% overscored by 1 subclass	22.0	13.7	26.7
% underscored by 1 subclass	22.9	32.3	16.8
Total	79.6	76.1	74.4

34% (BCC2) of the predictions of the VIA systems agreed with the reference panel scores, with between 74% (VBS2000) and 80% (BCC2) falling within one subclass of the reference panel score. There was a tendency for VBS2000 to overscore and VIAscan to underscore compared to the reference panel. There was no apparent overall bias for BCC2.

The percentage of carcasses that were predicted by the VIA systems to within 1 subclass of the reference panel fat score was below 50% for fat classes 5 and 5^+ for VIAscan and for fat class 1^+ for BCC2 (data not shown). The performance VBS2000 was poorest for fat class 2 with 54% of the predictions within 1 subclass of the reference panel score. The negative bias of VIAscan and the positive bias of VBS2000 compared to the reference panel were fairly consistent throughout the scale.

CONCLUSIONS

The percentage correspondence between the three VIA systems and the reference panel was higher for conformation class than for fat class for all three systems. This may reflect the greater variation in the beef carcasses fat class scores compared to conformation class scores (standard deviation = 3.43 for fat class v 1.88 for conformation class in trial 1). Another possibility is that it may reflect greater difficulty in determining the correct fat class either by the reference panel or by the VIA systems or both.

The accuracy of the VIA systems, as measured by the residual standard deviations, was reasonable and could probably be improved with more data.

In the first trial the VIA systems performed better at predicting conformation class for cows and light carcasses. These two effects may be related since cows tended to fall within the light weight category.

All three VIA systems predicted saleable meat yield with a similar high accuracy. The RSD of 1.1 - 1.2% compares favourably with other trials. It was not expected that the reference panel classification scores would predict saleable meat yield with similar accuracy to the VIA systems. However, the reference classification scores were determined by a panel of three experienced classifiers using a 15-point scale so a higher standard would be expected than from a single classifier using the 5-point scale.

The biases that were apparent in trials 1 and 2 suggest that the calibrations, while generally improved in the second trial, were not optimal for the sample population. This highlights the difficulty in calibrating objective systems against visually-assessed categorical scores and the need for continuous development of the calibrations. The main limitation of these trials was the relatively small number of U conformation carcasses.

The sample populations in the two trials differed in some characteristics that could be expected to influence the accuracy of the VIA systems. In the second trial, the carcasses were fatter than in the first trial and the fat was less yellow. This could be explained by the fact that in the spring most of the cattle would have come out of houses off a diet of silage and concentrates whereas in the summer they would have come off pasture. The equally good results from the second trial, given these differences suggest that the prediction equations were quite robust to this type of variability.

Based on these results, none of the three VIA systems would be likely to pass the criteria in the EU draft regulations for authorising mechanical grading, particularly for fat class predictions.

These two trials have expanded the knowledge of the potential of the VIA systems for beef carcass classification. Comparative data is available for the three VIA systems for the first time. Despite differences in hardware and software between the systems, differences in their accuracy of predicting EUROP classification were not large.

This was also the first time that any of the VIA systems had been tested on Irish carcasses. The performance of the VIA systems on Irish carcasses would appear to be similar to results reported for other European beef populations for BCC2 and VBS2000. VIAscan was calibrated and tested for EUROP classification for the first time and appeared capable of achieving a level of accuracy similar to the other systems.

Further work needs to be done to improve the VIA systems, particularly in removing the biases.

RECOMMENDATIONS TO INDUSTRY

The three VIA systems that were tested in these trials could be used to classify beef carcasses with reasonable accuracy. Some of the biases and the performance at the margins of the conformation range in particular would be unacceptable, but it is likely that these problems could be sorted out with more data. The industry could therefore consider devising a national classification scheme based on one or more of these VIA systems. Use of the scheme for official purposes such as price reporting or eligibility for support measures would require authorisation from the EU. It is unlikely that any of the VIA systems would pass the proposed criteria for authorisation. The EU authorities have stated a willingness to reconsider the criteria after a pilot authorisation trial in Germany has taken place and been assessed.

The VIA systems are able to accurately predict saleable yield or primal yield. The Irish beef industry could install VIA systems and take advantage of having an objective measurement of yield without waiting for official approval from the EU. Given the small differences between the systems in the accuracy of the yield predictions, the choice of system would depend on other factors such as cost and backup services.

The authors are not aware of technologies other than VIA that could be applied for the on-line classification of beef carcasses according to the EUROP scales for conformation and fat cover. Furthermore, the development of mechanical systems is hindered by the need to calibrate against classifiers rather than quantifiable characteristics such as saleable yield or lean content. Technologies such as ultrasound, electrical conductivity and X-ray imaging are capable of measuring the composition (fat and lean content) of carcasses but their implementation has been retarded by the requirement for EUROP classification. Nevertheless, the potential of these technologies for estimating the yield of carcasses and quarters should not be overlooked by the industry simply because they cannot replace the visual existing classification method. The potential of total body electrical conductivity (TOBEC) for sorting chilled beef hindquarters according to their expected yield has recently been investigated and reported on by Allen and McGeehin (2001).

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RESEARCH & TRAINING FOR THE FOOD INDUSTRY

Dunsinea, Castleknock, Dublin 15, Ireland.

Telephone: (+353 1) 805 9500

Fax: (+353 1) 805 9550