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Prediction of beef carcass yield from selected commercial cuts expressed as a percentage of side weight

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ABSTRACT

Given that almost all beef carcasses intended for export from New Zealand are boned out into cuts in the boning room of export plants, the feasibility was investigated of carrying the identification of individual animals from the point of slaughter through to sides in the boning room and using the weights (percentages) of selected cuts to predict the yield of saleable meat. A Ruakura beef cuts database with information from sides of 1461 bulls, 1097 steers, 320 heifers and 329 cows, all of known breeding, was used to test the accuracy of beef saleable meat yield prediction from the weights of three hindquarter cuts removed at the same time and site in the boning room. The inside round (topside), outside round (silverside) and thick flank expressed as a percentage of side weight were chosen for use alone and in multiple regression to predict the percentage of the carcass available as saleable meat. A model incorporating % inside and % outside and their interactions with sex (bull, steer, heifer and cow) provided useful prediction of % meat yield (R^2 0.77, RSD 2.11%) and if hot carcass weight was added to the equation the R^2 improved to 0.78 and the RSD was reduced to 2.06%. The sum of the inside and outside expressed as a percentage of side weight gave the same accuracy of prediction of percentage saleable meat yield as when they were treated as separate independent variables. The use of thick flank gave no improvement in prediction. These results should be compared with the present system where sex class, fat class (grade) and hot carcass weight predicted yield with an R^2 of 0.60 and an RSD of 2.80% for the same set of data.

Keywords: beef; carcass yield; prediction; inside; outside; thick flank; commercial system.

INTRODUCTION

Beef carcasses are currently classified into fatness/yield categories by carcass classifiers/graders subjectively on the basis of sight and touch. Graders try to assess fat cover and colour and the saleable meat content (yield) of each carcass. Attempts are now being made internationally to introduce objective methods including electronic probes and video and ultrasonic techniques to measure various attributes such as carcass fatness and colour standards for fat colour (particularly yellowness) assessments. Although in NZ a fat thickness range is specified for the depth over the 4th quarter of the eye muscle from the mid-line where the side is quartered (eg. Anon. 1975) this is seldom measured.

An alternative possibility for yield estimation might be the use of the weight or percentage of selected commercial cuts measured during side boning in an export beef plant to estimate the beef yield of a side (Kirton, 1989; Purchas, pers. comm.). Another alternative might be to weigh all the fat trimmed meat from each side provided the meat from different sides can be separated. A feasibility study (Kirton, Jordan and Saunders, 1991) was undertaken to identify problems of maintaining a side/animal identification system from the point of slaughter to the boning room and to identify suitable cuts likely to be removed from the side/quarter (depending on the break down system used; ideally at some common point in the boning room where they might be weighed). The approach was judged feasible in some boning rooms with some reorganisation, provided such a system did not slow operations.

Murray (1980) summarised information from various authors on the use of selected muscle weights to predict side muscle weight in cattle and showed that the prediction equa-

tions derived by various authors from their cattle investigations were not accurate for predicting muscle weight in different groups of cattle. This applied to cattle raised on 3 planes of nutrition (H, MH and L) which had the weights of the muscles to be used for prediction plus total muscle weight recorded. He suggested great caution in the use of this approach especially for scientific purposes.

A database at Ruakura that contained information on the side weights and the weights of 14 commercially trimmed cuts was available for this study. The weight of commercially meat trimmed bone and fat trim was also recorded. The object of the study was to determine the accuracy with which yield of saleable meat can be predicted from the inside round (cap on), the outside round and thick flank as well as hot carcass weight and sex. The 3 cuts were chosen because the animal identification of the hindquarter would be easier to maintain to give cut identification than would be the case for most other cuts as they are removed at a common site during boning. The accuracy of prediction from such regressions was also compared with the accuracy of prediction from fat class and carcass weight. The database fat classes do not include the K fat class introduced in October 1988.

MATERIALS AND METHODS

The Database

The cattle used had been slaughtered from a number of trials undertaken at the Ruakura Research Centre. The cattle were processed at the Ruakura experimental abattoir and the hot carcass weight, sex, breed and weight of the trimmed export cuts from the left side was recorded for each animal.

Each side was separated as appropriate into saleable meat, bone and trimmed fat approximating the cuts described in the New Zealand Trade Guide produced by the New Zealand Meat Producers Board (Anon., 1975) except that the cuts were trimmed to a 95% visual lean standard rather than to the more usual 90% standard.

The database included 1461 bulls, 1097 steers, 329 cows and 320 heifers, a total of 3207 cattle from a variety of breeds. These records were suitable to test the prediction of the percentage yield of saleable meat (95% visual lean) from the percentage (of side weight) of the inside round (topside or semimembranosus plus adductor femoris and covering muscle or cap), outside round (silverside or flat comprising most of the biceps femoris and the eye of round or semitendinosus). The other main muscle group identified in the feasibility study was the thick flank comprising mainly the knuckle or quadriceps femoris from which the patella or knee cap was removed. The thick flank differs from the knuckle in that it includes the "cap" which is made up mainly of subcutaneous fat and part of the fascia tensor latae muscle. However, it should be noted that these cuts are not removed as entire muscles in the boning room and commercially there can be some variation between boners.

As mentioned, the cuts chosen on the basis of the feasibility study were converted to percentage of side weight to provide the data to be tested in equations for predicting saleable meat yield as a percentage of side weight. This proposal is based on the assumption that cut weight or percentage (to correct for side weight differences) might be collected for predictive purposes in an export meat plant without disrupting the boning room.

Statistical Analyses

Using least squares regression, percentage saleable meat was modelled using different combinations of predictors: hot carcass weight, sex, breed and, inside, outside and knuckle as a percentage of side weight. A measure of the current grading system was obtained by using hot carcass weight, sex and fat class as predictors. First order interactions of those predictors (excluding breed) were also tested. For all models, R^2 and residual standard deviations were calculated to give an indication of how well particular groups of measurements predicted percentage yield. Analyses were carried out using the Genstat statistical package (Lawes Agriculture Trust, 1984).

RESULTS AND DISCUSSION

The numbers of animals and the means and variation for hot carcass weight (kidneys and kidney fats out; HCW), percentage yield of saleable meat and percentages of inside, outside and thick flank are given in Table 1. The three cuts chosen for predictive purposes when combined comprised 16-17% of side weight and 23-25% of saleable meat yield. Carcass weights were lighter than the NZ average in recent years.

The accuracy of the prediction systems using the inside, outside and thick flank should be compared with yield prediction within sex class based on HCW and fat class (M, L, P, G, T and E) which applied when these data were collected. Predicted yield from sex, fat class and HCW gave an R^2 value of 0.60 and a RSD for prediction of yield of 2.8% saleable meat. The mean differences in meat yield between the various fat classes were illustrated by Woods *et al.* (1986).

The results given in Table 2 indicate the accuracy of yield prediction overall from the variables listed ignoring sex class or within sex class allowing for various other factors including combinations of the three cuts with and without HCW, breed and some of the significant interactions. This Table shows that the use of the best 2 or all 3 suggested cuts ignoring sex class is not as accurate as the present method of carcass classification within sex based on the 6 fat classes. However, the use of sex class and either 2 or all 3 cuts in the prediction equation increases the R^2 values to over 0.72 and reduces the RSD values to around 2.3% yield. The use of thick flank % as well as inside % and outside % gave no worthwhile improvement over the use of the latter cuts alone. The combined weight of inside and outside as a percentage of side weight gave the same accuracy of prediction of percentage saleable meat as when they were treated as separate independent variables. Although the inclusion of HCW to % inside and % outside or the two combined within sex class only gives a small improvement in predictive accuracy, HCW should be included because this weight is recorded on all carcasses as a basis for payment, irrespective of whether it is required for predictive purposes or not.

The prediction equation using sex class, HCW, % inside and % outside (or these cuts combined) to predict % yield gave an R^2 value of 0.73 without allowing for interactions or 0.78 after allowing for significant interactions. The corresponding RSD were 2.29 and 2.06%. Although only of academic interest, the inclusion of breed as an additional variable increased the R^2 value of 0.81 and reduced the RSD

TABLE 1: Numbers, percentage meat yield and percentage of cuts being assessed for use for predictive purposes within cattle sex classes.

Item	Bull Mean	SD	Steer Mean	SD	Heifer Mean	SD	Cow Mean	SD
Number of carcasses	1461		1097		320		329	
Hot carcass weight (kg)	221	39.8	239	42.9	212	39.1	211	52.6
% meat yield	72.2	2.30	66.0	3.70	66.3	3.70	66.2	3.85
% outside round	6.02	0.36	5.72	0.49	5.90	0.51	5.62	0.46
% inside round	6.59	0.46	6.16	0.51	6.42	0.58	6.28	0.64
% thick flank	4.07	0.43	4.02	0.48	4.13	0.52	4.03	0.54

Total number of carcasses 3207

Note: Meat yield and cut weights from left sides expressed as a percentage of side weight.

TABLE 2: Accuracy of prediction of percentage saleable meat yield in beef carcasses within sex class using combinations of hot carcass weight (HCW), percentage inside, outside and thick flank.

Model	Predictive variates			R ²	RSD %	
	HCW	% Inside	% Outside			%TFIk ^a
Sex ^c + Fat Class ^c	X				0.602 ^d	2.80 ^d
No adjustments		X	X	X	0.493	3.13
Sex ^b		X	X	X	0.727	2.30
Sex ^{b,c}		X	X	X	0.774	2.10
Sex ^{b,c} + Breed ^b		X	X		0.797	1.99
No adjustments	X	X	X	X	0.498	3.12
Sex ^b	X	X	X	X	0.732	2.28
Sex ^{b,c}	X	X	X	X	0.785	2.05
Sex ^{b,c} + Breed ^b	X	X	X	X	0.814	1.91
No adjustments		X	X		0.491	3.14
Sex ^b		X	X		0.725	2.31
Sex ^{b,c}		X	X		0.772	2.11
Sex ^{b,c} + Breed ^b		X	X		0.794	2.01
No adjustments	X	X	X		0.497	3.12
Sex ^b	X	X	X		0.729	2.29
Sex ^{b,c}	X	X	X		0.783	2.06
Sex ^{b,c} + Breed ^b	X	X	X		0.811	1.92

- a Thick flank
- b Main effects only
- c With interactions
- d Current grading system

to 1.92%. Because breed is not recognisable at the scales after the hide has been removed and is even difficult at the beginning of the chain especially where cross breeds are involved, some carcass classification systems and in particular those in Europe, include carcass conformation as a classification factor. This indirectly takes account of breed (Kempster *et al.*, 1982). The effect of breed on carcass class for beef in NZ was reported by Butler-Hogg *et al.*, (1988) and this breed (conformation) effect recognises the higher yield of some European exotic crosses and lower yields of some dairy and traditional crosses. The alternative to inclusion of breed or conformation in the classification system would be for meat companies to purchase cattle of higher yielding breeds from farmers on contract with an appropriate premium for the known higher yield.

The present results obtained over a large number of beef carcasses from a variety of breeds shows that a system which involves the weighing of the inside and outside cut from the leg of individually identified cattle and using this information with the sex class and weight of the carcass gives a more accurate prediction of yield than the system which used sex, carcass weight and the classification into 6 fatness classes. Johnson *et al.* (1990) in a study on 42 light steer carcasses, reported that saleable beef yield was an unsatisfactory measure of carcass leanness for scientific purposes. This may have been due to the higher fat content of his trimmed cuts (85% or more visual lean in manufacturing beef). Saleable beef is an important measurement for industry related studies, especially when economic outcomes are a consideration. Kempster *et al.* (1982) reported lower SD and RSD for 805 cattle in a MLC beef breed evaluation trial which reported on the use of carcass weight, fat class, breed and conformation for predicting saleable meat yield, and reported smaller RSD reductions from adding variables than in the present trial. It was not clear

in that study whether sex was used as a classification factor; this factor clearly greatly improved the accuracy of prediction in the present trial.

The use of the weights of the inside and outside in the calculation of meat yield in beef carcasses appears likely to be able to improve the accuracy of beef carcass yield prediction. Whether it is possible to weigh and record the weights of these cuts at normal operating speeds in export boning rooms without disrupting the rate of operation remains to be seen. The possibility of weighing both cuts together as one unit would reduce the effort required in recording. Because of the variety of systems used in boning rooms (on rails side boning, on rail quarter boning, table boning) in different plants any system suggested would have to be designed specifically to meet the requirements of each individual plant. We have obtained better results than can be normally expected because of the higher level of fat trimming (95% visual lean) than is normally aimed for by industry (85% or 90% depending on the client) and cuts may have been prepared more carefully for research purposes. Accuracy may be improved if cuts from both sides were weighed.

The suggested system based on cut weights could do away with the need for fatness classes for many end uses. However, manufacturing grade carcasses may need to be separately identified because the meat may be removed from the bone ignoring cut demarcation (slash boning). In addition, for many table end uses, specified levels of fatness may be required. While meat yield is an important component of producer payment, meat quality and some level of fatness may be required in order to qualify for higher payments resulting from meeting customer requirements. The proposed system could be used for the steer, heifer, and cow classes excluding M class animals.

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