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# BREED AND SEX EFFECTS ON THE CONTENT OF EDIBLE MEAT IN BEEF CARCASSES

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## SUMMARY

Regression equations relating the weight of edible meat to carcass weight and the depth of fat cover over the 12-13th rib are presented for 3425 heifer, steer and bull carcasses of 11 breeds and crosses.

Carcass weight accounted for 95% of the variation in edible meat weight for steers and heifers, and 98% for bulls. Inclusion of fat cover measurement in multiple regression did not markedly improve prediction of edible meat content in this sample containing few relatively fat animals.

Steers and heifers of the same breed group did not differ significantly in edible meat yield, when yield was adjusted for carcass weight and depth of fat cover, but bulls produced 4.4% more meat than steers and heifers.

Significant breed differences in edible meat yield were recorded. Regression equations relating edible meat to carcass weight and depth of fat cover are presented for breed groups and the use of these discussed.

## INTRODUCTION

Subcutaneous fat thickness at the 12-13th rib level is positively correlated with beef carcass fatness and negatively with yield of edible meat or muscle (Preston and Willis, 1970; B.A.E., 1976; Charles and Johnson, 1976). Beef classification and grading schemes in several countries have incorporated this fat thickness measurement either as a specification (Locking, 1976; Luckock, 1976) or a guideline (Nicol, 1976; Ryan, 1976).

The value of measuring backfat in beef carcasses was shown in an analysis of the grading system used in New Zealand (Everitt and Evans, 1970). It was found that edible meat could be predicted, with acceptable industry precision, from knowledge of carcass weight and the fat thickness measurement. Breed differences in edible meat yield were not reported in detail.

This paper reports breed and sex differences in edible meat yield and regressions for prediction of meat yield.

## EXPERIMENTAL

### EXPERIMENTS

The data reported are derived from experiments either concluded during the past decade and reported elsewhere (Everitt

*et al.*, 1969; Everitt and Evans, 1969, 1970; Everitt, 1972; Hight *et al.*, 1973; Everitt and Ward, 1974) or still in progress (Everitt *et al.*, 1975, 1976; Everitt, unpublished; Hight, Everitt and Jury, unpublished).

## ANIMALS

The information refers to 3425 cattle summarized by breed and sex in Table 1. Breeds and crosses were represented by straightbred Jersey (J × J), Friesian (F × F) and Angus (A × A), and crossbred Friesian × Jersey (F × J), Hereford × Jersey (H × J), Charolais × Jersey (C × J), Hereford × Friesian (H × F), Charolais × Friesian (C × F), Angus × Friesian and Friesian × Angus pooled (A × F), Simmental × Friesian (S × F) and Limousin × Friesian (L × F).

## SLAUGHTER AND PROCESSING

Cattle were slaughtered at 15 to 23 months of age at the Horotiu Freezing Works of the Auckland Farmers' Freezing Co-operative Ltd. Carcass weight (standardized as hot carcass weight minus kidney and channel fat) and subcutaneous fat depth over the longissimus dorsi muscle ("eye muscle") at the 12-13th rib level were recorded. Weights of boneless, fat-trimmed edible meat, bone and excess fat were determined for each individual carcass, as described by Everitt (1961). Edible meat primal cuts were collated into a relatively high priced group (inside, outside, knuckle, eyeround, top sirloin, bottom sirloin, strip loin, flank steak, tenderloin, and cube roll), the remainder comprising a relatively low priced group.

TABLE 1: NUMBER OF CARCASSES CLASSIFIED BY BREED AND SEX

Breed	Heifers	Steers	Bulls
J × J	15	144	114
F × J	72	406	102
H × J	153	154	—
C × J	180	180	—
A × A	118	404	—
F × F	27	650	90
H × F	19	118	—
C × F	18	13	—
A × F	69	221	—
S × F	—	98	—
L × F	—	80	—
Total	671	2448	306

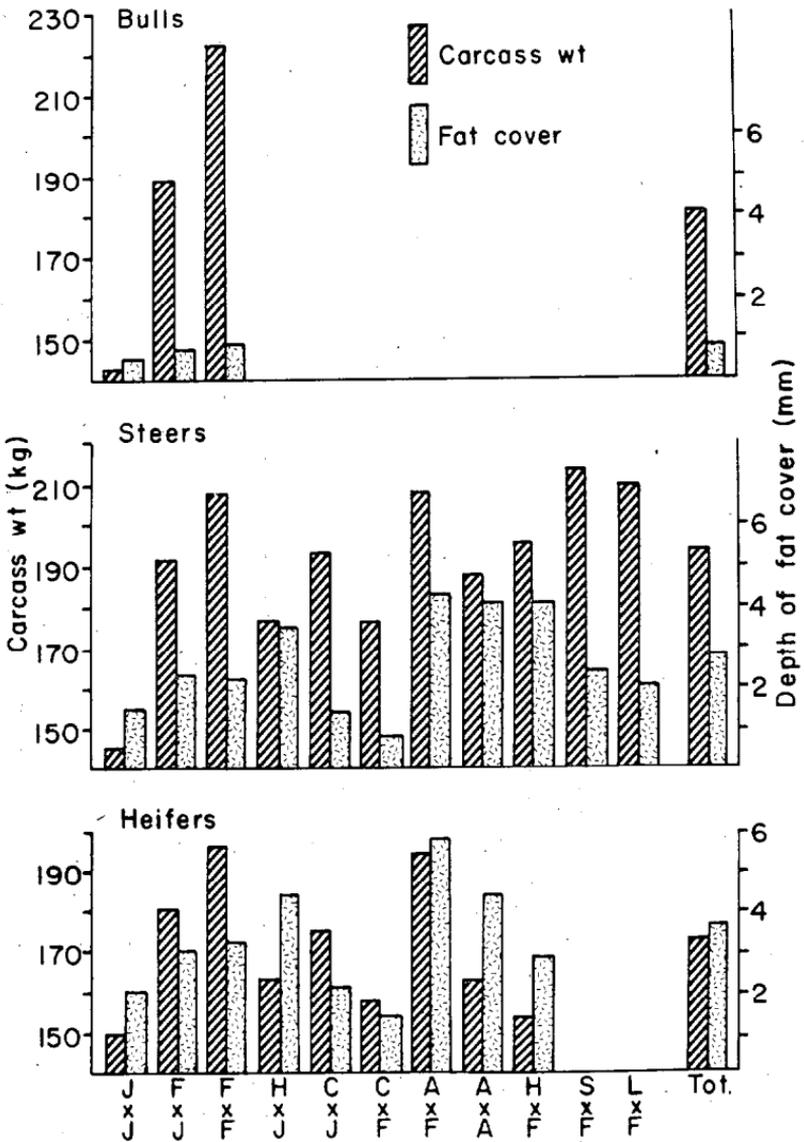


FIG. 1: Mean carcass weights and fat cover measurements for bull, steer and heifer carcasses classified by breeds and crosses.

## BIOMETRICAL PROCEDURES

Multiple regression equations were used for relating edible meat to carcass weight and depth of fat cover. Data were not adjusted for age at slaughter as this is not known accurately for cattle killed at freezing works. Inclusion of quadratic terms for carcass weight or fat cover, or use of logarithmic relationships, did not prove superior to linear regression.

## RESULTS

Figure 1 records the mean carcass weights and fat cover measurements for the three sexes classified by breed. Respectively, 60, 71 and 100% of heifers, steers and bulls, recorded 3 mm and less of fat cover. There were few relatively fat carcasses; 1.3, 0.2 and 0% of heifers, steers and bulls had 13 mm and more of fat cover.

Analysis of the relationship between edible meat and carcass weight and fat cover showed that a single equation could not be used for all breeds and sexes in the sample. Table 2 summarizes the multiple regressions for heifers, steers and bulls pooled within breeds and ignoring breeds.

Carcass weight alone accounted for 95% of the variation in edible meat weight for heifers and steers, and 98% for bulls, pooled within breeds. Inclusion of the fat cover measurement did not markedly improve prediction of edible meat content, the residual standard deviation (within breeds) being reduced by 0.02 kg in heifers and steers, and by 0.07 kg for bulls, compared with the values obtained from using carcass weight by itself. The regression coefficients for fat cover in bulls appear high in view of the small variation in the measurement for this sex, and need cautious acceptance.

Table 2 indicates similar coefficients for heifers and steers. Using a pooled regression, estimates of the weight of edible meat, and as a percentage of carcass weight (allowing for breed effects) are given in Table 3.

For a given breed, carcass weight and fat cover, bulls yielded 4.4% more edible meat than heifers or steers which did not differ significantly.

For each sex, differences in regression coefficients between breeds were not large but yields of meat at the same carcass weight and fat cover did differ between breeds, as shown in Fig. 2.

Some breeds were represented by a relatively small number of carcasses, especially for heifers (Table 1). High meat yields were

TABLE 2: RELATIONSHIPS OF EDIBLE MEAT WEIGHT (kg) TO CARCASS WEIGHT (kg) AND FAT COVER (mm) FOR HEIFERS, STEERS AND BULLS

Sex	No.	$b_1 \pm SE$	$b_2 \pm SE$	$c$	RSD (1)	RSD (2)	R
Within breeds:							
Heifers	671	0.69*** $\pm$ 0.010	-0.22** $\pm$ 0.080	—	4.04	4.02	0.977
Steers	2448	0.70*** $\pm$ 0.004	-0.26*** $\pm$ 0.060	—	5.25	5.23	0.975
Bulls	306	0.72*** $\pm$ 0.010	-1.41*** $\pm$ 0.390	—	3.61	3.54	0.988
Ignoring breeds:							
Heifers	671	0.69*** $\pm$ 0.010	-0.27*** $\pm$ 0.070	-3.89	4.23	4.18	0.979
Steers	2448	0.70*** $\pm$ 0.003	-0.005 $\pm$ 0.060	-5.67	5.69	5.69	0.977
Bulls	306	0.72*** $\pm$ 0.005	-1.37*** $\pm$ 0.39	-2.24	3.62	3.55	0.994

Note:  $b_1 \pm SE$  = partial regression coefficient of carcass weight  $\pm$  standard error.

$b_2 \pm SE$  = partial regression coefficient of fat cover  $\pm$  standard error.

$c$  = intercept.

RSD (1) = residual standard deviation for carcass weight alone.

RSD (2) = residual standard deviation for carcass weight and fat cover.

R = multiple correlation coefficient.

TABLE 3: MEAN WEIGHTS (kg) OF CARCASSES AND EDIBLE MEAT, MEAN FAT COVER (mm) AND PERCENTAGE OF EDIBLE MEAT OF HEIFERS, STEERS AND BULLS (ADJUSTED FOR BREED EFFECTS)

	Heifers	Steers	Bulls	SD	Steer-Heifer	Bull-Steer
No. of carcasses	671	2448	306	—	—	—
Carcass weight	174	190	192	32	16.7 *** $\pm$ 1.55	2.0 $\pm$ 2.14
Fat cover	3.3	2.6	1.2	1.0	-0.74*** $\pm$ 0.09	-1.42 *** $\pm$ 0.13
Edible meat weight	116	128	138	23	12.1 *** $\pm$ 1.10	9.6*** $\pm$ 1.51
(adjusted for carcass weight and fat cover)	(127)	(127)	(135)	(4.9)	(0.22 $\pm$ 0.25)	(7.82*** $\pm$ 0.33)
% edible meat	66.7	67.2	71.9	2.6	0.50*** $\pm$ 0.13	4.63*** $\pm$ 0.17
(adjusted for carcass weight)	(67.0)	(67.2)	(71.6)	(2.6)	(0.16 $\pm$ 0.13)	(4.43*** $\pm$ 0.17)

recorded for heifer and steer carcasses with European beef breed sires (especially the Limousin) and relatively low yields for dairy breeds — e.g., J × J. A range of 4.7% in meat yield existed between breeds of steer carcasses. Breed differences in meat yield of bull carcasses were not significant.

Multiple range tests suggested establishment of breed and sex groups. These are recorded in Table 4, together with appropriate regressions.

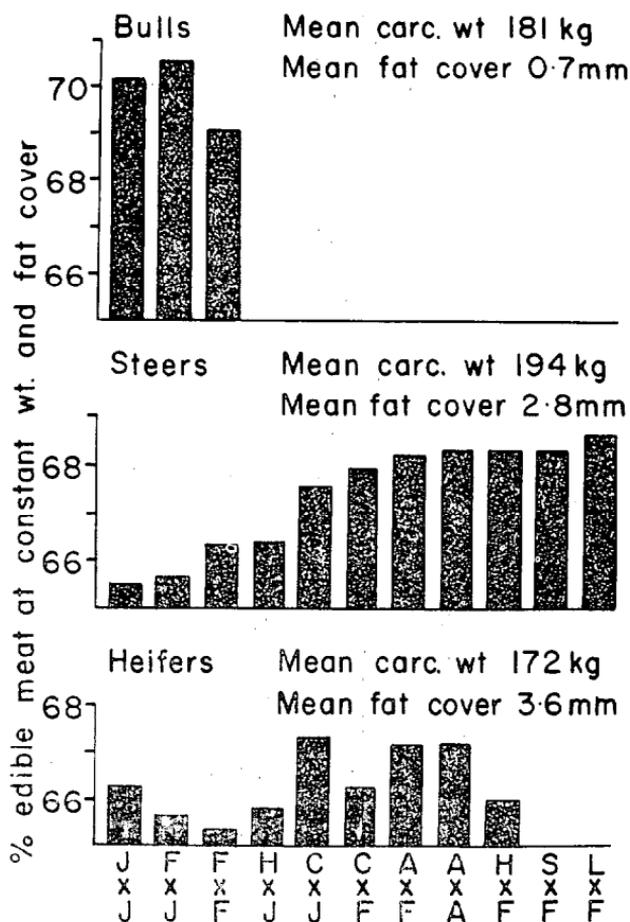


FIG. 2. Yields of edible meat at constant carcass weight and fat cover (within sex) classified by breeds and crosses.

TABLE 4: MULTIPLE REGRESSION EQUATIONS FOR BREED GROUPS RELATING EDIBLE MEAT WEIGHTS (kg) TO CARCASS WEIGHT (kg) AND FAT COVER (mm)

Breed	No.			$b_1 \pm SE$	$b_2 \pm SE$	<i>c</i>			RSD	R
	Heifers	Steers	Bulls			Heifers	Steers	Bulls		
1	267	1334	—			—6.4	—7.11	—		
2	404	1034	—	0.70*** $\pm$ 0.03	—0.24*** $\pm$ 0.04	—4.1	—2.99	—	4.78	0.982
3	—	80	—			—	0.12	—		
4	—	—	306	0.72*** $\pm$ 0.01	—1.37*** $\pm$ 0.39	—	—	—2.24	3.55	0.994

1 = J  $\times$  J, F  $\times$  J, F  $\times$  F, H  $\times$  J

2 = C  $\times$  J, C  $\times$  F, A  $\times$  F, A  $\times$  A, H  $\times$  F, S  $\times$  F

3 = L  $\times$  F

4 = J  $\times$  J, F  $\times$  J, F  $\times$  F

## DISCUSSION

The sample contained a high proportion of light weight, lean carcasses compared with the national average carcass weight (NZMPB, 1975) or the Auckland region average (Nicol, 1976). This reflects the nature of several of the experiments from which the data were drawn, and is probably the reason for the inclusion of fat cover measurement in the regression equations failing to improve greatly the accuracy of meat yield prediction. Additional data are required from heavier, fatter animals. The residual standard deviations (Tables 2 and 4) of the regressions relating edible meat to carcass weight and fat cover are similar to the value of 5.2 kg reported earlier (Everitt and Evans, 1970).

Carcass weight, without internal kidney and channel fat, had an overwhelming influence on edible meat yield. This agrees with other work (Everitt, 1964; Bass and Ackerley, 1975) and supports Nicol's (1976) advocacy of a continuous carcass weight range for producer payment purposes.

The present results support Everitt and Evans (1970) who found no difference in meat yield between steers and heifers compared at constant carcass weight and fat cover. Despite the recommendations of the Meat Export Grades Investigating Committee (MacIntyre, 1974) to the New Zealand Meat Producers Board, a price premium for steers continues to operate. The Canadian system of beef carcass grading (Locking, 1976) does not distinguish between sexes except for mature bulls and cows.

The yield advantage of bulls in this, and other studies (Preston and Willis, 1970), appears to justify an even greater price premium for bulls over manufacturing grade steers and heifers than exists at present.

The late-maturing breeds and crosses, especially those with Limousin sires, had an advantage in terms of meat yield compared with animals of dairy origin, such as the  $J \times J$  and  $F \times F$ .

The regression equations provided for the breed groups, relating edible meat to carcass weight and fat cover, may encourage greater precision in the beef cattle competitions discussed by Nicol and Todhunter (1976). Comparison of the residual standard deviations for the breed-sex group equations (Table 4) with those recorded in Table 2 suggests, however, that the improvement to be gained in such work is unlikely to be substantial.

Harrington (1976) has indicated the substantial breed improvement benefits deriving from the scientifically-based beef carcass classification scheme operated by the Meat and Livestock Commission in the United Kingdom. As an example of the use of the

equations to predict the boneless meat yield of a line of steers of the same breed, it follows from the prediction error for a single carcass (Table 2) that the true value will be estimated with an accuracy (95% confidence limits) of approximately  $\pm 3.3$ ,  $\pm 1.5$  and  $\pm 1.1$  kg for lines of 10, 50 and 100 animals, respectively.

Finally, it is hoped that studies of factors affecting edible meat content of carcasses will be continued and that those responsible for carcass classification and grading, and producer payment, will take notice of the results. As Preston and Willis (1970) aptly commented, "With all its imprecision and variability edible meat must be our yardstick since this is what is bought and sold. . . ."

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#### REFERENCES

- B.A.E., 1976. Developments in beef carcass classification. *Beef Res. Rep. No. 19*, 80 pp. Australian Bureau of Agricultural Economics, Canberra.
- Bass, J. J.; Ackerley, L. R., 1975. *N.Z. Jl exp. Agric.*, 3: 169.
- Charles, D. D.; Johnson, E. R., 1976. *J. anim. Sci.*, 42: 332.
- Everitt, G. C., 1961. *Inst. Meat Bull.*, No. 32: 2.
- 1964. Beef carcass appraisal by jointing. In *Carcass Composition and Appraisal of Meat Animals* (ed. D. E. Tribe). Section 16: 1-12. C.S.I.R.O., Melbourne.
- 1972. *Proc. Ruakura Fmrs' Conf. Week*: 77.
- Everitt, G. C.; Evans, S. T., 1969. *Proc. Ruakura Fmrs' Conf. Week*: 117.
- ; ——— 1970. *Proc. N.Z. Soc. Anim. Prod.*, 30: 144.
- Everitt, G. C.; Evans, S. T.; Franks, M., 1969. *Proc. N.Z. Soc. Anim. Prod.*, 29: 147.
- Everitt, G. C.; Jury, K. E.; Ward, J. D. B., 1975. *Proc. N.Z. Soc. Anim. Prod.*, 35: 119.
- ; ———; ——— 1976. *Proc. N.Z. Soc. Anim. Prod.*, 36: 222.
- Everitt, G. C.; Ward, J. D. B., 1974. *Proc. Ruakura Fmrs' Conf. Week*: 81.
- Harrington, G., 1976. *Proc. Carcase Classification Symposium, Adelaide*, Aust. Meat Bd, Section B2: 1-17.
- Hight, G. K.; Everitt, G. C.; Jury, K. E., 1973. *N.Z. Jl agric. Res.*, 16: 519.
- Locking, G. L., 1976. *Proc. Carcase Classification Symposium, Adelaide*, Aust. Meat Bd, Section B3: 1-16.
- Luckock, C. R., 1976. *Proc. Carcase Classification Symposium, Adelaide*, Aust. Meat Bd, Section B7: 1-18.

- Nicol, A. M., 1976. *Proc. Carcase Classification Symposium, Adelaide*, Aust. Meat Bd, Section B4: 1-11.
- Nicol, A. M.; Todhunter, R. C., 1976. *Proc. N.Z. Soc. Anim. Prod.*, 36: 204.
- MacIntyre, D., 1974. *Report of Meat Export Grades Investigating Committee* (D. MacIntyre, Chairman). N.Z. Meat Producers Board, Wellington, 86 pp.
- NZMPB, 1975. *53rd Ann. Rep.*, p. 16. N.Z. Meat Producers Board, Wellington.
- Preston, T. R.; Willis, M. B., 1970. *Intensive Beef Production*. Pergamon, Oxford.
- Ryan, P. O., 1976. *Proc. Carcase Classification Symposium, Adelaide*, Aust. Meat Bd, Section B5: 1-5.