The stability of the relationship between subcutaneous fat percent in the rack and the side for Southdown ram carcasses

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ABSTRACT

Two experiments, involving a total 78 Southdown rams from high- and low- backfat lines, were carried out to examine the relationship between subcutaneous fat percent of a rack cut and subcutaneous fat percent of the whole carcass side.

A simple regression was as effective as multiple regressions for 30 carcasses (Group 1), but for each equation there was a significant selection-line effect on the intercept. When the usual direct regression coefficient was replaced by an inverse or a geometric coefficient, the selection line effect was not significant.

The 3 prediction equations were evaluated by comparing predicted side subcutaneous fat percent with actual values for a separate lot of 48 ram carcasses (Group 2). The correlation between predicted and actual values was high, but the selection-line effect was significant for all 3 equations. These results serve to emphasise that even within a breed and sex, and for relations with high correlations, there may be problems with the stability of the prediction equations. This could introduce a bias into conclusions.

Keywords Southdown, rack cut, subcutaneous fat, genetic line, sample cut.

INTRODUCTION

The prediction of carcass composition from the composition of sample cuts is widely used because of the considerable savings in time and costs. Sample cuts in the rib region have proved particularly popular because of their accuracy and relatively small size (Hankins, 1947; Barton and Kirton, 1958; Field *et al.*, 1963; Timon and Bichard, 1965; Kempster *et al.*, 1976, 1986; Hanrahan *et al.*, 1978). There are however, several reports of relationships between the composition of the sample and the whole being significantly influenced by factors such as breed of animal (Hanrahan *et al.*, 1978; Kempster *et al.*, 1976). Kempster *et al.*, (1982) have described such relationships as being unstable, and have pointed out that their existence could lead to biased conclusions with regard to the size and nature of breed effects on fatness or other composition characteristics. Gill (1987) noted that the prediction of carcass composition from other carcass measurements does not always fulfil the requirement of regression theory that the independant variable (sample-cut composition in this case) be measured without error. He suggested that biases may be reduced by replacing the *direct* regression coefficient with either the *inverse* coefficient, in cases where the causation is opposite to that usually required for regression, or by a *geometric* coefficient in cases where there is no clear direction of causation.

In the present paper an assessment is made of the extent to which the form of the regression equation influences the stability of the relationship between subcutaneous fat percent (SCF%) in a rack cut and SCF% in the whole side for 2 selection lines of Southdown sheep.

MATERIALS AND METHODS

Southdown rams from the Massey University high- and low-backfat selection lines (Purchas *et al.*, 1982) were slaughtered between the ages of 15 to 17 months. The left side of each carcass was dissected into muscle, bone, subcutaneous fat, and intermuscular fat, as was a 5-rib rack cut (ribs 8 to 12) from both sides. Details of the anatomical boundaries of the rack cut are illustrated in Fig. 1. Errors in splitting the vertebral column were avoided by including the whole column in the side to be dissected (Brown and Williams, 1979).

Linear regression procedures were used to establish relationships between SCF% in the rack and SCF% in the side for a group of 30 carcasses (Group 1). These relationships were evaluated by applying them to a second group of 48 similar carcasses (Group 2).

Procedures given by Gill (1987) were used to derive equations incorporating inverse and geometric regression coefficients as outlined below.

If S = side SCF%
and R = rack SCF%

Then the *direct* prediction equation is

$$S_d o = a_d + (b_{S.R})R$$

the *inverse* prediction equation is

$$S_i = -a_i/b_{R.S} + (1/b_{R.S})R$$

and the *geometric* prediction equation is

$$S_g = \overline{S} + b_g(R-\overline{R})$$

Where $a_d = \overline{S} - (b_{S.R.})\overline{R}$

$a_i = \overline{R} - (b_{R.S.})\overline{S}$

$b_{S.R.}$ = regression of side on rack SCF%

$b_{R.S.}$ = regression of rack on side SCF%

and b_g = geometric mean of $b_{S.R.}$ and $b_{R.S.}$

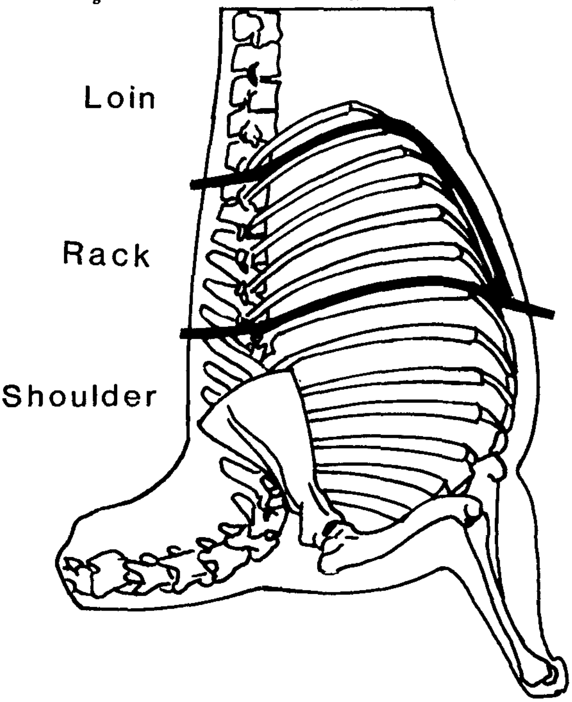

FIG. 1 Diagram showing the position of the rack cut. This cut was removed from the carcass by first cutting hard against the caudal edge of rib 7 and then sawing through the vertebral column. The second cut was made through the cartilage disc separating ribs 12 and 13 and then along the caudal edge of rib 12 and its costal cartilage until the first cut was met.

RESULTS

Table 1 presents the results of regression analysis for the Group 1 carcasses. These indicated that the simple linear regression of side SCF% on rack SCF% was as effective as several forms of multiple regression equation, including 1 containing a quadratic component. Table 1 also shows that for all the regression models there was a significant selection-line effect. This effect, which was on the intercepts rather than the slopes of the relationships, was such that at a given rack SCF% the predicted SCF% of the whole side was greater for the high-backfat line than for the low-backfat line (Fig. 2).

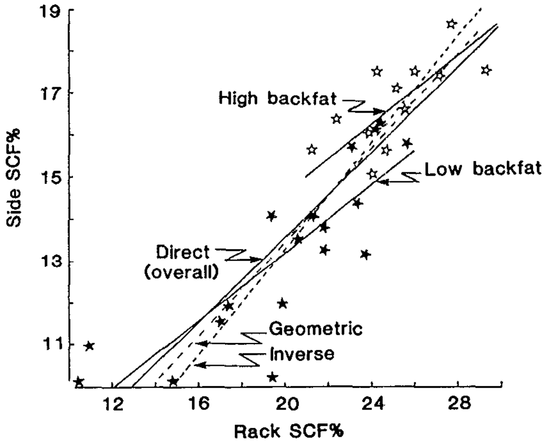

FIG. 2 Regression lines relating rack subcutaneous fat percent (SCF%) to side SCF% for high-backfat and low-backfat Southdown ram carcasses. Regression lines are shown over the appropriate range for the high- and low-backfat selection lines. The direct, inverse, and geometric regression lines are also included.

The use of prediction equations containing the inverse or geometric coefficients (Fig. 2) indicated that very similar mean predicted side SCF% values were obtained, and that the same correlations with actual values resulted (Table 2). However, the 3 equations differed in that the selection line effect on the difference between actual and predicted values

TABLE 1 A comparison of 4 prediction equations to estimate the side subcutaneous fat percent (SCF%) from side weight (kg), rack subcutaneous fat weight (SCF kg) and rack SCF% for the 30 carcasses in Group 1.

Independent variable (s)	Intercept	Regression coefficient	R^2 (%)	RSD (%)	Selection - line effect
Rack SCF%	5.78	0.40	86	0.97	**
Rack SCF%	-0.68	0.39	88	0.90	***
+ side kg		0.50			
Rack SCF kg	6.93	23.44	86	0.98	**
+ side kg		0.04			
Rack SCF%	9.01	0.01	86	0.96	**
+ (Rack SCF%)^2		0.03			

was significant only when the direct coefficient was used (Table 2). Mean differences between the actual and predicted values were similar for the 3 equations.

When the prediction equations developed from the Group 1 carcasses were applied to the 48 carcasses of Group 2, similar mean predicted side SCF% values were obtained for the 3 equations, and correlations with actual values were the same (Table 3).

Analysis of the differences between predicted values (using equations based on Group 1 carcasses) and actual values for Group 2 carcasses again revealed significant line effects together with positive correlations between the difference and actual values (Table 3). This effect was least when the inverse equation was used, but in all cases some bias existed, such that with increasing carcass fatness the tendency to overestimate side SCF% became more pronounced.

When equations based on the data of Group 2 were applied to Group 1 carcasses, similar results to those shown in Table 3 were obtained, but line effects on the difference between actual and predicted values were not significant.

TABLE 2 The accuracy of predicting actual side subcutaneous fat percent (SCF%) from rack SCF% for Group 1 carcasses using equations containing direct, inverse or geometric regression coefficients. Actual mean (± standard deviation) side SCF% = 14.56 (± 2.46).

	Equation		
	Direct	Inverse	Geometric
Intercept	3.63	0.91	2.45
Slope	0.50	0.62	0.55
Predicted side SCF%			
Mean	14.64	14.57	14.56
Standard deviation	2.22	2.79	2.45
Correlation[1] with actual	0.90	0.90	0.90
(Actual-predicted) side SCF%			
Mean	-0.08	-0.01	0.00
Standard deviation	1.09	1.22	1.11
Correlation[1] with actual	0.43	-0.01	0.24
Selection-line effect	*	NS	NS

[1] Simple correlation coefficient

TABLE 3 The accuracy of predicting actual side subcutaneous fat percent (SCF%) from rack SCF% for Group 2 carcasses using equations derived from data for Group 1 carcasses. Prediction equations containing direct, inverse or geometric regression coefficients are compared. Actual mean (± standard deviation) side SCF% for Group 2 carcasses = 17.77 (± 3.31).

	Equation		
	Direct	Inverse	Geometric
Predicted side SCF%			
Mean	16.86	17.31	17.00
Standard deviation	2.46	3.05	2.70
Correlation[1] with actual	0.95	0.95	0.95
(Actual-predicted) side SCF%			
Mean	0.92	0.46	0.78
Standard deviation	1.26	1.06	1.14
Correlation[1] with actual	0.78	0.40	0.65
Selection-line effect	***	*	***

[1] Simple correlation coefficient

DISCUSSION

The results presented in this paper serve to emphasise the potential risks associated with estimating carcass composition from sample-cut composition using prediction equations. In the present case the nature of the relationship was significantly different for rams from 2 genetic lines within the Southdown breed. Other workers have reported similar relationships to be significantly different between the Texel and other breeds of sheep (Kempster *et al.*, 1982), between Finnish Landrace and Galway breeds of sheep (Hanrahan *et al.*, 1978), and between lambs of different sexes (Carpenter *et al.*, 1969).

The use of modified forms of regression equations incorporating inverse or geometric regression coefficients (Gill, 1987), was to some extent effective in overcoming the significant line effects, with the inverse equation being the best in this respect when it was applied to either the original data set or to a separate set of data. However, although it may be possible to reduce the level of bias by the use of statistical methods such as those described by Gill (1987), or others (Mattfeldt and Mall, 1987), there is no way of knowing whether bias has in fact been avoided when only the predictor has been measured. For this reason it may very often be more appropriate to report the composition of sample cuts as such, rather than to report estimates of side or carcass composition based on them.

For the data set considered here there was little advantage in using multiple regression equations to predict side composition. This contrasts with the report of Williams (1976) in which the inclusion of side weight or cut weight as a second independent variable was shown to lead to lower residual standard deviation values for beef.

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