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Relationship between skin area, carcase weight and fat score DAV.087

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CONTENTS

EXECUTIVE SUMMARY

Skin area is commonly used as a specification for the trading of sheepskins. However, there is a dearth of published information relating skin area to its carcase of origin.

Consumer research has indicated a strong preference for cuts from larger carcases which are also known to be more economical to process. Additionally, manufacturers prefer skins of larger area to reduce cost inefficiencies and to extend their product range.

The ability to predict skin area from carcase measurements should allow skin buyers/processors to purchase skin lots from abattoirs with more confidence and to offer prices commensurate with expected yield of skin area. Further, the use of electronic trading of livestock by description, through service providers such as CALM, is increasing in popularity. The ability to predict average skin area of sale lots from the descriptions provided is likely to be of interest to traders/processors who use the electronic marketing system.

The objectives of this study were:

1. To examine the relationship between the carcase parameters of hot weight and fatness with skin area for sheep and lambs
2. To develop formulae to predict skin area from carcase parameters
3. To investigate the relationship between skin area and the commercial practices of salting, trimming and skin length measurement

A total of 888 carcases and skins were examined (204 sheep and 684 lambs). There was a wide variation in the green (ie fresh) skin area (GSA) at any given hot carcase weight (HCW), the variation being larger for sheep than for lambs.

Three formulae were derived to predict average GSA from HCW, within the normal range, with 95% confidence (ie the equations are likely to be correct 95 times out of 100). The formulae are:

Lambs:	Average GSA (dm^2) = (40.8 + 2.5 x HCW (kg)) ± 0.5
Sheep:	Average GSA (dm^2) = (62.6 + 2.0 x HCW (kg)) ± 1.3
Ovine:	Average GSA (dm^2) = (34.4 + 3.0 x HCW (kg)) ± 0.6

The addition of carcase fatness provided only a marginal increase in the accuracy of the prediction.

Skin salting for preservation reduced skin area, with the average reduction reaching a maximum of 15% within 2 weeks, with some skins suffering a reduction of 22%.

Trimming of salted skins destined for wool-on tanneries resulted in a further reduction in area by 5%, with some skins being reduced by as much as 10%.

Skin length was a less accurate predictor of skin area than HCW. However, in the absence of carcase data, its use to predict average skin area is likely to continue.

LIST OF TABLES AND FIGURES

TABLES

FIGURES

1. INTRODUCTION

Skin area is used as a major specification in the trading of processed sheepskins. However, there is little published information on the relationship between skin area and the carcase the skin originated from.

It is well known that there are cost efficiencies in the processing of larger carcases and skins. Manufacturers who use processed sheepskins prefer skins which provide them with more "workable" or "cuttable" area (ie larger skins). Additionally, market research has shown a strong consumer preference for cuts of meat from large lambs.

Although production of larger sheep and lambs should benefit the industry as a whole, there has been some reluctance by producers to adopt management and breeding techniques which would allow them to produce larger stock. One of the main factors for this reluctance has been a lack of financial incentive provided by buyers who have been accustomed to trading in smaller stock. A clear demonstration of the additional skin area which may be obtained from larger sheep and lambs would help to persuade buyers that, as well as satisfying consumer demand, it is worth paying more for the skins from larger stock.

The ability to predict skin area from carcase measurements (which may be estimated from the live animal) would allow skin buyers/processors to purchase with more confidence and this should then be reflected in the price. A knowledge of these relationships would also enable future development of some preliminary size grading at the abattoir as well as allow producers to gain a more thorough understanding of their product.

Further, the use of electronic trading of livestock by description, through service providers such as CALM, is continuing to become more popular. The ability to predict average skin area of sale lots from the descriptions provided by qualified livestock assessors may be of interest to purchasers who wish to trade or process the skins.

This project examined the relationship between the commonly measured carcase parameters of hot weight and fatness (as measured at the GR site) and green (ie fresh) skin area. The relationship was then used to develop formulae to predict the surface area of sheepskins from carcase parameters.

Additionally, the relationship between skin area and the common commercial practices of skin preservation (by salting), skin length measurement and skin trimming were investigated.

2. METHODS

2.1 Carcase and Green Skin Measurements

All measurements were carried out on the premises of the one abattoir with carcases and skins being treated in exactly the same way as occurs on a day-to-day basis at the works.

Randomly selected carcases of sheep and lambs and their skins were tagged on the slaughter floor prior to removal of the skin. Hot carcase weights (AUS-Meat Standard trim) were recorded for each of the identified carcases.

Carcase fatness was measured as tissue depth (mm) at the GR site on a sub-sample of 305 ewe lambs which were obtained from the Central Progeny Test Program at Rutherglen Research Institute. The lambs were sired by 20 different sires which included Poll Dorset, Suffolk, White Suffolk, Hampshire Down and Wiltshire Horn. Additionally, skins from this sample were measured for length (cm) from neck to tail.

Skins were removed by a mechanical puller following a "work up" which did not remove a strap of skin from the brisket area. Skins were then given a rudimentary trim - headpieces and cheeks removed and the sleeve in the hind legs slit - prior to transport to the skin shed.

The area of each tagged green skin was measured in square decimetres and recorded within an hour after slaughter using an Ellwood area measurement table (as commonly used by wool-on tanners). Care was taken to ensure that minimum stretching of the green skin occurred and that overlap of wool was not included in area measurements.

Carcase and skin measurements were matched by tag number prior to statistical analysis.

2.2 Salted Skin Measurements

A sub-sample of 92 tagged skins was measured for area two hours, 24 hours and two weeks after normal commercial drum salting. The amount of shrinkage at each time interval was then calculated as a percentage of green skin area.

Length of the salted skins was measured, two weeks after drum salting, from neck to tail as per normal commercial grading practice. Skin length was then related to salted skin area.

An additional sub-sample of 50 salted lambskins, destined for wool-on tanning, was randomly selected and measured for area prior to and following trimming. The level of trim was that commercially used by skin merchants who supply wool-on tanners ie a "tidying" trim on the legs (any remaining shanks removed) as well as removal of heavy deposits of cod/udder fat from the flanks.

2.3 Statistical Analyses

Data were analysed for regression line of best fit using the Systat computer package. The 95% confidence interval of the mean and individual predictions were calculated and data points along with the predicted mean and individual ranges were plotted.

Due to the skin trade's continued use of square feet as an area measurement, areas are generally presented in both square decimetres and square feet; the conversion factor used was: 1 sq ft = 9.29 dm^2

3. RESULTS AND DISCUSSION

3.1 Carcase and Green Skin Relationships

3.1.1 Green Skin Area and Hot Carcase Weight

Data for a total of 888 carcases and skins were collected (204 sheep and 684 lambs). Summaries of the data are presented in Tables 1, 2 and 3.

Table 1. **Statistics summary for 684 lambs**

	Mean	Minimum	Maximum	Std. Deviation
Hot Carcase Weight (kg)	17.9	9.9	29.8	3.27
Green Skin Area (dm^2)	85.5	60.2	122.6	10.14

The lambs sampled in the survey varied widely in breeding and represented both "old" (ie weaned/shorn lambs) and "sucker" lambs. Breeds represented were predominantly second-cross (Dorset x Border Leicester/Merino), but included carpetwool types, Merinos and first-cross (eg Dorset x Merino).

Table 2. **Statistics summary for 204 sheep**

	Mean	Minimum	Maximum	Std. Deviation
Hot Carcase Weight (kg)	23.8	12.6	36.0	4.41
Green Skin Area (dm^2)	110.6	68.0	150.8	12.67

The sheep sampled in the survey also varied widely in breed (the majority being Merino), frame size, condition and wool length.

Table 3. **Statistics summary for all stock (sheep & lambs)**

	Mean	Minimum	Maximum	Std. Deviation
Hot Carcase Weight (kg)	19.9	9.9	36.0	4.35
Green Skin Area (dm^2)	94.9	60.2	150.8	15.10

Data for each group were analysed for a linear relationship using regression analysis with hot carcase weight (HCW) as the independent variable and green skin area (GSA) as the dependent variable.

Raw data points for lambs, sheep and all the stock, along with the 95% confidence interval of the mean and the 95% confidence prediction interval for an individual animal, are shown below in Figures 1, 2 and 3.

The linear regression prediction equation determined for lambs was:

$$GSA(dm^2) = 40.8 + 2.5 \times HCW(kg) \qquad \textbf{(Equation 1)}$$

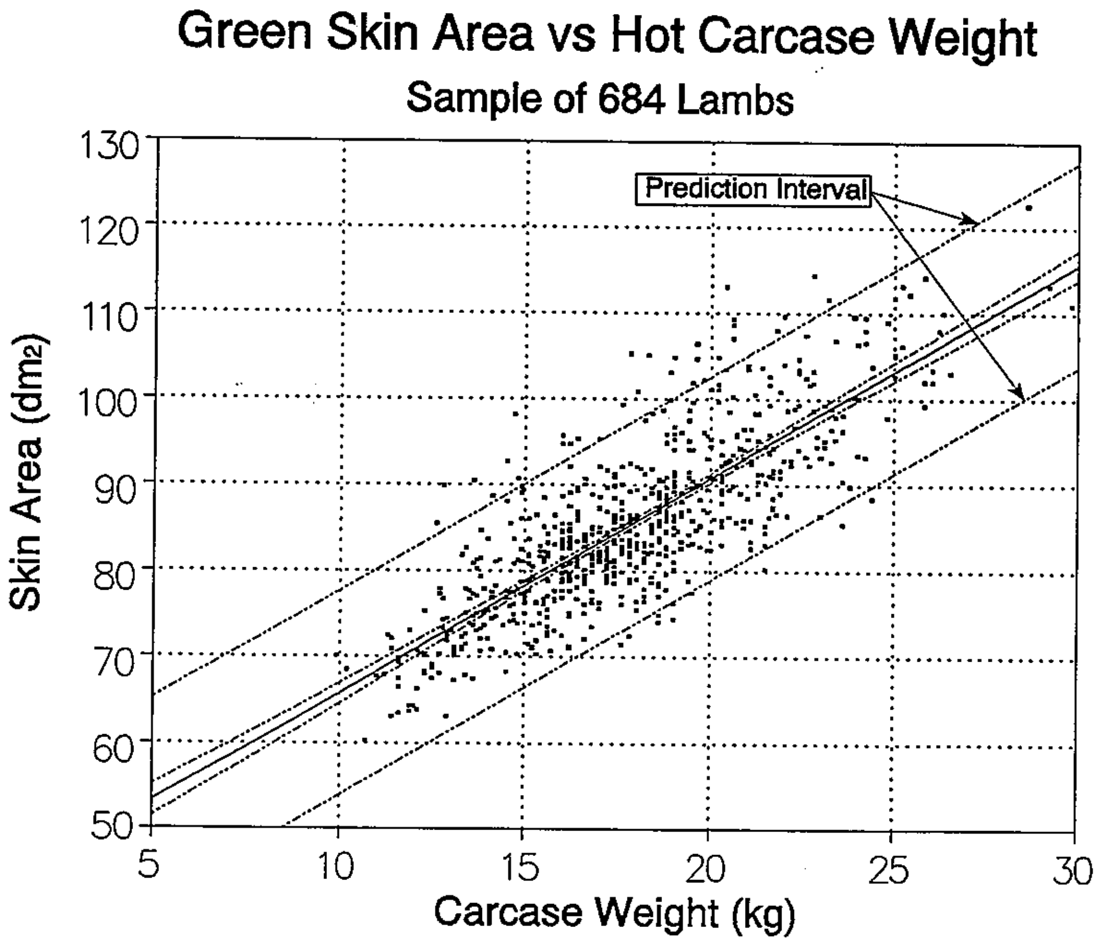
with a mean GSA range of ± 0.5 dm^2 and individual GSA range of ± 11.8 dm^2.

All coefficients were significant at the $P<0.1\%$ level. The correlation coefficient (r) for this relationship was 0.805, with 64.8% of the variation in GSA being attributed to HCW.

Analysis of individual lots demonstrated that the explanation of the variation in GSA by HCW ranged between 55% and 85%. This would be expected from observation of the lambs prior to slaughter; some lots obviously contained a mixture (ie different breeding or from different environments) while others originated from the one property and were relatively even.

The relationship above indicates that, on average, the GSA of a lamb will increase 2.5 dm^2 (0.27 sq ft) for each increase of 1 kg in HCW. This is of particular interest to producers and processors of the "Elite" lambs being grown for the export market. Elite lambs average about 24 kg of HCW which is approx. 7 kg heavier than the traditional trade lamb; Elite lambs, therefore, would have approx. 17.5 dm^2 (1.8 sq ft) more GSA. The larger skin area of Elite lambs should make them more attractive to processors of lamb leather and, if their wool is not too long (<7.5 cm), also to woolskin tanners.

Figure 1 **Line of best fit, mean and prediction intervals (95% confidence) for green skin area as a function of hot carcase weight for lambs**



The equation above predicts that the average GSA from lambs with a HCW of 17 kg is 83.3 ± 0.5 dm^2 (≈ 9 sq ft). While the predicted average GSA falls within a small range, the large variability in GSA between skins from lambs at the same HCW (see Figure 1) means that the predicted GSA for a skin from a 17 kg lamb will be between the much larger range of 71.5 - 95.1 dm^2 (7.7 - 10.2 sq ft).

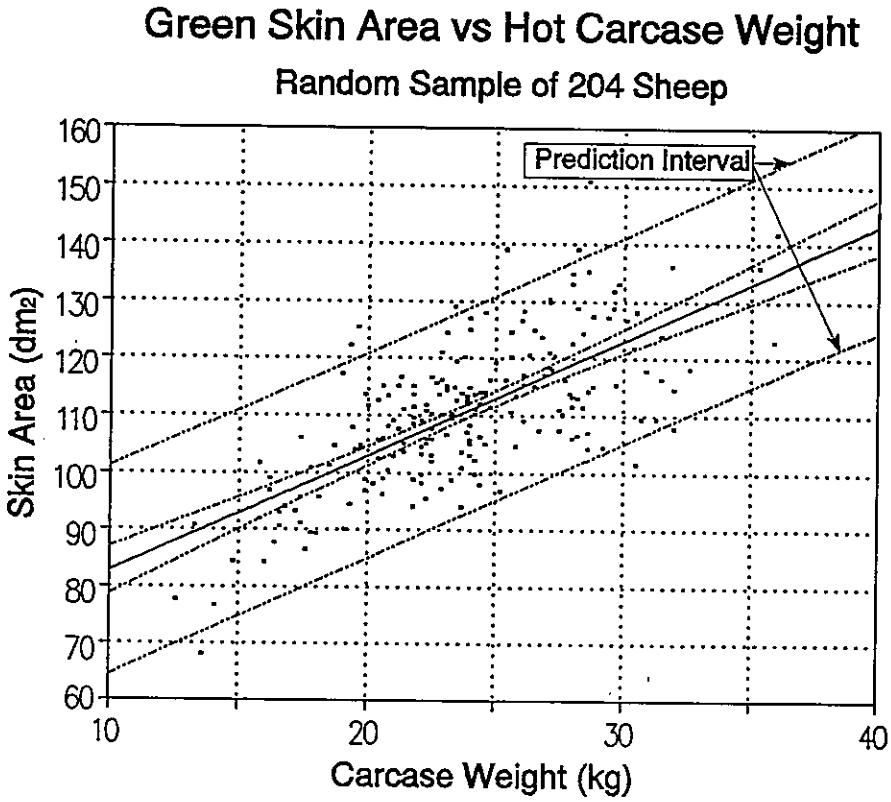
The linear regression prediction equation determined for sheep was:

$$GSA = 62.6 + 2.0 \times HCW \qquad \textbf{(Equation 2)}$$

with a mean GSA range of ± 1.3 dm^2 and individual GSA range of ± 17.9 dm^2.

All coefficients were significant at the P<0.1% level. The correlation coefficient for this relationship was 0.702, with 49.3% of the variation in GSA being attributed to HCW.

Figure 2 **Line of best fit, mean and prediction intervals (95% confidence) for green skin area as a function of hot carcase weight for sheep**



Equation 2 predicts that the mean GSA for sheep having HCW's of 28 kg will be 119.0 ± 1.7 dm^2 (12.8 ± 0.2 sq ft), with the GSA of individual sheep falling within a range of ± 17.9 dm^2 (± 1.9 sq ft) from the mean GSA.

The wider variation in GSA for sheep, as compared with lambs at any given HCW, may be due to the amount of wrinkle over the body and the amount of folding/wrinkle in the neck region. However, it was not possible to measure or score those attributes in this trial.

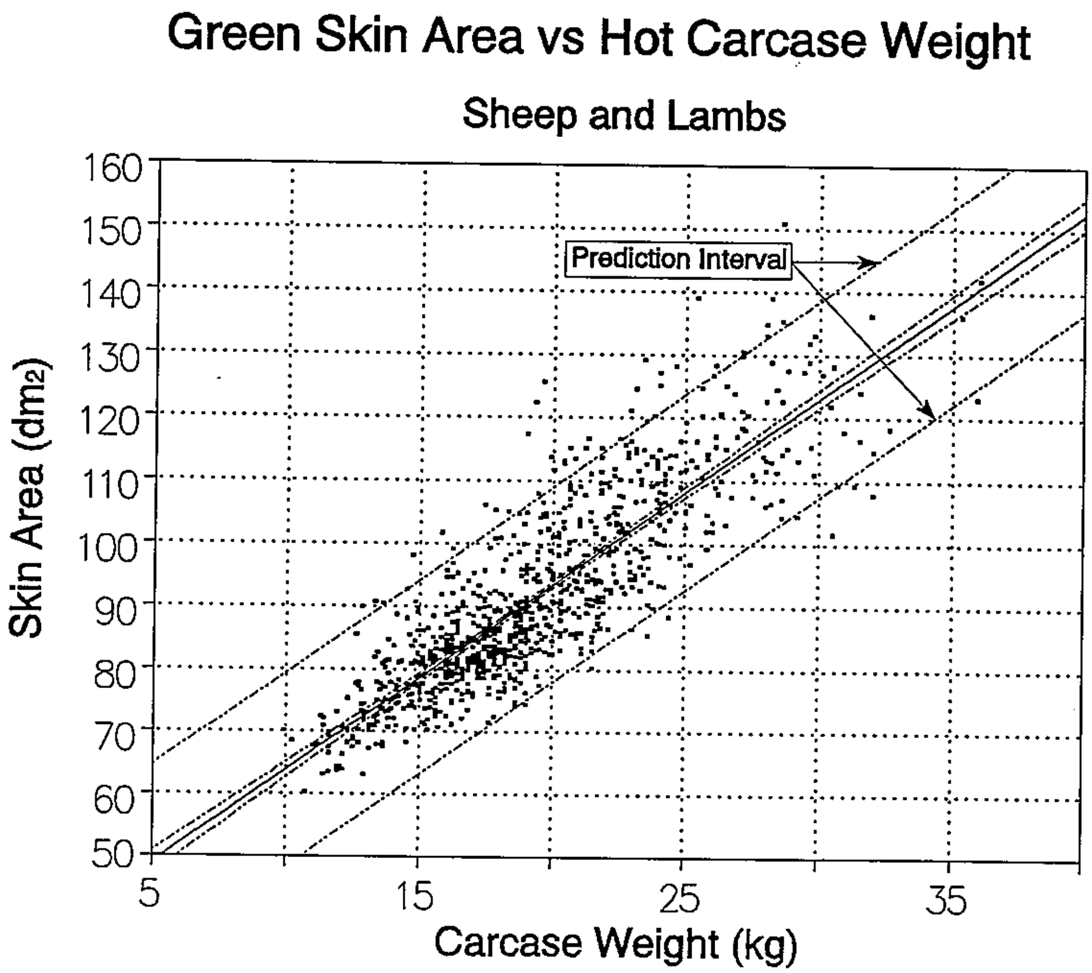
Another factor which could add to greater variation in GSA is that sheep have had the opportunity to reach their full mature size (and maximum GSA) and then to lose both weight and condition due to nutritional and/or health effects.

The linear regression prediction equation determined for all the stock surveyed was:

$$GSA = 34.4 + 3.0 \times HCW \qquad \textbf{(Equation 3)}$$

with a mean GSA range of ± 0.6 dm^2 and individual GSA range of ± 15.5 dm^2.

Figure 3 **Line of best fit, mean and prediction intervals (95% confidence) for green skin area as a function of hot carcase weight for all stock**



All coefficients were significant at the P<0.1% level. The correlation coefficient for this relationship was 0.853, with 72.6% of the variation in GSA being attributed to HCW.

Equation 3 predicts that the average GSA of lambs or sheep with a HCW of 17 kg will be between 84.0 and 85.2 dm^2, while GSA for individual skins will be between 69.1 and 100.1 dm^2.

A summary of the predicted values of GSA using the specific equations (Lambs = Eqn. 1; Sheep = Eqn. 2) and the combined equation (All Stock = Eqn. 3) is presented below in Table 4.

The figures presented in Table 4 indicate that the predicted mean and ranges for both mean and individual GSA is increased for lambs (and reduced for sheep) when Equation 3 is used for prediction, rather than the equation developed specifically from the lamb (or sheep) sample. This effect has occurred through combination of the samples - sheep, with their larger values of GSA and variability in GSA at any given HCW, have provided a weighting towards larger values of GSA with more variability. Conversely, the smaller values of GSA and variation for lambs have reduced the predicted values for sheep. Thus, for the most accurate predictions for GSA of sheep and lambs, the specific equations (Equations 1 and 2) should be used rather than the combined data equation (Equation 3).

Table 4. Predicted values of green skin area (GSA) for lambs and sheep using different predictive formulae.

	Lambs of 18 kg HCW		Sheep of 24 kg HCW	
	Equation 1	Equation 3	Equation 2	Equation 3
Mean GSA (dm^2)	85.8	87.6	111.0	105.3
Range of mean (dm^2)	± 0.5	± 0.5	± 1.3	± 0.8
Individual Range (dm^2)	± 11.8	± 15.5	± 17.9	± 15.5

3.1.2 Green Skin Area, Hot Carcase Weight, GR Depth and Green Skin Length

Carcase fatness, at the GR site, and green skin length (GSL) were measured on 305 lamb carcases in addition to HCW. The additional measurements were taken to test whether their inclusion would improve the accuracy and, if so, by how much. A summary of the sample statistics is presented in Table 5.

Table 5. Statistics for sample of 305 lambs which had additional carcase and skin measurements.

	Mean	Minimum	Maximum	Std. Deviation
Hot Carcase Weight (kg)	18.1	12.3	26.0	2.69
Green Skin Area (dm^2)	84.4	67.4	102.0	6.83
GR (mm)	10.8	2	24	3.92
Green Skin Length (cm)	107.6	91	124	5.60

The addition of GR tissue depth (mm) to the regression analysis resulted in only a 1% improvement in the explanation of variation in GSA, while the addition of GSL (cm) improved the explanation of variation in GSA by a further 6%.

The results presented in Table 6, along with the level of variation in GSA explained in Equations 4, 5 and 6, indicate that there is only a marginal gain in the accuracy of predicting GSA from HCW through the addition of measurements for GR and GSL. Therefore, the cost of obtaining measurements other than HCW is unlikely to be justified.

3.2 Reduction in Area Due to Trimming and Preservation by Salting

3.2.1 Preservation by Salting

The reduction in skin area due to preservation/dehydration by salting is presented in Table 7. A small sample of skins was remeasured eight weeks after salting; no difference was found between the two week and eight week measurements.

Table 7. Area reduction over time (using green skin area as a base) due to preservation by drum salting

Time after salting	2 hours	24 hours	2 weeks
Mean Shrinkage (%)	10.3	11.8	13.5
Minimum Shrinkage (%)	0.3	1.7	4.7
Maximum Shrinkage (%)	17.7	22.4	22.4
Standard Deviation (%)	3.5	4.5	4.0

These results indicate that the majority of shrinkage occurs immediately upon salting. The low levels of minimum shrinkage may, in part, be due to the fact that some drying (and therefore shrinkage) of skins occurred during the skin collection and GSA measurement periods. However, it is unlikely that any pre-measurement drying could fully account for the large variation in area reduction following salting. Other possible sources of the variation could be the amount of water consumed prior to slaughter, the general health/stress level of the stock, whether lambs had been weaned or not, and the subjective quality which the trade describes as "bloom" or "sappiness".

The data from Equations 1 and 2 and Table 7 can be combined to produce a table of predictions for average skin areas (green and salted) (table 8).

It is important to remember, however, that the predicted average skin area will have a range of at least ± 0.5 dm^2 (± 11.8 dm^2 for individual skins) for lambs and ± 1.3 dm^2 (± 17.9 dm^2 for individual skins) for sheep.

Table 8. **Mean skin area (in square decimetres & square feet) predicted from a range of hot carcase weights for lambs and sheep**

Stock type	Hot Weight	Predicted Green Skin Area		Predicted Salted Skin Area	
	(kg)	(dm^2)	(sq ft)	(dm^2)	(sq ft)
Lambs	12	70.8	7.6	61.2	6.6
	14	75.8	8.2	65.6	7.1
	16	80.8	8.7	69.9	7.5
	18	85.8	9.2	74.2	8.0
	20	90.8	9.8	78.5	8.4
	22	95.8	10.3	82.9	8.9
	24	100.8	10.9	87.2	9.4
	26	105.8	11.4	91.5	9.8
Sheep	16	94.8	10.2	82.0	8.8
	20	102.9	11.1	89.0	9.6
	24	111.0	11.9	96.0	10.3
	28	119.0	12.8	102.9	11.1
	32	127.1	13.7	110.0	11.8
	36	135.1	14.5	116.9	12.6

3.2.2 Area Reduction Due to Trimming

A summary of the results of a "tannery" trim given to 50 salted lamb skins is presented in Table 9. The trim is mainly used to provide tanners with a skin which has had areas of excess cod/udder fat and any loose strips removed.

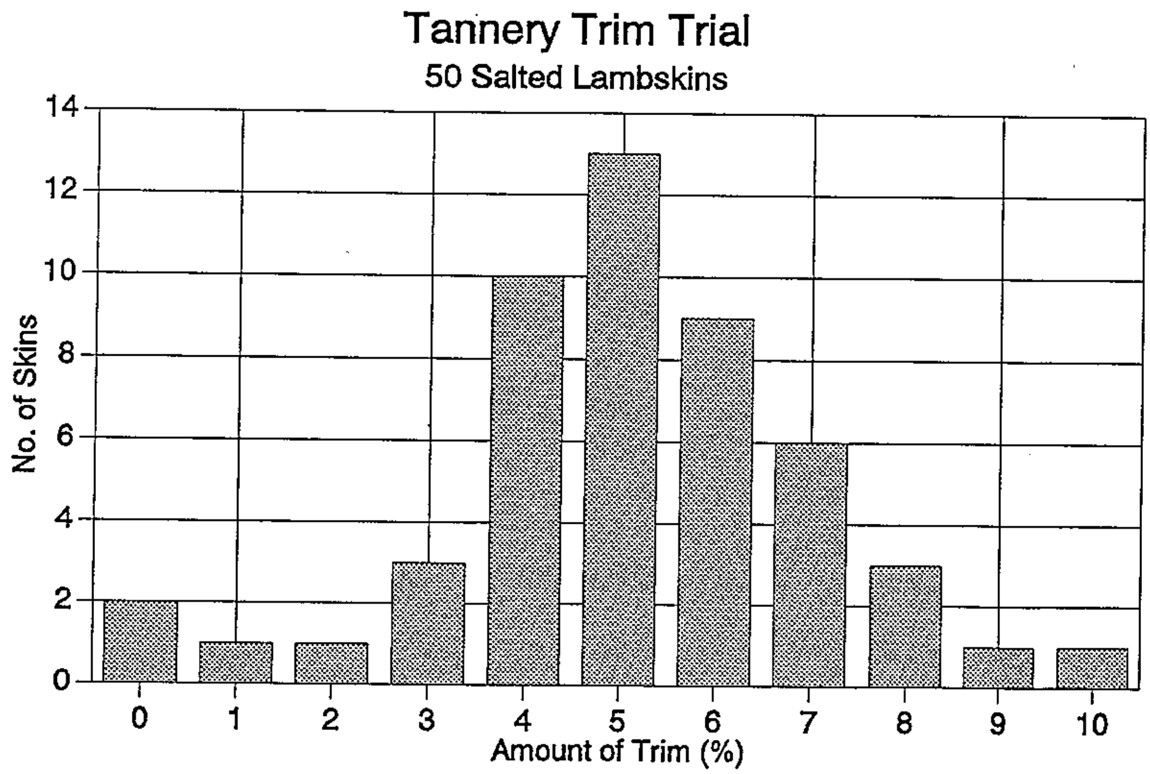
The average reduction in SSA due to trimming was 4.6%, with two skins receiving no measurable trim and two receiving more than 9% trim. The frequency distribution for the amount of trim given to the skins is presented in Figure 4.

While the results of this trial are useful in assessing the amount of trim carried out by merchants on lambskins suitable for tanning, it is likely that the skins will receive additional trimming at the tanners.

Table 9. Summary of results for tannery trim trial with 50 salted lambskins

		Average	Minimum	Maximum	Standard Deviation
Untrimmed Skin Area	dm^2	59.3	48.2	76.4	5.7
	sq ft	6.4	5.2	8.2	0.6
Trimmed Skin Area	dm^2	56.6	46.8	73.0	5.6
	sq ft	6.1	5.0	7.9	0.6
Amount of Trim	dm^2	2.7	0.0	5.6	1.2
	sq ft	0.3	0.0	0.6	0.1
Amount of Trim (%)		4.6	0.0	10.0	2.0

Figure 4. Frequency distribution for the amount of trim (as a percentage of total skin area) from lambskins destined for wool-on tanning



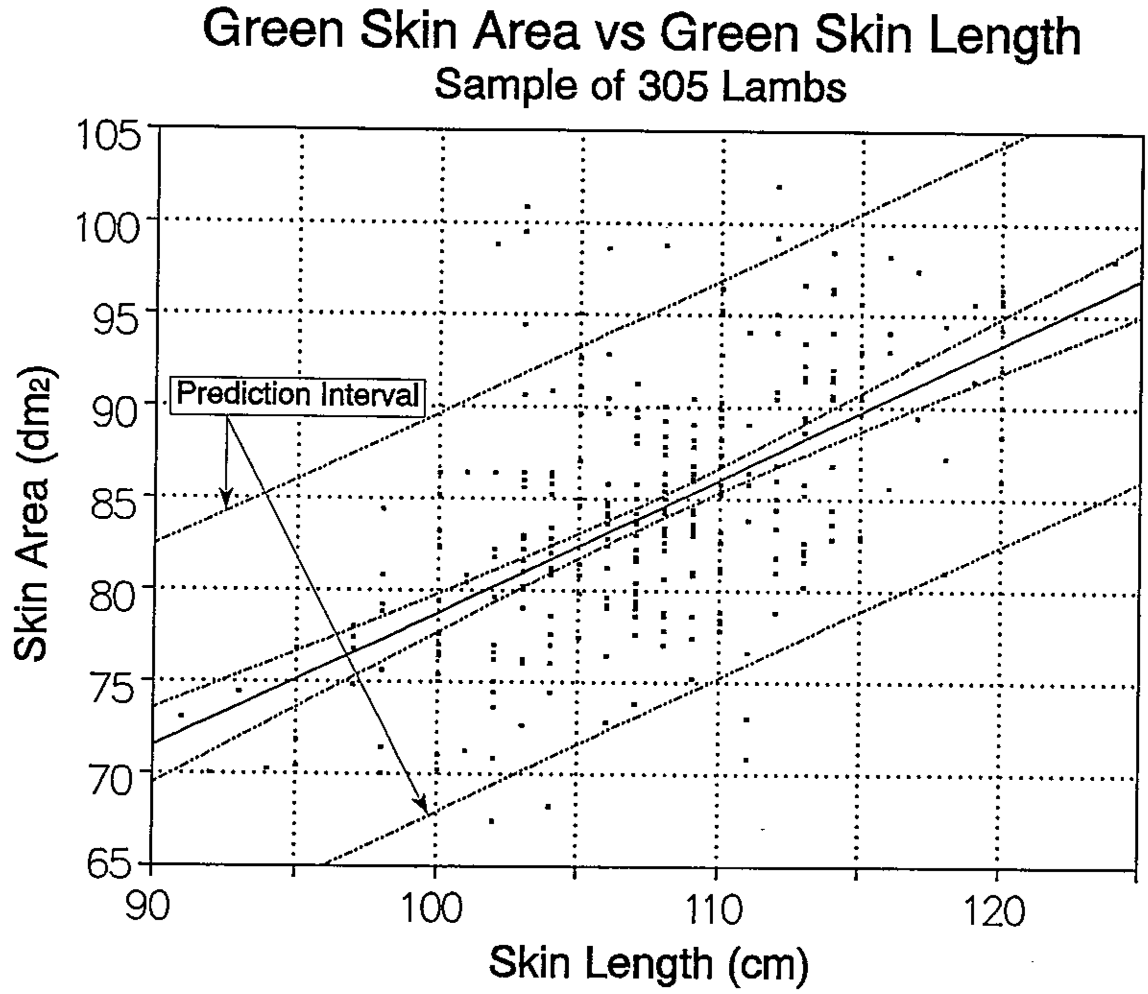
3.3 Skin Length as a Predictor of Skin Area

Skin length has been used as a specification for trading skins for many years. The following sections compare the use of skin length, measured from neck to tail, with HCW as a predictor of skin area.

3.3.1 Green Skins

The relationship between GSA and GSL for a sample of 305 lambs is presented in Figure 5.

Figure 5 **Line of best fit, mean and prediction intervals (95% confidence) for green skin area as a function of green skin length**



Regression analysis was used to determine the relationship between GSA, GSL and HCW . The predictive equations for GSA are presented below; all coefficients were significant at the $P<0.1\%$ level. The initial regression analysis for the effect of GSL on GSA included a constant; however, this was not significant at the $P<5\%$ level.

GSA = 0.784 x GSL (R^2 = 0.996) **(Equation 7)**
Predicted mean range: ± 0.6 dm^2 Predicted individual range: ± 10.8 dm^2

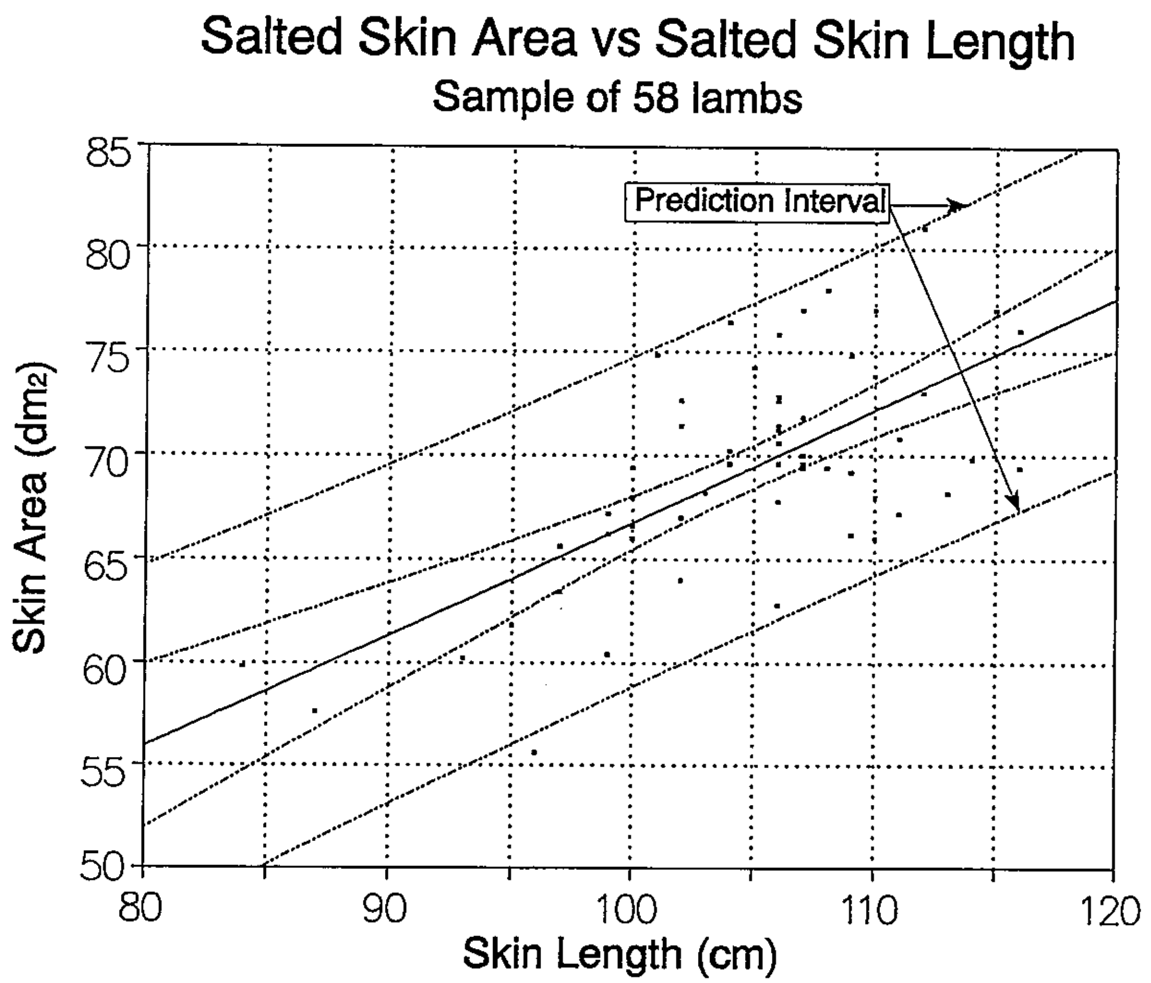
(from above) GSA = 48.5 + 2.0 x HCW (R^2 = 0.610) **(Equation 4)**
Predicted mean range: ± 0.5 dm^2 Predicted individual range: ± 8.5 dm^2

The results above indicate that HCW is a better predictor (on a linear basis) of GSA than GSL due to the lower range in predicted values.

3.3.2 Salted Skins

The relationship between salted skin area (SSA) and skin length (SSL) for a sample of 58 lambs is presented in Figure 6.

Figure 6 Line of best fit, mean and prediction intervals (95% confidence) for salted skin area as a function of salted skin length



The initial regression analysis for the effect of SSL on SSA included a constant; however, this was not significant at the P<5% level. The predictive equations for

SSA are presented below; all coefficients were significant at the $P<0.1\%$ level.

$SSA = 0.661 \times SSL$ ($R^2 = 0.997$) **(Equation 8)**
Correlation coefficient of SSA with SSL: 0.685
Predicted mean range: $\pm$ 1.2 dm^2 Predicted individual range: $\pm$ 8.0 dm^2

$SSA = 38.37 + 183 \times HCW$ ($R^2 = 0.489$) **(Equation 9)**
Correlation coefficient of SSA with HCW: 0.731
Predicted mean range: $\pm$ 1.5 dm^2 Predicted individual range: $\pm$ 7.8 dm^2

The differences in the ability of HCW and skin length to predict skin area were not as marked for salted skins as they were for green skins. This is probably due to the differences in the sample size used, a factor which was added to by the loss of skin identification tags during the salting process. However, the prediction interval coupled with the correlation coefficient, suggests that there is a better linear relationship between HCW and SSA than between SSL and SSA.

Additionally, the manual measurement of skin length is unlikely to be carried out with the same level of accuracy in the commercial environment, due to the pressures of throughput and variable trimming of the headpiece, as it was in this study; these factors would tend to further diminish the accuracy of skin length as a predictor for skin area.

However, it is unlikely to be practical to grade skins based on the HCW of the carcase of origin, and the use of skin length as a trading specification between merchants and tanners is likely to continue. Where it is feasible to install an automated system to measure skin length, it is also possible to measure area and thus the measurement of skin length would become redundant (unless required for certain markets).

4. CONCLUSIONS

This study has shown that there is a large variability in skin area both between and within lambs and sheep of similar carcase weight. The variability is likely to be further accentuated by differing methods of "work-up" (eg removal of a strap of skin in the brisket area) and levels of preliminary trim carried out at abattoirs.

Sheep demonstrate a greater variability in skin area than lambs at any given carcase weight due to factors such as the amount of body wrinkle, wrinkle and folds in the neck area, and the fact that they have had the opportunity to reach mature size.

Hot carcase weight can be used to predict average skin area within an acceptable tolerance. Due to the variability between lambs and sheep, it is recommended that separate predictive equations be used. However, where the use of separate equations is not feasible, a single equation may be used without significant loss of accuracy, although lamb skins will tend to have higher (and sheep lower) predicted areas than when separate equations are used. Nonetheless, the use of hot carcase weight to predict the skin area of individual sheep or lambs is too inaccurate to be of any commercial significance.

The addition of measurement of carcase fatness at the GR site provides only a slight improvement, if any, to the accuracy of the prediction and is unlikely to be warranted on a cost/benefit basis.

The salting of skins reduces skin area by about 14%, with the maximum reduction being achieved two weeks following salting.

The pre-sale trimming of salted lamb skins destined for wool-on tanning further reduces the skin area by 5%.

The use of skin length (tip of neck to top of tail) to predict skin area appears to be less accurate than the use of hot carcase weight.

Knowledge of the carcase weight averages and distribution of donor stock will provide skin merchants/processors with a good indication of average skin areas when purchasing lots from abattoirs. However, where the linkage of carcase data to skin lots is broken, it is likely that skin length measurements will continue to be used as predictors of skin area.

5. ACKNOWLEDGMENTS

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