RELATIONSHIP IN LAMBS BETWEEN LEAN WEIGHT ESTIMATED USING CT SCANNING AND VIASCAN®

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Abstract – Data from 171 Dorset Down x Coopworth lambs born in two years were included in this study. The difference between two machines; a computer tomography (CT) scanner and a VIAScan® system for their predictions of carcase lean weight in lamb carcases was examined. The CT scanner provided a significantly higher estimate of carcase lean weight. The rank correlation (0.88) between the CT scanner and the VIAScan® system for the prediction of carcase lean weight was significant, and there was a different ranking for carcase lean weight depending on which machine was used. This has important ramifications for the use of VIAScan® data in the New Zealand Sheep Improvement Ltd (SIL) genetic program and also on the payments to producers for carcase meat yield.

Key Words – Carcase meat yield, Computed tomography, Breeding

I. INTRODUCTION

More than 20 years ago studies were undertaken using ultrasound technologies to examine the accuracy with which measures of fat and muscle depth on live sheep could be used to estimate body composition [1]. This technology developed to provide real time measures of fat and muscle depth and these measures have been incorporated into sheep breeding programs in countries like New Zealand [2] and Australia [3]. In most terminal meat breeds, the breeding goal is to improve rate of live weight or carcase gain and carcase composition [4].

In New Zealand computer tomography (CT) has been used as a part of sheep breeding programs since 1995 [5] for breeds focused on meat production. CT scanning can provide very accurate in vivo estimates of body composition, in particular lean content [6] and there have been a number of studies which have examined the accuracy levels achievable [7].

More recently with the introduction of video image analysis (VIAScan®) of slaughtered lambs in some New Zealand abattoirs based on technology developed in Australia [8], there has been a move to use data collected from VIAScan® systems to generate estimated breeding values for the weight of lean meat within the hindleg, loin and shoulder primal cuts [2].

Heritability estimates for CT measured lean and fat of 0.40 and 0.50 have been derived [6], while heritability's of 0.20-0.53 for VIA based linear and area measurements have been published [9]. As such measurement obtained by either CT scanning or VIAScan® technology will contribute greatly to sheep breeding programs. The genetic improvement system in New Zealand, Sheep Improvement Ltd. (SIL) allows data from both systems to be entered for genetic evaluation, thereby increasing the accuracy of estimated breeding values and rates of selection for carcase composition. However, to date there has been no comparison made between a CT scanner and a VIAScan® system to examine how well their predictions of carcase composition align. This paper outlines an examination of the relationship between such predictions from the two machines and discusses the ramifications of the findings in relation to the use of data from the two systems in sheep breeding programs.

II. MATERIALS AND METHODS

In 2011 and 2012 Dorset Down (sire) x Coopworth (dam) mixed sex lambs (based at Lincoln University, New Zealand) were studied.
CT scanning was undertaken at seven anatomical reference sites: 7th Cervical, 5th Thoracic, 1st Lumbar, 6th Lumbar, 3rd Sacral, 2nd Caudal and Ischium vertebrae. Image analyses were performed on each resulting reference CT image to remove non-carcase portions of the images. Using STAR: Sheep Tomogram Analysis routine [10]. Carcase tissues weights and yields were calculated for each carcase region (shoulder, loin and hindquarter) based on the CT scans. The shoulder region was predicted from the 7th Cervical, or 1st Thoracic and 5th Thoracic, the loin from the1st Lumbar, and 6th Lumbar, and the hindquarter from the scans at 3rd Sacral, 2nd Caudal and Ischium vertebrae.

From the VIAScan® image data captured at slaughter, predictions of the percentage of lean in the three carcase regions using undisclosed company specific algorithms were provided. This data is identical to that provided to producers. The algorithms are based on measures of carcase dimensions and colour [8].

A joint analysis of the CT and VIAScan® weight results for lean in the hindleg, loin and shoulder across the animals for both years was undertaken using linear mixed model analysis, and fitted using the *asreml* package [11] under R [12]. The model included, as fixed effects, main and interaction effects for Scan (CT and VIA), Year (2011 and 2012) and Primal (hindleg, loin and shoulder). Animal × primal effects were included as independent random effects across animals and correlated within animals, with the variance-covariances allowed to differ across years. Random error, i.e. variation within each animal × primal, was allowed to differ for the two scan types across years. Spearman's rank correlation was determined within years for the association between lean determined by CT scanning and that predicted by VIAScan®.

III. RESULTS AND DISCUSSION

The average carcase weight of the lambs in 2011 and 2012 was 17.5 ± 2.6 and 13.5 ± 1.7 kg respectively. The proportion of the lean in the three primal regions of the carcase derived by either VIAScan® or CT relative to the carcase weight is given in Table 1 according to the year of birth.

Table 1 Lean per primal and total lean expressed as % of carcase weight according to year of birth from CT and VIAScan® scanning.

		CT scanning		
Year	Hind Leg (%)	Loin (%)	Shoulder (%)	Total lean (%)
2011	25.1	17.3	24.4	66.8
2012	28.4	18.8	21.1	68.3
		VIAScan®		
2011	22.6	14.8	16.8	54.2
2012	22.9	14.3	16.8	54.0

There was a significant interaction between drop (year of birth), primal and the scanning method ($P < 0.001$) for the weight of lean as outlined in Table 2. For each primal the weight of lean predicted by VIAScan® was significantly less on average than predicted by CT scanning, for both years. The sources of variation also differed significantly across the year drops, with more variation in 2011 drop lambs and greater variance associated with predictions from CT scanning.

The relationships between the expected VIAScan® total amount of lean given the CT scan total lean for 2011 and 2012 drops are given below;

Year 2011 (Model 1)
VIAScan® total lean equals -0.44 + 0.82 CT lean on average, with variance equal 0.76

Year 2012 (Model 2)
VIAScan® total lean equals 0.32 + 0.81 CT lean on average, with variance equal 0.47

The ranking of the lambs for total lean weight between measurement methods across the two years based on a spearman rank correlation was 0.88 which suggests that the order for estimated lean does change between machines and year did not impact on this with a correlation of 0.78 in 2011 and 0.79 in 2012.

Table 2 Predicted means, standard error (s.e.) and LSD rank for the weight of lean in primals as derived from either VIAScan® or CT scanning across 2 years.

Year of birth	Scanning method	Primal	Mean weight (s.e.) (kg)	LSD rank
2011	VIAScan®	Hindleg	3.88 (0.07)	g
		Loin	2.55 (0.06)	cd
		Shoulder	2.89 (0.07)	e
	CT	Hindleg	4.46 (0.08)	h
		Loin	3.06 (0.08)	e
		Shoulder	4.37 (0.08)	h
2012	VIAScan®	Hindleg	3.08 (0.07)	e
		Loin	1.93 (0.07)	a
		Shoulder	2.27 (0.07)	b
	CT	Hindleg	3.59 (0.08)	f
		Loin	2.36 (0.08)	bc
		Shoulder	2.65 (0.08)	d

Further, in both years there is only a 48% chance that VIAScan® will rank the same lambs as having the largest total lean as CT, based on Monte Carlo simulations. There is only a 15% chance that VIAScan® will rank the same two lambs as having the largest total lean as CT. Based on the analysis presented in this paper there are differences in the measurement of total lean between the VIAScan® system tested and the CT scanner tested. For the CT measurement of total lean there was a 28% and 18% (Table 2) increase in the prediction of total weight of lean respectively for years 2011 and 2012 over the VIAScan® measurement. The greatest difference between the predicted lean weight of a primal was for the shoulder in 2011 (Table 2), with VIAScan® predictions much less than the CT estimate, in fact by 44% less (Table 2). It is not possible to derive whether this purely reflects the change in CT scanning position from the 7th Cervical to 1st Thoracic site or the much different carcase weight of the lambs between years. However, the data suggests that in 2011 in the heavier lambs VIAScan® predictions for lean in the hindleg were greater than CT measurements so this suggests the predictions for the shoulder were in fact a reflection of differences more of the machines.

The bias in measurement of total lean between the two measurement techniques as tested in this study raises some important issues, particularly if VIAScan® tissue weights were included in genetic analysis. The rank correlation in this study was 0.88, which suggests that the order for lean does change between machines. VIAScan® with its automated data capture is able to record carcase information from lambs. The data consists of carcase weight, total weight of carcase lean yield and the percentage lean per region expressed as a percentage of carcase weight. This data can then be entered into the SIL database for genetic evaluations. Currently only one meat company in New Zealand has VIAScan® installed. Producers who commit their lamb supply to this company can be rewarded for a yield payment over and above the ruling weekly schedule based on carcase weight. Lambs which achieve all three primal targets qualify for payment. The combined qualifying yield targets are – leg 21.1%, loin 13.6% and shoulder 16.4%, based on the percentage lean per region expressed as a percentage of carcase weight. Lambs outside the weight range 14.5 – 21.2kg do not qualify for yield payments. Lambs in 2012 were below the carcase weight limit, 40% of lambs failed to meet the three thresholds set by VIAScan®, whereas using CT yields no lambs failed in 2012 and 1% failed in 2011. VIAScan® is calibrated to meet market requirements and therefore represents a traditional butchers market as opposed to CT measurements which can remove all the lean meat from the bone. The main issue arises where data is required for genetic selection and progeny testing [2, 14]. SIL convert the % lean yields to a weight of lean using the formulae (yield/100)*Cwt. Based on the phenotypic correlations reported here it suggests there is likely to be a re-ranking of animals for lean if VIAScan® predictions were used compared to CT measurements. Derivation of genetic correlations between the two traits is obviously needed. If CT scanning is regarded as the ‘gold standard’ a case could be made to refine the VIAScan® predictions for the primal weights by calibrating the VIAScan® system against the primal weights collected by CT scanning rather than by manual dissection. The refined predictions would increase the accuracy of primal weight predictions [9].

In terms of payments to producers based on VIAScan® predictions it is apparent that if differential prices are paid within the carcase according to primal that there will be little relative change in price as carcase weight changed. This is despite the fact that based on CT data it would be expected that proportionally more lean weight would be predicted in the shoulder than the hindleg in heavier lambs as found in 2011 drop lambs.

IV. CONCLUSION

These results clearly show that the CT scanner used in this study estimated the weight of lean in lambs with a higher degree of accuracy than the VIAScan® system as tested. This has important ramifications for the use of VIAScan® data in the SIL genetic evaluation program. The results suggest the need to refine the VIAScan® predictions for primal weights by calibrating measurements against CT measurements and for robustness this would need to be done using more than one CT scanner and VIAScan® system.

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