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Factors affecting dressing-out percentage of lambs

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ABSTRACT

The trial objective was to determine if hot carcass dressing out percentage (DO%) calculated as hot carcass weight/live weight, differed with either lamb pre-slaughter live weight (SlLW) or total tissue depth over the 12th rib (GR) and to identify other factors altering DO%. Data from ten experiments showed that SlLW only accounted for small, and measured GR moderate, amounts of variation in DO%. DO% was increased; by increasing the pre-slaughter fasting time; by increasing pasture allowance and by feeding more digestible forages such as clover, chicory or plantain versus grass based pasture. Similar trends occurred with the relationship between GR and DO%. At the same SlLW wether lambs had a lower DO% than female lambs but at the same GR there were no gender differences. At the same SlLW and GR, faster growing lambs had a lower DO%. While many factors significantly altered DO% including SlLW or GR, large amounts of variation in DO% remained unexplained.

Keywords: weight; fatness; crops; allowance; gender; rate of growth; dressing out percentage.

INTRODUCTION

In New Zealand, farmers pick lambs for sale to slaughter using visual or measured live weight, or they use experienced lamb drafters that subjectively estimate the depth of soft tissue over the 12th rib (GR) by manual palpation. Hot carcass weight (HCW) and GR combine in the New Zealand lamb schedule to give step changes in carcass value. To optimise carcass value, farmers want to place all lambs in the most profitable HCW/GR classes. In order to estimate a HCW from a preslaughter live weight S1LW, it is necessary to know the hot carcass dressing out percentage (DO%), calculated as hot carcass weight/live weight. Some variation in DO% is accounted for by SlLW and by GR. In weaned lambs DO% generally increases in older, heavier, and/or fatter lambs (Kirton *et al.*, 1984). DO% is higher in fast growing lambs, and in female compared to ram lambs (Kirton *et al.*, 1995; P.D. Muir, Personal communication).

Arguably, the biggest variable in DO% is the weight of the contents of the gastrointestinal tract at the time of the pre-slaughter weighing. Gutfill can vary between 10% and 22% of prefast live weight. Gutfill increases with high intakes and is lower following ingestion of highly digestible forage (Kirton *et al*., 1968; Hughes, 1976), time off feed before weighing (fast), and time from weighing to slaughter (time to kill) (Thompson *et al.*, 1987; A.R. Bray, Personal communication).

Data from 10 experiments were used to evaluate factors affecting DO%.

METHODS

Experiments 1 to 10 are briefly described in Table 1 and Table 2.

Experiment 1 and Experiment 2 have been described by Fraser *et al.*, (1996). Three replicated pure stands of five forages (High endophyte-Nui ryegrass (*Lolium perenne L.*), Grasslands Huia white clover (*Trifolium repens L.*), Grasslands Goldie lotus (*Lotus coniculatus L.*), Grasslands Puna chicory (*Cichorium intybus L.*), and Grasslands Lancelot plantain (*Plantago lanceolata L.*)) were established in 1992. The stands were evaluated in 1993 (Experiment 1, without lotus) and in 1994 (Experiment 2, with lotus), using 20 Coopworth ram lambs per treatment with a mean live weight (LW) of 22 kg.

In Experiment 3, Coopworth ram and wether lambs (n = 216) were offered ryegrass/white clover pastures at three replicated treatments of either high (400 g DM/kg LW/d) or low (100 g DM/kg LW/d) allowance for 42 days. Lambs were shifted weekly. After an additional four days of grazing at the end of the treatment period, lambs were randomly allocated into four treatments balanced for live weight (one hour off-feed) and weighed after either a 1 hour or a 24 hour fast, and slaughtered (SlLW 33.9 kg) after either a 24 hour or a 56 hour fast. Hot carcass weights were obtained and DO% calculated. (A.R. Bray, Personal communication).

In Experiment 4 Coopworth-cross twin lambs (n = 240) born and reared grazing parasite-free pasture, were parasitised by trickle infection, not infected or drenched at two weekly intervals and weaned at seven or 14 weeks of age. Lambs were slaughtered at seven, 14, 23 and 28 weeks of age (R.A. Dynes, Unpublished data).

TABLE 1: Description of experiments compiled in dataset.

Experiment	Number of lambs	Year	Age (month)	Sex	GR	Allowance	Feed type	Length of fast (h)	Time to kill (h)
1	76	1993	7	R	N	Av	C Cl P RG	24	25
2	96	1994	6	R	Y	Av	C Cl L P RG	24	25
3	414	NA	NA	E M	N	H L	RG	1 or 24	24 or 56
4	93	2005	4 5	E W	N	NA	RG	2	26
5	81	2006	6	E W	N	NA	RG	2.5	26
6	203	2002	5	E W	N	Av	L RG	2.5	27
7	207	1990	9	W	Y	H L	RG	2.5	24
8	1,764	1986-1992	6 7 8 9 10	R	Y	Av	RG	2	24
9	952	1982	5 6 7	E W	Y	Av	RG	2	NA
10	809	1983	5 6 7 8	E W	Y	Av	RG	2	NA

NA = Not available;
Sex: R = Ram, E = Ewe, M = Male, W = Wether;
GR = Depth of soft tissue measured over 12th rib in slaughter plant;
Allowance: Av = Average, H = High, L = Low;
Feed: C = Chicory, Cl = White clover, L = Lotus, P = Plantain, RG = Ryegrass;
Length of fast = Time between removal from pasture and weighing;
Time to kill = Time from weighing to slaughter.

TABLE 2: Mean, standard deviation (SD) and range of hot carcass weight, GR and dressing out percentage for the ten experiments.

Experiment	Hot carcass weight (kg)			GR (mm)			Dressing out (%)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
1	17.7	2.2	12 - 23				47.2	2.0	42 - 51
2	19.2	4.2	11 - 27	10.2	5.3	2 - 23	48.8	4.2	40 - 59
3	14.8	2.1	9 - 22				43.6	3.7	25 - 58
4	11.5	1.9	7 - 16				37.8	2.6	33 - 44
5	14.8	2.0	8 - 20				40.6	1.9	36 - 45
6	13.5	2.4	8 - 20				39.3	2.2	34 - 45
7	15.7	3.0	10 - 23	8.0	4.2	1 - 19	40.9	3.2	34 - 48
8	18.5	2.9	8 - 28	10.9	4.0	1 - 27	45.5	2.9	27 - 54
9	14.8	2.5	8 - 25	11.8	3.0	1 - 23	47.3	2.6	29 - 70
10	14.4	2.7	5 - 24	7.0	3.0	1 - 20	47.0	2.5	32 - 54

GR = Depth of soft tissue over 12th rib measured in slaughter plant

Experiment 5 consisted of Suffolk/Coopworth twin reared lambs (n = 81). Comparisons included creep vs non-creep grazing of lambs at two pasture allowances of 3.8 kg DM/ewe/d and 6.9 kg DM/ewe/d, from six weeks of age until weaned at 13 weeks of age, they were then run as one mob on grass based pasture until slaughtered at 21 weeks of age (Moss *et al*., 2009).

In Experiment 6, 5-month-old Suffolk/Coopworth lambs (n = 212) were divided into three pasture type groups (lotus, ryegrass (both endoparasite free) and ryegrass with parasites) on which they grazed for eight weeks receiving a pasture allowance of 2 kg DM/hd/d (A.R. Bray, Personal communication).

In Experiment 7 Coopworth wether lambs (n = 207) from three sources were uniformly divided into four pasture allowance groups offered 1.3, 1.8, 3.9 and 9.9 kg DM/hd/d, from 27 weeks of age for 56 days. All groups were then combined on a high pasture allowance for 24 hours and then slaughtered (R.A. Moss, Unpublished data).

Also in experiment 7 two groups of Coopworth/Romney mixed sex lambs were selected at weaning on the basis of slow and fast pre-weaning growth rate (n = 180/group). They were then run for 26 weeks as “slow”, “fast” and “mixed treatment” groups at each of two pasture allowances (Low = 86 g DM/kg live weight/d, High = 434 g DM/kg live weight/d). Unfasted live weights were recorded three days before slaughter (Bray *et al.,* 1990).

Experiment 8 was a genetics trial conducted over seven years from 1986 with pure bred Coopworth ram lambs (n = 1,764) run as one mob per year on ryegrass based pasture. They were selected at random for slaughter at monthly intervals from between six and ten months of age (Francis *et al.,* 1994).

Data from Experiment 9 and Experiment 10 were obtained from genetics trials conducted in 1982 and 1983 with Coopworth, Dorset, Border Leister and Romney cross (n = 1,760) lambs grazing on Wiremu Lands and Survey block in Taranaki. Ewe and wether lambs were slaughtered at an average age of six months and a weight of 30.9 kg (Kirton *et al.*, 1999).

Statistical analysis

The analysis was conducted using SAS general linear models using the solution option (SAS, 2005). Statistical differences between slopes and intercepts were determined by the absence of overlap in 95% confidence intervals. With management treatments such as allowance and feed type being confounded by differences in SlLW and GR, a regression analysis using the relationship of SlLW or GR with DO% were fitted. Other factors were fitted as class variables and R^2 values reported are for the complete models. All ± values in text and tables are the standard error of the mean.

RESULTS

Slaughter live weight and GR

SlLW accounts for a small proportion of the variation in DO% (R^2 = 0.03-0.29; Table 3). Experiments could only be grouped into four (Table 3) based on similar intercepts and slopes. In Groups 1 to 3, a 10 kg increase in S1LW increased DO% by between 2% and 8%.

In experiments where GR was measured at the works, each experiment had a different relationship between GR and DO% (Table 4). This relationship explained a further small amount of DO% variation (R^2 = 0.03-0.60). DO% increased by 3% to 6% for every 10 mm increase in GR in Experiments 7 to 10.

Times of slaughter or weighing

The weaned, mixed sex pasture-fed lambs in Experiment 3 weighed after one hour off-pasture had means of 34.5 ± 0.4 kg and 43.3 ± 0.2% for SlLW and DO% respectively. In comparison, when lambs were weighed after 24 hours off-pasture, the DO% was higher (2.2 ± 0.3%; R^2 = 0.25, P <0.0001) at the same SlLW. DO% was 1.4 ± 0.4% (R^2 = 0.05, P <0.003) higher in lambs slaughtered 24 hours after weighing compared to those slaughtered at 56 hours after weighing.

Pasture allowance

Lambs at the same S1LW with a high pasture allowance had higher DO% values (3.8 ± 0.4; R^2 = 0.59, P <0.0001) than lambs with low pasture allowance in both Experiments 3 (34.5 vs 32.7 ± 0.7 kg) and Experiment 7 (41.9 vs 34.3 ± 0.3 kg). In Experiment 7, lambs at the same GR had a higher DO% (2.4 ± 0.4%; R^2 = 0.66, P <0.0001) when grazing high compared to low pasture allowances.

Pasture type

The liveweight gain preslaughter and SlLW for ewe lambs grazing clover, chicory, plantain or ryegrass in Experiment 1 are shown in Table 5. Lambs grazing all crops had higher DO% (2.2 ± 0.5%) than lambs grazing ryegrass (P <0.0001, R^2 = 0.49) at the same SlLW.

TABLE 3: Linear relationship (± Standard error) between dressing-out percentage (Y axis) and preslaughter live weight (kg) (X axis) in Experiments 3 to 10, either combined or grouped according to having similar slopes and intercepts. RMSE = Root mean square error of regression equation.

Experiment	Group	Slope	Intercept	R^2	RMSE	Number of carcasses	P value
Overall	All	0.09 ± 0.01	42.4 ± 0.3	0.02	3.0	4,688	<0.001
9, 10	1	0.27 ± 0.01	38.7 ± 0.4	0.21	2.2	1,758	<0.001
3, 8	2	0.23 ± 0.01	36.2 ± 0.5	0.16	2.6	1,868	<0.001
5, 7	3	0.32 ± 0.03	29.0 ± 1.0	0.29	2.4	286	<0.001
4, 6	4	0.10 ± 0.04	35.0 ± 1.0	0.03	2.2	120	0.03

TABLE 4: Linear relationship (± Standard error) between dressing-out percentage (Y-axis) and GR (mm) (X axis) in Experiments 7 to 10, either combined, or singly. RMSE = Root mean square error of regression equation.

Experiment	Slope	Intercept	R^2	RMSE	Number of carcasses	P value
Overall	0.40 ± 0.01	42.0 ± 0.1	0.27	2.6	3,600	<0.001
7	0.59 ± 0.03	36.2 ± 0.3	0.60	2.0	206	<0.001
8	0.46 ± 0.01	40.6 ± 0.1	0.43	2.1	1,759	<0.001
9	0.32 ± 0.03	29.0 ± 0.1	0.28	2.2	831	<0.001
10	0.01 ± 0.04	35.0 ± 1.0	0.03	2.2	120	0.03

TABLE 5: Mean ± standard error of live weight gain (LWG) prior to slaughter, preslaughter weight (S1LW), GR measurement and the hot dressing-out percentage (DO%) for groups of 20 lambs grazing different forages in Experiments 1 and 2, listed in order of decreasing liveweight gain in Experiment 2.

Forage	Experiment 1		Experiment 2			
	LWG (g/d)	S1LW (kg)	LWG (g/d)	S1LW (kg)	GR (mm)	DO%
Clover	149 ± 12	41.5 ± 0.6	194 ± 7	47.4 ± 0.6	16.4 ± 0.7	52 ± 0.5
Lotus	-	-	125 ± 7	41.1 ± 0.6	11.9 ± 0.7	49 ± 0.5
Chicory	97 ± 12	38.0 ± 0.6	122 ± 7	40.3 ± 0.6	12.4 ± 0.7	54 ± 0.5
Ryegrass	26 ± 12	34.6 ± 0.5	95 ± 7	34.0 ± 0.6	4.7 ± 0.7	45 ± 0.5
Plantain	85 ± 12	35.2 ± 0.6	82 ± 7	33.0 ± 0.6	5.6 ± 0.7	45 ± 0.5

In Experiment 2, the lamb's preslaughter liveweight gain, SlLW and GR varied with diet ($P < 0.0001$) (Table 5.) as did DO% ($P < 0.0001$). As there was an unusual negative relationship between SlLW and DO% in clover that also generated a feed by SlLW interaction, this treatment was removed from this part of the subsequent analysis. At the same SlLW, DO% was similar in plantain and ryegrass-grazed lambs, but was higher in lotus 2.19 ± 0.09) and chicory (7.05 ± 0.09) fed lambs ($R^2 = 0.77$, $P < 0.0001$). At the same GR, DO% was similar in lambs fed plantain and ryegrass, but higher for lambs fed lotus (1.2 ± 0.7%), clover (1.7 ± 0.9%) and chicory (5.6 ± 0.7%)-fed lambs ($P < 0.0001$, $R^2 = 0.87$). The mixed-sex lambs in Experiment 6, grazing lotus or ryegrass were slaughtered at 34.2 ± 0.5 kg following modest growth at 65 ± 4 g/d. The average DO% was 39.0 ± 0.2%. There was no effect of feed type on DO%.

Slaughter age

The effects of slaughter age on DO% were minor and conflicting. At the same GR and SlLW, a decrease in DO% of 0.14% ($R^2 = 0.47$, $P < 0.05$) was found with each additional month to slaughter in ram lambs in Experiment 7 and Experiment 8. On the other hand, an increase of 0.45% ($R^2 = 0.34$, $P < 0.0001$) with each additional month to slaughter in ewe and wether lambs was found in Experiment 9 and Experiment 10.

Gender

At the same SlLW, ewe lambs had 0.3% higher ($P < 0.01$) and 0.13% higher ($P < 0.0001$) DO% compared to wether lambs in Experiment 9 and Experiment 10 ($R^2 = 0.22$) and Experiments 4, Experiment 5 and Experiment 6 ($R^2 = 0.27$) respectively. At the same GR there was no effect of gender on DO%.

Liveweight gain to slaughter

Analysing data from Experiments 4, 5, 6, 7 and 8 demonstrated that liveweight gain over the post-weaning to finishing period had a greater impact on DO% than liveweight gain immediately before slaughter. However, the magnitude of both period of liveweight gain on DO% was relatively small. At the same SlLW, there was a reduction ($P < 0.0001$) in DO% of 1.6 ± 0.2% per 100 g of liveweight gain from weaning to finishing ($R^2 = 0.31$, n = 2,168). At the same GR, there was a reduction ($P < 0.0001$) in DO% of 0.7 ± 0.1% per 100 g of liveweight gain to finishing ($R^2 = 0.48$, n = 1,962). For both SlLW and GR, the negative effect of liveweight gain on DO% was replicated in all experiments and could not be removed using slaughter age.

DISCUSSION

There are increasing opportunities for farmers to supply lambs under contract to processors and exporters. Frequently these contracts specify both grade and carcase weight. Understanding factors affecting DO% could assist farmers and lamb drafters to more accurately link live weight to carcass weight thereby helping farmers to meet their contracted specifications. Existing data have been pooled to determine factors affecting DO%.

The average increase in DO% following a 1 kg increase in SlLW found in Groups 1 to 3 (Table 3) was 0.27%. This compares very favourably with the Australasian average for pasture fed lambs of 0.25% (0.1 to 0.47) (Atkins, 1979; Kirton *et al.*, 1984, Thorrold *et al.*, 1988; Bennett *et al.*, 1991; Hopkins, 1992; Scales *et al.* 2000). In contrast, in the recent comprehensive analysis of New Zealand lambs drafted on GR (P.D. Muir, Personal communication), DO% only increased by 0.09% per 1 kg increase in SlLW.

The average increase in DO% with an increase of 1 mm GR was 0.45%, similar to the average of the published values of 0.37% (0.2 to 0.55) (Thorrold *et al.*, 1988; Hopkins, 1992).

The amount of variation in DO% described by SlLW was disappointingly small. Using GR to predict DO% was a more robust approach with a consistently higher R^2, but used a GR measurement taken by the plant at slaughter and not an eye estimate by a grader which is the only practical application for prediction of DO% on live animals from GR. Both prediction via SlLW or GR retained large differences in estimates of DO%. This was largely driven by large differences in intercept values (Tables 3 and 4), probably partially due to differences in the methods used to calculate DO%. Before 1994, cold carcass weight was measured and then hot carcass weight calculated using an assumed value for carcass shrinkage while cooling (Kirton *et al.*, 1984; P.D. Muir, Personal communication). In addition, variation in factors such as timings of weighing, wool length and feed quantity and quality, all alter DO%. The influence of these factors could not all be removed because the data were not well balanced, or in some cases because these factors were not known. The effects of these factors could only be determined in well-balanced subsets of data.

When lambs were fasted for 24 hours before weighing, DO% increased by 2.2%. This is lower than the 3-5% found in previous studies (Hughes, 1976; Kirton *et al.*, 1984; Kirton *et al.*, 1995; Thompson *et al.*, 1987; A.R. Bray, Personal communication). Smaller increases in DO% with fasting do occur on poor compared to good quality feeds. To avoid loss of carcass weight, farmers are unlikely to keep lambs off-pasture for 24 hours before weighing. Instead, they may opt to weigh less than 4 hours off-feed, thereby having little impact on DO%. The LW loss up to 24 hours of a fast is made up almost solely of losses in gutfill and urine (A.R. Bray, Personal communication). Extended fasts result in loss of carcass and organ weight (Kirton *et al.*, 1968) as seen in the 1.5% drop in DO% by increasing the pre-slaughter fast from 24 hours to 56 hours.

Compared to lambs consuming pasture, lambs consuming high quality forages such as legumes or crops generally grow faster and are heavier and fatter, factors likely to increase DO%. However, when using regression analysis to remove either SlLW or GR effects, a substantial increase in DO% remained (Speijers *et al.*, 2004), presumably due to lower gut fills on crops (Thomson *et al.*, 1985). The relative importance of feed quality over feed quantity in increasing DO% (Hughes, 1976) was also observed in lambs fed a high versus a low allowance. Despite the greater quantity of feed consumed on a high versus a low allowance, the higher quality of the diet and low gutfill, achieved through diet selection, increased DO% by 3%.

There were conflicting effects of age of lamb on prediction of DO% with both an increase and decrease of DO% with age. Muir (P.D. Muir, Personal communication) found in lambs progressively slaughtered on the basis of a GR measurement over summer/autumn, DO% decreased. This was possibly due to a proportionate increase in gutfill relative to live weight with increasing age, with effects often confounded by seasonal changes in pasture quality.

In this study and others (Kirton *et al.*, 1995; P.D. Muir, Personal communication) male lambs were leaner than ewe lambs at the same LW and had slightly lower DO%. However, this gender effect disappears when compared at the same GR. Other studies have reported minor or no significant effects of gender on DO% (Kirton *et al.*, 1984; Hopkins, 1992) when compared on a GR basis.

The most intriguing result of this study was that at the same GR and SlLW, lambs that grew faster to slaughter had a lower DO% in all five experiments (Table 2) indicating that age at slaughter affects DO%. Thus, when compared at the same GR and S1LW, younger lambs had a lower DO%. Lambs that grow faster to slaughter are often heavier, occasionally fatter (Hopkins *et al.*, 2007) and sometimes younger than their slower growing cohorts. These factors all contribute to the published findings that fast growing lambs have higher DO% (Bray *et al.*, 1990; Kirton *et al.*, 1995; Bray *et al.*, 1990). However, when compared at the same S1LW and GR, DO% was lower, possibly due to lower gut fills with better diet quality in faster-growing lambs.

In conclusion, several factors were identified that significantly alter the prediction of DO% from either SlLW or GR. However, even when these factors are included in the prediction of DO%, only relatively minor amounts of variation are explained leaving large amounts of between experiment variation unexplained.

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