Does increasing body frame size in Merinos increase profit? A case study[1]

G Burbidge[A] and J Virgona[BC]

[A] 'Connemara', Tarcutta NSW

[B] Graminus Consulting, Wagga Wagga NSW 2650

[C] EH Graham Centre, Charles Sturt University, Wagga Wagga NSW 2650

Abstract: *Grassgro™ was used to model the impact of frame size on production and profitability in a self-replacing ewe flock, at 'Connemara', Tarcutta in southern NSW. Three frame sizes (48, 53 and 58 kg adult weight) were modelled in a productions system which allowed variations in selling strategy, the impact of frame size on stocking rate and varying prices of wool and meat. As frame size increased, at a constant effective stocking rate (DSE/ha), the nominal stocking rate (number of ewes per hectare), the number of sheep sold per ha and wool production per ha decreased, while meat production increased. Gross margins per hectare decreased as frame size increased due to the increased meat income being unable to compensate for the decreased wool income. At fixed nominal stocking rates the gross margin per hectare increased as frame size increased but pasture utilisation and effective stocking rate increased. Increasing body size could only be more profitable at very low wool prices and very high meat prices.*

Key words: metabolisable energy, fleece, liveweight, feed utilisation

Introduction

Scale presents major difficulties in evaluating and implementing new technologies in agriculture. Ensuring that new technologies or ideas are tested at a scale relevant to the production system being examined is essential if a realistic evaluation is to take place. The introduction of larger bodied sheep in a Merino production system is a case in point. The push for larger body types with faster growing progeny and higher fecundity requires an evaluation at a scale which relates to the profitability of grazing enterprises – per ha rather than per head. Three issues need to be addressed before proceeding with a description of the analysis presented below:

1) an understanding of how frame size relates to per hectare production;
2) the importance of making fair comparisons that do not confound cause with effect; and
3) economically robust analyses that are not confined to a single set of prices and/or costs.

One of the major components determining the efficiency of grazing systems is the body size of the animals within that system. Larger animals have greater metabolisable energy (ME) requirements than smaller animals: cattle require more ME per head than sheep and larger sheep require more ME per head than smaller sheep. The ME required to maintain the liveweight (W) of a dry sheep grazing in an extensive system is approximately 0.5 MJ ME/kg $W^{0.75}$ (calculated using the *Sheep Explorer* spreadsheet[2] and based on relationships described by CSIRO (2007)). Nicol and Brookes (2007) calculated similar values and produced general coefficients depending on the energy required for grazing: 0.48, 0.52 and 0.56 for flat, rolling and hilly country, respectively. So in simple terms, with a finite amount of feed being produced per hectare then the larger the frame size the lower the number of those animals per hectare which can be run for a given level of feed consumption.

Frame size also is related to other important factors that will have an impact on the

1 This paper was prepared for the annual MerinoLink conference, 'Improving the profitability of your Merino enterprise', held by at Wagga Wagga on Wednesday 4 March, 2015. Lead author G Burbidge is a member of MerinoLink Limited.

2 http://www.grazplan.csiro.au/?q=node/15

productivity of a Merino enterprise. In particular, the progeny of larger framed animals will grow faster as there is a high positive genetic correlation between adult weight (AWT) and growth rate (Safari *et al.* 2005). In addition, there is a positive correlation between body weight and fertility. The genetic relationship equates to 0.38% increase in number of lambs weaned (NLW) per kg increase in AWT (R Banks pers. comm.). So while deliberate selection towards a larger frame size will produce a greater number of faster growing progeny this will be balanced by lower stocking rates (of adult sheep). Any analysis of larger frames will, at the very least, need to take this trade-off into account.

The productivity of grazing systems is limited by the amount of feed produced, the utilisation rate of that feed and any supplementary feed consumed by livestock in that grazing system. Generally, productivity can be directly related to pasture utilisation rate. However, there is a point at which greater pasture utilisation will cause unacceptable damage to resources such as pasture and soils. It is necessary to set in place management strategies to avoid degradation. These may include removal of livestock from pastures at set groundcover thresholds and feeding in drought lots. How often lower limits are reached will be a function of seasonal conditions, the utilisation rate and the economics of supplementation. Nonetheless, when comparing enterprises or management strategies within an enterprise it is crucial that the limitations posed by the availability and quality of feed on offer are recognised. Comparisons based on frame size should, therefore, be at the same level of feed utilisation. Otherwise, an increase in frame size can be confounded with an increase in effective stocking rate or utilisation rate.

Kennedy *et al.* (2011) used the simulation platform, AusFarm to investigate the effects of a range of mature ewe sizes on whole farm profit. The study comprised 4 ewes sizes (50, 60, 70 and 80 kg; no fleece or conceptus; at condition score (CS) 3, combined with 4 nominal stocking rates (8, 10, 12 & 14 ewes/ha) and 3 lamb slaughter weights (45, 50 and 55 kg/head). Their working hypothesis was that gross margin would decrease as ewe mature size increased due to higher feed costs.

Kennedy *et al.* (2011) found that gross margin increased at all stocking rates except the highest in the 80 kg ewes. Even though (as they pointed out) there was some flattening out of the gross margin versus stocking rate (ewes/ha) relationship at higher stocking rates for the 60 and 70 kg ewes, the hypothesis was rejected. This was not a fair analysis as the lower body mass sheep were stocked (effectively) at much lower rates. Indeed for the 50 kg ewes there was a linear relationship between nominal stocking rate and gross margin. Given that 80 kg ewes will require around 30% more feed than a 50 kg ewe for maintenance alone then it is clear that pasture utilisation in the 50 kg ewe system could not have been as high as for those with the larger frame sizes. Hence larger frame size may have achieved greater profitability through an increase in stocking rate, and pasture utilised rather than frame size *per se*. In short, any fair comparison of frame size must take into account the effect of stocking rate and/or pasture utilisation.

Simulation modelling can be used to investigate issues such as frame size (Kennedy *et al.* 2011), selling policy (Robertson *et al.* 2014) or a range of factors like lambing time, comparative profitability of enterprises and stocking rate across a range of locations and seasons (e.g. see Warn *et al.* 2006a, 2006b). It is simply not possible to generate experimental data to the same extent. Simulation exercises using Grassgro™ and AusFarm can assign dollar values to inputs and outputs to generate gross margins. In most studies a fixed price or cost is used – often averaged over the last few years. Price arrays can also be used to cover variation in wool quality or carcase size but again these are usually fixed. It is important to take into account the level to which these prices might realistically vary. With respect to frame size the ratio of wool to carcase prices could conceivably have a large influence on gross margin; this too should be included in model output.

In this paper we examine the results of a modelling exercise that was undertaken to investigate the impact of body size on the physical and financial performance of a self-replacing Merino flock in the South West Slopes of NSW. We chose the property 'Connemara' as it had been used in the development of the modelling tool Grassgro™ and close agreement between paddock measurements and model output had previously been demonstrated (Simpson *et al.* 2003, Salmon 2006). The base production system simulated is very similar to the commercial enterprise that is currently run on the property by one of the authors (G Burbidge).

Methods

Grassgro™ was used to model the impact of frame size on production and profitability at Connemara (35.52° S, 147.88° E) in southern NSW. A synthetic interpolated data set was obtained from the SILO climate database[3] for the period 01/01/1889 to 01/12/2014. A 1,000 ha single-paddock farm containing well fertilised phalaris-sub clover pastures (fertility scalar = 0.9), on sandy loam over sandy clay loam soil was simulated. Management practices that were common across all simulations were as follows:

- The livestock enterprise was a self-replacing Merino flock with ewes being replaced at 5–6 years of age. Cast-for-age ewes were sold on 15 December and replacements made on 16 December each year.
- Ewes were joined on 23 March at 1–2 years old, lambing took place around 19 August, all male lambs were castrated and all lambs weaned on 12 November.
- Supplementary feeding took place in a feedlot when:
  - the CS of the thinnest mature ewes in the flock reached 2.0 or pasture availability declined below 500 kg/ha total dry matter available. Feeding continued until available green dry matter reached 550 kg/ha. The ration was made up of 80% whole barley and 20% lupins;
  - weaners were fed with the same ration as above to maintain CS at 2.5 or when total feed available fell below 600 kg/ha; and
  - in addition all young stock were fed barley grain from 1 January to ensure all young ewes reached a target weight of 40 kg by 1 July and young wethers reached a target weight of 35 kg by 1 July.
- Main flock and weaners were shorn on 1 September.

The prices and costs used in the Grassgro™ analyses of the Connemara case study are shown in Tables 1 to 4. The lamb and ewe prices are shown in Table 1 (based on carcase weight), wool prices are presented in Table 2, monthly price scaling of both ewes and lambs in Table 3, and enterprise costs in Table 4.

Table 1. Lamb and ewe prices (c/kg) based on a range of carcase weights (CWT) and a dressing percentage of 40%.

Lamb CWT class	**Price (c/kg CWT)**
< 12.0 kg	429
< 20.0 kg	452
> 20.0 kg	460
Dressing percentage	40%
Skin price – female	$10
Skin price – male	$7
Ewe CWT class	**Price (c/kg CWT)**
< 14.0 kg	311
< 18.0 kg	321
> 18.0 kg	341
Dressing percentage	40%
Skin price	$10

Table 2. Wool prices (c/kg clean) for fibre diameters from 16 to 19 µm used for the Grassgro™ analyses of the Connemara case study.

Micron class (fibre diameter)	**Price (c/kg clean)**
16 micron	1669
17 micron	1411
18 micron	1333
19 micron	1262
Av. Fleece price	93%
Wool selling costs	5%

3 https://www.longpaddock.qld.gov.au/silo/datadrill/

Table 3. Monthly price scaling for ewes and lambs used for the Grassgro™ analyses of the Connemara case study.

Month	Ewes	Lambs
January	0.90	0.95
February	0.96	0.85
March	1.04	0.83
April	1.06	0.91
May	1.10	0.97
June	1.14	1.05
July	1.19	1.07
August	1.04	1.05
September	0.85	1.05
October	0.85	1.07
November	0.89	1.10
December	0.91	1.02

Table 4. Enterprise costs used for the Grassgro™ analyses of the Connemara case study.

Item	Cost $
Ewe Shearing ($/head)	6.60
Shearing Lambs ($/head)	6.60
Ewe Husbandry ($/head)	2.50
Lamb Husbandry ($/head)	6.40
Ewe Replacement ($/head)	0.00
Rams ($/head)	500.00
Sheep sales commission (%)	5
Sheep sales cost ($/head)	2.00
Pasture costs ($/ha)	60.00
Supplement costs	
Barley, whole ($/tonne)	280.00
Lupin ($/tonne)	380.00

Frame Size and related characteristics

Frame sizes of 48, 53 and 58 kg/per ewe (mature weight without fleece or conceptus, CS 3) were investigated in the series of simulations presented below. These frame sizes will be referred to as Small, Medium and Large, respectively, from here on. Increases in frame size are correlated with changes in reproductive output. To account for this the conception rates at CS 3 were varied to achieve an increase in lambs weaned at a rate of 0.38% per kg increase in AW (Rob Banks pers. comm.). Hence for all simulations the average number of lambs weaned for ewes mated was 0.84, 0.86 and 0.89 for Small, Medium and Large flocks, respectively. To achieve these levels conception at CS 3 was set to 70% singles and 24% twins for Small, 70% singles and 26% twins for Medium, and 70% singles and 28% twins for Large.

To ensure that flocks containing animals with different frame sizes were compared at the same effective stocking rate (DSE/ha), a number of simulations were made to find the nominal stocking rate (ewes/ha) at which the effective stocking rate was the same as currently being run at Connemara (i.e. 15.1 DSE/ha). The nominal stocking rates that achieved 15.1 DSE/ha noticeably varied for different production systems that were investigated (Table 5).

In general, across Merino flocks there has been a positive correlation between body size (AWT) and clean fleece weight (CFW) with a genetic relationship equating to 16 g extra CFW per kg increase in AWT (R Banks pers. comm.). A breeding program to increase body size would most likely use sires from within the top 150 for one of the indices on MerinoSelect. In mid-February 2015 the correlation between adult body weight (AWT) and adult CFW (ACFW) for the top 150 sires on each of 5 indices in MerinoSelect (FP+, MP, MP+, DP and DP+)[4] were highly variable (0.15, −0.45, −0.17, −0.38, −0.12, respectively) with variable regression coefficients (0.08, −0.21, −0.09, −0.12 and 0.06 respectively). This is quite different to the genetic relationship above. For the same 5 indices, correlations between AWT and fibre diameter (FD) [0.09–0.38] and regression coefficients [0.37–1.62] show a generally accepted positive relationship between AWT and FD. One of the systems in which the frame sizes were compared included an allowance for greater CFW with increases in AWT with no increase in FD.

4 http://www.sheepgenetics.org.au/Getting-started/ASBVs-and-Indexes/MERINOSELECT-Indexes

Production systems

Each of the three frame sizes was examined in three production systems:

1. *Sell @ 50 kg* – lambs were sold when they reached 50 kg.
2. *Sell on Time* – 1 November for wethers, 15 December for young ewes
3. *More Wool* – lambs sold at 50 kg but the genetic relationship between AWT and CFW described above, i.e. 16 g of CFWT per kg AWT, is included in the sheep genotype.

The nominal stocking rates used to achieve around 15.1 DSE/ha vary with production system. These and their impact on effective stocking rate, pasture utilisation and ground-cover are shown in Table 5.

Further analyses

Three further analyses were undertaken to investigate aspects of the impact of frame size on stocking rate and examine how varying prices affected economic outcomes. In the *Sell @ 50 kg* production system a common nominal stocking rate of 6.9 ewes/ha was used for each frame size. The differences between gross margin for the small and large frame sizes were calculated for a wide range of meat and wool prices for each of the three production systems. An analysis of the effect supplementary feed price on gross margin was made but results are not included as there was very little impact when supplement was varied by $50 above or below the prices listed in Table 4.

Results

Frame size and production system

Some of the key production outputs were closely related to the nominal stocking rates presented in Table 5. In terms of wool cut and number of stock sold – a higher stocking density of smaller framed animals produced more. Conversely, there was a decline in the amount of supplement needed for larger framed flocks and slightly higher meat production per ha (Table 6).

Gross Margins

Using the prices and costs shown in Tables 1 to 4, it is clear that the average gross margin of the smaller framed flocks was higher in each of the three production systems (Table 7). The difference between the small and the large frame sizes in terms of gross margin was lower in the *More Wool* system where larger framed sheep also had greater fleece weight. Variability of the gross margins was similar for each of the frame sizes and production systems (data not shown). Box plots of the gross margins data reveal much greater 'down-side' variability than upside – as expected (Fig. 1). Generally, median

Table 5. Nominal stocking rate (number of ewes/ha), average DSE per ha, pasture utilisation (total pasture intake as a proportion of feed grown) and proportion of the year that groundcover fell below 0.7 for Small, Medium and Large Merino flocks from simulations carried out using 124 years of weather data. Flocks were compared in three production systems: lambs sold at 50 kg liveweight (*Sell @ 50 kg*), sold on set dates (*Sold on Time*) and lambs sold at 50 kg but also with fleece weight increasing with body size (*More Wool*).

Production system	Ewe frame size	Nominal stocking rate (ewes/ha)	Average DSE (per ha)	Pasture utilisation (%)	Groundcover < 70% (% of years)
Sell @ 50 kg	Small	8.1	15.11	38.74	4.23
	Medium	7.5	15.15	39.17	4.39
	Large	6.9	15.15	39.52	4.54
Sell on Time	Small	7.8	15.21	38.93	3.99
	Medium	7.1	15.20	39.28	4.35
	Large	6.4	15.00	39.11	4.39
More Wool	Small	8.1	15.11	38.74	4.23
	Medium	7.5	15.15	39.17	4.40
	Large	6.9	15.16	39.51	4.49

gross margins were much higher than average gross margin – reflecting the skewed nature of the data set.

When the *Sell @ 50 kg* system was tested at the same stocking rate for each of the frame sizes i.e. 6.9 ewes/ha (allowing the large framed sheep to reach 15.1 DSE/ha), large framed sheep were the most profitable (Fig. 2a). However, in this case the effective stocking rate of the larger framed sheep was much higher than the smaller framed sheep (Fig. 2b).

The impact of wool and meat prices was examined by comparing the median difference in gross margin between the smallest and largest frame size flocks. This was done for each of the three production systems but only the results for *Sell @ 50 kg* and *More Wool* are shown. For each year the gross margin of the larger frame size flock was subtracted from that of the smaller frame size flock. The median of the resulting values is shown in Tables 8 and 9 across a wide range of wool and meat prices. Variation in supplementary feed costs (+/– $50 from the costs presented in Table 4), while having an effect on overall gross margin, had such a very minor impact on the relationship between frame sizes that it was considered unimportant.

Table 6. Key physical outputs for three different flock types in three production systems (*Sell @ 50 kg, Sell on Time* and *More Wool*) from simulations carried out using 124 years of weather data. Fibre diameter below is for the mature ewes and varied by only 0.0–0.2 µm for lambs. Treatments are described in the Methods section.

Production system	Flock type (Ewe frame)	Ewes sold (per ha)	Lambs sold (per ha)	Meat sold (kg/ha)	Wool cut (kg/ha)	Fibre diam. (µm)	Supplement fed (t/ha)
Sell @ 50 kg	Small	1.42	3.27	245	42	17.2	0.34
	Medium	1.31	3.17	247	39	17.1	0.31
	Large	1.20	3.04	251	35	17.1	0.28
Sell on Time	Small	1.37	3.13	251	40	17.2	0.32
	Medium	1.24	2.98	255	37	17.1	0.29
	Large	1.12	2.8	256	33	17.1	0.25
More Wool	Small	1.42	3.27	245	42	17.2	0.34
	Medium	1.31	3.17	247	39	17.1	0.32
	Large	1.2	3.04	251	37	17.1	0.29

Table 7. Average total expenses, income and Gross margin (all in $/ha) for Small, Medium and Large framed Merino flocks from simulations carried out using 124 years of weather data. Details of the flocks can be found in the Methods section. Flocks were compared in three production systems: lambs sold at 50 kg liveweight (Sell @ 50 kg), sold on set dates (Sell on Time) and lambs sold at 50 kg but also with fleece weight increasing with body size (More Wool).

Production system	Flock type (Ewe frame)	Total Income ($/ha)	Total Expenses ($/ha)	Gross Margin ($/ha)
Sell @ 50 kg	Small	968	342	626
	Medium	930	322	608
	Large	899	305	594
Sell on Time	Small	959	345	615
	Medium	919	324	596
	Large	877	301	576
More Wool	Small	968	342	626
	Medium	940	324	616
	Large	918	306	611

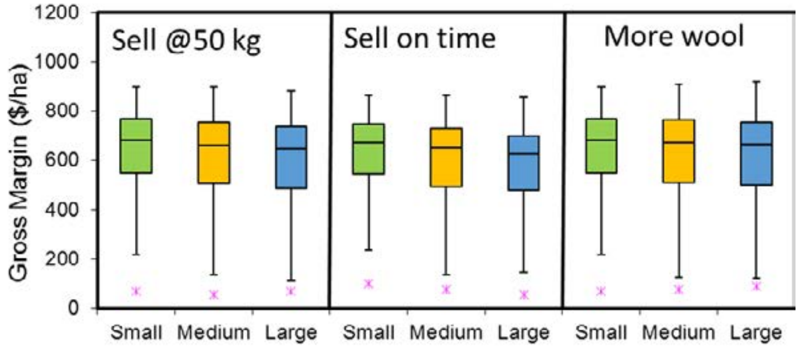

Figure 1. Box plots showing the gross margin of each combination of the frame size and production systems. An asterix denotes an outlier – defined as greater than 1.5 times the interquartile range.

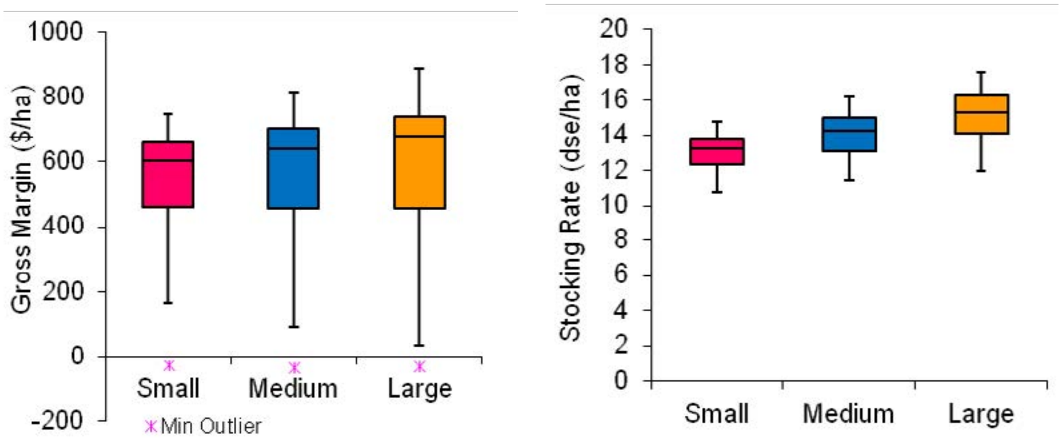

Figure 2. (a) Gross margin at the same nominal stocking rate (6.9 ewes/ha) for each of the frame sizes; and (b) Effective stocking rate for each of the three frame sizes when stocked at the same nominal rate.

Table 8. Median difference between small and large framed flocks in terms of gross margin ($/ha) in the *Sell @ 50 kg* system across a range of wool prices (c/kg Clean) and meat prices (c/kg dressed weight).

		Wool 17 micron (c/kg Clean)										
	14.48	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Lamb (c/kg DW)	100	–3.08	1.93	6.94	12.17	17.67	22.60	27.70	32.66	37.57	42.71	48.00
	150	–5.14	–0.09	5.00	10.15	15.30	20.34	25.26	30.34	35.41	40.62	45.90
	200	–7.02	–1.62	3.80	9.22	14.36	19.47	24.32	29.59	34.91	40.01	45.11
	250	–9.11	–3.87	0.99	6.05	11.18	16.32	21.66	26.75	31.95	37.32	42.55
	300	–12.16	–6.80	–1.51	3.91	9.25	14.37	19.78	25.12	30.17	35.50	40.84
	350	–15.39	–9.80	–4.35	1.15	6.23	11.54	17.08	22.56	28.05	33.41	38.43
	400	–18.71	–13.14	–7.56	–2.01	3.46	9.01	14.07	19.55	24.96	30.19	35.62
	450	–22.21	–16.77	–11.38	–5.86	–0.25	5.36	11.16	16.97	22.16	27.56	32.95
	500	–24.48	–19.44	–13.97	–8.48	–2.68	2.77	8.17	13.44	18.95	24.45	29.89
	550	–25.46	–20.34	–15.22	–10.11	–4.99	0.32	5.80	11.29	16.51	22.00	27.50
	600	–27.93	–22.81	–17.70	–12.59	–7.46	–2.36	2.96	8.27	13.74	19.35	24.95
	650	–30.05	–24.80	–19.62	–14.45	–9.28	–4.06	1.26	6.57	11.87	17.18	22.49
	700	–32.28	–26.58	–21.65	–16.24	–10.81	–5.21	0.40	5.99	11.35	16.72	22.09
	750	–35.17	–29.54	–23.85	–18.36	–13.23	–7.90	–2.49	2.96	8.56	14.17	19.77
	800	–36.30	–31.24	–25.75	–20.71	–15.34	–9.92	–4.64	0.83	6.31	11.77	17.22

Table 9. Median difference between small and large framed flocks in terms of gross margin ($/ha) in the More Wool system across a range of wool prices (c/kg Clean) and meat prices (c/kg dressed weight).

		Wool 17 micron (c/kg Clean)										
	$2.35	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Lamb (c/kg DW)	100	–$9.38	–$5.99	–$2.64	$0.88	$4.71	$8.28	$11.84	$15.45	$19.20	$22.96	$26.78
	150	–$10.25	–$6.77	–$3.15	$0.75	$4.64	$8.50	$11.98	$15.63	$19.28	$22.89	$26.48
	200	–$12.76	–$8.74	–$4.79	–$1.16	$2.38	$6.00	$9.72	$13.60	$17.45	$21.05	$24.81
	250	–$15.23	–$11.24	–$7.08	–$3.26	$0.31	$4.11	$8.00	$11.85	$15.39	$18.91	$22.73
	300	–$17.26	–$13.37	–$9.47	–$5.44	–$1.34	$2.35	$6.28	$10.19	$14.25	$18.11	$21.86
	350	–$20.80	–$16.83	–$12.75	–$8.79	–$4.79	–$0.72	$3.34	$7.40	$11.46	$15.54	$19.71
	400	–$23.49	–$19.30	–$15.21	–$11.08	–$6.82	–$2.55	$1.73	$6.01	$10.27	$14.39	$18.39
	450	–$25.68	–$21.43	–$17.32	–$13.21	–$9.11	–$5.08	–$1.22	$2.86	$6.95	$11.03	$15.11
	500	–$27.63	–$23.63	–$19.63	–$15.63	–$11.45	–$7.12	–$3.01	$1.10	$5.21	$9.09	$13.08
	550	–$28.73	–$24.89	–$21.06	–$17.22	–$13.39	–$9.55	–$5.49	–$1.41	$2.77	$7.06	$10.96
	600	–$30.35	–$26.33	–$22.39	–$18.47	–$14.57	–$10.82	–$6.97	–$3.12	$0.97	$5.08	$9.19
	650	–$33.36	–$28.98	–$24.60	–$20.65	–$16.33	–$12.42	–$8.58	–$4.75	–$1.00	$2.96	$7.06
	700	–$35.73	–$31.51	–$27.28	–$22.94	–$18.61	–$14.73	–$10.57	–$6.32	–$2.24	$1.94	$6.10
	750	–$38.21	–$34.03	–$29.86	–$25.68	–$21.65	–$17.32	–$13.15	–$9.32	–$5.09	–$0.79	$3.39
	800	–$40.67	–$36.62	–$32.52	–$28.41	–$24.30	–$20.14	–$15.75	–$11.36	–$7.34	–$3.77	$0.50

Discussion

The Grassgro™ analyses have produced similar results to those experienced in the paddock at Connemara and are therefore considered a reliable method of evaluating changes to the production system.

Three production systems: *Sell @ 50 kg*, *Sell on Time* and *More Wool*, which were all tested at the same stocking rate of 15.1 DSE per ha, had very similar responses to varying ewe frame size. These responses showed that as frame size increased the number of ewes that could be run, number of stock sold and total wool production decreased, while the amount of meat sold increased slightly, on a per hectare basis. The amount of supplement required per hectare decreased only very slightly as body weight increased. The resultant gross margins per hectare decreased as frame size increased, mainly as a result of the increase in meat income being unable to compensate for the decrease in income from wool.

Although all three production systems showed similar trends there were only small differences in magnitude. The *Sell on Time* system resulted in a gross margin of between $11 and $12 per hectare lower than the *Sell @ 50 kg* system, largely due to a slightly lower stocking rate in the *Sell on Time* system. This slightly lower stocking rate was due to the wether portion of the flock being kept for longer during the spring before sale and therefore the nominal stocking rate in the whole system decreased, resulting in lower numbers of heavier animals being turned off and lower wool production. A flexible sale policy of turning off lambs at 50 kg rather than on a fixed date at the end of spring was more profitable.

Within the MerinoSelect database there are now a large number of sires at the top of all the indices with large frame sizes (AWT). Many of these larger animals have a wool value (CFW, FD and Staple Strength), which is no better than that of smaller animals. The use of larger framed sires with the same wool values as currently used at Connemara would decrease profitability.

The model output, based on costs and prices in February 2015, indicates very poor relationships between frame size and CFW in the top sires on index within MerinoSelect and does not reflect the longer term relationship between these variables. This was the reason for modelling the *More Wool* system. The *More Wool* system had identical stock and meat production to the *Sell @ 50 kg* system; however, the increase in wool production resulted in increased gross margins for the two larger frame sizes: Medium increased $8 and Large increased $17 over that of the Small flock. This underlies the importance in a Merino enterprise of maximising wool value at any body weight.

The *More Wool* analysis could be criticised for not including an increase in fibre diameter as frame size and clean fleece weight increased, which may have resulted in no corresponding increase in fleece value. The correlations between frame size and fibre diameter were clear for all MerinoSelect indices, however the correlations were not clear for frame size and clean fleece weight. So to avoid any possibility of disadvantaging the larger frame sizes long term genetic relationship between frame size and clean fleece weight was used in this analysis.

In the fixed nominal stocking rate (6.9 ewes/ha) simulations, increasing frame size from Small to Large resulted in increasing stocking rates from 13.1 to 15.1 DSE per hectare. This increase in frame size also resulted in an increase in pasture utilisation and a very slight increase in the amount of time the grazing system did not meet the threshold of 70% groundcover. In this case it was only the Large flock that reached the currently applied stocking rate of 15.1 DSE per hectare. At these fixed nominal stocking rates the gross margin per hectare also increased as frame size increased. This increase in gross margin per hectare can all be explained by the concurrent increase in stocking rate and related pasture utilisation rather than intrinsic factors associated with the increased body weight. If Connemara was being run at a sub-optimal stocking rate then increasing frame size could increase profitability, however this method of increasing stocking rate is less efficient and less profitable than increasing the nominal stocking rate with smaller ewes.

The relationship between wool and meat prices is a key consideration in the profitability of all Merino production systems. The wool and meat price sensitivity analysis conducted around the *Sell @ 50 kg* system shows that for there to be an financial advantage of running large frame sheep instead of small frame sheep, wool prices would have to be very low and meat prices would have to be very high. Price sensitivity around the *More Wool* system had a similar pattern to *Sell @ 50 kg* but the difference in gross margin between small and large framed sheep decreased over the same price combinations used for the *Sell @ 50 kg* system.

The typical use of a single average price for meat or a simple price series based on average prices for different carcase weights is inadequate to reflect the reality of changing prices throughout any year. The use of a monthly adjustable price to derive a series of prices, for different carcase weights, has given a more realistic price situation than the usual single average price usually used in modelling. There is a need to further develop meat price series to more accurately take into account major changes which occur over time and particularly when there are highly distorted prices such as during drought.

MerinoSelect is a very good genetic tool available to Merino producers that provides information on a per head basis, for individual animals. The analyses conducted in this paper show that to ascertain the most sustainable and profitable genetic direction requires detailed analysis on a per hectare basis not a per head basis. The standard indices provided by MerinoSelect may not adequately reflect profit per hectare.

Within any modelling exercise there are always some things which are difficult to model accurately. In the systems modelled here the survival rate of lambs post-weaning has been kept constant over different frame sizes, whereas in reality the large framed sheep with faster growth rates are likely to have a lower mortality rate than the small framed sheep. Another factor which has been kept constant has been birth related death rate in ewes. It is possible that variations in birth related deaths could occur at different frame sizes.

Only one type of supplementary feed could be allocated for maintenance feeding of both ewes and lambs within Grassgro™. A mix of 80% barley: 20% lupin was chosen to allow enough protein for lamb growth even though the ewes did not need the extra protein. There was little difference in quantity of supplements fed to the different frame sizes in all analyses and therefore price of supplements had no effect on the gross margin relationships between frame sizes.

There are also intangibles within any system which are difficult to quantify. One of these is the 'wear and tear' on labour of having to handle large frame sheep and its flow-on effects on costs for shearing and crutching.

Acknowledgements

Meat, wool and supplement prices were supplied by:

- Andrew Woods, Independent Commodity Services, Wagga NSW, ic-s@ic-s.com.au
- Stephanie Williams, Meat & Livestock Australia.

References

CSIRO (2007) Nutrient requirement of domesticated ruminants. CSIRO publishing, Collingwood, Vic.

Kennedy AJ, Ferguson MB, Martin GB, Thompson AN, Pannell DJ (2011) Different mature ewe sizes require different stocking rates and lamb slaughter weights to maximise whole-farm profit. Proc. Assoc. *Advmnt. Anim. Breed. Genet.* **19**, 339–342.

Nicol AM, Brookes IM (2007) The metabolisable energy requirements of grazing livestock. *In*: 'Pasture and Supplements for Grazing Animals. Eds PV Rattray, IM Brookes, AM Nicol. Occasional Publication No. 14, New Zealand, pp. 151–172.

Robertson SM, Southwell AF, Friend MA (2014) Modelling the risk of different joining times and lamb sale policies. *Animal Production Science* **54**, 1694–1698.

E. Safari, N.M. Fogarty, A.R. Gilmour (2005). A review of genetic parameter estimates for wool, growth, meat and reproduction traits in sheep. *Livestock Production Science* **92** (2005) 271–289

Salmon L (2006). Changing shearing date attracts hidden costs. *Farming Ahead (Kondinin Group)*, No 169. pp 56–57.

Simpson RJ, Salmon L, Marshall D, Stefanski A (2003) Computer tool pinpoints poor paddock performance. *Farming Ahead (Kondinin Group)*, No 141. pp 46–47.

Warn LK, Geenty KG, McEachern S (2006a) What is the optimum wool–meat enterprise mix? *In*: 'Proceedings of the 2006 Australian Sheep Industry CRC Conference, Orange, NSW '. pp 60–69.

Warn L, Webb Ware J, Salmon L, Donnelly J, Alcock D (2006b) Analysis of the profitability of sheep wool and meat enterprises in southern Australia. Final Report for project 1.2.6, Sheep CRC.