Which breeding direction for sheep on the Southern Tablelands?

P Graham[A] and AK White[B]

[A] NSW Department of Primary Industries, Yass, 2582: phillip.graham@dpi.nsw.gov.au

[B] NSW Department of Primary Industries, Cowra, 2794

Abstract: *Breeding more profitable sheep is crucial for sheep businesses to deal with the predicted increase in climate variability. We have good selection tools available to help but the question is 'in which direction should we breed for the future?' We could very easily head in a given direction and find when we get there that we are at the wrong destination. Modelling future climate scenarios, then overlaying with the sheep that we will have by then, can help inform breeding decisions now. Wool and sheep meat enterprises and the potential consequences of current breeding strategies are examined and discussed across a range of future climates for Binda on the Southern Tablelands of NSW.*

Key words: body weight, micron, pasture, soil fertility

Introduction

There is current discussion in the sheep industry about the value of adult body weight. Should we be increasing the body weight of ewe flocks? To answer this question, producers need to have an understanding of the impact that bigger ewes will have on their existing enterprise as well as potential changes to their future pasture production systems. Heavier ewes should be a good thing for lamb production, however to achieve the same level of pasture utilisation and groundcover would require a lower stocking rate.

In the light of uncertain future climates, are heavier ewes the breeding direction we should pursue? Heavier ewes produce lambs that grow faster, but what is the impact on profit in Merino flocks? Costs such as labour, infrastructure and shearing that come with heavier ewes also need to be examined. This paper will look at the current situation, potential changes to pasture production as a result of future climate, and the impact of different breeding directions for a fine wool, self-replacing Merino enterprise and a second cross prime lamb enterprise.

The following work is based on GrassGro™ modelling using weather and soil data for Binda (near Crookwell) in NSW. The daily weather data used is from 1 January 1960 to 31 December 2014. The site has high soil fertility and perennial ryegrass/ sub clover/ Microleana pastures. Financial data is based on the average prices and costs for 2014. Production data for each sheep enterprise is district average as judged by the authors. There is a 35% difference in lambing percentage between the Merino and prime lamb enterprises.

The current situation

It is important for producers to have a clear understanding of which traits contribute to income and profit for their enterprises. The following data (Table 1) provides a breakdown of income for the 2014 year into wool, meat and the sale of surplus animals for both enterprises. The figures are $/ha or expressed as a percentage of total income. In the Merino enterprise the wethers are sold off shears at 18 months of age, at mutton prices.

Table 1. Income breakdown ($/ha)* for 18 µm self-replacing Merino and second cross prime lamb enterprises at Binda, NSW. The percentage contribution of each income source is shown in brackets.

	18 µm Merino ($/ha)	Prime lamb ($/ha)
Wool	$383 (56.8%)	$113 (13.3%)
Cast-for-age animals (CFA)	$ 60 (8.9%)	$ 83 (9.8%)
Sale of surplus ewes	$ 85 (12.6%)	
Sale of wethers	$147 (21.8%)	
Lambs		$652 (76.9%)
Profit ($/ha)	$261	$233

* Average prices and costs for 2014 were used in the calculations.

A comparison of the average prices for 2014 to the prices from the 2010 to 2014 period provides an indication of where they sit against recent years. For example, the 2014 lamb price of 522 c/kg carcass is at the 25% level. This means that the lamb price has been below 522 c/kg for 75% of weeks in the five year period. The mutton price of 302 c/kg carcass is near the middle point, so there have been just as many weeks below as above this price point. The 18 µm wool price of 1242 c/kg clean is at the 65% level, so only 35% of weeks have been below this price. In summary, the income breakdown in Table 1 is based on lamb price being strong, mutton at a mid-point and wool at below average.

The percentages would change if different relative prices were used. The calculations in Table 2 are based on the spot prices at the start of April 2015, with mutton and wool worth 348 c/kg carcass weight and 1305 c/kg clean, respectively. The lamb price did not change.

Table 2. Income break down ($/ha)* for 18um self-replacing Merino and second cross prime lamb enterprises at Binda, NSW. The percentage contribution of each income source is shown in brackets.

	18 µm Merino	Prime lamb
Wool	$400 (56.1%)	$139 (15.7%)
CFA	$ 68 (9.5%)	$ 94 (10.6%)
Sale of surplus ewes	$ 85 (11.9%)	
Sale of wethers	$162 (22.7%)	
Lambs		$652 (73.7%)
Profit ($/ha)	$297	$269

* April 2015 spot prices were used in the calculations.

In comparing Table 1 and Table 2 it can be seen that profit ($/ha) has improved for both enterprises, when the April 2015 spot price is used, with the Merino enterprise increasing from $261 to $297/ha and prime lamb increasing from $233 to $269/ha. While wool income has increased in the Merino enterprise, its overall percentage has dropped due to the stronger rise in mutton price. The improved prime lamb profit is mainly driven by the increased price for strong wool.

Previous work by the authors has shown that the percentage break down in income with changing relative commodity prices moves in the +/– 4% range. In other words, the proportion of income from wool, meat and cast-for-age (CFA) animals is very stable, even when commodity prices change significantly.

Changing adult ewe body weight has very little impact on the enterprise profit via income from CFA animals in either the self-replacing or second cross lamb enterprise. Where it does have an impact is in the prime lamb enterprise, as heavier ewes improve lamb growth rates, resulting in faster turn-off of prime lambs. This reduces supplementary feeding, thereby altering the profit margin rather than changing overall income.

It is important to note that the sale of surplus ewes in self-replacing flocks is driven by reproduction rates rather than a meat value. Therefore, it is important that producers look at the total income and profit rather than just the percentage breakup of income.

Many Merino and maternal and terminal sire breeders select for growth and subsequently, adult weight. Adult ram weights have increased, creating work, health and safety concerns for livestock handlers. Unlike Breedplan where mature cow weight for beef cattle is reported, mature ewe weight is not easily monitored as it is not a standard maternal trait reported by Sheep Genetics (SG). This is a concern for geneticists and breeders alike (Brown and Swan 2014).

Historical first cross ewe weights are difficult to source. Grassgro™ uses empty adult reference weight in fat score 3, with no fleece and conceptus-free (i.e. empty). Unpublished lamb production experiments, conducted by DPI Victoria, which monitored first cross ewe weights and fat score, show that ewes in 1990 averaged about 60 kg (range 48.5–95.3 kg) when factored back to score 3, no fleece and empty. Information nucleus flock ewes at Cowra bred around 2010 (consisting of a mixture of breeds and crosses) averaged 75 kg as adults, with a range of 50 to 90 kg. The lighter weight ewes were bred from Corriedale/ Merino type sires.

It would appear that adult first cross ewe weights have increased in the order of 15 kg from 1990 to 2010, which equates to 1.33 kg per year on average. This may be an over estimate, however, if an increase of this magnitude has occurred across the industry then it warrants investigation to help determine the profitability of future breeding direction. If this rate of increase continues, by 2030 the average mature first cross ewe will weigh 90 kg at fat score 3. Although this is the top of the weight range of the above data sets, it is commonly reported by producers, so it is well within the realms of possibility.

The future

Changes to the production traits of adult ewes result from changes to a producer's breeding direction either because of their direct actions or because the stud industry has made the change and commercial producers are swept along.

A number of breeding directions within each enterprise are examined below to see what impact they may have on future profits. Changes to the breeding direction take time (e.g. 10 years) so it makes sense to examine the 'new ewe flocks' under the potential pasture production that might be expected in the Binda area in 2030. A number of projects (e.g. Southern Livestock Adaptation 2030) have looked at the impacts of the potential changes to rainfall, CO_2 and temperature on pasture production. The three global circulation models (GCMs) we have used in this project are C4, MP and H2. These represent a range of potential outcomes and create three future farms from which we can consider the different breeding directions that producers and industry might take.

Table 3 shows average annual rainfall and mean annual temperature for Binda based on 45 years of data (1960 to 2014) as well as estimates of future climate scenarios from the three GCMs. The estimated temperature change is similar across the three models with an increase of just over 1°C. The annual rainfall changes are more variable with two models (C4 and MP) giving no change and one model (H2) showing a reduction of approximately 60 mm. Increasing temperatures will increase evaporation rates resulting in lower soil moisture levels.

a) Prime lamb system assumptions and results

Using Grassgro™ modelling, first cross (Border Leicester × Merino) ewes were joined to terminal sires. Ewes cut 5.78 kg of 28 µm greasy wool. Ewes scanned 70% twins when joined at 3 score. Lambing percentages then varied according to the year. Historical weaning percentage averaged 126%. Lambing occurred late August, weaning mid-November. Ewes were supplemented with grain at $280/t to maintain them in fat score 2.

Replacement ewes cost $170/per head. Lambs were turned off at domestic target weights of 44 kg liveweight (20–21 kg carcase weight) and were supplemented with grain to achieve this weight in dry years. The opportunity to grow lambs out to heavier weights in better years was not included within the model.

Mature ewe weights modelled were 60, 75 and 90 kg. The number of ewes per hectare was adjusted to maintain similar levels of groundcover. The standard system used a terminal sire mature weight of 105 kg, with weights of 95 kg and 125

Table 3. Long term and projected annual rainfall and temperature data for Binda, NSW, using historical climatic data from 1960 to 2014 and the Global Circulation Models – C4, MP and H2.

	Average annual rainfall (mm)	Average annual temperature (°C)
Historical data (1960 to 2014)	781	12.8
Global system models		
C4	817	13.9
MP	790	13.8
H2	714	14.1

kg also tested. The model outputs for this 30 kg range in mature sire weight gave a similar variation in lamb growth rate to on-farm trials with 8 kg difference in post weaning weight (PWWT) Australian Sheep Breeding Value. The genetic trends for average terminal sire PWWT show that it has taken about 15 years to achieve an increase of 8 kg. Given the same genetic progress in PWWT and correlated mature weight, by 2030 we are likely to have terminal sires with a mature weight of 155 kg. Unfortunately this is outside the current limits the Grassgro™ model.

Mature ewe live weight: The impact on profit ($/ha) of changing the mature live weight of first cross ewes , based on historic data and predicted future conditions from the global circulation models is shown in Table 4. Average commodity prices and costs for 2014 have been used in all calculations, unless otherwise stated.

Table 4. Profit ($/ha)* for different mature live weight cross bred ewes using historical climatic data from 1960 to 2014 and the Global Circulation Models – C4, MP and H2.

C	60 kg ewe	75 kg ewe	90 kg ewe
Historical data (1960–2014)	$356	$358	$352
Global systems models			
C4	$386	$399	$414 ($390)#
MP	$365	$352	$347 ($326)#
H2	$218	$241	$240 ($221)#

* Profit at same groundcover targets for each GCMs.
# The value in brackets takes into account the additional cost for shearing larger ewes, i.e. 1.5 times the standard rate for 90 kg ewes. This results in approximately $20/ha decrease in profit.

According to the Grassgro™ model, in order to achieve the same minimum groundcover targets for the different ewe liveweights, the stocking rate of ewes per hectare would need to be altered, as shown in Table 5. High levels of soil fertility need to be maintained to sustain these ewe stocking rates. When soil fertility is lowered, future pasture production could be as low as 56% of the high fertility system with subsequent profit decreasing to $0/ha for the most severe H2 future climate scenario. Maintenance supplement costs escalate to the point where it is uneconomic to run a second cross lamb production enterprise in 2030 at Binda and the impact of low soil fertility far outweighs any advantage in growth rate that comes from genetic gain or ewe body weight.

Table 5. Variation in estimated stocking rate for different mature liveweight first cross ewes (ewes/ha), based on historical climatic data and the Global Circulation Models – C4, MP and H2.

	60 kg ewe (ewes/ha)	75 kg ewe (ewes/ha)	90 kg ewe (ewes/ha)
Historical data (1960–2014)	5.9	5.1	4.5
Global circulation models			
C4	6.0	5.1	4.5
MP	5.8	4.8	4.1
H2	4.6	3.9	3.4

The Grassgro™ model indicates that as mature ewe weight increases, ewe stocking per hectare must decrease (Table 5) or pasture utilisation rates would increase to the point where unacceptable levels of groundcover are common. Where stocking capacity is below optimum an option is to run heavier ewes to increase effective per hectare stocking rate. However, if a shorter growing season, with longer and more frequent dry spells is the future (i.e. H2), then supplementary feeding these larger ewes is a challenge and builds inherent risk into the business.

Lambs from heavier ewes have faster growth rates and reach the turn-off weight of 44 kg more quickly than lambs of lighter ewes, and in effect reduce the amount of feed required to finish lambs. This benefit is greatest with the shorter growing season of the harsher future climate (H2).

The total amount of lamb (kg/ha) sold is reduced with heavier ewes when all lambs are sold at the target live weight. If lambs are grown out to heavier weights, it affords the opportunity to make use of the higher growth genes from heavier ewes in good seasons but would further increase production feeding costs in the dry years that are predicted under the H2 climate scenario.

This analysis has assumed that reproduction rate (RR) has not increased with higher adult ewe weight. The flock in this modelling example is highly fertile, assumed to already be conceiving at 70% twins. This leaves most of the selection pressure for reproduction traits to be placed on improved rearing ability, rather than conception rates. This is not necessarily related to adult weight. Much of the improvement in RR has accrued through improvements in breeding ewe management in the last 20 years, such as body condition prior to lambing.

Selection for growth in terminal sires: Based on the estimated stocking rates for each climate scenario shown in Table 5, a prime lamb system using high growth (high mature liveweight) terminal sires could lower lamb finishing cost by one third to one half across all climate scenarios (Table 6). High growth terminal sires are more profitable per hectare but are unable to negate the full impact on profit of the more severe future climate and resultant reduced ewe stocking rate predicted from the H2 climate scenario.

Further analysis is warranted to investigate the impact of targeting heavier carcase specifications with high growth sires. High growth terminal sires provide more flexibility than lower growth sires. Lambs can be tuned off faster in drier years or taken to heavier weights more quickly in better seasons to increase lamb turn-off per hectare.

Take home messages

Mature ewe live weight: For the prime lamb system used in this analysis, heavier ewes are not necessarily making more money. Any benefit of heavier ewes is negated by extra costs and management issues (i.e. shearing costs increase by a factor of 1.5 times the standard rate). The capital required for infrastructure improvements to handle heavier ewes, such as sheep handlers and yard and fence modifications, has not been considered in the analysis.

From the lamb producer's perspective, we should consider breeding strategies that cap mature liveweight of sires and dams, both of which contribute genes to the first cross ewe. Breeders of composite sheep for lamb production should give this even closer attention. Selection for early growth should be maintained but most emphasis for growth genes should be placed on the terminal sires. When purchasing cross bred ewes, the high price of the first run of the largest ewes in the sale may not be the most profitable replacements.

Selection for growth in terminal sires: High growth terminal sires will make more money and provide seasonal flexibility in turn-off times and weights. This observation is supported by producer experience.

Terminal sire breeders should continue to place selection pressure on early growth traits, which is likely to be a profitable strategy in the future, regardless of climate outcomes. This validates the emphasis on growth traits and the high rates of genetic gain made in recent years. However, terminal sire breeders need to consider future

Table 6. Profit ($/ha)* for high and low growth terminal sires joined to 75 kg ewes at stocking rates achievable under historical weather conditions and future Global Circulation Models – C4, MP and H2.

Climate scenarios		Historical	C4	MP	H2
		75 kg ewe @ 5.1 ewes/ha	75 kg ewe @ 5.1 ewes/ha	75 kg ewe @ 4.8 ewes/ha	75 kg ewe @ 3.9 ewes/ha
High growth sires (125 kg mature weight)	Profit ($/ha)	$366	$364	$361	$243
	Finishing supplement costs ($/ha)	$ 20	$ 12	$ 24	$ 16
Low growth sires (95 kg mature weight)	Profit ($/ha)	$358	$351	$351	$237
	Finishing supplement ($/ha)	$ 33	$ 24	$ 36	$ 30

* Using 2014 average prices and costs.

handling systems and infrastructure to manage even larger sheep.

The lamb industry should make maximum use of the efficiencies of the terminal sire breeding structure. High growth genes can be purchased by commercial producers as terminal sired lambs are not retained as replacements. This allows producers to take full advantage of the growth genes without the maintenance cost of heavier adult ewes.

b) 18 μm Merino system assumptions and results

The Merino self-replacing flock used in the analysis comprises 50 kg ewes (empty, no fleece, in fat score 3) cutting 4.80 kg of 18 μm greasy wool. Lambing occurred in late August and lambs were weaned mid-November. The historical weaning percentage averaged 80%. Ewes were supplemented with grain at $280/t to maintain them in fat score 2 score during any dry period. The wethers and surplus ewes were sold after shearing, at 15 months. The wethers were sold as mutton at a carcass price and the ewes on a per head basis.

The impacts of possible breeding changes are examined across the three GCMs (C4, MP and H2), in two ways:

- using the current industry breeding indices of fleece production (FP), Merino production (MP) and dual purpose (DP)
- by changing one trait at a time (fleece, body weight, or fibre diameter) by a similar amount to test the sensitivity of each trait on profit.

Using industry breeding indices: The breeding indices of the base flock (i.e. 18 μm, 4.93 kg greasy fleece weight and 50 kg ewes) were changed to reflect 10 years of breeding to give three new flocks:

- Fleece production (FP) – 17.2 μm, 4.93 kg fleece, 50.4 kg body weight
- Merino production (MP) – 17.6 μm, 5.10 kg fleece, 51.8 kg body weight
- Dual purpose (DP) – 17.9 μm, 5.0 kg fleece, 53.3 kg body weight
- No improvement –18 μm, 4.8 kg fleece, 50 kg body weight

The average profit per hectare for each of the 'new' flocks run under the three different climate scenarios are shown in Table 7.

Table 7. Profit ($/ha)* of three flocks following 10 years of breeding using the Fleece production, Merino production and Dual purpose breeding objectives for the Global Circulation Models – C4, MP and H2.

Flock	C4	MP	H2
Fleece production	$333	$297	$199
Merino production	$328	$295	$193
Dual purpose	$313	$273	$186
No improvement	$308	$278	$179

* Using 2014 average prices and costs.

The difference between the three GSMs is substantial and swamps any changes to the breeding direction. The trend with the three new flocks is the same across all climate scenarios; FP is always the most profitable and the DP flock is always the least profitable of the new flocks. DP is either close to or below the 'No improvement' (do nothing) option.

The impact of individual traits: The above scenario using breeding indices combines a number of changes within the flock. The impact of individual traits on profit ($/ha) is shown in Table 8 which looks at the effect on profit per hectare of changes to a single trait. These changes and the new flock traits are:

- reduced fibre diameter – 17.2 μm, 4.8 kg fleece, 50 kg body weight
- increased fleece weight – 18 μm, 5.07 kg fleece, 50 kg body weight
- increased body weight – 18 μm, 4.8 kg fleece, 52.1 kg body weight

Table 8. Profit* ($/ha) of three flocks where a single trait has been altered in order to achieve a change in either Fibre diameter, Fleece weight or Body weight analysed across the Global Circulation Models – C4, MP and H2.

Trait change	C4	MP	H2
Reduce Fibre diameter	$323	$288	$190
Increase Fleece weight	$329	$297	$197
Increase Body weight	$308	$269	$171
No improvement	$308	$278	$179

* Using 2014 average prices and costs.

Similar to the effect of altering breeding indices shown in Table 7, the impact of climate also swamps the genetic changes. Increasing fleece weight gave the highest profit across all climate scenarios, with reduced fibre diameter slightly less than fleece weight. Body weight increase produced the least profit and was not much different from 'No improvement' (doing nothing).

Take home messages

A breeding direction that placed emphasis on fleece weight and fibre diameter produced the highest profit for the Merino enterprise used in the above example. However, it is important to note that the emphasis that a producer places on fleece weight and fibre diameter will depend on current production levels and his or her view on potential changes to the micron premiums.

A breeding objective aimed at increasing body weight was shown to have no advantage in the above example. However, the results will differ depending on the structure of the Merino enterprise. For example, if the wethers are kept as wool cutters then the benefits from concentrating on the wool trait would increase; or if the enterprise aims to sell the wethers as lambs, then increasing ewe body weight could be more beneficial. However, as indicated by the data from the prime lamb system, any increase in the mature ewe weight should be moderate.

Conclusions

All sheep enterprises must be very careful in the emphasis placed on mature ewe weight. If current climate trends persist, higher ewe weights might not result in improved profits. There are management issues that also need to be considered:

- future shearing costs;
- will you get them shorn (i.e. will it be difficult to attract shearers)?
- ability to handle the ewes; and at what cost?
- will the increased ewe weight lead to animal health problems, such as increased incidence of foot abscess in higher rainfall areas?

This paper considers three possible climate scenarios for 2030 at Binda. At an altitude of 820 m, by 2030 the Binda area is likely to experience the benefits of increased pasture growth during winter, which at present is a restriction to any livestock system. In nearby localities with a lower altitude the impact of all GCMs could be very different. It is important for industry to monitor weather trends and compare these to the modelled scenarios. This will assist in fine-tuning breeding objectives and capitalising on their benefits.

References

Anon (Undated) Southern Livestock Adaptation 2030. www.sla2030.net.au. Accessed 19 May 2015.

Brown D and Swan A (2014) Genetic Analysis of Adult Body Weight and Condition Scores in Merino Sheep. In 'Proceedings of the 10th World Congress of Genetics Applied to Livestock Production, Vancouver, Canada'.

Correction to page 5 of **Which breeding direction for sheep on the Southern Tablelands?**

18um merino assumptions and results
The merino self-replacing flock is a 50kg (empty and no fleece) ewe cutting 4.80kg of 18.0um greasy wool. The historical weaning percentage averaged 80%. Lambing occurred late August, weaning mid-November. Ewes were supplemented with grain at $280/t to maintain them in 2 score during any dry period. The wethers and surplus ewes are sold at 15 months after shearing. The wethers are sold as mutton at a carcass price and the ewes on a per head basis.

The impact of possible breeding changes will be examined in 2 ways:

- Using the current industry breeding indexes, fleece production FP, merino production MP or dual purpose DP
- By changing 1 trait at a time (fleece or body weight, fibre diameter) by a similar amount to test the sensitivity on profit.

This will be done across the 3 GCMs by using 30 years of potential weather at 2030.

The base flock of 18um, 4.8kg greasy fleece weight and 50kg ewes were changed to reflect 10 years of breeding using the different industry indexes to give 3 new flocks:

- FP – 17.2um, 4.93kg fleece, 50.4kg body weight
- MP – 17.6um, 5.1kg fleece, 51.8kg body weight
- DP – 17.9um, 5.0kg fleece, 53.3kg body weight
- No improvement -18um, 4.8kg fleece, 50kg body weight

Table 7 gives the average profit per hectare for the 'new' flocks run under the 3 different climates. By looking across the table you see the effects of the 3 potential climates. By looking down a column you see the effects of the different breeding strategies. The 2014 prices and costs have been used for all time periods.

Table 7.

	C4	MP	H2
FP	$333	$297	$199
MP	$328	$295	$193
DP	$313	$273	$186
No improvement	$308	$278	$179

The difference between the 3 climates is substantial and swamps any changes to the breeding direction. The trend with the 3 new flocks is the same across the climates, FP is always the most profitable and the DP flock is always the least and rarely above the do nothing option. This work combines a number of changes within the flock so to separate the effects of the different traits; the next table looks at the effects of changes to a single trait.

The 3 new flocks are:

- A fibre diameter change – 17.2um, 4.8kg fleece, 50kg body weight
- A fleece weight change – 18um, 5.07kg fleece, 50kg body weight
- A body weight change – 18um, 4.8kg fleece, 52.1kg body weight

These changes are of the same order of magnitude or ability to achieve.

Table 8.

	C4	MP	H2
- FD	$323	$288	$190
+ Flc WT	$329	$297	$197
+ B WT	$308	$269	$171
No improvement	$308	$278	$179

The same effect of climate applies to this work; it swamps the changes from genetics. Increasing fleece weight gave the best result across all climates with fibre diameter just behind. Body weight increase was always the lowest strategy and not much different from doing nothing.