# Unpublished Report

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# Calculating Relative Economic Values

## using MIDAS

Farming Systems Analysis Service
19th December 2010

## Background

Genetic selection allows breeders to alter the production and fitness characteristic of animals. These changes can and do impact on the profitability of commercial growers. To maximise the financial benefit for commercial producers from genetic selection of animals requires that all traits that are commercially important are included in the breeding objective and that the weighting applied in the index reflects their commercial reality.

The aim of this paper is to calculate the economic values of a range of traits using the MIDAS wholefarm models.

## Method

### *MIDAS*

The analysis was carried out using the MIDAS suite of models. Two regions have been analysed, the high rainfall regioin of SW Victoria and the cereal sheep zone in WA. For the High rainfall region the Hamilton version was used and for the cereal-sheep zone the Central Wheatbelt model was used. The standard prices and a summary of the standard farm are provided in Tables 1, 2 & 3.

**Table 1: Prices used in this analysis**

| | Quality | Units | |
|---|---|---|---|
| Wool price by fibre diameter | 17u<br>18u<br>19u<br>20u<br>21u<br>22u | $/kg clean<br>(sweep the board) | 16.75<br>14.20<br>11.70<br>9.60<br>8.45<br>7.66 |
| Animal sale price | Lamb<br>Ewe Hogget<br>CFA Ewe 5.5yo<br>6.5yo<br>Wether Hogget<br>Older Wethers | $/kg DW<br>$/kg DW / ($/hd)<br>$/kg DW / ($/hd)<br>$/kg DW / ($/hd)<br>$/kg DW / ($/hd)<br>$/kg LW / ($/hd) | 3.25<br>2.05 (43)<br>1.65 (41)<br>1.40 (35)<br>2.40 (53)<br>0.90 (60) |
| Crop Prices | Wheat<br>Barley<br>Oats<br>Lupins<br>Canola | $/t gross<br>$/t gross<br>$/t net on farm<br>$/t gross<br>$/t gross | |

**Table 2: High rainfall SW Victoria standard farm production profile for the 3 flocks examined.**

| | Units | Merino | MPL | 1st Cross |
|---|---|---|---|---|
| Profit | $/farm<br>$/ewe | -5 490<br>-1.55 | 21 155<br>4.70 | 30 880<br>6.85 |
| Farm size | ha | 1000 | 1000 | 1000 |
| Area of Pasture | ha<br>% of farm | 1000<br>100% | 1000<br>100% | 1000<br>100% |
| Stocking rate | DSE/WG ha | 7.8 | 8.1 | 8.1 |
| Number of ewes | hd | 3600 | 4510 | 4500 |

| | | | | |
|---|---|---|---|---|
| No. of ewe hoggets | hd | 1495 | 1880 | 1135 |
| Lambing % | Lambs/ewe joined | 88 | 88 | 89 |
| Flock structure | % ewes<br>Sale age ewes (yr)<br>Sale age wethers (yr) | 66%<br>5.5<br>1.5 | 79%<br>5.5<br>0.5 | 79%<br>5.5 & 6.5<br>0.5 |
| Grain feeding | kg/DSE | 24 | 27 | 30 |

**Table 3: Cereal sheep zone of WA standard farm production profile for the 3 flocks examined.**

| | Units | Merino | MPL | 1st Cross |
|---|---|---|---|---|
| Profit | $/farm<br>$/ewe | 115 500<br>90.43 | 119 850<br>71.65 | 127 100<br>66.95 |
| Farm size | ha | 2000 | 2000 | 2000 |
| Area of Pasture | ha<br>% of farm | 492<br>25% | 440<br>22% | 530<br>27% |
| Stocking rate | DSE/WG ha | 8.2 | 7.5 | 7.9 |
| Number of ewes | hd | 1275 | 1675 | 1900 |
| No. of ewe hoggets | hd | 526 | 690 | 450 |
| Lambing % | Lambs/ewe joined | 87 | 87 | 88 |
| Flock structure | % ewes<br>Sale age ewes (yr)<br>Sale age wethers (yr) | 45%<br>5.5<br>4 | 72%<br>5.5<br>0.5 | 64%<br>6.5<br>4 |
| Grain feeding | kg/DSE | 15 | 28 | 24 |

Three different animal production systems were evaluated:

1. Merino Wool system: Merino ewes are mated to merino rams and wether progeny are sold at the optimum time selected from the range from 5 months of age through to 6.5 years.
2. Merino Prime Lamb system: As for the Merino wool system except there is the option to finish the merino lambs and turn them off as prime lamb at 6.5 months of age.
3. First Cross Lamb system: As for the Merino Prime Lamb system with the addition that surplus young ewes and 5.5 year old ewes can be mated to a terminal sire to produce first cross lambs that are sold as finished lambs at 5 months of age.

The models were able to optimise the flock structure by altering the sale age of CFA ewes (5.5yo or 6.5yo) and the sale age of wethers (5mo through to 6.5yo). However, the sale age of surplus young merino ewes was fixed at 18 months to represent that these animals will need to be carried through to this age to allow an opportunity for them to be evaluated as to their genetic potential. The model was constrained to only one CS profile for the ewes to allow the Lifetimewool relationships to be represented because the model doesn't include the capacity to represent the Lifetimewool relationships and optimise ewe CS profile.

All husbandry costs other than drenching were costed on a $/hd basis, whereas cost of drenching was costed on $/kg on the basis that the quantity of drench used would vary with the weight of the animal being treated.

One shortcoming of MIDAS in calculating the economic value of genetic change is that it is a static equilibrium model and as such it doesn't account for the change of production over time and the implication for discounting the benefits that accrue in future years.

## *Traits Valued*

Traits have been valued from the perspective of the commercial producer assuming that there is no affect of improving any of the traits on prices received for produce. This assumption is valid if decisions on breeding objectives are made in isolation, however, it may not be valid for some traits if a majority of the industry follow a similar index.

This analysis has been done for a breeding objective that includes clean fleece weight (CFW), fibre diameter (FD), post weaning weight (PWWT), adult weight (AWT) and number of lambs weaned (NLW). Where traits are expressed multiple times during the animal's lifetime (eg animals are shorn each year and therefore express CFW & FD each year) it has been assumed that the change in the trait is the same on each expression. This however, is unlikely to occur in reality so separating into multiple traits at each time of expression would be more accurate.

**Table 4: Traits that were valued in this analysis and possible high level parameters that could be altered in the model to achieve variation in the trait. The parameter used in the analysis is highlighted in bold.**

| Trait | Model parameters that affect this trait | | |
|---|---|---|---|
| CFW | **Efficiency** | Appetite | Partitioning |
| FD | **Follicle density** | **L/D ratio** | Wool density |
| PWWT | **SRW** | Maintenance req | Appetite |
| AWT | **SRW** | | |
| NLW | **Fertility** | **Prolificacy** | **Survival** |

CFW = clean feece weight, FD = fibre diameter, PWWT = post weaning weight, AWT = adult weight, NLW = number of lambs weaned, BWS = breech wrinkle score, SRW = Standard Reference Weight.

## *Modelling the Economic Values*

Two changes were made to the model to reflect ideas of Goddard (1998)

1. All fixed costs associated with animal production were changed to variable costs
2. A cost on assets was introduced into the objective function so that the objective function better reflects 'normal profit' and it is closer to zero.

Use of the MIDAS suite of models also ensures that all management variables are optimised and this removes any inaccuracies caused by scale variables.

As described by Goddard 1998 the calculation of the economic value of a trait should be done when other traits that are included in the breeding objective are held constant i.e. only the corresponding change in traits that aren't in the breeding objective are valued. The rational for this is that the (genetically) correlated change in the other traits will be valued because of the change in that traits breeding value. An implication of this is that the economic value of a trait will change depending on the list of other traits included in the breeding objective.

There appears to be a shortcoming in this approach described above which occurs when the genetic correlation between 2 traits has been corrected for another trait such as rear rank or weight at measurement. An example of this is the number of lambs weaned trait (NLW) for which the correlation to CFW & FD is corrected for birth rank and rear rank, in this case the genetic correlation will be captured by the change in breeding value of CFW & FD however, the phenotypic change that occurs because more lambs are born as twins will be missed. Furthermore when NLW is increased more ewes are pregnant and more ewes are pregnant with twins and this reduces the wool production from these ewes. In this analysis the economic value of number of lambs weaned has been calculated for both sets of assumptions.

In this analysis the change in appetite and energy requirement that occurs when the trait values are altered has been calculated using a simulation model that relates appetite and maintenance requirement to current liveweight and the standard reference weight (SRW) of the genotype. When altering the simulation model there are a number of possible parameters (related to different physiological mechanisms) that could be altered to achieve the required change in production. The implications of choosing different physiological mechanisms for the change in production has not been examined, but is an area that deserves further analysis, particularly for CFW.

### Clean Fleece Weight

The increase in CFW was achieved by assuming the increase is achieved by increasing the efficiency of wool growth i.e. intake, maintenance requirement and animal growth was unaffected. This is consistent with genetic studies that have shown that there is no genetic correlation between CFW and intake (*reference required*), however, this doesn't examine whether there is a metabolic cost associated with the increased CFW. An example of possible mechanisms that would result in a metabolic cost would be having the maintenance cost of a more metabolically active skin or the cost of increased protein turnover to provide the amino acids necessary for wool growth.

### Fibre Diameter

The reduction in FD was achieved by assuming that the wool is grown from more follicles (so each follicle is producing less wool) and that the length/diameter ratio for the follicle changes such that the same length of fibre is produced even though less is grown by each follicle. It was assumed that there was no metabolic cost associated with this change in production.

### Post Wean Weight & Adult Weight

The increase in post weaning weight was achieved by increasing the SRW of the genotype. Increasing the SRW increases the animals appetite at a given liveweight and it also alters the muscle:bone:fat ratio at any given weight & age combination. For each 1kg increase in SRW the AWT at 4 years of age increased by 1kg, however, the increase in PWWT at 8.7mo varied depending on the level of feeding of the lambs and the growth potential. For the store merino lambs the increase was 0.3kg, for the merino prime lambs with a higher level of nutrition the increase was 0.55kg and for the first cross lambs the increase was 0.45kg. The increases in post wean weight was utilised by selling the heavier animals at the same age and growing them out to heavier weights.

The variation in PWWT between the finished merino lamb and the store merino lamb for the same change in genotype raises the question of what magnitude should be used for the change in the trait when calculating the economic value per unit of change. Also, if nutrition is having an impact as calculated by the simulation model then there are implications for genetic analyses that are linked across environments because a 1kg difference in PWWT between genotypes in a high nutrition environment will only be expressed as a 0.55kg difference in a low nutrition environment.

For the lambs being retained it was calculated from the relationships developed by Angus Campbell that an increase in weaning weight of 0.3kg would result in a 0.08% increase in weaner survival during their first summer.

To bend the growth curve (and get dissociation between PWWT & AWT) it was assumed that the SRW of the animal reduced once the animal reached 10 months of age i.e. the animal grew as if it was a large genotype but once it reached 10 months of age the growth reverted to that expected from a smaller genotype. The reversion was assumed to occur over a period of 14 months.

The increases in number of lambs weaned and clean fleece weight that were predicted from having animals with a higher SRW were not included in the analysis, but the increase in feed consumption that was simulated for animals run on the same pasture base (FOO and digestibility) was included.

### Number of Lambs Weaned

The increase in number of lambs weaned was achieved by a combination of an improvement in fertility, fecundity and survival. As previously described this analysis has included the reduction in CFW & FD of ewes that occurs as a result of being pregnant and lactating with more lambs and the effect on the progeny as a result of more of the progeny being twins. Twin born lambs are phenotypically smaller than their single born counterparts however, the implications of this on sale weights has not been included and the impact on post weaning survival has also not been included.

## Results

**Table 5: High Rainfall zone, change in farm profit ($/farm) from altering the genotype of animals in each of the 3 flocks.**

| Trait | change | Merino | MPL | 1st X |
|---|---|---|---|---|
| CFW | +1% | 2060 | 2080 | 2030 |
| FD | -0.1u | 3125 | 2920 | 2770 |
| NLW | +0.05 lamb | 1895 | 3985 | 12 470 |
| PWWT | +2.25kg | 155 | 1000 | 940 |
| AWT | +4.5kg | -5330 | -10 086 | -15 720 |

**Table 6: Cereal Sheep zone, change in farm profit ($/farm) from altering the genotype of animals in each of the 3 flocks.**

| Trait | change | Merino | MPL | 1st X |
|---|---|---|---|---|
| CFW | +1% | 1330 | 1340 | 1720 |
| FD | -0.1u | 3345 | 1245 | 2765 |
| NLW | +0.05 lamb | 1185 | 1210 | 6630 |
| PWWT | +2.25kg | -515 | 1485 | 525 |
| AWT | +4.5kg | -2320 | -2415 | -3500 |

The value of increasing PWWT in the merino wool flocks is close to zero or negative because the lambs are being retained and sold as hoggets so having greater early growth rate and improved lamb survival is outweighed by the extra energy requirement. Whereas for the flocks selling merino prime lamb or crossbred lamb there is an increase in profit from increasing PWWT.

### *Pasture Productivity*

**Table 7: Impact of varying the pasture system on the economic values for the Merino Wool flock of each of the production traits relative to the value of altering clean fleece weight.**

| Trait | | High rainfall zone Standard | Pasture Triple | Cereal Sheep zone Standard | plus Lucerne |
|---|---|---|---|---|---|
| CFW | +1% | 1.0 | 1.0 | 1.0 | 1.0 |
| FD | +1u | -15.20 | -15.20 | -25.15 | -12.44 |
| NLW | +1 lamb | 18.41 | 21.47 | 19.79 | 7.81 |
| PWWT | +1kg | 0.10 | 0.06 | -0.28 | -0.14 |
| AWT | +1kg | -0.58 | -0.50 | -0.39 | -0.42 |

## *Animal Production System*

**Table 8: High rainfall zone, economic values of each of the production traits relative to the value of altering clean fleece weight for each of the 3 animal production systems examined.**

| Trait | change | Merino | MPL | 1st X |
|---|---|---|---|---|
| CFW | +1% | 1.0 | 1.0 | 1.0 |
| FD | +1u | -15.20 | -14.06 | -13.66 |
| NLW | +1 lamb | 18.41 | 38.36 | 122.96 |
| PWWT Maternal | +1kg | 0.10 | 0.19 | 0.35 |
| Terminal | +1kg | - | - | 0.68 |
| AWT | +1kg | -0.58 | -1.08 | -1.72 |

**Table 9: Cereal Sheep zone, economic values of each of the production traits relative to the value of altering clean fleece weight for each of the 3 animal production systems examined.**

| Trait | change | Merino | MPL | 1st X |
|---|---|---|---|---|
| CFW | +1% | 1.0 | 1.0 | 1.0 |
| FD | +1u | -25.15 | -9.27 | -16.07 |
| NLW | +1 lamb | 19.79 | 20.04 | 85.58 |
| PWWT Maternal | +1kg | -0.28 | 0.44 | 0.23 |
| Terminal | +1kg | | | 0.36 |
| AWT | +1kg | -0.39 | -0.40 | -0.45 |

## *Initial Genotype*

**Table 10: Impact of initial genotype on the economic values for the Merino Wool flock of each of the production traits relative to the value of altering clean fleece weight.**

| | | High rainfall zone | | Cereal Sheep zone | |
|---|---|---|---|---|---|
| Trait | | Standard | FD -1u | Standard | FD -1u |
| CFW | +1% | 1.0 | 1.0 | 1.0 | 1.0 |
| FD | +1u | -15.20 | -15.83 | -25.15 | -14.17 |
| NLW | +1 lamb | 18.41 | 16.17 | 19.79 | 5.54 |
| PWWT | +1kg | 0.05 | -0.18 | -0.28 | -0.22 |
| AWT | +1kg | -0.58 | -0.64 | -0.39 | -0.32 |

## *Price Scenario*

**Table 11: High rainfall zone, impact of different price scenarios on the economic values for the Merino Wool flock of each of the production traits relative to the value of altering clean fleece weight.**

| Trait | | Standard | Wool Prc +20% | FD Prem -50% | Meat Prc +20% |
|---|---|---|---|---|---|
| CFW | +1% | 1.0 | 1.0 | 1.0 | 1.0 |
| FD | +1u | -15.20 | -15.12 | -7.63 | -15.20 |
| NLW | +1 lamb | 18.41 | 13.71 | 18.71 | 26.27 |
| PWWT | +1kg | 0.05 | -0.24 | 0.27 | 0.19 |
| AWT | +1kg | -0.58 | -0.66 | -0.51 | -0.58 |

**Table 12: Cereal sheep zone, impact of different price scenarios on the economic values for the Merino Wool flock of each of the production traits relative to the value of altering clean fleece weight.**

| Trait | | Standard | Wool Prc +20% | FD Prem -50% | Meat Prc +20% |
|---|---|---|---|---|---|
| CFW | +1% | 1.0 | 1.0 | 1.0 | 1.0 |
| FD | +1u | -25.15 | -14.55 | -8.00 | -14.53 |
| NLW | +1 lamb | 19.79 | 3.53 | 13.55 | 18.00 |
| PWWT | +1kg | -0.28 | -0.23 | -0.08 | -0.08 |
| AWT | +1kg | -0.39 | -0.29 | -0.31 | -0.14 |

## *Correlated Traits & NLW*

**Table 13: Economic value of NLW relative to CFW and the impact of excluding the impact of NLW on twin lamb production and production of pregnant and lactating ewes.**

| | High rainfall | | Cereal sheep | |
|---|---|---|---|---|
| | Included | Excluded | Included | Excluded |
| Merino | 18.41 | 32.33 | 19.79 | 48.15 |
| MPL | 38.36 | 50.90 | 20.04 | 30.23 |
| 1st X | 122.96 | 134.40 | 85.58 | 98.37 |

## *Feed Demand & Growth Rate*

**Table 14: Economic value of PWWT relative to CFW and the impact of excluding the change in energy requirements resulting from increasing animal size.**

| | High rainfall | | Cereal sheep | |
|---|---|---|---|---|
| | Included | Excluded | Included | Excluded |
| Merino | 0.05 | 1.70 | -0.28 | 0.81 |
| MPL | 0.19 | 0.86 | 0.44 | 0.57 |
| 1st X | 0.35 | 1.60 | 0.23 | 1.07 |

**Table 15: Economic value of AWT relative to CFW and the impact of excluding the change in energy requirements resulting from increasing animal size.**

| | High rainfall | | Cereal sheep | |
|---|---|---|---|---|
| | Included | Excluded | Included | Excluded |
| Merino | -0.58 | 0.64 | -0.39 | 0.58 |
| MPL | -1.08 | 0.49 | -0.40 | 0.26 |
| 1st X | -1.72 | 0.47 | -0.45 | 0.58 |

## Discussion

There are 4 useful comparisons that can be made using the results and these are:

1. Comparison of these results with current industry indices. This provides an indication of the possible benefits for the industry from improving the method used to quantify breeding objectives.
2. Comparison of the economic values calculated for different regions, different pasture systems and different animal production systems. This provides an idea of the magnitude of the benefits that could be achieved from matching the genotype to the environment and management system.
3. Comparison of the economic values calculated with different assumptions relating to correlated traits and energy requirements. This quantifies some of the differences between methods that have been used in the past for calculating the economic value of different traits.
4. Comparison of the economic values calculated with the different physiological assumptions made. This indicates how important it is to understand the physiological changes that are occurring in the animal when genetic selection is occurring.

Each of these comparisons will be discussed separately

### *Comparison with Industry indices*

To be able to make these comparisons requires access to the standard indices developed by Sheep Genetics that are used by the industry.

### *Comparison between regions and pasture systems*

A comparison of the economic values between regions and between pasture production systems gives an indication of the importance of tailoring a breeding index to the environment. Currently 2 regions have been calculated and there are also comparisons that can be made between pasture systems and animal production systems (Table 7, 8 & 9).

The pasture system being used within a region has an impact on the value of increasing NLW because changing the pasture production profile alters the cost of providing feed for the extra ewes that are pregnant and lactating and for the extra lambs that are born and survive. A comparison of perennial ryegrass and summer active perennials in SW Victoria shows an increase in the value of NLW of 16.5%.

Changing the animal production system has a major impact on the value of NLW and it also alters the value of early growth of animals. The value of increasing NLW is lowest in the merino wool flock and highest for the 1$^{st}$ cross lamb flock which is consistent with the sale value of the lambs. The difference in the value between these flocks is 607%, however, the impact of this on the rate of gain in NLW that would be achieved from the different breeding objectives has not been quantified.

Comparing between regions (Table 8 c.f. Table 9) shows there are big differences in the value of increasing PWWT between the 3 animals systems across regions. In the high rainfall zone the benefits of increased PWWT in the lamb productions systems are much higher than in the cereal sheep zone.

The value of increasing the growth rate of animals is a trade-off between the extra energy required in order to grow faster and the extra income that can be achieved from the heavier sale animals. For the Merino Wool flock there is very little benefit from heavier animals because there are relatively few animals being sold compared with the amount of energy required to maintain the animals being retained on the farm and the value of increasing PWWT is 0.05 & -0.28 for the HRZ & CSZ respectively. Whereas, for the flocks turning off Merino Prime Lamb or 1st cross lamb there are relatively more sale animals compared with the extra energy required and the value of PWWT is 0.19 & 0.35 for the HRZ and 0.44 & 0.23 for the CSZ.

For all flocks in both zones there are costs involved in having larger mature animals because the increase in the energy required to maintain the larger animals each year is less than the extra sale value of the animals when they are sold. The value of AWT is more consistent between the 3 flocks and varies between -0.39 & -1.72.

### *Comparison between calculation systems*

Including or excluding the assumptions of the impact of NLW on twin lamb production and ewe production has a large impact on the value of NLW for the merino wool flock but less effect on the Merino Prime Lamb flock and the 1st cross flock (Table 13). The magnitude of the impact on the merino wool flock (+75% & +140% for HRZ & CSZ) means that this is likely to be a significant factor and should be examined in more detail.

### *Comparison between different physiological assumptions*

A comparison between different physiological assumptions has not been carried out yet.