# Whole farm analysis versus activity gross margin analysis: a sheep farm example

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**Abstract**

Analysing and understanding the performance of livestock activities is important for an effective assessment of how management changes might influence farm returns and risk. Models have been developed that allow simulation of pasture and animal growth across different years and climatic conditions to provide some estimate of performance and climate risk. Gross margins are a traditional method used to assess farm activities. However, they have a limited ability to inform farm management decisions. This study uses a whole farm approach and risk assessments to compare two alternative sheep activities for a farm business. The performance of a 'first cross ewe' (1 x ewe) activity is compared to the performance of a 'Merino ewe joined to terminal sire' (M x T) activity.

The 'M x T' activity generated a higher average gross margin than the '1 x ewe' activity ($423 vs. $353/ha). Using the whole farm systems approach, the 'M x T' activity generated higher annual average Net Farm Income, Net Cash Flow, Change in Equity, Return on Capital and Return on Equity with greater variance around the means. Results indicate that for assumed degrees of aversion to risk, the values of profit generated by the 'M x T' enterprise outweigh the extra risk associated with this activity. The conclusion is that the whole farm approach enables decision makers to better weigh up the choice of livestock activities by considering the implications for economic efficiency of the business, cash flow, growth in wealth and risk.

**Keywords:** gross margin, whole farm systems analysis, risk, sheep activities

## Introduction

A key task of farm management is to make choices between alternatives (Malcolm *et al.* 2005). The complexity of livestock activities has long been recognized (Dillon and Burley 1961). Key elements that determine outputs from livestock activities are rainfall and temperatures and variation in seasonal conditions. They are out of the control of managers. A challenge for graziers is determining the economic merit of alternative livestock activities. The development of the pasture and animal growth model GrassGro® (Moore *et al.* 1997) has enabled the key elements of the pasture and livestock complex to be represented soundly and over time (Clark *et al.* 2000), providing a powerful analytical tool that can explain much about livestock activities and seasonal variation in production.

Many articles published in the technical literature report applications of GrassGro®, answering questions about how farm livestock activities might perform when changes are imposed (e.g. Salmon *et al.* 2004; Warn *et al.* 2006;Graham and Hatcher 2006; Mokany *et al.* 2009). These analyses use gross margin (Total Income – Variable Costs) to determine the performance of livestock activities and draw conclusions accordingly. Activity gross margins are partial representations of reality and have limited ability to answer questions about which livestock activity to run in a farm business. Whole farm analysis is a more complete approach than gross margin analysis. Users of the whole farm approach are able to consider cash, profit, wealth and risk aspects of the investment. Risk and return both matter in decisions, especially the trade-off between them.

Therefore, the hypothesis is that linking whole farm economics, finance and risk to information from GrassGro® analysis informs decision-makers about their choices better than gross margin analyses. A sheep farm model is used to demonstrate the two approaches.

## Materials and Methods

A comparison is made of two potential sheep activities a farm business might consider. The activities and the whole farm system used is previously defined in a gross margin analysis published by Graham and White (2010). One potential activity is a 'first cross ewe' (1 x ewe) enterprise, characterised by Border Leicester x Merino ewes joined to Dorset rams. The alternative activity is a Merino ewe flock joined to Dorset rams (M x T). Each activity was defined in GrassGro® and adjusted so that annual animal intake of pasture was similar, with stocking rates adjusted according to differences in animal demand in each activity (Graham and White 2010). A project steering committee of farmers, consultants and scientists directed this work. A minor modification was made to the farm system of the Graham and White (2010) analysis.

In the original study, the base farm comprised 100 ha of arable land, as the results were compared on a gross margin $/ha basis. For the whole farm management economic approach used here, the farm area was increased to a farm size of 800 ha; the size determined to be representative of farms in the Yass region of NSW (P. Graham pers. comm.). Production data was calculated for each animal activity and for each year, based on soil, plant and daily weather data for Yass from 1960-2012. Details of the physical resources of the farm, plus each of the activities, are provided in Table 1. The average and standard deviation of various production parameters for each of the farm systems are provided in Table 2. Gross margins (income minus variable costs, presented on a per hectare basis) for each of the farm systems were determined using GrassGro® and the costs and prices are presented in Table 3.

A one year whole farm systems economic model (the 'Lamb Directions' model) was developed using whole farm management economic principles, e.g. Malcolm *et al.* (2005), as this was considered the most valid comparison with Graham and White's work. Annual (1960-2012) production outputs from GrassGro® modelling were inputs in the 'Lamb Directions' model. While the outputs from GrassGro® simulated weather risk, price risk was also included for the 1 x ewe and M x T farmmodels. Stochastic simulation was carried out using @RISK, an add-in package to Microsoft Excel, which allows probability distributions to be defined for uncertain variables using Monte Carlo sampling (Palisade 2013). The key inputs to each system for which probability distributions were defined were: lamb price (c/kg carcase weight (CW)), skin price ($/hd), replacement ewe price ($/hd), wool price (c/kg clean wool), sheep meat price ($/kg CW), supplementary feed price ($/t) and fertiliser price ($/t). The key percentiles and distribution type for each of these distributions are presented in Table 4. Justification for using the distributions is presented in Table 5. Correlations between lamb price and cull ewe price (+0.9), and lamb price and replacement ewe price (+0.9) were included. Activity variable costs taken from the NSW Industry and Investment Farm Enterprise Budget Series (December 2011, Table 6) are used and whole farm fixed costs were estimated by the project steering committee (Table 7). It was assumed that the farmer had 80% equity in the business (Table 8).Interest of 8% p.a. was charged on the outstanding debt balance.An average tax rate of 15% on positive annual net farm income was assumed.

Sampling was such that the production outputs from the GrassGro® analysis of one randomly selected year (1960-2012) was multiplied by variable costs and prices determined through Latin Hypercube sampling of the probability distributions of the stochastic variables. A large number of iterations of the annual budget using this sampling technique were analysed to form a distribution of the full range of possible outcomes for each of the key measures of whole farm performance for each of the two sheep activities. Key measures of performance used in this analysis were Annual Operating Profit, Annual Net Farm Income, Annual Net Cash Flow, Annual Change in Equity, Annual Return on Capital and Annual Return on Equity.

Multivariate stepwise regression was used to determine the contribution of each uncertain variable to the estimated variability of return on capital for each activity. The derived coefficients generated using @RISK represent normalised regression coefficients associated with each input, indicating the standard deviation change in output for each unit standard deviation in the input (Palisade 2013).

Finally, a formal approach to considering risk in farm decision making was included in the analysis. Stochastic Efficiency with Respect to a Function (SERF, Hardaker *et al.* 2004) analysis was used to investigate which risk-return combination from the 1 x ewe and M x T activity analyses would best suit decision makers with a range of degrees of aversion to risk. This approach uses information about the risk-return trade-off as shown in the distribution of operating profits from each whole farm system. For a range of assumed degrees of aversion to risk, the SERF analysis uses certainty equivalent calculations to define which risk-return combination would best suit decision makers with a range of degrees of aversion to risk.

**Results**

Using the production parameters outlined in Table 1, and costs and prices outlined in Table 3, estimated average (+/- standard deviation) annual gross margin derived from the GrassGro® analysis was $344/ha (+/- $136/ha) for the 1 x ewe activity and

$361/ha (+/- $147/ha) for the M x T activity (Table 9). The standard deviation of these results represents annual variation in production parameters due to weather variation (1960-2012). Based on the production details of Table 1, and Monte Carlo sampling of costs and prices outlined in Tables 4 and 6, estimated average annual gross margin derived from the whole farm model was $353/ha (+/- $159/ha) and $423/ha (+/- $165/ha) for the 1 x ewe and M x T activities respectively (Table 9).

The average and standard deviation of the results of the whole farm analysis are presented in Table 10. Gross farm income derived from lamb sales on average is approximately $22K higher in the 1 x ewe activity than the M x T activity ($529K vs $507K). However, the higher wool income ($133K) in the M x T activity compensated for this, being $214K for the M x T activity vs $81K for the 1 x ewe activity. Gross income was around $110K higher in the M x T activity than the 1 x ewe activity. The standard deviation around gross income was $120K in the 1 x ewe activity and $114K in the M x T activity.

Total variable costs were higher ($446K vs $393K) in the M x T activity due to higher average supplementary feed costs (~$34K higher), higher replacement ewe costs, animal health costs and shearing/crutching labour. Variability in variable costs is also slightly higher compared to the 1 x ewe activity. The overall result is that the average total gross margin of the M x T activity was around $70/ha greater than the 1 x ewe activity.

Earnings before interest, lease and tax is $49K higher for the farm system with the M x T activity. After taking into account interest charges (8% on 20% of total farm assets), average net farm income is $138K for the system with the 1 x ewe activity (+/- $127K) and $186K for the M x T activity (+/- $131K). After allowing for 15% tax on positive net farm income, annual average change in equity is $127K for the 1 x ewe activity (+/- $118K) and $170K (+/- $120K) for the M x T activity.

The M x T activity had $109K higher average cash income and $66K higher average expenses than the 1 x ewe activity however this resulted in a $43K higher net cash flow (Table 11). The farm business with the M x T activity also has a slightly higher standard deviation around average net cash flow. The analysis indicated that the M x T activity has a higher Return on Capital and Return on Equity but also has a greater variability in return (Table 12).

Risk analysis enables the contribution of each uncertain variable to the estimated variability of whole-farm profit to be identified. The contribution of key variables to return on capital for the 1 x ewe and M x T activities are presented as regression coefficients in tornado graphs (Figures 1 and 2). These graphs indicate that, based on the probability distributions included in the whole farm model, lamb price ($/kg CW) had the greatest influence on the profitability of each of the activities. For the 1 x ewe activity, replacement ewe price ($/hd) and lamb skin price ($/hd) contributed the next most to estimated variation in return on capital. 'Year' (the fourth most important variable for the 1 x ewe activity) represents the quantities of inputs used and outputs produced by the farm. Distributions of these quantities were obtained from the biophysical model GrassGro®. Variation in these quantities is primarily caused by differences in rainfall from year to year. 'Year' does not rate in the top five regression coefficients for the M x T system (Figure 2). After lamb price ($/kg CW), replacement ewe price and wool price were the next key drivers of profitability with the M x T activity. While correlations have been included in the whole farm model, they had little impact on the results of this regression analysis. These results indicate that price variability contributes more to the variability of farm profit than variation in quantities of farm inputs and outputs for both the 1 x ewe and M x T activities described here.

A SERF analysis was used to estimate the 'certainty equivalent' value of each distribution of profit, across the range of attitudes to risk that Australian farmers are likely to have (Figure 3). Previous studies have found that Australian farmers generally have relatively low levels of risk aversion (Bardsley and Harris 1987). The more risk averse an individual is, the stronger is their preference to avoid risk. Figure 3 shows that an individual with an extremely low level of risk aversion will accept approximately $100,000 in exchange for the risky distribution of profit generated by the business with the 1 x ewe activity (which had a mean of $126,652 +/- $117,535). Conversely, someone with a much higher degree of risk aversion will accept approximately $34,000 in exchange for the same risky distribution of profit. In comparison, this analysis suggests that an individual with an extremely low level of risk aversion will accept around $141,000 in exchange for the risky distribution of profit generated by the farm with the M x T activity (mean $170,029+/- $119,972). The certainty equivalent values of profit generated by the

M x T activity are higher than those associated with the 1 x ewe activity across the range of risk preferences represented in this analysis. This indicates that the value of the extra profit generated by the M x T enterprise is more than enough to compensate for the extra risk associated with this farming system.

## Concluding discussion

The hypothesis is that decision makers will be better informed regarding the choices about animal activities if they used a whole farm economics approach rather than a more traditional approach like activity gross margin analysis. The latter method cannot describe the profitability or financial viability of a changed farm business. However, using the whole farm approach (Table 10), Operating Profit was used to calculate Return on Capital (ratio of operating profit to value of total capital used in the business), which is an indicator of economic efficiency. Return on Equity (ratio of net farm income to value of owner's equity) indicates the addition to owner's wealth. In this example, Return on Capital was 5.4% (+/- 3.5%) and 6.7% (+/- 3.6%) for the 1 x ewe and M x T activities respectively. These rates of return reflect the efficiency of use of capital in the business, and can be directly compared with alternate investment opportunities. Further valuable information comes from determining the average and standard deviation of annual growth in wealth, as well as annual net cash flows of each of the enterprises after accounting for finance and tax obligations. With risk incorporated, the decision maker is better informed to make decisions on choices about running their business that meet their return and risk preferences.

From the analysis conducted, the certainty equivalent values of profit generated by the M x T activity are higher than those associated with the 1 x ewe system across the range of risk preferences represented. This indicates that for famers with the risk preferences tested here, the value of extra profit generated by the M x T activity would be enough to outweigh the extra risk associated with this farm system.

The whole farm approach presented here ultimately provides a superior method of assessing the costs and benefits of alternative investments than the gross margin approach. For the purposes of this analysis, the time period of the analytical method was set by the analytical method of the original paper which was the basis of the comparison, and by the GrassGro® tool which estimates changes in annual gross margin as the measure of performance. The aim of the research was to highlight the limits of farm gross margin as a measure of whole farm performance, compared with the whole farm approach which assesses performance in terms of profit, cash, wealth and risk. However, farm investments are usually considered over a longer planning period, and incorporating a discounted net cash flow budget over a medium term (5-10 year) planning period to this analysis would improve the value of this method to decision makers. Additionally, the analysis could be further strengthened by investigating the sensitivity of alternative investments to different levels of gearing, as well as variable interest rates, over time. The attitude of farmers to taking and bearing risk in changing circumstances is also part of whole farm analysis.

The discipline of farm management economics is built on a whole farm system approach. Activity analysis is an important building block of any analysis of the whole system. The whole farm system economic approach takes activity analyses and goes further, considering relationships between all activities in a farm system, multiple goals of owners, and the farm business balance sheet (equity, debt, gearing, debt servicing requirements). In addition, changes in overhead costs as activity changes are implemented, changes in exposure to business risk and financial risk as activity change occurs and time aspects of change to individual activities are considered. Most important, the focus of the whole farm approach is on return *and* risk. Both matter to decision makers.

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## Appendix

Table 1. Details of the physical characteristics of the farm and the 1 x ewe and M x T lamb production systems as described by Graham and White (2010).

| | | General farm system information | |
|---|---|---|---|
| Total farm area | 100 ha | | |
| Weather Station | Yass | | |
| | | | |
| Steepness | Gentle | | |
| Soil evaporation | 3.5 mm/d$^{(1/2)}$ | | |
| Soil | Bookham P demonstration site - sandy loam over heavy clay | | |
| | | | |
| **Soil** | | Topsoil | Subsoil |
| Cumulative depth | (mm) | 460 | 1200 |
| Field Capacity | ($m^3/m^3$) | 0.24 | 0.33 |
| Wilting point | ($m^3/m^3$) | 0.06 | 0.28 |
| Bulk density | ($Mg/m^3$) | 1.36 | 1.7 |
| Saturate conductivity | (mm/hr) | 62.31 | 0.01 |
| Initial water | ($m^3/m^3$) | 0.06 | 0.32 |
| | | | |
| **Annual grass-sub clover** | | Annual ryegrass | Subclover - Seaton Park |
| Phenology | | senescent | senescent |
| Live DM | (kg/ha) | 0 | 0 |
| Standing dead DM | (kg/ha) | 3000 | 1000 |
| Litter DM | (kg/ha) | 500 | 200 |
| Below ground DM | (kg/ha) | 0 | 0 |
| Max. rooting depth | (mm) | 600 | 600 |
| Seed DM | (kg/ha) | 100 | 300 |
| | | | |
| **Farm system** | | **1 x ewe** | **M x T** |
| Livestock | | | |
| Breed | | Border Leicester x Merino | Medium Merino |
| Standard reference weight | | 70.0 kg | 55.0 kg |
| Greasy fleece weight | | 4.20 kg | 4.50 kg |
| Fibre diameter | | 27.0 microns | 20.0 microns |
| Fleece yield | | 68% | 69% |
| Ram breed | | Dorset (mature ram : 105 kg) | Dorset (mature ram : 105 kg) |
| Death rate : adults | | 4.0%/yr | 4.0%/yr |
| Death rate : weaners | | 1.5%/yr | 2.0%/yr |
| | | | |
| **Management Policy : ewe management** | | | |
| Stocking rate | | 5.3/ha | 6.9/ha |
| Shearing date | | 15-Dec | 15-Dec |
| Replacement rule | Purchase | ewes 2 Jan age 16 mo. LW 55 kg CS 2.5 | ewes 2 Jan age 16 mo. LW 43 kg CS 2.5 |
| | CFA | stock aged 6-7 years on 1 Jan. | stock aged 6-7 years on 1 Jan. |
| | | | |
| **Reproduction** | | | |
| First join at | | 1 year | 1 year |
| Mating date | | 29-Mar | 29-Mar |
| Conception at CS 3 | (1) | 21% | 45% |
| | (2) | 77% | 53% |
| | (3) | 0% | 0% |
| Birth date | | 25-Aug | 25-Aug |
| Castration | | yes | yes |
| Weaning date | | 15-Nov | 15-Nov |
| One ram per | | 100 ewes | 100 ewes |
| Keep rams for | | 3.0 years | 3.0 years |
| Sell young ewes | | when they reach 44 kg after 15 Nov, sell any remaining 0 year old animals on 15-Jun | |

| | | |
|---|---|---|
| Sell young wethers | when they reach 44 kg after 15 Nov, sell any remaining 0 year old animals on 15-Jun | |
| **Maintenance feeding rule** | | |
| Main flock | Feed in paddock. If animal condition falls to 2.0 during 1 Jan to 31 Dec, feed to maintain condition of the thinnest animals | |
| Weaner flock | Feed in paddock. If animal condition falls to 1.0 during 1 Jan to 31 Dec, feed to maintain condition of the thinnest animals | |
| | | Wheat, whole |
| Supplement | Proportion of mix | 100 |
| | Dry matter content | 89+% |
| | dry matter digestibility | 84% |
| | ME:DM (MJ/kg) | 13 |
| | Crude protein (%) | 13 |
| | Rumen degradable protein (%) | 92 |
| **Production feeding rule** | ad libitum in paddock from 1 Jan to 1 Jul<br>start feeding when available green DM <200 kg/ha<br>end feeding when available green > 800 kg/ha | |
| **Pasture rule reset** | 15-Apr | |

Table 2. Average and standard deviation of various production parameters for the 1 x ewe and M x T systems. The results represent the average and standard deviation based on GrassGro® modelling including 52 years of weather data for the Yass area.

| | **1 x ewe system** | | **M x T system** | |
|---|---|---|---|---|
| **Physical Details** | **Mean** | *Standard deviation* | **Mean** | *Standard deviation* |
| Land area | 800 | | 800 | |
| Rainfall | 686 | *136* | 686 | *136* |
| Feed budget - pasture growth | 8,292 | *2,681* | 8,155 | *2,644* |
| Feed budget - animal intake | 3,644 | *526* | 3,599 | *537* |
| Supplementary feed (t) | 273 | *307* | 424 | *314* |
| Average stocking rate (DSE/ha) | 13.1 | *0.80* | 13.6 | *0.8* |
| Average No. adults over the year (Mature & 1-2 y.o. Females) | 4,136 | *16* | 5,390 | *13* |
| Lamb marking % | 122% | *11%* | 93% | *5%* |
| Total No. of lambs sold | 5,055 | *515* | 5,029 | *297* |
| Lamb Production - Total Kilograms Carcass Weight | 104,928 | *9,738* | 99,945 | *5,897* |
| Lamb Production - Kilograms Carcass Weight per Hectare | 131.2 | *13.3* | 130.5 | *7.7* |
| No. kilograms of wool produced per hectare | 19.8 | *1.9* | 27.2 | *2.8* |

Table 3. Costs and prices used in the GrassGro® gross margin analysis of the 1 x ewe and M x T systems.

| **Costs** | | **1 x ewe** | | **M x T** |
|---|---|---|---|---|
| Ewe shearing ($/hd) | | 6.00 | | 6.00 |
| Lamb shearing ($/hd) | | 6.00 | | 6.00 |
| Ewe husbandry ($/hd) | | 4.75 | | 5.75 |
| Lamb husbandry ($/hd) | | 2.00 | | 4.50 |
| Ewe replacement ($/hd) | | 145.00 | | 120.00 |
| Ram replacement ($/hd) | | 1,100.00 | | 1,100.00 |
| Sheep sales commission (%) | | 5 | | 5 |
| Sheep sales cost ($/hd) | | 4.00 | | 4.00 |
| Pasture cost ($/ha) | | 40.00 | | 40.00 |
| Supplement costs ($/t) | | 280.00 | | 280.00 |
| **Prices** | | **1 x ewe** | | **M x T** |
| Wool prices for ewes (c/kg CF) | 23 µm | 1,250 | 18 µm | 1,461 |
| | 26 µm | 822 | 19 µm | 1,383 |
| | 28 µm | 632 | 20 µm | 1,328 |
| | 30 µm | 572 | 21 µm | 1,307 |
| | Average fleece price (%) | 89 | | 90 |
| | Wool commission (%) | 4 | | 4 |
| Ewe sales | Base price (c/kg CW) | 272 | | 272 |
| | Dressing percentage (%) | 42 | | 42 |
| | Skin price ($/hd) | 1.00 | | 1.00 |
| Ewe lamb sales | Base price (c/kg CW) | 452 | | 431 |
| | Dressing percentage (%) | 46 | | 44 |
| | Skin price ($/hd) | 10.00 | | 5.00 |
| Wether lamb sales | Base price (c/kg CW) | 452 | | 431 |
| | Dressing percentage (%) | 47 | | 45 |
| | Skin price ($/hd) | 10.00 | | 5.00 |

Table 4. Distribution types and key percentiles for various costs and prices included in the whole farm systems economics 'Lamb Directions' model.

| Variable | Distribution type | Min | 2% | 25% | 50% | 75% | 98% | Max | Average |
|---|---|---|---|---|---|---|---|---|---|
| Lamb Price ($/kg CW) | Gamma | $1.77 | $3.21 | $3.99 | $4.48 | $5.02 | $6.35 | None | $4.55 |
| Replacement 1st X ewe price ($/hd) | LogNormal | $0.00 | $93.25 | $123.68 | $141.99 | $163.02 | $216.21 | None | $145.00 |
| Replacement Merino ewe price ($/hd) | LogNormal | $0.00 | $65.70 | $93.59 | $111.28 | $132.30 | $188.48 | None | $115.00 |
| Cull ewe price ($/kg CW) | Beta general | $0.00 | $1.20 | $2.01 | $2.62 | $3.28 | $4.69 | $8.26 | $2.68 |
| 1st cross ewe wool price ($/kg CF) | Pert | $4.56 | $4.64 | $5.10 | $5.57 | $6.19 | $7.63 | $9.40 | $5.71 |
| Merino ewe wool price ($/kg CF) | Pert | $7.88 | $8.26 | $9.58 | $10.71 | $12.05 | $14.80 | $17.57 | $10.92 |
| Skin price (Lamb, $/hd) | Pert | $0.22 | $2.69 | $7.76 | $11.24 | $14.93 | $21.32 | $25.97 | $11.44 |
| Supplementary feed ($/t) | LogNormal | $0.00 | $149.52 | $207.23 | $243.10 | $285.17 | $395.23 | None | $250.00 |
| Fertiliser ($/t) | LogNormal | $0.00 | $292.52 | $329.17 | $348.72 | $369.44 | $415.71 | None | $350.00 |

Table 5. Justification for distributions used in the farm management economic 'Lamb Directions' analysis.

| Variable | Detail |
|---|---|
| Lamb Price ($/kg CW) | @RISK Fit Distribution function based on consumer price index adjusted Eastern States Trade Lamb Indicator data (2003-2013). |
| Replacement 1st X ewe price ($/hd) | @RISK Fit Distribution function used, based on expert opinion (project steering committee of farmers, consultants and research scientists). |
| Replacement Merino ewe price ($/hd) | @RISK Fit Distribution function used, based on expert opinion (project steering committee of farmers, consultants and research scientists). |
| Cull ewe price ($/kg CW) | @RISK Fit Distribution function based on consumer price index adjusted National Livestock Reporting Service data from NSW (2003-2012). |
| 1st cross ewe wool price ($/kg CF) | @RISK Fit Distribution function based on consumer price index adjusted northern micron price guide for 28 micron wool (2003-2012) |
| Merino ewe wool price ($/kg CF) | @RISK Fit Distribution function based on consumer price index adjusted northern micron price guide for 20 micron wool (2003-2012) |
| Skin price ($/hd) | @RISK Fit Distribution function based on consumer price index adjusted skin prices from the Hamilton sale yards (2000-2010). |
| Supplementary feed ($/t) | @RISK Fit Distribution function used, based on expert opinion (project steering committee of farmers, consultants and research scientists). |
| Fertiliser ($/t) | @RISK Fit Distribution function used, based on expert opinion (project steering committee of farmers, consultants and research scientists). |

Table 6. Variable costs for the 1 x ewe and M x T systems included in the whole farm systems economics 'Lamb Directions' analysis. Assumed average wool bale is 180 kg. Assumed 90% of clean fleece value across entire wool clip to take account of discounted lines (bellies/pieces/locks).

| Sheep Health | | $/application | No. applications | $/head |
|---|---|---|---|---|
| Broadspectrum | adults | $0.65 | 2 | $1.30 |
| | lambs | $0.33 | 3 | $0.99 |
| Narrowspectrum | adults | $0.45 in 1 x ewe<br>$0.38 in MxT | 1 | $0.45 in 1 x ewe<br>$0.38 in MxT |
| | lambs | $0.21 | 0 | $0.00 |
| Dipping | adults | $1.16 | 1 | $1.16 |
| | adults | $1.85 | 0 | $0.00 |
| Vaccination (6 in 1) | adults | $0.27 | 1 | $0.27 |
| | lambs | $0.27 | 1 | $0.27 |
| Marking | lambs | $1.55 | 1 | $1.55 |
| Scanning | ewes | $0.80 | 1 | $0.80 |
| **Labour** | | | | |
| Shearing | ewes | $5.89 | 1 | $5.89 |
| | rams | $8.50 | 1 | $8.50 |
| Crutching | ewes/lambs | $1.04 | 1 | $1.04 |
| | rams | $1.95 | 1 | $1.95 |
| **Wool costs** | | | | |
| Wool tax | | 2% | of wool income | |
| Commission, warehouse, testing charges | | $39.27 | /bale | |
| Wool | cartage | $18.00 | /bale | |
| | packs | $13.81 | /bale | |
| **Livestock Selling costs** | | | | |
| Livestock cartage | | | | $2.00 |
| Commission on sheep sales | | | 5.00% | |
| Levies (yard dues, MLA transaction levy and RLPB rates) | | | 2.14% | |
| **Other costs** | | | | |
| Fuel & Vehicle (annual cost) | | | $7,500 | |
| Repairs & maintenance (annual cost) | | | $10,000 | |
| Pasture maintenance | | $10/ha | | |
| Fertiliser | | 0.0005 t P/dse | | |

Table 7. Fixed costs used in the whole farm systems economics 'Lamb Directions' analysis. An additional $8,000 labour was included in the M x T activity to allow for additional labour requirements with higher ewe numbers (A. Kennedy pers. comm.).

| **Fixed Costs** | 1 x ewe system | M x T system |
|---|---|---|
| Labour | $ - | $8,000 |
| Depreciation | $15,000 | $15,000 |
| Rates | $7,000 | $7,000 |
| Administration | $3,000 | $3,000 |
| Other *(Electricity, Insurance, etc)* | $9,000 | $9,000 |
| | | |
| Operator's allowance | $ 52,000 | $52,000 |

Table 8. Assumed value of assets for each of the farm systems in the whole farm systems economics 'Lamb Directions' analysis.

| Value of assets | | 1 x ewe | | M x T |
|---|---|---|---|---|
| Owned land | $ | 2,900,000 | $ | 2,900,000 |
| Livestock | $ | 645,735 | $ | 621,730 |
| Plant and Equipment | $ | 105,000 | $ | 105,000 |
| Fodder | $ | 8,000 | $ | 8,000 |
| Total | $ | 3,658,735 | $ | 3,634,730 |

Table 9. Comparison of gross margins determined from the GrassGro® analysis and the whole farm systems economics 'Lamb Directions' analysis of the 1 x ewe and M x T lamb production systems.

| **Gross Margin comparison** | **GrassGro®** | **Lamb Directions** | **GrassGro®** | **Lamb Directions** |
|---|---|---|---|---|
| | **1 x ewe** | **1 x ewe** | **M x T** | **M x T** |
| | **$/ha** | **$/ha** | **$/ha** | **$/ha** |
| **Income** | | | | |
| Lamb sales | $647 | $661 | $565 | $634 |
| Cull ewe sales | $80 | $80 | $82 | $79 |
| Wool sales | $115 | $102 | $312 | $268 |
| Inventory change | $0 | $0 | $0 | $0 |
| Other | $0 | $0 | $0 | $0 |
| **Gross Income - per ha** | **$842** | **$843** | **$959** | **$981** |
| **Variable Costs** | | | | |
| Replacement ewe/ram purchase | $189 | $180 | $206 | $185 |
| Animal health | $37 | $38 | $67 | $44 |
| Shearing/crutching labour | $68 | $43 | $77 | $55 |
| Shearing/crutching supplies | | $2 | | $2 |
| Freight and cartage - lambs | | $17 | | $18 |
| Freight and cartage - wool | | $2 | | $3 |
| Selling costs - lambs | $65 | $53 | $62 | $51 |
| Selling costs - wool | | $6 | | $6 |
| Other | | $4 | | $5 |
| Supplementary feed costs | $99 | $87 | $146 | $130 |
| Fertiliser (super) | | $26 | | $27 |
| Fuel & Vehicle | | $9 | | $9 |
| Repairs & maintenance | | $13 | | $13 |
| Pasture maintenance | $40 | $10 | $40 | $10 |
| **Variable Costs** | **$498** | **$490** | **$598** | **$558** |
| **Total Gross Margin - per ha** | **$344** | **$353** | **$361** | **$423** |
| *standard deviation* | *$136* | *$159* | *$147* | *$165* |

Table 10. Average and standard deviation of income, variable costs, overhead costs, operating profit, net farm income and change in equity for the 1 x ewe and M x T systems using the whole farm systems economics 'Lamb Directions' model.

| | Whole Farm Profit and Loss | | | |
|---|---|---|---|---|
| | 1 x ewe system | | M x T system | |
| | Mean | Standard Deviation | Mean | Standard Deviation |
| **Income** | | | | |
| Lamb sales | $ 529,076 | $ 98,806 | $ 506,934 | $ 84,946 |
| Cull ewe sales | $ 64,029 | $ 22,676 | $ 63,449 | $ 21,847 |
| Wool sales | $ 81,340 | $ 13,667 | $ 213,893 | $ 39,761 |
| Inventory change | $ 91 | $ 2,734 | $ 38 | $ 2,503 |
| Other | $ - | $ - | $ - | $ - |
| **Gross Income** | **$ 674,536** | $ 119,215 | **$ 784,314** | $ 113,077 |
| **Variable Costs** | | | | |
| Replacement ewe/ram purchase | $ 144,559 | $ 29,462 | $ 148,494 | $ 36,548 |
| Animal health | $ 30,644 | $ 1,406 | $ 34,850 | $ 3,595 |
| Shearing/crutching labour | $ 34,435 | $ 489 | $ 43,607 | $ 4,342 |
| Shearing/crutching supplies | $ 1,214 | $ 116 | $ 1,670 | $ 169 |
| Freight and cartage - lambs | $ 13,407 | $ 1,076 | $ 14,385 | $ 620 |
| Freight and cartage - wool | $ 1,582 | $ 151 | $ 2,177 | $ 221 |
| Selling costs - lambs | $ 42,348 | $ 8,309 | $ 40,725 | $ 7,378 |
| Selling costs - wool | $ 5,077 | $ 537 | $ 5,077 | $ 537 |
| Other | $ 3,214 | $ 176 | $ 3,610 | $ 377 |
| Supplementary feed costs | $ 69,663 | $ 80,461 | $ 104,544 | $ 85,075 |
| Fertiliser (super) | $ 20,899 | $ 2,205 | $ 21,668 | $ 2,226 |
| Fuel & Vehicle | $ 7,500 | $ - | $ 7,500 | $ - |
| Repairs & maintenance | $ 10,000 | $ - | $ 10,000 | $ - |
| Pasture maintenance | $ 8,000 | $ - | $ 8,000 | $ - |
| **Total Variable Costs** | $ 392,542 | $ 86,318 | $ 446,308 | $ 94,671 |
| **Overhead Costs** | $ 34,000 | $ - | $ 42,000 | $ - |
| Labour | $ - | $ - | $ 8,000 | $ - |
| Depreciation | $ 15,000 | $ - | $ 15,000 | $ - |
| Rates | $ 7,000 | $ - | $ 7,000 | $ - |
| Administration | $ 3,000 | $ - | $ 3,000 | $ - |
| Other | $ 9,000 | $ - | $ 9,000 | $ - |
| Owner/Operator Allowance | $ 52,000 | $ - | $ 52,000 | $ - |
| **Operating Profit (EBIT)** | $ 195,994 | $ 127,535 | $ 244,006 | $ 132,599 |
| Interest & Lease Costs | $ 58,567 | $ 440 | $ 58,168 | $ 571 |
| **Net Farm Income** | $ 137,427 | $ 127,342 | $ 185,838 | $ 132,409 |
| Tax Payable | $ 10,848 | $ 11,141 | $ 16,394 | $ 13,351 |
| **Change in equity** | $ 126,579 | $ 117,910 | $ 169,445 | $ 120,854 |

Table 11. Average and standard deviation of cash flow (after interest, lease and tax) for the 1 x ewe and M x T enterprise systems with variable costs and prices using the whole farm systems economics 'Lamb Directions' model.

| | 1 x ewe system | | M x T system | |
|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation |
| Cash In | $674,588 | $119,861 | $784,382 | $113,837 |
| Cash Out | $533,014 | $84,371 | $599,409 | $87,831 |
| Net Cash Flow (after interest/lease/tax) | $141,573 | $117,651 | $184,973 | $120,219 |

Table 12. Average and standard deviation of return on capital and return on equity for the 1 x ewe and M x T enterprises using the whole farm systems economics 'Lamb Directions' model.

| | **1 x ewe system** | *standard deviation* | **M x T system** | *standard deviation* |
|---|---|---|---|---|
| Return on Assets | 5.35% | *3.46%* | 6.72% | *3.60%* |
| Return on Equity | 4.68% | *4.32%* | 6.40% | *4.50%* |

Figure 1. Regression coefficients for key variables influencing return on capital for the 1 x ewe system.

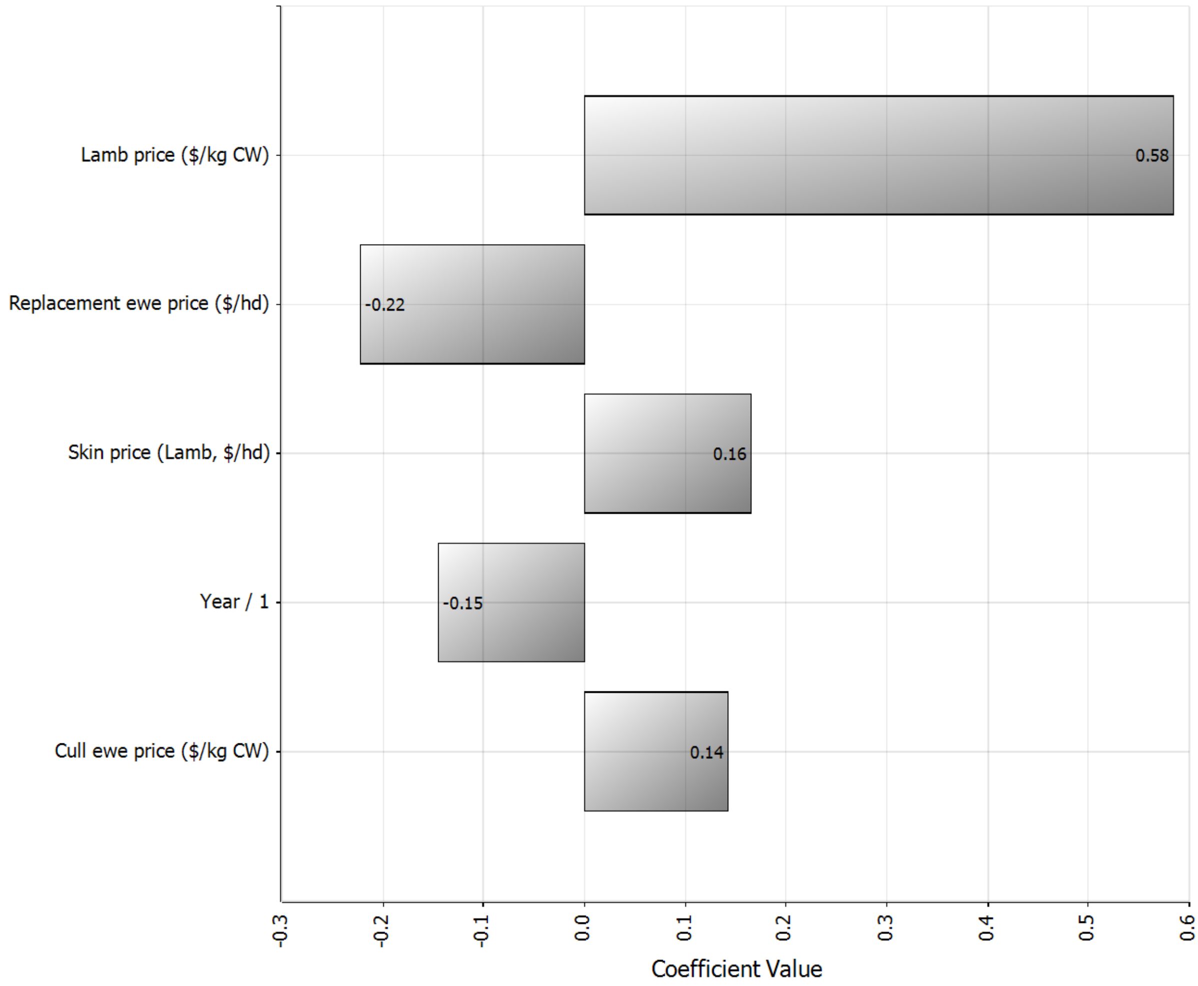

Figure 2. Regression coefficients for key variables influencing return on capital for the M x T system.

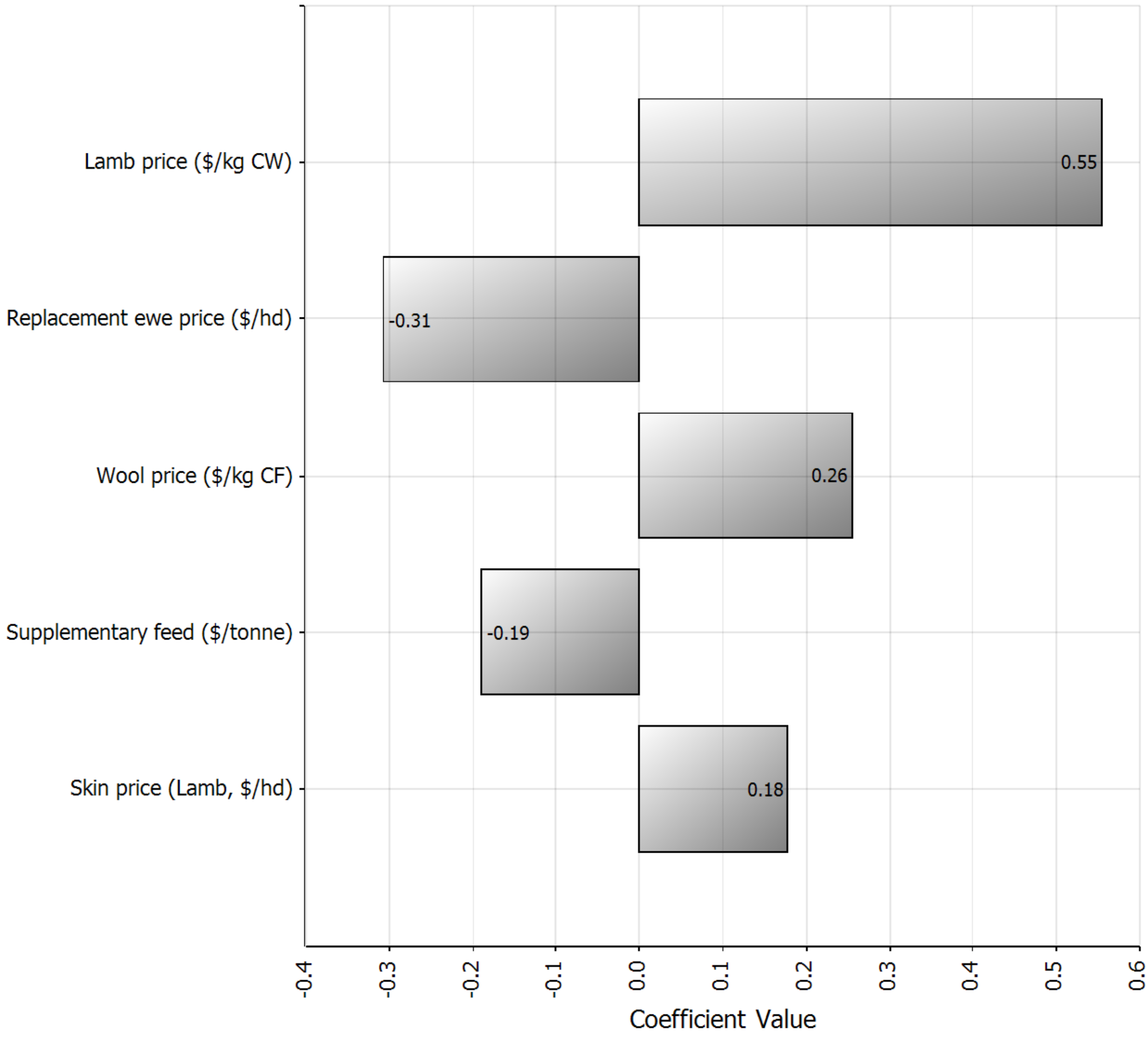


Figure 3. Certainty equivalent values of the annual change in equity for the 1 x ewe and M x T systems.