A farm-level economic assessment of the Australian Merino, Dohne Merino, and South African Meat Merino sheep breeds in southern Australia.

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ABSTRACT

In Australia very favourable prices for lamb and mutton since 2001 has encouraged a switch from the Merino to other sheep breeds better suited to meat production, namely the Dohne Merino and South African Meat Merino. To date, little research on the performance and profitability of these meat breeds in Australian farming systems has been carried out. A whole-farm bio-economic model was used to assess the likely profitability of these breeds in a southern coastal region of Western Australia. Sensitivity analysis was undertaken to identify the production characteristics that influence farm profit most, and commodity price risk was modelled endogenously to identify the robustness of profitability for each breed. Results indicate that weaning rate, fleece weight and fibre diameter are important to the profitability of each breed to varying degrees. However, despite important different production characteristics between the breeds, these differences generate no clear economic comparative advantage for any one breed in the broadacre farming system of the region studied. This finding, plus the high changeover costs for breed replacement, means there is little economic merit in disinvesting in one breed to fully switch to another.

Keywords: Whole-farm modelling, sheep breeds, profit maximisation

1. INTRODUCTION

Wool production has been a long-standing feature of broadacre farming in Australia. However, in the 1990s many farmers began to question the financial wisdom of committing so many farm resources to wool production. The Reserve Price Scheme for wool which supposedly was administered to provide price stability for woolgrowers collapsed in 1991 through mismanagement (Watson 1990, Bardsley 1991, Garnaut *et al*. 1993). The collapse of the scheme saw dramatic reductions in the price of wool. In May 1990 the reserve price was set at 870 c/kg clean but by late April 1991 the market indicator had dropped to 380 c/kg clean. Hence in less than 12 months wool prices received by growers had declined by almost 60 per cent.

Throughout much of the 1990s low prices for wool persisted (Richardson 2001). Competitive fibres (cotton and synthetics) expanded their value and share of wool end use markets; this occurred at falling real prices for wool. More casual dressing in developed countries and increased use of wool blends rather than pure wool in developing countries restricted growth in demand for wool. Also affecting wool production in the 1990s were large increases in grain prices during the mid-1990s. These heightened prices, combined with several favourable growing seasons, particularly in Western Australia, strongly shifted the profit relativity toward cropping and away from wool production. Also, as discussed later, a resurgence in sheepmeat prices in the early 2000s has further dampened interest in wool production.

It is against this backdrop of a prolonged period of diminished profitability of wool production that has led many Australian woolgrowers to reappraise their commitment to the Merino sheep breed, the mainstay of wool production in Australia. Many farmers are now curious about the performance of alternative sheep breeds and wish to know how profitable those breeds might be in Australian broadacre farming systems. Accordingly, this paper examines the likely profitability of sheep breeds that could be alternatives to the Australian Merino; namely the South African Meat Merino and the Dohne.

To examine the profitability of these sheep breeds this study uses a whole-farm profit optimisation model that typifies a mixed crop and livestock farming system in a region of southern Australia. The study includes a risk analysis using two methods, Monte Carlo simulation and sensitivity analysis of a type advocated by Pannell (1997).

The paper is structured as follows. The following section briefly describes the sheep breeds: Australian Merino (Merino); Dohne Merino (Dohne); and South African Meat Merino (SAMM) and outlines why these breeds are production alternatives for farmers in the southern region of Australia. Section three provides an overview of the nature of the whole-farm model used in analysing the profitability of the three sheep breeds. Section four presents modelling results, including a range of sensitivity analyses and simulation output. Finally, section five contains a set of conclusions.

2. BACKGROUND

The shift of farm resources out of wool production in Australia since the early 1990s has triggered a change in many farmers' Merino breeding programs. Traditionally these programs sought to improve wool production traits, with sheepmeat traits largely ignored. However strong market conditions for lamb and mutton since 2001 (Figure 1) have caused many farmers to consider improving the genetic merit of meat production and meat quality in their Merino flocks. For some producers, trialling breeds other than the Merino to improve meat production was considered appropriate, rather than investing in the gradual genetic alteration of their traditional wool Merino flocks.

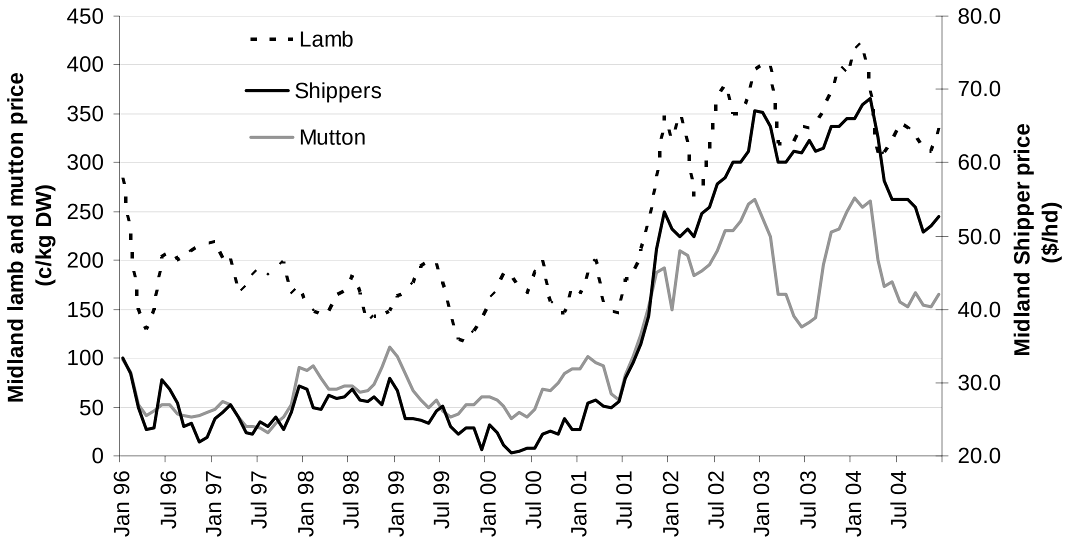

Figure 1: Lamb, mutton and shipper weekly sale prices.
Source: Elders Weekly, Midland Saleyards, medium – condition score 3 animals

The Dohne and SAMM are two South African breeds of current interest to many traditional woolgrowers. These breeds have been bred with a combined emphasis on wool and meat production. The SAMM was derived from the German Merino, which was imported from Germany by the South African Department of Agriculture in the 1930s (Terblanche 1979). The name was changed to SAMM in 1971 after years of selection for wool quality and conformation. The Dohne was developed by crossing the local South African Merino strain with the then SAMM, with breeding trials commencing in 1939 (Kotzé, 1951). Breeding programs for both Dohnes and SAMMs were intended to improve meat production and maintain wool quality. However the production of more meat from these newer breeds was clearly at the cost of wool production (Falepau *et al.*,2003).

Reported breed characteristics of SAMMs include: high fertility; good mothering ability; excellent carcase weight; and wool compatible with the Australian Merino (22-23 micron). Reported breed characteristics of Dohnes include: high fertility; good mothering ability; good carcase weight; and wool compatible with the Australian Merino (19-22 micron).

Using a whole farm model, the following analysis examines the likely relative profitability of these breeds and determines the importance and sensitivity of the sheep characteristics which impact most on farm profit. The analysis also examines the profitability of the breeds under varying commodity price scenarios to determine the robustness of the profitability of each breed.

3. METHOD

The Merino, Dohne and SAMM were included in a representative farm model for a region of southern Australia. The study region is the agricultural hinterland of a broad stretch of the southern coast of Western Australia (Figure2). The region covers 5.4 million hectares, of which about 3.7 million hectares is devoted to farming. The dominant agricultural enterprises across the region are broad scale cropping; mostly wheat, barley and canola. Also large areas of subterranean or medic pastures support mostly sheep enterprises devoted to wool and prime lamb production. The region experiences a Mediterranean climate and receives between 400 and 500 mm average annual rainfall, of which approximately two-thirds falls between May and October. The growing season is followed by a summer drought usually lasting from November to March.

Figure 2: South coast region of Western Australia.

The representative farm model of this region is known as the South Coast MIDAS (Model of an Integrated Dryland Agricultural System) model. It is a whole-farm, profit maximizing model that represents a 2500 hectare mixed crop and livestock farming system. The model describes the main enterprise options available to farmers in the region, including wheat, barley, oats, lupins, field peas, canola, lucerne, annual and saltland pasture phases. The rotation sequences involving these crops and pastures are described for each of five soil classes. Input requirements and production output for each rotation component on each soil type production are included in the farm model. Inter-year rotational effects, beneficial and adverse, are represented within a steady-state framework.

Sheep energy requirements and production vary across a year and vary between age groups and classes of sheep. Output from a sheep simulation model is included in the linear programming tableau to describe in detail the nature of sheep production; including energy requirements and growth rates for each class of sheep class in each sub-period of an average production year, their wool yield and quality, lambing percentages, death rates and retention rates required to form a self-replacing ewe flock.

The model includes descriptions of farm labour, machinery and finance requirements and overhead costs involved in running a farm business. The model's objective function is to maximise the farm's net return to capital and management, achieved by selecting an optimal set of farm enterprises and farm resources. Hence, output from the model is a listing of preferred rotations for each soil type, including their input and resource requirements and production outcomes; the size and structure of the sheep flock including their feed requirements and feed sources; and the use of labour, machinery and finances that accompanies this optimal farm plan.

The linear programming tableau is generated by a 13.8 MB Excel file containing 27 worksheets that describe the data sources and data included in the model. The tableau comprises around 1900 columns and 860 rows (Bathgate 1999, O'Connell et al. (forthcoming)). Other versions of the MIDAS model, similar to the south coast MIDAS model, are described in more detail by Kingwell and Pannell (1987), Pannell and Bathgate (1994), Young (1994) and Kingwell (2002).

The flock structures of Merinos, Dohnes and SAMMs represented in this analysis are described in Table 1. Pure bred flocks were examined.

Table 1: Description of flock structures of the Merino, Dohne and SAMM

Flock	**Description**
Merino - wool and prime lamb	Emphasis is on wool production, except a draft (up to 33%) of wether lambs that can be sold as Merino prime lamb.
Dohne - wool and prime lamb	Emphasis is on wool and meat production. Up to 90% of wether lambs can be sold as prime lamb.
SAMM - wool and prime lamb	Emphasis is on wool and meat production. Up to 90% of wether lambs can be sold as prime lamb.

Note: All flocks lamb in late July and August and are shorn in January.

To date, little research on the performance of Dohnes and SAMMs in Australian farming systems has been carried out. For this reason, assumptions on the relative performance of Merinos, Dohnes and SAMMs mostly were estimated from South African research (Steinhagen and Wet 1986, Cloete 1992, Cloete *et al.* 1999, Fourie and Cloete 1993, Fourie and Heydenrcyh 1983, Karberg *et al.* 1985, Greeff 1990, Basson *et al.* 1969).

Fourie and Cloete (1993) investigated the reproductive efficiency of commercial Merino, Dohne and SAMM ewes over a 4 year period. Average weaning rate (lambs present at marking per ewe joined) was 87% for Merinos, 93% for Dohnes and 113% for SAMMs. Cloete *et al* (1999) investigated the reproductive efficiency of stud flocks of Merinos, Dohnes and SAMMs over a 15 year period. They found that larger litter sizes were more prevalent in Dohnes and SAMMs than Merinos, however Merino and Dohne lambs were more likely to survive than SAMMs lambs.

Cloete *et al (1999)* also investigated the total weight of lamb weaned by ewes over three consecutive production seasons. Merino ewes (n=169) produced an average of 31.3kg of lamb per season, whereas the output of Dohne ewes (n=260) was 33.5% higher (41.8 of lamb per season). Means derived from data of Basson *et al* (1969) suggested a 20.3% advantage of Dohne Merino ewes compared to Merino ewes. A further improvement of 6.9% was observed in SAMM ewes which produced 44.7 kg of lamb per season. The lamb output of SAMM ewes was previously reported to be 14.5% higher than in Dohnes (Schoeman, 1990).

There have been a number of studies that have investigated wool production characteristics across breeds. Basson *et al* (1969) found the clean fleece weights (CFW) of mature Dohnes to be 69.7% of that recorded in Merinos. Cloete *et al*, (1999) found the CFW of 1 year old Dohnes and SAMMs to be 70.1% and 52.8% of that recorded in Merinos, and the corresponding values for rams were 66.5% and 48.9%. Greef (1990) reported that the CFW of Dohnes and SAMMs amounted to 54.3% and 51.8% of Merinos. Mature Dohne ewes produced 4.3kg of greasy wool in the study of Schoeman (1990) compared to 2.9kg in SAMMs. The fibre diameter of Merinos and Dohnes was found to be similar for both ewes and rams, while SAMM fleeces were approximately 8% broader (Cloete *et al*, 1999)

A majority of this South African research was conducted in the high rainfall area of the South West Cape where there is a winter predominant annual precipitation of around 600mm. The region in southern Australia climatically most similar to the South West Cape is the southern region shown in Figure 2. Hence, the South Coast-MIDAS model was used in this analysis because it describes the main farming system alternatives available to farmers in that southern region of Australia.

Drawing on the South African studies the various production traits of each breed are listed in Table 2. These traits (expressed as percentages of the Merino breed) were then included in the South Coast-

MIDAS model to represent the production performance of each breed. This analysis is therefore based on the important underlying assumption that the relative performance of all breeds in South Africa is transferable to the South Coast region of Western Australia.

Table 2: Base case characteristics for the Merino, Dohne and SAMM.

	Merino	**Dohne**	**SAMM**
Time of lambing	August	August	August
Time of lamb sale	January	January	January
Max. % lambs sold as prime lamb [1]	33	90	90
Age at first mating (years)	2	1	1
Lambs weaned per ewe joined (%) [2,3,4,5,6]	81	91 (+10%)	111 (+30%)
Average weaning weight (kg) [3]	25	29 (+16%)	31 (+24%)
Ewe mature weight (kg)	67	71 (+6%)	76 (+13%)
Stocking rate (DSE/ winter grazed ha)	8.3	7.3 (-11%)	7 (-17%)
Clean fleece weight (kg cln wt) [1,3,7,8]	2.44	1.70 (-30%)	1.22 (-50%)
Fibre Diameter (µm) [1,3,5]	20	20	21.5 (+7.5%)

[1] Steinhagen and Wet (1986), [2] Cloete (1992), [3] Cloete *et al* (1999), [4] Fourie and Cloete (1993), [5] Fourie and Heydenrcyh (1983), [6] Karberg *et al* (1985), [7] Greeff (1990), [8] Basson *et al* (1969).

Due to the uncertainty surrounding the performance of Dohnes and SAMMs in Australian farming systems, sensitivity analysis of a type advocated by Pannell (1997) was carried out to identify characteristics most likely to influence farm profit[1]. Firstly, the parameters (characteristics) to be varied were identified and realistic ranges were selected. Sensitivity analysis was then performed so that both unresponsive and responsive key production characteristics could be identified. Unresponsive parameters were excluded from further analysis and the key characteristics: CFW, fibre diameter and weaning rate were studied further. The break-even changes in key characteristics required to make Dohnes and SAMMs as profitable as Merinos also were identified.

The impact of movements in prices of crops, wool and sheepmeat on farm profit of Dohnes, SAMMs and Merinos was examined. Probability distributions of commodity prices were created from historical monthly data and the correlations between commodities were calculated. For most commodities, historical data from the past eight years was taken to be indicative of expected future prices. Using the software package @RISK, the relevant probability distributions and commodity prices correlations were used to simulate commodity price scenarios. To overcome some period differences in the dataset, the correlation matrix was made consistent within @Risk (Palisade, 2002).

[1] Profit is calculated as monies left over from production receipts after deducting all operating costs, overhead costs, depreciation and opportunity costs associated with farm assets (exclusive of land).

The sampling technique used to generate the data was Latin Hypercube. This sampling technique uses stratified sampling, and was chosen for the reasons of increased sampling efficiency and faster runtime (Palisade, 2002). To ensure of convergence in sampling, 5000 iterations of commodity prices were run.

The base case or standard (Std) prices used in the analysis are outlined in Table 3 below. Standard prices are intended to represent medium term estimates and so may not directly correspond to current market prices. SAMM ewes (mutton) and wethers (shippers[2]) were assumed to attract a 20% premium ($/hd) over Merinos. Dohnes were assumed to attract a 10% premium ($/hd) over Merinos (Metcalf *pers comm*.)

Table 3: Price assumptions

	Wheat[1] $/t	Barley [2]$/t	Oats[3] $/t	Canola[4] $/t	Lupin[5] $/t	Wool[6] (c/kg)	Lamb[7] $/kg	Shipper[8] $/hd	Ewe[9] $/hd
Merino								50	45
Dohne	195	200	140	375	200	900	3.20	55	50
SAMM								60	54

1 Price for wheat APW 10% ($45/t freight, handling charges & levies to be removed).
2 Pool price for malt barley ($38/t freight, handling charges & levies to be removed).
3 Price of milling oats net at port ($17/t freight to be removed).
4 Price for canola with 42% oil ($44/t freight, handling charges & levies to be removed).
5 Price for lupin ($45/t freight, handling charges & levies to be removed).
6 Western Market Indicator (c/kg clean).
7 Sale yard price of lamb sold in January ($/kg dressed weight)
8 Price landed Perth (Commission and freight to be removed).
9 Saleyard price for 5½ yo ewes. 1½ yo ewes assumed to be $3/hd higher. 6½ yo ewes assumed to be $5/hd lower. Purchase price for ewe replacements is $2/hd higher (transport costs).

4. RESULTS AND DISCUSSION

At standard prices the most profitable breed is the Merino. As shown in Table 4, the next most profitable breed is the SAMM which earns $4,000 less profit in a year followed by the Dohne which is $6,600 less profitable.

Table 4: Optimal farm profit at standard prices ($'000).

	Farm profit	% from Merino
Merino	168.0	n.a.
SAMM	164.0	- 2.4%
Dohne	161.4	-3.9%

n.a. not applicable

2 Shippers are adult male sheep exported live on cargo vessels to Middle Eastern ports.

Fleece weight, weaning rate and fibre diameter all influence the profitability of each breed differently. The degrees to which these characteristics influence profit are discussed below.

Fleece weight

As indicated by the slope of each profit line in Figure 3, changes in CFW impact more on Merino profit than the profit of other breeds. For Merinos, a 10% increase in CFW from 2.44kg to 2.68kg results in an increase in profit of around $19,500. For Dohnes a 10% increase in CFW from 1.70kg to 1.87kg results in an increase in profit of around $12,200. SAMM profit is least influenced by changes to CFW with a 10% increase (from 1.22kg to 1.34kg) resulting in an increase in farm profit of only $9,500.

These results are intuitive, and occur because Merinos produce a greater quantity of wool that is higher in value (finer in fibre diameter) than Dohnes and SAMMs. Similarly, Dohnes produce more wool that is higher in value than SAMMs.

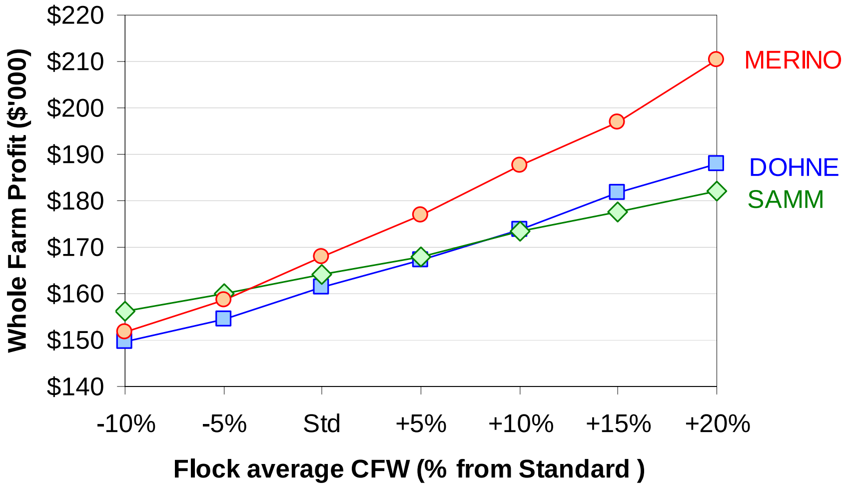

Figure 3: Effect of clean fleece weight (CFW: kg clean) on farm profit of Merinos, Dohnes and SAMMs.

Note: Standard CFW for Merino: 2.44 kg, Dohne: 1.70 kg and SAMM: 1.22 kg.

To be as profitable as Merinos (all other characteristics standard), Dohnes require a CFW of 1.80 kg (6% greater than the assumed 1.7 kg). Similarly, SAMMs require a CFW of 1.27 kg (5% greater the assumed 1.22 kg) to be as profitable as Merinos when all other characteristics are standard.

Weaning rate

Weaning rate is the number of lambs weaned per ewe mated. As indicated by the slope of each profit line in Figure 4, changes to weaning rate cause SAMM profit to shift more than Dohne and Merino profit. A 10% increase in SAMM weaning rate from 111% to 122% results in a profit increase of

$23,600. For Dohnes, a 10% increase in weaning rate from 91% to 100% results in a profit increase of $19,700. Merino profit is least sensitive to changes in weaning rate with a 10% increase in weaning rate (from 81% to 89%) resulting in an increase in profit of $13,700. SAMM profit is most sensitive to weaning rate because SAMMs produce more lambs and larger lambs than Dohnes and Merinos, with the SAMM lambs attracting a higher sale price per head due to their size.

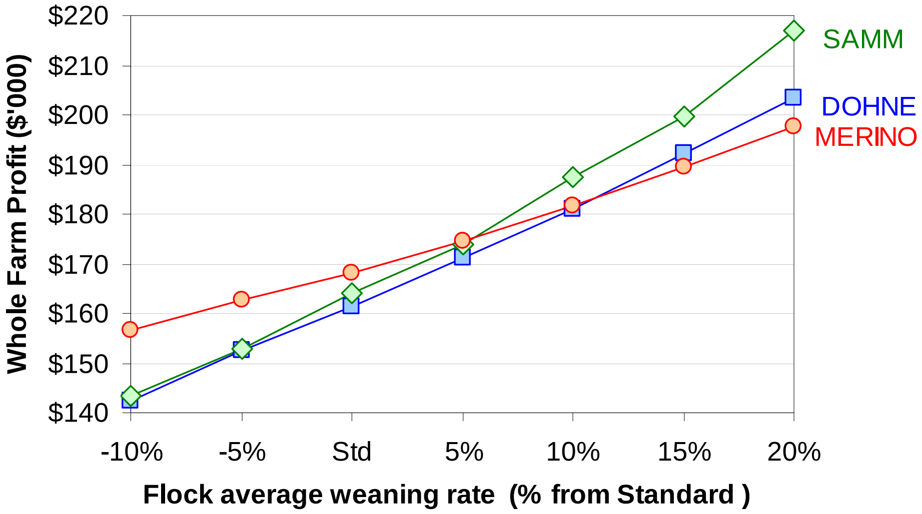

Figure 4: Effect of weaning rate on farm profit of Merinos, Dohnes and SAMMs.

Note: Standard weaning rates for Merino: 81%, Dohne: 91% and SAMM: 111%.

To be as profitable as Merinos, Dohnes require a weaning rate of 102% (4% greater than the assumed 91%) when all other characteristics are standard, whereas SAMMs require a weaning rate of 114% (2.5% greater than the assumed 111%).

Fibre diameter

Fibre diameter is a measure of the thickness of individual wool fibres. It is expressed in micrometers (µm) or microns. Wool similar in quality but finer in diameter usually attracts a price premium. Figure 5 illustrates how whole-farm profit is influenced by changes to the fibre diameter of Merinos, Dohnes and SAMMs when micron premiums are small. This is indicative of the premiums experienced in the market during the period in late 2002 to 2003.

As indicated by the slope of each profit line in Figure 5, changes to fibre diameter when premiums are small, impact more on Merino profit than profit from other breeds. For Merinos a 3 micron increase above the standard (20µm) results in a reduction in farm profit of $10,800 (-6.5%), whereas for Dohnes (20µm) and SAMMs (21.5µm) a similar micron increase results in a reduction of farm profit of only $5,800 (-3.5%) and $1,500 (-1.0%).

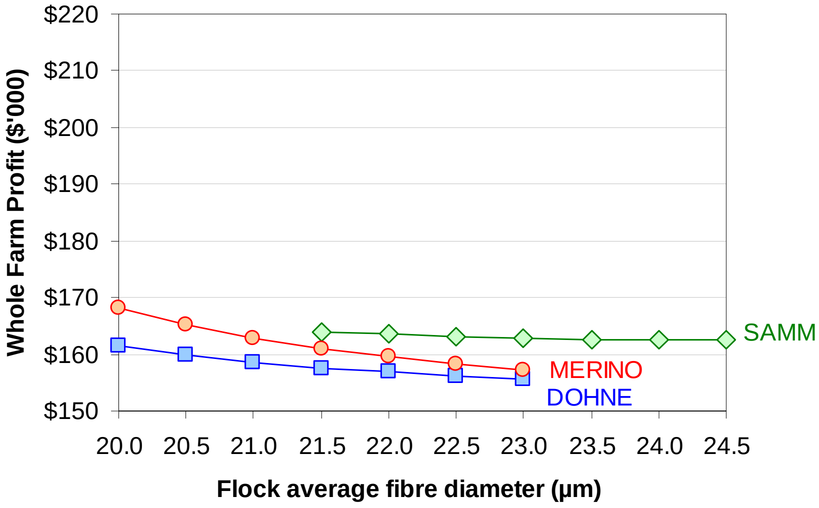

Figure 5: Impact of average flock diameter on profit of Merinos, Dohnes and SAMMs when micron premiums are small.

Micron premiums have been relatively low in late 2002 and 2003 due to an oversupply of hunger fine wool, a consequence of the 2002 drought in many wool-producing regions. However, traditionally there have been significant price differences paid for wool of different fibre diameters. These prices differences are illustrated in Appendix 1.

During 2004 fibre diameter premiums have been broadening and it is expected that this pattern will continue in the medium to long term. If fibre diameter premiums return to traditional levels, the difference in standard profit between Merinos, Dohnes and SAMMs will widen significantly (See Figure 6). For Merinos a return to traditional premium levels will result in an increase in profit of $51,200 or 30% (from $168,000 to $219,200). For Dohnes the increase in profit would be $24,800 or 15% (from $161,400 to $186,200), and for SAMMs the increase would be $6500 or 4% (from $164,000 to $170,500).

As indicated by the slope of each profit line in Figure 6, when fibre diameter premiums are large, changes to fibre diameter impact on Merino profit significantly more than other breeds (Figure 6). For Merinos a difference in fibre diameter of 3 micron (20µm to 23µm) results in a reduction in farm profit of $62,900 (-29%), whereas for Dohnes (20µm to 23µm) and SAMMs (21.5µm to 24.5µm) a similar micron difference results in a reduction in farm profit of $29,400 (-16%) and $6,900 (-4%).

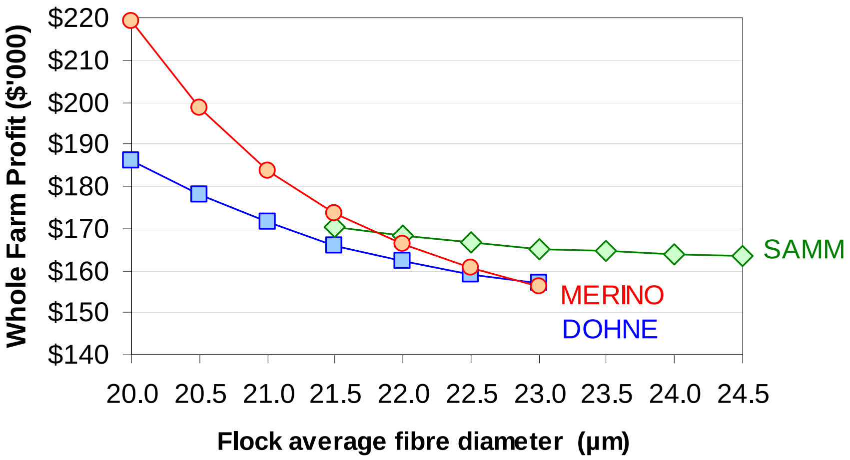

Figure 6: Impact of average flock diameter on profit of Merinos, Dohnes and SAMMs when micron premiums are large (representative of traditional levels).

Commodity Price Risk

Historically, the consequences of risky outcomes for farmers have been explored mostly through use of sensitivity analysis. The preceding figures are an illustration of such sensitivity analysis. However a probability distribution of outcomes, rather than point values, provides greater information about risky outcomes. To demonstrate this, probability distributions of profit were generated using MIDAS and probability distributions of real commodity prices. The relevant probability distributions were modelled endogenously using the risk analysis tool @Risk (as explained earlier in the method section of this paper).

Figure 7 shows the probability distribution for whole farm profit of Merinos, Dohnes and SAMMs. These distributions are based on the assumption that real historical prices are indicative of future prices.

The most noticeable aspect of Figure 7 is that the shape of each probability curve of profit is similar. That is, mean and variation of profits are similar for each of the breeds. Statistical tests of the relative size of the means and variances of the profit distribution associated with each breed failed to reject the null hypothesis of no difference in means or variances.

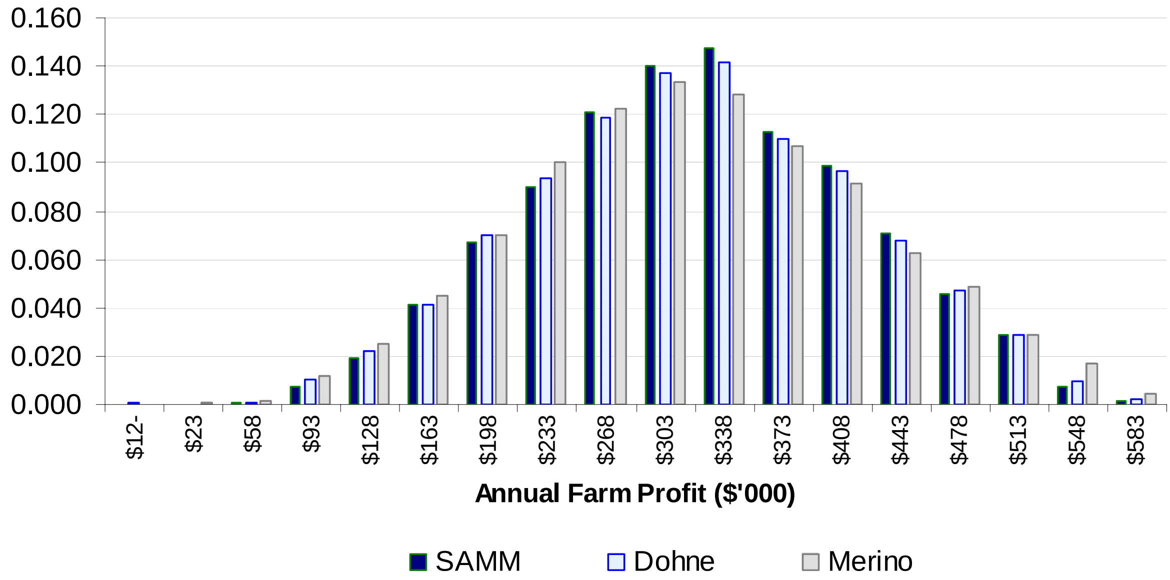

Figure 7: Probability distribution of whole farm profit of Merinos, Dohnes and SAMMs

These results indicate that although there are obviously important different production characteristics between the breeds, as listed in Table 2, these differences generate no clear economic comparative advantage for any one breed in the broadacre farming system of the region studied. The sensitivity analysis that considered a range of commodity price scenarios yielded the finding that there was no marked commercial advantage for any particular breed, either in terms of higher mean profit and/or reduced variance of profit. Further, in practice, the high changeover costs for breed replacement would add to the finding that there is little economic merit in disinvesting in one breed to fully switch to either of the two alternatives. Even if adjustment or replacement costs were low there would still be no strong economic case (based on the sensitivity range considered) for switching breeds. In this case the quasi-fixity of sheep assets, as found by Agbola and Harrison (forthcoming), would be found to be a rational decision by farmers.

CONCLUSIONS

Favourable prices for lamb and mutton since 2001 have sparked Australian farmers' interest in sheep breeds such as the Dohne Merino and South African Meat Merino that are better suited to meat production than the Merino. However, to date, little research on the performance and profitability of these meat breeds in Australian farming systems has been carried out. To redress this neglect this study uses a whole-farm bio-economic model to assess the likely profitability of these breeds in a southern coastal region of Australia.

The farm modelling analysis found that fleece weight, weaning rate and fibre diameter are important determinants of the profitability of each breed to varying degrees. However, despite important different production characteristics between the breeds, there emerged no clear economic comparative advantage for any one breed in the broadacre farming system of the study region. Further, if the likely high changeover costs for breed replacement were to also be considered, then any economic case for disinvesting in one breed to fully switch to another would be further weakened.

A practical implication of this study's findings is that when comparing breeds other than their traditional Merino, farmers need to consider alternative ways of improving the profitability of their Merino enterprise, such as increasing stocking rates or altering their flock structure to include more profitable enterprises such as first cross prime lambs (Kopke *et al.*, 2003).

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Appendix 1: Trends in micron price guides (Ac/kg clean AWEX basis – monthly).
Source: AWEX, Woolmark.

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