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Sheep breeding: An enterprise budgeting decision support model for on-farm planning

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ABSTRACT

In selecting a sheep breeding strategy farmers need to evaluate the likely physical and financial outcomes relative to continuing the existing policy. The strategy should be assessed in terms of the new status quo production levels and costs and prices at this time, and the possible associated effect of changes in product attributes relative to market requirements. To assist farmers evaluate alternative breeding scenarios a spreadsheet-based enterprise budgeting model was developed. The input data and output are summarised to a one-page template to allow the user to assess the sensitivity of returns to different market and production scenarios for a particular farm situation. A flock at current performance levels and those in 5 years, following genetic and management improvement, is compared to a crossbreeding strategy to illustrate the model's application.

Keywords: sheep breeding, scenarios, strategy, enterprise budgeting

INTRODUCTION

New Zealand sheep farmers have a wide range of breeds with distinctive traits from which they can select. The choice of breed, or crosses thereof, affects farm profit and long-term viability and as such, is a strategic business decision. In selecting a sheep breeding strategy farmers need to evaluate the likely medium- to long-term production and financial outcomes relative to continuing the status quo. The proposed strategy should be assessed in terms of both the transition costs (Hawkins *et al*. 1989) and the relative net returns for sheep products once the new policy is established (Parker 1996). Further, the relationship between expected future, rather than current, prices should be moderated against market expectations for likely changes in the attributes of saleable products. If the current policy is continued, changes in sheep performance must be accounted for because improved productivity from the existing breed, associated with on-going improvement to management practice and use of technology, can be expected. In this respect, the analysis of the effects of implementing a new sheep policy is analagous to farm development budgeting (Cartwright 1967).

The second problem farmers confront in assessing the merits of a new breed policy is the substitution rate between sheep with different productive capacities. The substitution rate is a function of feed requirements, and therefore dependent upon factors such as live weight and the management system adopted (e.g. hogget mating, lamb weaning age). Substitution rates are normally estimated by applying stock unit (su) conversion factors. However, the applicability of these factors can be challenged where the attributes of the new sheep breed, and the management system that is to be applied to it, are substantially different from the parameters for which the su equivalents were originally derived, as Crawford & Lowe (1994) demonstrated for beef cattle policies.

The purpose of this paper is to present a spreadsheet enterprise budgeting template which enables farmers to quickly assess the impact of different production, price and substitution rates for alternative sheep breeding policies. The philosophy of decision support for strategic planning is to enable the farmer to evaluate alternative future scenarios in order to determine the farm policy which gives the 'best' long-term fit with the external environment and which meets the aspirations of the owner(s) (Parker *et al*. 1997). Medium to long-term forecasting, of product prices in particular, is notoriously difficult and for this reason when it comes to choosing a breeding strategy, complex bioeconomic simulation models are unlikely to be superior to simple spreadsheet-based models that demonstrate the effect of key performance parameters on production and profit.

METHOD

Model design

The model was formatted on a spreadsheet (Microsoft Excel) because this software is readily available to farmers. A single-page template comprising an input and output table was designed to minimise and simplify data entry (Figure 1). The inputs describe farm and flock attributes (e.g. area, death rates by class, lambing percentage, wool weights, ewe:ram ratio), management practice (replacement rate, shearings per year, hogget mating) and costs and prices associated with a sheep enterprise. These data are used to develop (off-screen) a stock reconciliation and enterprise margin, from which the output table is derived. An enterprise, rather than gross margin, budget was adopted because this allows fixed costs associated with a particular enterprise to be considered (Boehlje & Eidman 1983). For the comparison of livestock policies the opportunity cost of capital invested in livestock is the main difference in fixed costs, but there may be circumstances (e.g. milking sheep) where other fixed cost considerations should be accounted for.

The enterprise margin (EM, $), expressed per ewe, su or hectare, was calculated as:

$$EM = GR - (DC + OC)$$

where:

GR = Gross revenue from the sale of products
DC = Direct costs (shearing, animal health, breeding)
OC = Opportunity cost of livestock capital.

The OC of capital invested in livestock is estimated from the total value of animals wintered times the bank deposit rate. The interest rate will vary according to farm circumstances and can be derived from future values for Government bonds. Future product prices are not discounted because they primarily reflect international market forces rather than domestic inflation. Similarly, costs are not discounted because annual changes in the farm input price index are small when inflation is low and therefore do not have a substantial influence on the EM over a 3-5 year planning horizon. Product prices and costs, and thus their relativities, are instead estimated subjectively for the year when the status quo for the new policy is reached. Secondary and tertiary data (industry forecasts, consumer trends, personal communications) and the user's own intuition, combined with 'What if?' analysis enables a profit response function to be estimated for various price-product combinations. The output also includes an EM sensitivity analysis.

Scenario analysis

Scenario planning provides a framework for describing possible futures for the sheep industry and the context for developing a farm strategy for breeding. In addition, to the quantitative information provided by modelling, scenario analysis incorporates more 'fuzzy' aspects such as trends, value shifts, and innovation (Schoemaker 1995). The model was used to estimate the EM for two sheep breeding policies: a Romney crossbred flock (XB) and

Figure 1: Spreadsheet template showing sheep enterprise model inputs and outputs.

Crossbred plus 5 years

INPUT TABLE:

Farm area		300 HA
Ewe numbers		2078 EWES
Lambing		140.0 %
Ewe repl. Rate		25%
Ewe deaths		4.5%
Hogget deaths		4.0%
Lamb deaths		4.0%
Rams to ewes		1.2%
Ram repl. Rate		25%
Ram price		$500/HEAD
Ram wool		5.00 KG/RAM
Ram wool price		$3.80/KG
Cull ewe sales		$45.00/HEAD
Ewe wool		4.20 KG/EWE
Ewe wool price		$3.80 /KG
Hogget wool		2.70 KG/HGT
Hgt wool price		$4.10/KG
Ave lamb sales		$32.00/HEAD
% lambs shorn		75%
Lambs wool		0.80 KG/LAMB
Lamb wool price		$4.10/KG
Shearing cost		$1.50/SHEEP
No. shearings		1/YEAR
Animal health		$1.75/EWE
Interest rate		7%pa
Stock units	– ewes	1.2 SU
	– hoggets	0.9 SU
	– rams	0.8 SU
Hogget lambing		65.0%
Hogget lamb price		$25.00 $/HEAD
Capital values		
	– ewes	36 $/HEAD
	– hoggets	45 $/HEAD
	– rams	400 $/HEAD

OUTPUT TABLE:

	$/TOTAL	$/EWE	$/SU	$/HA
Total GM:	126342	59.26	41.05	410
Total SU:	3000			

(Note: Indices per SU and HA relate only to sheep enterprise)

Physical production indices:

Wool production	12617 KG TOTAL
Stocking rate	10.0 SU/HA
Wool/su	4.2 KG/SU
Wool/ha	42 KG/HA
Lambs sold	2590 TOTAL
Cull ewes sold	425 TOTAL
Sheep sales	99691 $ TOTAL
Sheep sales/su	33.23 $/SU
Sheep sales/ha	332 $/HA
Ewes lamb sales	2253 TOTAL
Hogget lamb sales	337 TOTAL
Meat output	116 kg/HA

steady improvement in the pure Romney flock (R+5). If the crossbred option is adopted the new status quo will be reached in five years (2003). This situation was compared with the Romney flock in 1998 (R) to illustrate the magnitude of on-going improvement to the existing policy and changes in the farm business environment. The production and price inputs for 2003 reflect a scenario where the wool:lamb price ratio improves compared to the situation in 1998 (Table 1). Under the XB strategy, hogget mating is adopted and this management practice, combined with the greater live weight and lambing percentage of the XB ewes (and R+5 Romneys), was used to modify the su conversion factors for the respective classes of each sheep breed (Brookes *et al*. 1998). The increased number of multiple lambs was the justification for decreasing the average XB lamb price. Wool weights for XB hoggets and MA ewes were reduced according to on-farm trial data (Brookes *et al*. 1998) but this was associated with only a minor reduction in micron, and hence only a 5c/kg improvement in wool price. Clearly other scenarios may apply and the model can easily be modified to investigate these. The total utilised feed supply, and hence su carrying capacity, of the case farm was fixed at 3000 su (10 su/eff. ha wintered) for each policy option. The effect of substitution rates on stock numbers and EM was derived by altering the su conversion factors.

TABLE 1: Input values for the comparison of a breed improvement versus a crossbreeding strategy. Values for the Romney flock (1998) are also shown.

Parameters		Romney flock Current (R)	Romney flock + 5 years (R+5)	Crossbred flock + 5 years (XB)
Prices				
Lamb prices ($/hd)				
Lambs	- 1998	40.00	38.50	35.00
	- 2003	38.00	36.00	32.00
Hogget lambs				
	- 1998	-	-	28.00
	- 2003	-	-	25.00
Wool prices (c/kg)				
Ewes	- 1998	3.40	3.40	3.45
	- 2003	3.75	3.75	3.80
Hoggets	- 1998	3.60	3.60	3.65
	- 2003	4.05	4.05	4.10
Lambs	- 1998	3.75	3.75	3.75
	- 2003	4.05	4.05	4.10
Production				
Lambing (%)				
	Ewes	105	115	140
	Hoggets	-	-	65
Wool (kg greasy)				
	Ewes	4.5	5.0	4.2
	Hoggets	3.3	3.5	2.7
	Lambs	1.0	1.0	0.8
Stock units[1]				
	Ewes	1.00	1.05	1.20
	Hoggets	0.70	0.80	0.90
Interest rate				
	1998	8.5%	8.5%	8.5%
	2003	7.0%	7.0%	7.0%

[1] Interpolated from assumed production data and published su tables.

Risk analysis

The sensitivity of the EM margin to changes in production and price variables was initially estimated by parametric budgeting (±10% variation from expected value). A distribution for two variables (lamb price and lambing percentage) was described, by specifying the mean, variance, maximum and minimum values. Hogget lambing percentage was calculated as 0.46 x ewe lambing percentage and the value of hogget lambs was calculated as 0.78 x lamb price. Ten values, each representing 10 percent of the price distribution, were calculated for the two variables using the Excel betainv function (Shadbolt 1996). The EM/ha and associated statistics were generated for each price:production combination.

RESULTS AND DISCUSSION

The EM for the three breeding policies at 1998 and 2003 costs and prices are presented in Table 2. The effect

TABLE 2: Enterprise margin (per ewe and per ha) and the effect of a ± 10% change in price and production.

		Romney (R)		Romney (R+5)		Crossbred (XB)	
		Ewe	Ha	Ewe	Ha	Ewe	Ha
Gross Margin ($)							
1998		50.75	434	55.28	445	60.74	421
2003		51.63	441	55.71	448	59.26	410
Change in price ($)							
1998	– Lamb	3.15	26.95	3.41	27.42	4.25	29.43
	– Wool	2.07	17.76	2.29	18.41	2.00	13.82
2003	– Lamb	2.99	25.60	3.19	25.64	3.87	26.84
	– Wool	2.29	19.58	2.52	20.24	2.20	15.25
Change in production							
1998	– Lambing %	4.26	36.40	4.49	36.17	5.34	36.95
	– Wool (kg)	2.06	17.61	2.27	18.27	1.98	13.69
2003	– Lambing %	4.06	34.73	4.22	34.00	4.91	34.03
	– Wool (kg)	2.27	15.08	2.50	20.16	2.18	15.08

TABLE 3: The effect of su conversion factors on the enterprise margins (EM) at 2003 average prices and production (see Table 1 for input values).

	Romney (R)	Romney (R+5)		Crossbred (XB)			
Stock units							
Ewes	1.0	1.05	1.0	1.4[1]	1.2	1.05	1.0
Hoggets	0.7	0.8	0.7	1.0	0.9	0.8	0.7
Ewes (n)	2565	2415	2565	1796	2078	2366	2517
EM/ewe ($)	51.63	55.71	55.76	59.30	59.26	59.22	59.10
EM/su ($)	44.15	44.83	47.68	35.51	41.05	46.72	49.60
EM/ha ($)	441	448	477	355	410	467	496

[1] Based on data presented by Brookes *et al.* (1998) and Montes de Oca (1998).

of a 10% change in lamb carcass weight, lambing percent and wool weight, and the price for wool and lambs is also shown. The EM per hectare for the R+5 flock was slightly superior ($38/ha) to that of the XB policy. This reflected the greater number of ewes and wool production under the R+5 policy, and the associated better wool:lamb price ratio. It also meant the XB margin changed more in 2003 than that for the R+5 policy (-$11/ha vs. +$3/ha). The markedly increased lambing percentage of the crossbred ewes and hoggets was mitigated by a $4/head lower lamb price (reflecting the effect of more multiple lambs on average carcass weight) and 0.8 kg/ewe less wool. The change in EMs ranked on a per head rather than a per hectare basis confirms Wright & Pringle's (1983) discussion concerning the economic optimum stocking rate and the influence of price relationships in choosing a livestock policy.

The su conversion factors impacted on ewe numbers and the EM as illustrated in Table 3. If no adjustment to conversion factors was made an additional 439 XB ewes are shown to be able to be carried: this would significantly mislead a farmer about the profitability of this policy (i.e. the EM is $496/ha vs. $410/ha at 1.0 and 1.2 su/ewe, respectively). Determining appropriate su factors for the various stock classes under the new breed policy is therefore a critical aspect of the pre-adoption planning exercise. Information on the feed consumption of higher performing crossbred sheep is sparse. Brookes *et al*. (1998) estimated su equivalents from data for traditional breeds rather than empirical measurements on the new breeds under New Zealand grazing conditions. They calculated su conversion factors of 1.65 for a crossbred ewe producing 1.50 lambs per ewe mated and 1.22 for a Romney ewe producing 1.05 lambs per ewe mated. An independent STOCKPOL analysis (Montes de Oca 1998) for a case farm analysis comparing 61 kg Coopworth ewes weaning 1.35 lambs per ewe mated with 73 kg crossbred ewes weaning 1.55 lambs per ewe mated indicated su conversion factors of 1.1 and 1.4, respectively. Such differences significantly influence the EM, as illustrated in Table 3.

The expected EMs and the probability of returns are illustrated in Table 4, for a minimum and maximum lamb price and lambing percentage. An EM of $411 ± 35/ha is expected and there is a 4 % chance that less than $350/ha

TABLE 4: The range of EM/ha that can be expected at 2003 prices for different lamb price and lambing percentage combinations. The Romney (R) column illustrates expected future profitability if no change in current flock productivity is achieved.

	Romney (R)		Romney (R+5)		Crossbred (XB)	
Input Variables	Lamb $	Lamb %	Lamb $	Lamb %	Lamb $	Lamb %
Mean	40	105	36	115	32	140
Minimum	30	90	25	100	20	125
Maximum	50	120	45	130	40	155
Variance	16	25	16	25	16	25
EM/ha ($)						
Mean	441		449		411	
Std deviation	30.8		31.3		34.8	
Minimum	378		380		336	
Maximum	521		522		485	
Median	439		449		413	
EM frequency (%)						
0 – 350	0		0		4	
351 – 400	8		6		35	
401 – 450	54		45		47	
451 – 500	34		44		14	
500+	4		5		0	

could be realised and the same likelihood that returns will exceed $450/ha. This information allows the farmer to assess the risk of alternative sheep policies.

CONCLUSIONS

The choice of a breeding policy is a key element in formulating a sheep farm business strategy because it involves trade-offs between higher per ewe performance, production per hectare and profit, and requires an appreciation of how changes in product attributes and their relative market values affect profit. This is especially important when a farmer confronts a suite of possible breeding options, many of which offer impressive per head performance figures. The model described in this paper integrates the primary drivers of sheep farm profit into an enterprise budget to allow farmers, with a limited number of inputs, to quickly answer 'What if?' questions about possible future scenarios for sheep farming. Once the likely 'best' breeding option is identified more detailed planning can be conducted, using whole farm feed planning models, to optimise the within year timing of management decisions for this breed.

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