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# ECONOMIC EVALUATIONS OF EXOTIC SHEEP CROSSES IN NEW ZEALAND

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## SUMMARY

Preliminary economic evaluations of exotic sheep breed crosses are presented as examples of economic studies of agricultural research being undertaken at Ruakura. The economic performances to date of exotic crosses and local sheep breeds are compared using gross margin analysis of data from Ministry of Agriculture and Fisheries (MAF) experiments. A cost-benefit analysis of the introduction of exotic crosses into New Zealand, to predict possible national economic return from the expenditure required to import, quarantine and evaluate the exotic breeds, is then outlined. Results indicate that the introduction of these new breeds into the national sheep flock is likely to be profitable to the nation and to farmers, and that the internal rate of return to the nation of the research could be about 25%. The usefulness of the types of evaluations described in this paper as an aid in allocating research resources is briefly discussed.

## INTRODUCTION

There has been considerable discussion about the importation and evaluation of the European exotic sheep breeds. Some agriculturalists and veterinarians have questioned the value of this research, claiming it to be unduly risky and expensive. In view of these doubts preliminary economic evaluations of trial results to date were undertaken to determine the likely profitability of the exotic sheep crosses (relative to traditional breeds) to farmers and the nation.

The objectives of the exotic sheep trials and results to date have been discussed by Clarke and Meyer (1977) and Meyer *et al.* (1977).

## GROSS MARGIN ANALYSIS

A gross margin is defined as the difference between gross income of an activity (a particular method of producing a crop or operating a livestock enterprise) and its variable costs. Gross income is the sum of income received from the sale of all commodities produced by the activity; variable costs are those which increase or decrease proportionately to changes in its scale. For livestock activities, gross margins are either expressed per head of livestock or per ewe equivalent, or on a per hectare basis.

TABLE 1: PHYSICAL PERFORMANCE<sup>1</sup> AND GROSS MARGINS

<i>Breed of Sire</i> × <i>Romney Dam</i>	<i>Lambs Weaned/ Ewe Mated</i> (%)	<i>Fleece Weights</i> (kg)			<i>Carcass Weights</i> (kg)		<i>Gross Margin</i> (\$/ewe)
		<i>Ewes</i>	<i>Hoggets</i>	<i>Lambs</i>	<i>Lambs</i>	<i>Cull Ewes</i>	
Finnish Landrace (Finn)	147	3.4	2.1	0.8	13.6	21.0	23.80
East Friesian	125	4.0	2.5	1.0	14.2	22.0	22.90
Border Leicester	101	4.5	2.5	1.1	14.1	22.6	20.20
Dorset	106	3.7	2.3	0.9	14.1	22.6	19.50
German Whiteheaded Mutton	93	4.3	2.7	1.1	14.1	22.4	18.70
Cheviot	99	3.7	2.3	0.9	13.6	21.5	18.00
Romney	80	4.0	2.5	1.0	13.0	19.0	15.40

<sup>1</sup> Physical performance data from Clarke and Meyer (pers. comm.).

Table 1 presents the physical performance data and gross margins calculated from the results to date of the exotic sheep evaluation programme being carried out at Mana Island and Crater Research Stations. These data are preliminary results only and final results could differ.

The gross margins in Table 1 suggest an overall economic advantage of 13% for Friesian halfbreeds and 18% for Finn halfbreeds relative to Border Leicester halfbreeds. The gross margin of the Finn halfbred is 55% higher relative to that of the straightbred Romney. Allowing additional labour costs for the management of Friesian and Finn crossbreeds at lambing time reduces the predicted advantages to 10, 15 and 51%, respectively, assuming the same stocking rate for all breeds. This assumption, which implies that performance on a per-ewe basis would parallel that on a per-hectare basis, should eventually be tested experimentally.

In the MAF trials to date, exotic crossbreeds have consistently out-performed traditional breeds and crosses in lamb production and this has resulted in higher estimated gross margins per ewe. What are the possible implications of these results for New Zealand and its sheep industry?

#### A NATIONAL ECONOMIC EVALUATION

Gross margins calculated for the major breeds involved in the evaluation programme were used, with estimated current and expected numbers of breeding ewes of each breed in the national flock, to estimate the possible overall benefits to the nation from the introduction of these exotic genes into the industry. The relative performance levels of the breeds, rather than the absolute, are relevant here since only the differences between the gross margins enter the evaluation.

These benefits were then compared, in a cost-benefit framework, with the expenditure to date and expected future expenditure on the overall evaluation programme. In addition to information on the exotic crosses, these trials are also providing needed comparative assessments among various traditional crosses.

#### BREED PROJECTIONS

Projections of the future breed composition of the national flock were based on those of Coop (1971) and updated (Coop, pers. comm.).

It was assumed for most calculations that by the year 2020 30% of the national ewe flock would be exotic crossbreeds and

these would replace potential Romneys, Perendales (Cheviot  $\times$  Romney) and Coopworths/Border-Romneys.

It was also assumed that total breeding ewe numbers would continue to increase from the current level of approximately 41 million, according to a linear trend equation based on increases in ewe numbers between 1960 and 1974. In addition, the effect of ewe numbers remaining static was investigated and is discussed in the section on sensitivity analyses.

#### BASIC METHODOLOGY

Cash flows were prepared in a cost-benefit framework to represent the differences between the costs and benefits of a possible future situation *with* exotics, and one *without* exotics.

The Romney, Border cross and Cheviot cross gross margins were subtracted from the exotic crossbred gross margins and the residuals multiplied by the appropriate number of exotic crossbreds projected to replace sheep of these other breeds in the national flock.

From these were subtracted, on an annual basis, the importation and research costs associated with the exotic sheep. Extra *on farm* costs associated with the more productive sheep are included in the gross margins. No allowance has been made for extension costs.

All costs and benefits were expressed in 1977 money values then compounded or discounted to a present value. Present value can be defined as the value now of a past or future sum of money. The present value of money received in the past is calculated by compounding, and that in the future is calculated by discounting it at a rate of interest equivalent to the rate at which it could otherwise be invested. The effects of inflation are removed by expressing all prices, of both costs and benefits, in 1977 money values.

#### BENEFITS

The exact role of the exotics in the New Zealand sheep industry is unknown. On present evidence the most likely role of the Finn would be in the generation of half- and quarter-bred Finn  $\times$  Romneys (Clarke and Meyer, pers. comm.).

The following assumptions were made:

- (1) The economic performances of exotic crosses are represented by Finn  $\times$  Romneys.

- (2) The Finn will play two separate roles — as a quarter-bred Finn  $\times$  Romney on hill country  $((F \times R) \times R)$  and as a half-bred Finn  $\times$  Romney on easy country  $(F \times R)$ . The number of sheep in each role will be the same.
- (3) The genetic merit of all breeds will increase in future but the differences in merit between breeds will remain at their present levels.

In the immediate future, improvement in the traditional breeds should be more rapid than in the exotic crosses. However, this is likely to be counterbalanced in the longer term since the superior prolificacy of the exotics could enable greater selection pressure to be applied (Meyer, pers. comm.).

### COSTS

Total actual costs associated with the exotic sheep importation and evaluation, including an allowance for scientist salaries, up to March 31, 1977, were \$1 065 402. Estimates of future costs (\$280 000 per year) were also included in the analysis.

### RESULTS

The results of the cost-benefit analysis are presented in terms of Net Present Value (NPV)\* and Internal Rate of Return (IRR) criteria.

The NPV of an investment is the difference between the present value of the benefit flows of the investment and the present value of the cost flows.

The IRR is that rate of interest which, when used to discount the cash flows associated with an investment project, reduces its NPV to zero. It can be interpreted as the average annual rate of return per dollar invested. The IRR was calculated to be 27%. This compares very favourably with the 10% interest rate recommended by Treasury for the evaluation of public-funded investments.

$$*NPV = \sum_{t=0}^n \frac{B_t - C_t}{(1+i)^t}$$

Where  $B_t$  = benefits in year  $t$

$C_t$  = costs in year  $t$

$n$  = number of years

$i$  = interest (compound and/or discount) rate.

The NPV at 10% discount rate was estimated to be \$62.9 m which appears small considering that the evaluation is over a 50-year period and large numbers of sheep. However, the nature of this investment is such that most of the expenditure is undertaken in the early years of the project life (*i.e.*, 1971-8) while the benefits do not start accruing until after the release of the exotics in 1982 and only build up slowly at first. Most of the benefits, therefore, accrue late in the project life and are heavily discounted, particularly at high interest rates. Undiscounted, the annual net benefits increase to \$72 million by the year 2020. At 5% the NPV was estimated to be \$221.3 m and at 15% \$21.5 m.

#### SENSITIVITY ANALYSES

Sensitivity analyses were carried out by changing one parameter at a time, and observing the effect.

##### *Future Breed Composition of the National Flock*

In the model previously described it was assumed that the exotic crossbreds would comprise 50% of the national flock by 2020. Varying this by 10% points, either up or down, alters the NPV (at 10%) by only  $\pm$  \$8 million, and the IRR by less than  $\pm$  0.2% points. This insensitivity, particularly of the IRR, is largely explained by the nature of the investment, already discussed.

If a higher rate of adoption of the exotic crossbreds in early years is assumed (20% by 2000) then a substantial increase in the NPV (increased by \$36.1 m) and the IRR (increased by 3.2% points) is achieved.

##### *Future Breeding Ewe Numbers*

A model was constructed which assumed that total breeding ewe numbers would remain static over the next 50 years and that 20% of these would be exotic crosses after that time. For this alternative the NPV (at 10%) was \$33.9 million and the IRR 24.4%. Although considerably reduced, the NPV and IRR indicate that the introduction of the exotic would still be clearly profitable.

##### *Lambing Performance of the Exotics*

All the exotic crossbred gross margins were recalculated using a 10% lower lambing % (assuming that a 10% lower lambing

% meant a corresponding reduction in fat lamb sales). This had quite a substantial effect on the NPV (reduced by \$27.1 m) and IRR (reduced by 3.8% points). However, a 10% decrease is a relatively large one and again, even with such a decrease, the introduction of the exotics would still be profitable.

#### *Timing of the Benefits*

The effect of delaying, by 5 years, the release of the exotics to farmers was investigated, *i.e.*, no benefits would accrue until 1988. This had a very substantial effect on both the NPV and the IRR. For the model which assumed static breeding ewe numbers for the next 50 years and 20% exotic crossbreds by 2020, the NPV (at 10%) was reduced from \$33.9 million to \$11.2 million and the IRR from 24.4% to 15.3%.

#### CONCLUSIONS

The economic evaluations carried out are necessarily preliminary in view of the limited information currently available regarding exotic crossbred performances under New Zealand conditions. The performances used relate to a small number of animals over a short period of time (three seasons for hogget growth and wool traits, but only one season for reproductive performance of exotic crosses). However, the animals used for comparative purposes represent a fair cross-section of local sheep breeds and all sheep in the trial have been run under the same conditions.

The cost-benefit analysis is useful at the national level in comparing the possible profitability to the nation of the exotic sheep programme with that of other public funded investments, and in comparing the economics of the exotics programme to that of other areas of research which also lend themselves to evaluation.

Provided that the per-ewe gross margins in Table 1 adequately reflect per-hectare gross margins, there is likely to be quite substantial gains in profitability for a farmer changing to exotic crossbreds. In general, increasing output per hectare through higher stocking rate systems introduces both higher costs and risks (Taylor and McRae, 1977). Therefore any innovation, such as the use of exotic crossbreds, that is capable of increasing net output per hectare through increasing per-animal performance would stand a much better chance of being acceptable to farmers.

The adoption rate and the time of release of the sheep from quarantine would have a major influence on the economic re-

turn to the nation from the exotic sheep research programme. Benefits resulting from lowering the risks of introducing scrapie by lengthening the quarantine period must be carefully weighed against the decrease in potential profitability.

On the basis of results to date, it is concluded that the profitability to the nation and to individual farmers of introducing exotic sheep breeds into New Zealand is potentially high, and that there are good economic grounds for the continuation of the exotic sheep research and development programme.

#### ACKNOWLEDGEMENTS

The authors gratefully acknowledge the co-operation received from many MAF personnel in carrying out the evaluations reported in this paper. Drs J. N. Clarke and H. H. Meyer, Genetics Section, MAF, Ruakura, deserve special mention.

Dr R. W. M. Johnson and A. A. Shepherd (Assistant Director and Senior Agricultural Economist, respectively, Economics Division, MAF) and G. K. Hight (Director, Whatawhata Hill Country Research Station, MAF) provided very valuable comments on drafts of this paper.

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