Chapter 8 Strategies for including helminth resistance in a Merino breeding objective

8.1 Introduction

Merino breeders wanting to include resistance to internal parasites in their selection program need to decide on an appropriate testing procedure for the resistance trait. For the reasons discussed in Chapter 2.2, FEC is a relatively easy measurement to add to a breeding program as either a first or second-stage selection criterion. There is no additional capital investment required and the extra costs are the marginal costs associated with testing each animal. The important issue is to assess the cost-effectiveness of different testing strategies and this can be determined by appropriately combining the genetic gain in FEC for each strategy with the relative cost of testing for each strategy.

When a new trait is introduced into the breeding objective for a population with overlapping generations, the rate of response for this trait is initially erratic until, over time, it asymptotes to the response predicted by classical theory (Hill 1974). In a self-contained flock the flow of genetic change will be affected by the age structure of the population being selected. The rate of response can be predicted by accumulating the proportion of genes that are passed on to offspring from each age group in the flock. This procedure assumes that the population structure remains fixed, the genetic selection differential remains constant (the heritability and variance do not change with selection), and that inbreeding depression does not cause a departure from additive gene action (Hill 1974). The assumption is also made that animals are selected from progeny only. Across-age comparisons are not used to determine the sheep selected, as this would impact on the age structure of a population undergoing genetic change, and on the flow of superior genes.

In the Australian Merino industry, the benefit of genetic change is not only expressed in the stud undergoing selection, as surplus males are usually used in larger commercial enterprises. Overall increased productivity as a result of selection in the stud, also includes improvements that occur in the commercial base, allowing testing and selection costs to be shared among the total population benefiting from the selection program. This assumes that there is some mechanism of ensuring additional reward to the ram breeder, either in terms of greater returns for the sale of rams or some levy on improved commercial production, that subsides the initial cost of the testing and selection program.

Alternate strategies for including resistance testing will involve different costs. FEC testing can be included at either first-stage selection (6-12 months of age) or second-stage selection (12-18 months of age) or both. If artificial challenge is used, the timing of FEC measurement is controlled, allowing animals to be challenged at a specified time and repeat measures to be fitted into the management program. The pattern of monetary return from genetic improvement is also erratic in the early years of selection when genes from selected animals are being distributed through the whole population (Hill 1971). A discounted cash flow procedure, as described by Hill (1971), can be used to compare alternate strategies that have different costs and returns over time.

The goal of this chapter is to use a simplified model to examine the general implications of different selection strategies for incorporating FEC into a Merino breeding program. This was done by simulating gene flow for a stud and base population and calculating the resultant net discounted returns of including FEC, using a range of testing strategies. The model was simplified by assuming the selection program was commencing for all traits simultaneously. This would represent the situation for newly established studs and would partially equate with the situation where selection for production had previously been based on visual traits.

8.2 Materials and Methods

Predictions of genetic gain were made using SELIND (Cunningham 1969). Where there was two-stage selection, predictions of genetic gain were made using a version of SELIND (modified by R.R. Woolaston) that used a two-stage selection program (Wade 1990) to calculate overall selection differentials. The two-stage selection program accounted for differences in trait variances at each stage of selection. The various testing strategies that were investigated are given in Table 8.1. The aggregate index was calculated from the multiplying the genetic differential by the REV for each breeding objective trait and is expressed in $/standard deviation of the index.

The phenotypic and genetic parameters assumed for all traits were the same as in Chapter 7, but with the addition of a second FEC trait. FEC at first-stage selection (FEC1) was treated as a separate, but correlated trait, to FEC measured at second-stage selection (FEC2). The phenotypic standard deviation and heritability was assumed to be the same for FEC1 and FEC2. The genetic correlations of both FEC traits with production traits were zero and the genetic correlation between the two FEC traits was 0.8. Where there was a repeat measure of FEC2 the repeatability was 0.35.

Predictions of discounted net returns were made for a range of selection strategies under three different economic scenarios. These economic scenarios were defined as low, medium and high emphasis for worm resistance and used the implied REVs for a desired gain of 30%, 50% or 70% for FEC (-$12.59, -$23.11 and -$39.24 respectively for the three desired gains, See Table 7.2). It is important to note that the relationship between these desired gains and the REVs for FEC are specific to the assumptions used in predicting trait responses. Should the genetic parameters or amount of information from relatives change, the implied REVs for a specific desired gain will also change.

Table 8.1 Traits measured at each stage of selection for rams and ewes and the resulting aggregate index value and cost of obtaining FEC information for each strategy. Trait names are defined in Chapter 7.

Strategy evaluated	1st-stage selection	2nd-stage selection	Low emphasis for FEC		Medium emphasis for FEC		High emphasis for FEC		FEC cost ($/sheep)
			Aggregate index ($)	FEC gain (units/sel.diff.)	Aggregate index ($)	FEC gain (units/sel.diff.)	Aggregate index ($)	FEC gain (units/sel.diff.)	
Index 1 (rams)	16CFW 16FD 16BW	Nil	20.64	0	20.64	0	20.64	0	0.00
Index 2 (rams)	16CFW 16FD 16BW FEC1	Nil	21.64	-0.1548	23.84	-0.2579	28.91	-0.3611	3.80
Index 3 (rams)	16CFW 16FD 16BW FEC1	FEC2	21.86	-0.1885	24.52	-0.3087	30.49	-0.4211	5.29
Index 4 (rams)	FEC1	16CFW 16FD 16BW	19.02	-0.3493	22.95	-0.3964	29.83	-0.4537	3.80[A]
Index 5 (rams)	16CFW 16FD 16BW	FEC2 x 2	22.10	-0.2240	25.15	-0.3414	31.31	-0.4096	2.98
Index 6 (rams)	16CFW 16FD 16BW	FEC2	21.64	-0.1547	23.81	-0.2510	28.51	-0.3200	1.49
Index 7 (ewes)	16GFW 16FD	Nil	5.42	0	5.42	0	5.42	0	0
Index 8 (ewes)	16GFW 16FD FEC1	Nil	5.79	-0.0564	6.58	-0.0911	8.33	-0.1222	3.80
Index 9 (ewes)	16GFW 16FD	FEC2	5.78	-0.0538	6.48	-0.0764	7.85	-0.0910	3.14

[A] Reduced to $0.65/animal when savings in fleece testing are accounted for.

The final proportion of rams selected was 5%, with 30% being selected at the first stage when two-stage selection was used. The final proportion of ewes selected was 60%, with 80% being selected at the first stage when two-stage selection was used. Output from selection index calculation was expressed in trait units per selection differential achieved for rams (2.063 sd) and ewes (0.644 sd).

The costs associated with estimating a FEC breeding value were calculated in terms of dollars per animal considered for measurement at the first stage of selection and are given for each strategy in Table 8.1. A breakdown of these costs is given in Table 8.4. In the net discounted returns a value of $0.65 was used for ram Index 4 as there was a saving on fleece testing charges in this option (where fleece measurements were made at second-stage selection only). The cost per animal for fleece testing was assumed to be $4.50 which represented a saving of $3.15 per animal when only 30% of the drop were tested. For all other indexes the cost of fleece testing was constant.

The breeding objective traits and their economic values are given in Table 8.2. The age of expression of merit for the objective traits was assumed to be year 2 for FEC plus traits measured at 16 months of age, year 4 for adult wool traits and reproductive rate, and year 5 for adult body weight (Table 8.2).

Table 8.2 Breeding objective traits and their economic values and assumed age of expression

Breeding objective traits	REV ($/ewe lifetime)	Age of expression
16CFW (hogget)	0.87	2
16FD (hogget)	0.99	2
16BW (hogget)	-4.56	2
21CFW (adult)	-4.56	4
21FD (adult)	0.32	4
21BW (adult)	0.06	5
RR	84.29	4

Gene flow and discounted returns and costs were simulated in a spreadsheet for a stud and commercial base population. Returns from individual traits in the breeding objective were estimated independently to allow their expression at different times after the year of selection (as indicated in Table 8.2). Certain assumptions were made about flock structure, the proportion of animals tested and proportion of rams used in the base population, as follows.

The age structure assumed for the stud is given in Table 8.3 and comprised two age groups of rams with no mortalities, and 4 age groups of ewes with 5% mortalities per annum. The generation interval in the stud was 2.97 years. The base introduced average rams from the stud each year and no ewes. Under these conditions the generation lag between stud and base is 2 generations (Bichard 1971). Therefore, contributions from the base, to the economic returns from selection, occurred 6 years after contributions from the stud.

Table 8.3 Proportion of animals in each age group and generation interval in the stud

Age (years)	2	3	4	5	Generation length (years)
Rams	0.5	0.5			2.5
Ewes	0.27	0.26	0.24	0.23	3.4
Average					2.97

The size of the stud was fixed at 600 breeding ewes, with a reproductive rate of 90% lambs weaned, a figure which is representative of Merino studs in NSW (Casey and Hygate 1992). This gives 270 young sheep of each sex available for selection. Only a proportion of these were measured for production traits and FEC (70%, Casey and Hygate 1992) giving 189 animals of each sex tested. The assumption was made that visual classing prior to measurement had no effect on the variance of the measured traits.

There was no culling of rams or ewes after they entered the breeding flock until the contemporary group was culled for age. There were 12-13 replacement sires required each year, assuming a joining percentage of 4% and no deaths. The proportion of rams selected was 5% giving 13 replacement rams available each year. There were 162 replacement ewes required each year to maintain the ewe flock at 600, assuming 5% annual mortality. This means that 60% of the ewe hoggets were selected.

The size of the base population was determined by the number of surplus rams available from the stud. In the stud 189 rams were tested, of which the 13 best were kept as stud replacements, leaving 176 rams. The worst 13 of these rams were culled leaving 163 rams, which were representative of the stud average. The joining percentage in the base was assumed to be 1.85%, giving a base size of 8,800 ewes. The units of expression for REVs are $/ewe lifetime (Ponzoni 1987), so the number of times these units are expressed in a year was assumed to be equivalent to the number of replacement ewes entering the stud or the base. The same flock age structure was assumed for both the stud and base.

The cost of obtaining FEC information (Table 8.4) included the provision of infective larvae to artificially challenge the sheep, one extra anthelmintic treatment to terminate the infection, a laboratory charge for the FEC and a marginal charge per animal for including another trait in the genetic analysis. A nominal labour cost of half a day at $100/day was included for faecal sampling regardless of the number sampled, resulting in a variable labour component depending on the number of sheep sampled in the group.

Table 8.4 Costs of estimating a breeding value for FEC

Cost of FEC EBV ($)	1st stage	2nd stage
Infective larvae	0.50/head	0.50/head
Extra anthelmintic	0.20/head	0.20/head
FEC	2.00/head	2.00/head
Breeding value estimation	0.60/head	0.60/head
Labour	0.50/head	1.67 (rams)
		0.63 (ewes)

Discounted net returns of using FEC to select for worm resistance were estimated for the different ram and ewe strategies given in Table 8.1, and combinations of these strategies under each economic scenario (implied REV for FEC). The returns from these strategies were compared with returns from selecting for production traits alone over both a long-term time period (20 years) and a short to medium-term time period (10 years). The discount rate used was 5%. One of the indexes (Index 5) using one REV for FEC (-23.11, medium emphasis for FEC), was evaluated over a range of discount rates (0%, 5%, 10%, 15% 20% and 25%), the returns for Index 5 being compared to Index 1 at each discount rate.

8.3 Results

An evaluation of the different ram selection strategies that included FEC (Index 2 to Index 6, see Table 8.1) showed that the greatest genetic response for FEC would be achieved by testing the rams for FEC alone at the first stage of selection (Index 4). This was followed closely by repeat testing for FEC at second-stage selection (Index 5) and then by testing for FEC at both first and second-stage selection (Index 3). The next best strategy was testing all animals for FEC with no second-stage selection (Index 2) and the lowest gain was when FEC was tested once at the second-stage of selection (Index 6). An evaluation of the ewe strategies including FEC (Index 8 and 9) showed that more gain for FEC was achieved when all ewes were tested for FEC with no second-stage selection (Index 8), than when FEC was tested at the second-stage of selection (Index 9). The magnitude of the difference between strategies was amplified with increasing REV for FEC.

The ranking of indexes on predicted genetic gain for FEC was not consistent with the ranking on overall merit of the aggregate index, of which FEC was a part (Table 8.1). For instance at medium emphasis for FEC, the ram indexes including FEC ranked (highest to lowest) Index 5, 3, 2, 6 then 4 for aggregate index merit (versus Index 4, 3, 5, 2 then 6 for ranking on FEC gain). Index 4 changes rank because it involves first-stage selection for FEC alone, then second-stage selection on fleece traits, a strategy which results in high gain for FEC but relatively poor aggregate merit due to the lower gains for fleece traits. The aggregate merit of Index 1, which did not include FEC, changed in its value relative to the other indexes depending on the REV for FEC, being the second lowest at low emphasis for FEC and the lowest at medium and high emphasis for FEC.

The net discounted returns for all indexes were plotted over a 20 year period, for each implied REV for FEC, to show their relative performance in the long-term. The scale on the y-axis varied in magnitude for the three scenarios, increasing as the emphasis on FEC increased. The scale on the y-axis did not allow the clear differentiation of data during the early years of selection for the ram, and ram plus ewe indexes, so the same data were plotted over a 10 year period to show the relative performance of each index in the short to medium-term.

The relative performance of each ram index (Index 2 to 6) that included FEC, compared to the production only index (Index 1), is shown in Figures 8.1 to 8.6. The relative merit of many of the indexes was variable under different REVs for FEC. The following performance of specific indexes is of interest. Over a 20 year period returns from Index 5 were consistently the greatest for each REV for FEC. Index 6 was ranked second on merit when there was a low emphasis on FEC but progressively dropped in rank as emphasis increased. Index 4 showed reducing economic benefits (compared to benefit of selecting for production alone) at low emphasis for FEC, but when the emphasis was greater, showed increasingly positive returns. The low testing costs of this Index with only 30% of animal being fleece tested resulted in Index 4 appearing favourable in the short-term, especially as the emphasis on FEC increased. The strategy of FEC testing all rams at first-stage selection and then again at second-stage selection (Index 3) was less efficient in both short and long-term compared to repeat testing of only those rams considered at the second-stage of selection (Index 5).

The short to medium-term returns for each index were relatively consistent in rank for the three different REVs for FEC. The break-even point of indexes when there was low emphasis for FEC was from 11 to 15 years, with Index 3 and 4 never breaking even. This was shortened to 6 to 11 years with moderate emphasis for FEC and to 4 to 9 years with high emphasis on FEC with all indexes breaking even. The additional returns from the base population, which commenced in year 9, reversed the trend in negative returns when there was low emphasis on FEC. However, when there was moderate or high emphasis on FEC the negative trend in returns was reversed for most indexes before base contributions occurred.

The relative performance of the two ewe indexes that included FEC (Index 8 and 9), depended on the emphasis on FEC (Figure 8.7 to 8.9). Index 9 was superior at low emphasis for FEC, while at medium and high emphasis they swapped in merit at 18 and 11 years respectively.

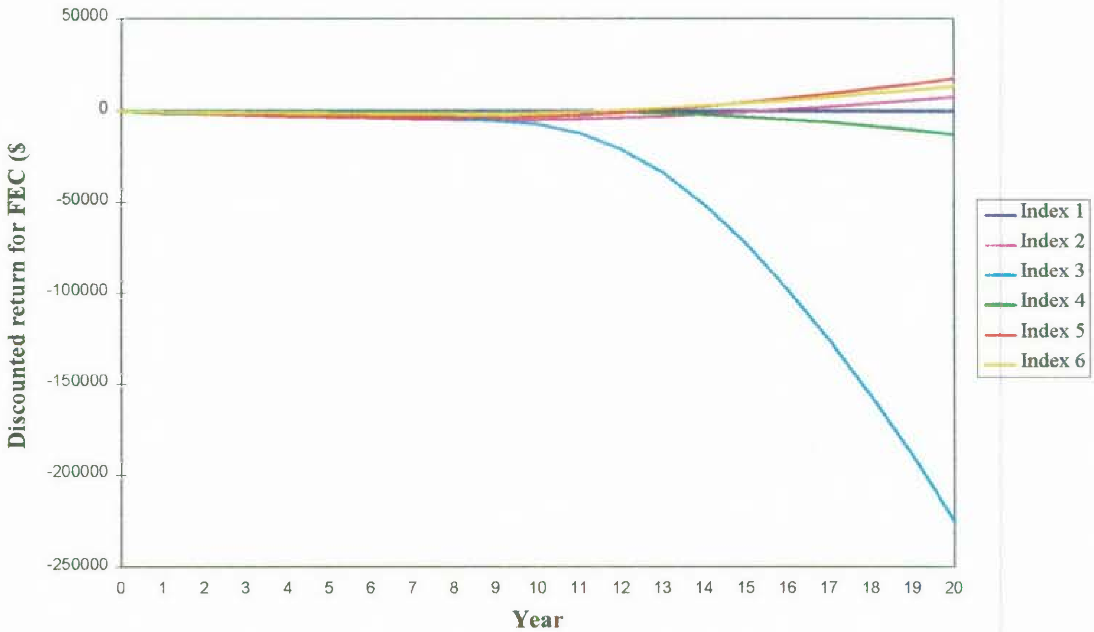

Figure 8.1 Long-term accumulated net discounted return for FEC measurement strategies for rams (ewes unselected for FEC) compared to returns from measuring production traits only, when emphasis for FEC was low (implied REV for FEC of -12.59 or 30% desired gain).

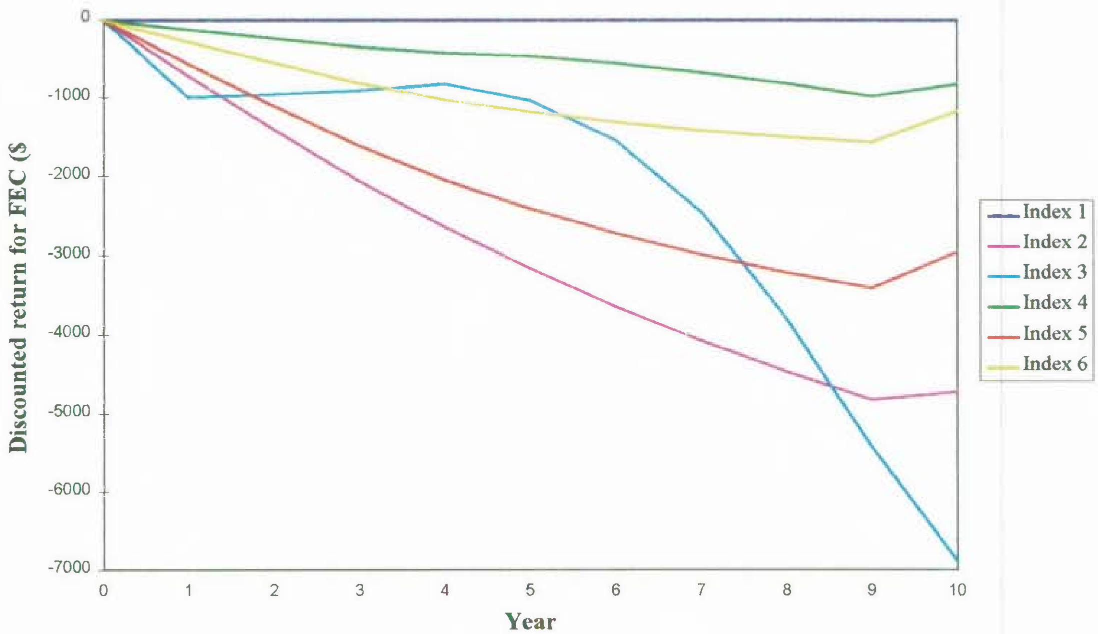

Figure 8.2 As for Figure 8.1 but for first 10 years only.

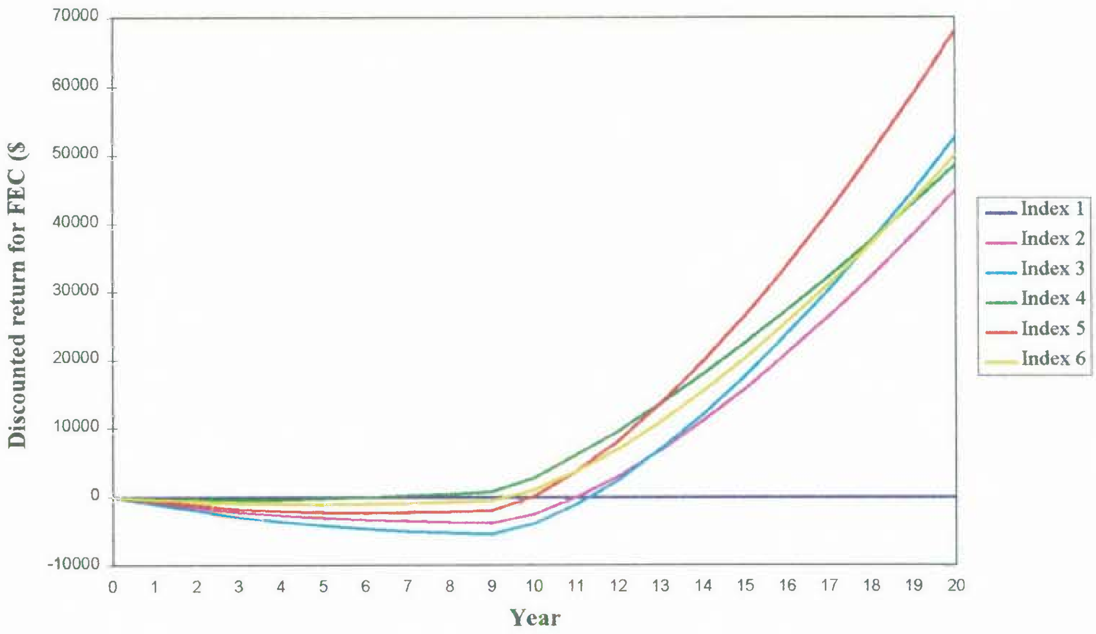

Figure 8.3 Long-term accumulated net discounted return for FEC measurement strategies for rams (ewes unselected for FEC) compared to returns from measuring production traits only, when emphasis for FEC was medium (implied REV for FEC of -23.11 or 50% desired gain).

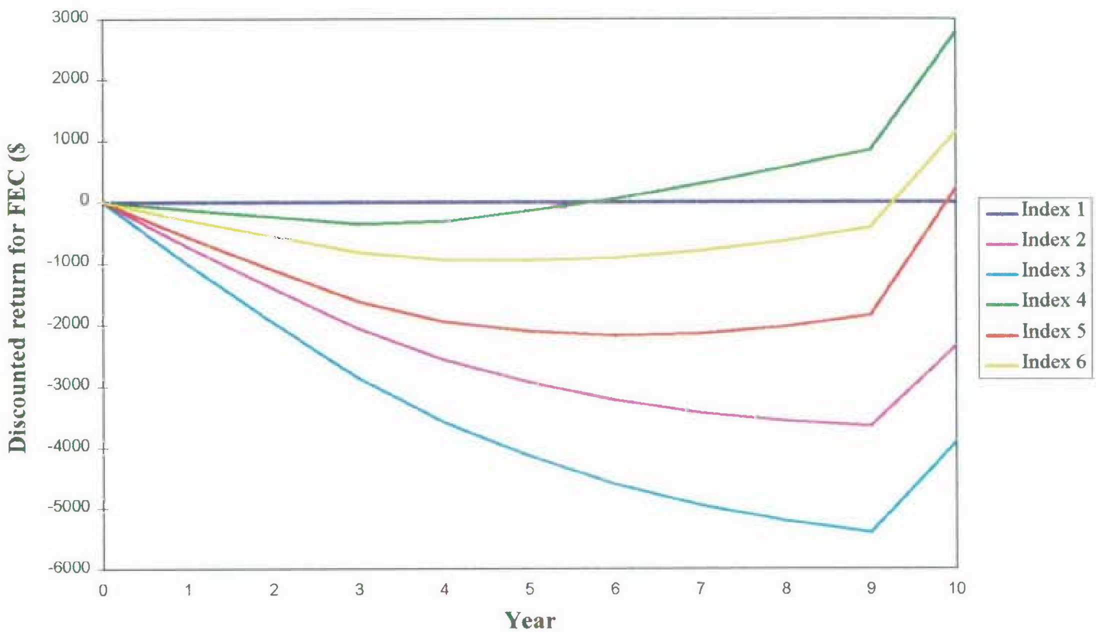

Figure 8.4 As for Figure 8.3 but for first 10 years only.

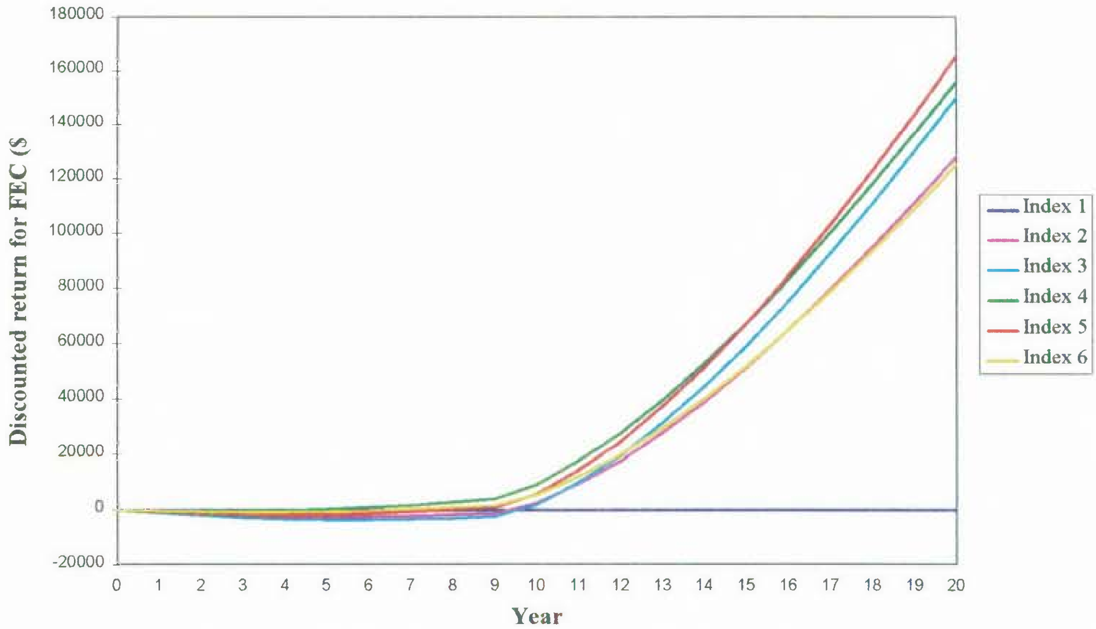

Figure 8.5 Long-term accumulated net discounted return for FEC measurement strategies for rams (ewes unselected for FEC) compared to returns from measuring production traits only, when emphasis on FEC was high (implied REV for FEC of -39.24 or 70% desired gain).

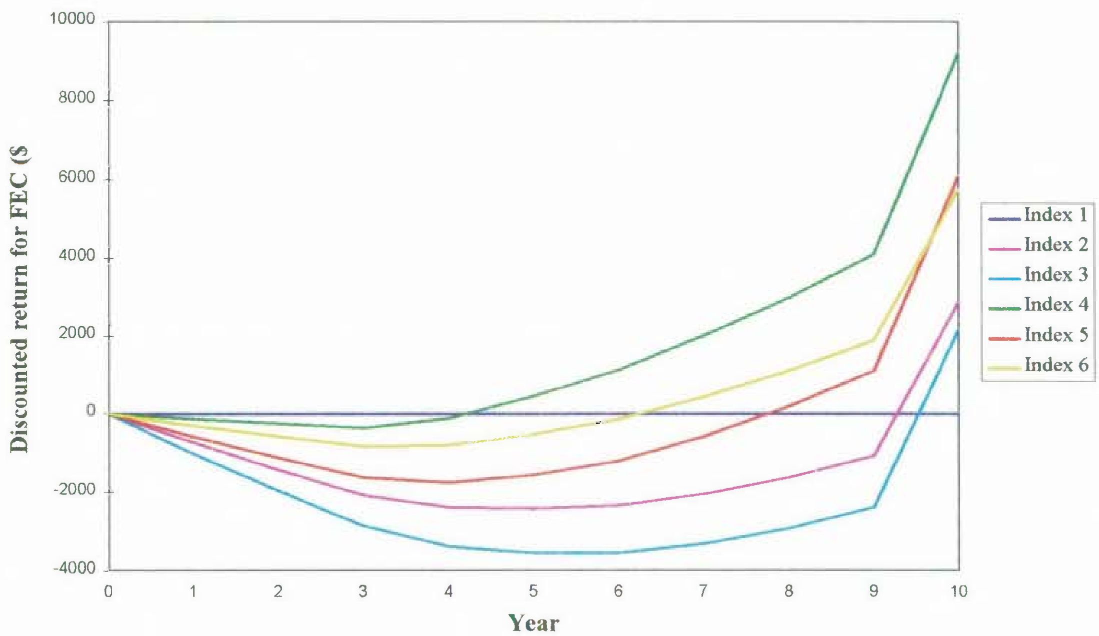

Figure 8.6 As for Figure 8.5 but for first 10 years only.

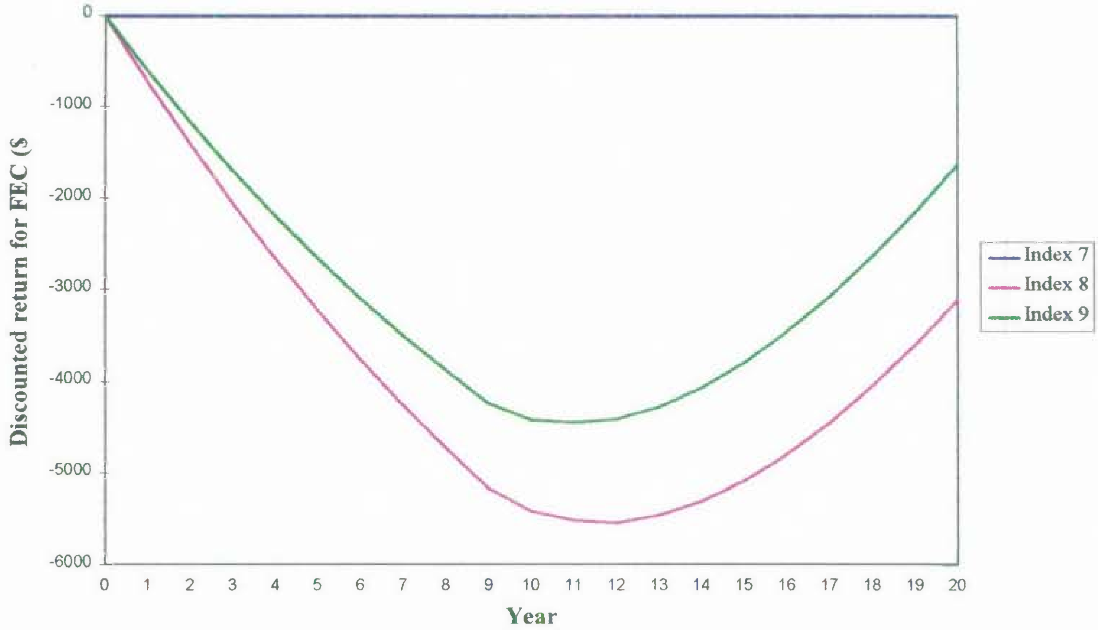

Figure 8.7 Accumulated net discounted return for FEC measurement strategies for ewes (rams unselected for FEC) compared to returns from measuring production traits only, when emphasis on FEC was low (implied REV for FEC of -12.59 or 30% desired gain).

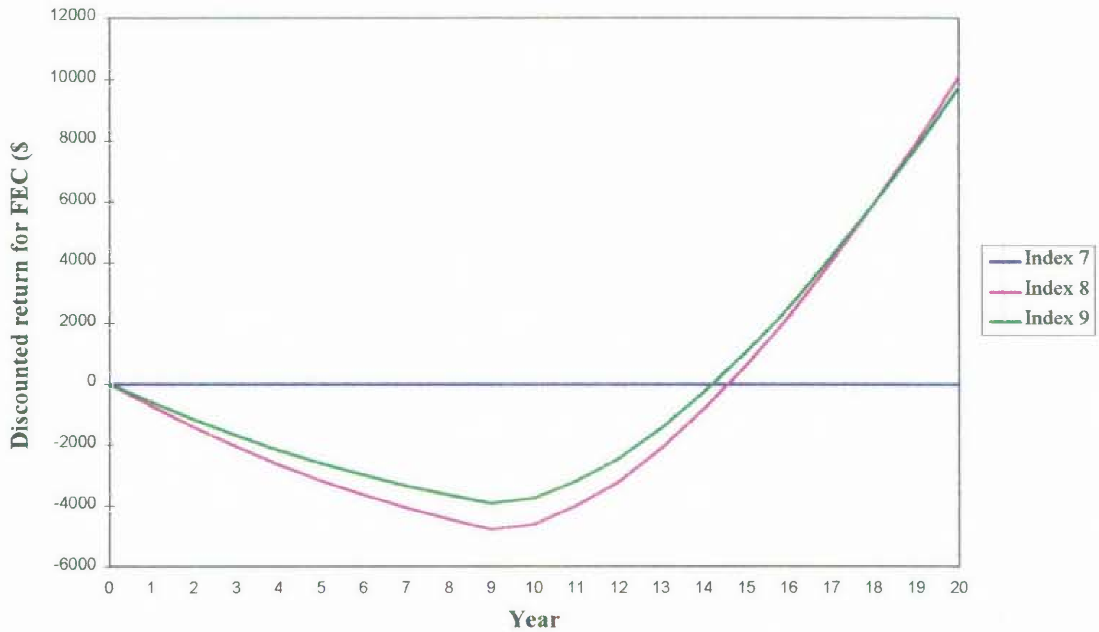

Figure 8.8 Accumulated net discounted return for FEC measurement strategies for ewes (rams unselected for FEC) compared to returns from measuring production traits only, when emphasis on FEC was medium (implied REV for FEC of -23.11 or 50% desired gain).

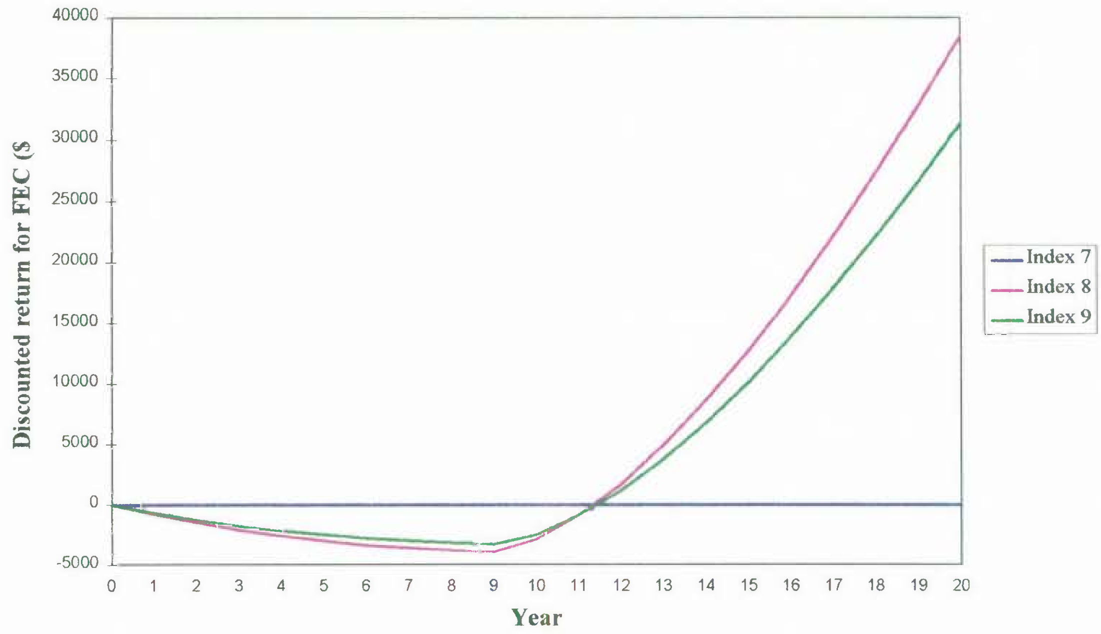

Figure 8.9 Accumulated net discounted return for FEC measurement strategies for ewes (rams unselected for FEC) compared to returns from measuring production traits only, when emphasis on FEC was high (implied REV for FEC of -39.24 or 70% desired gain).

Ram and ewe testing strategies were combined to compare the returns from testing of ewes compared to repeat testing of rams (Figures 8.10 to 8.15). In the longer term the combination of indexes that included repeat testing of rams (Index 5) and second-stage testing of ewes (Index 9) gave the greatest returns at medium and high REVs for FEC. However, in the short term this was much more expensive than the combination of Index 5 and no testing of ewes (Index 7). The returns from testing ewes at the second stage, in preference to repeat testing of rams (Index 2 + Index 9 versus Index 5 + Index 7), were lower when there was either a low or medium emphasis on FEC, but comparable when there was high emphasis. The strategy of testing ewes in this manner was relatively expensive in the short to medium-term.

Returns from Index 5 at the varying discount rates are shown for a 20 year period in Figure 8.16 and 10 years in Figure 8.17. The time to break-even increased with increasing discount rate, from 8 years at 0% to 10 years at 25%.

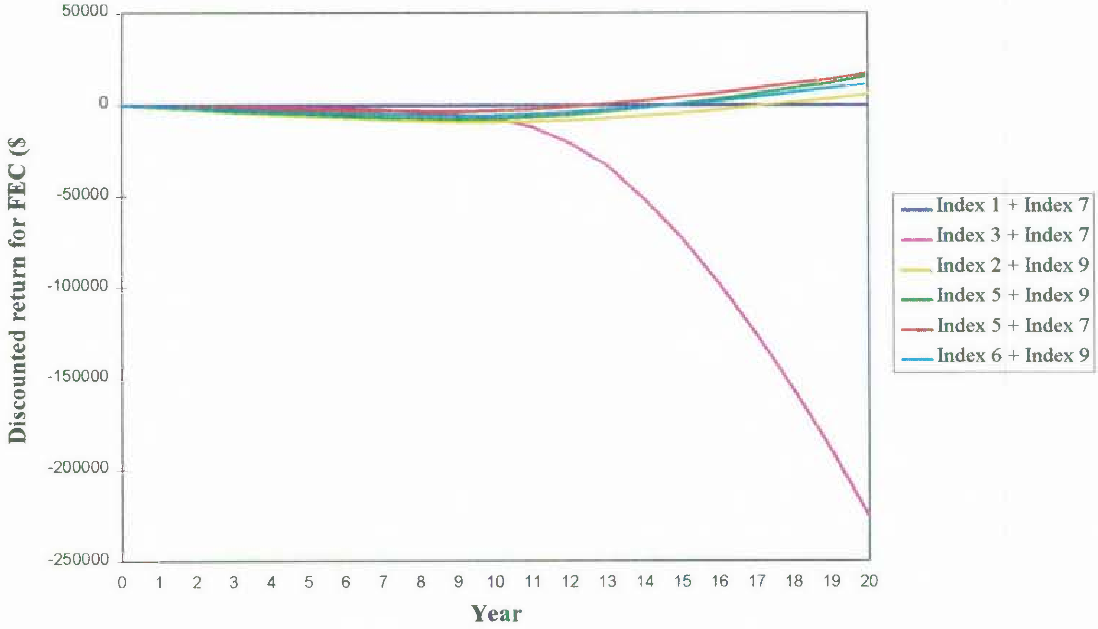

Figure 8.10 Long-term accumulated net discounted return for FEC measurement for combinations of ram and ewe strategies compared to returns from measuring production traits only, when emphasis on FEC was low (implied REV for FEC of -12.59 or 30% desired gain).

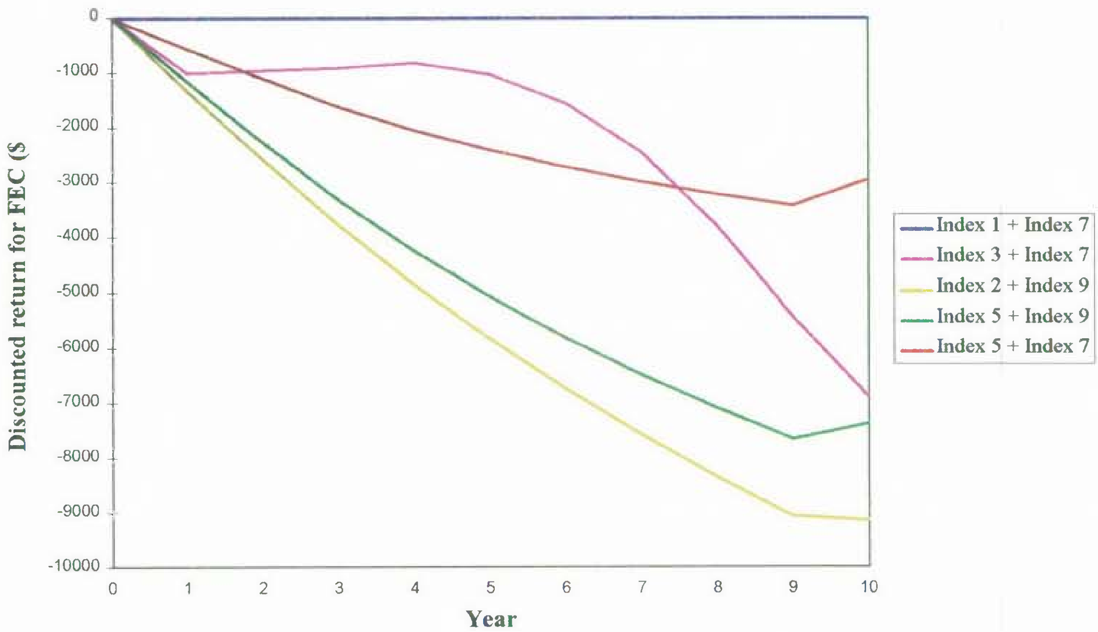

Figure 8.11 As for Figure 8.10 but for first 10 years only.

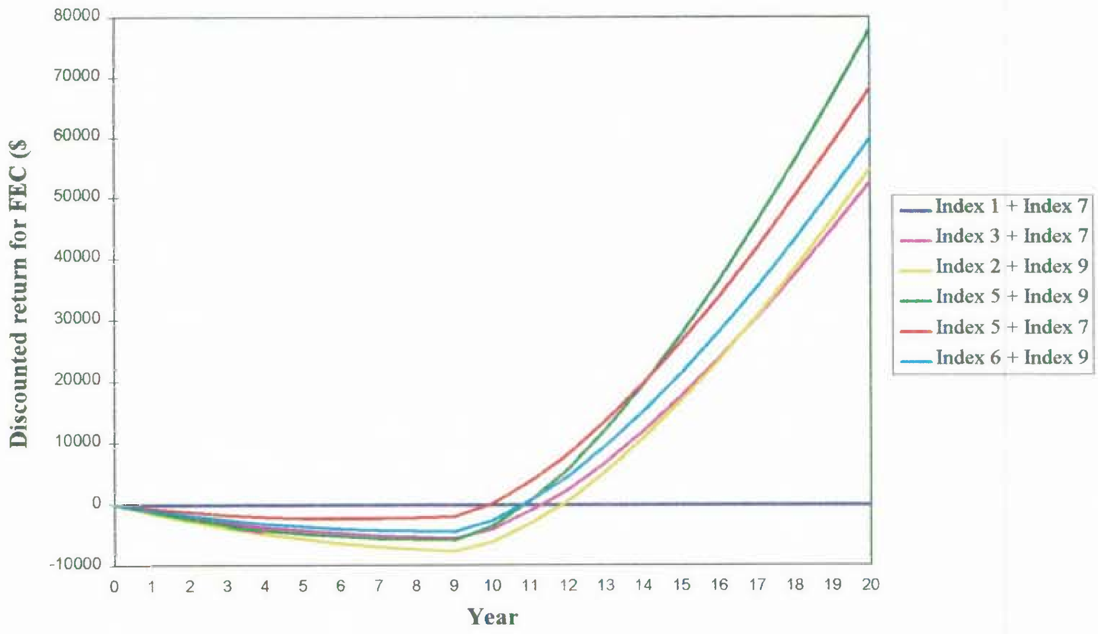

Figure 8.12 Long-term accumulated net discounted return for FEC measurement for combinations of ram and ewe strategies compared to returns from measuring production traits only, when emphasis on FEC was medium (implied REV for FEC of -23.11 or 50% desired gain).

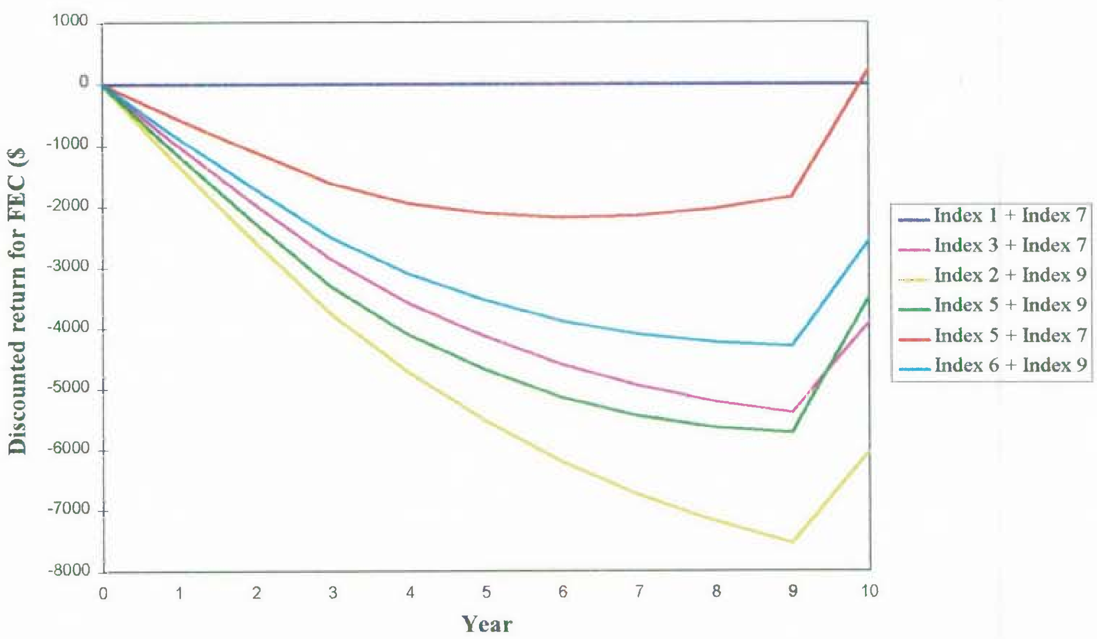

Figure 8.13 As for Figure 8.12 but for first 10 years only.

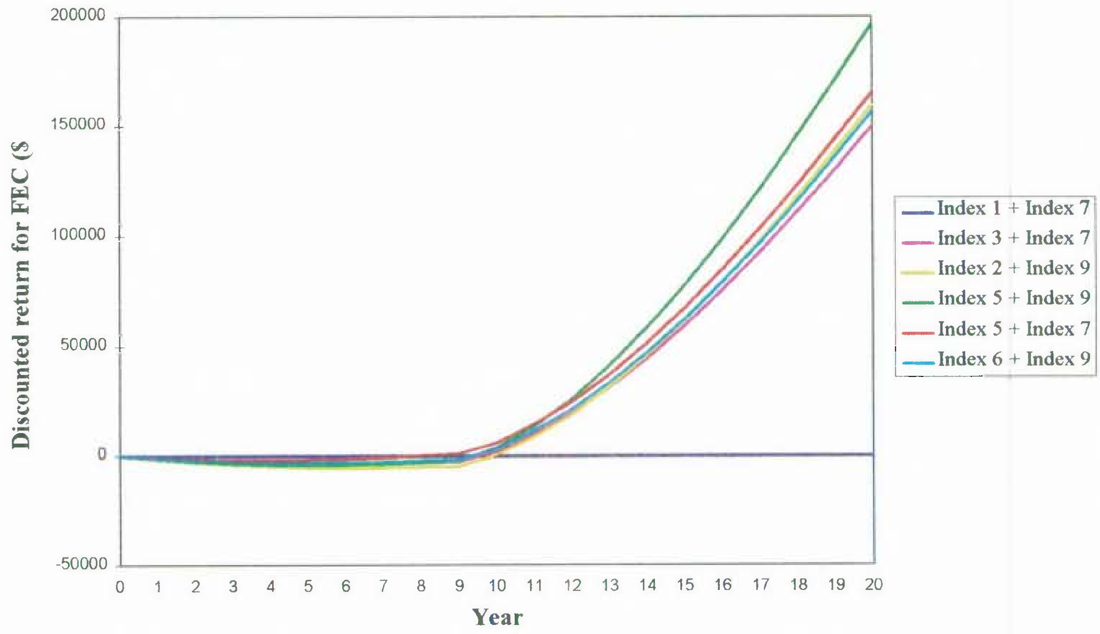

Figure 8.14 Long-term accumulated net discounted return for FEC measurement for combinations of ram and ewe strategies compared to returns from measuring production traits only, when emphasis on FEC was high (implied REV for FEC of -39.24 or 70% desired gain).

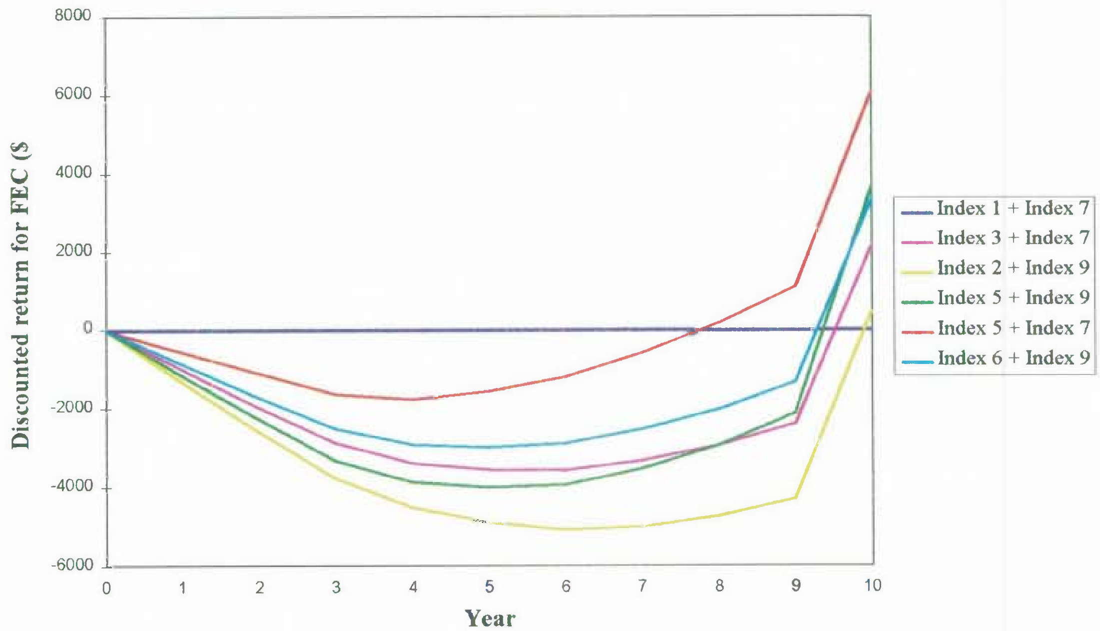

Figure 8.15 As for Figure 8.14 but for first 10 years only.

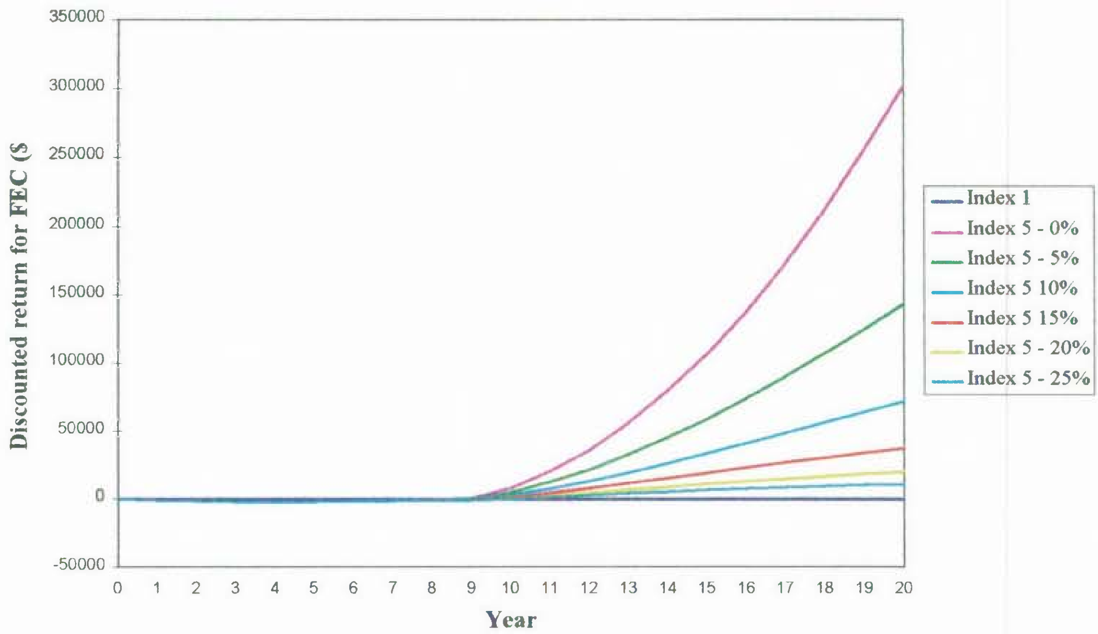

Figure 8.16 Long-term accumulated net discounted return for FEC measurement for Index 5 using varying discount rates compared to returns from measuring production traits only, when emphasis on FEC was medium (implied REV for FEC of -23.11 or 50% desired gain).

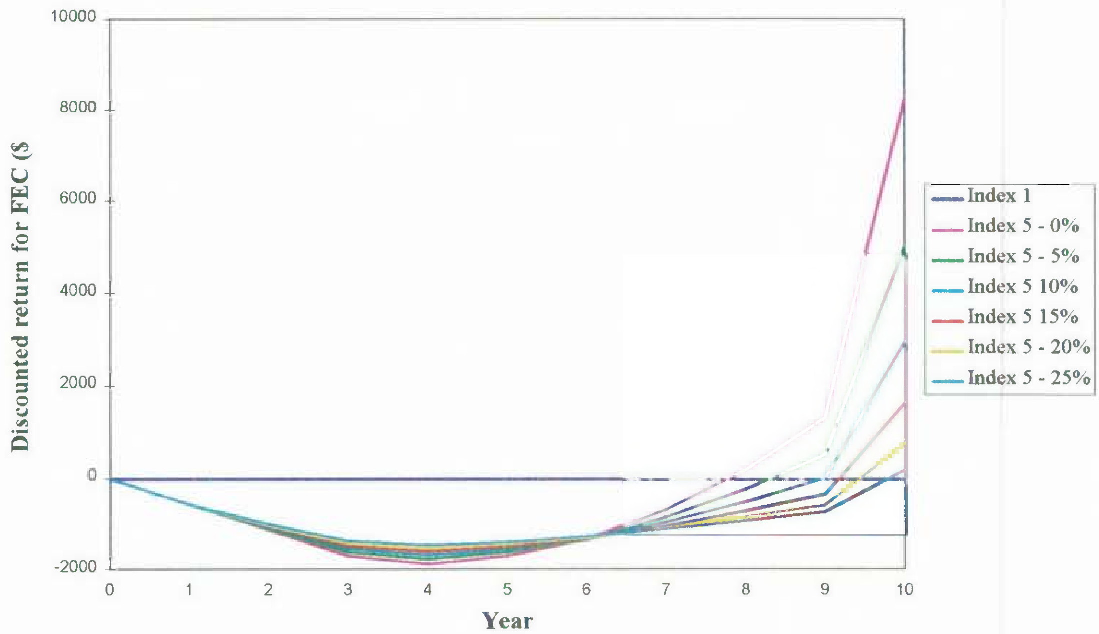

Figure 8.17 As for Figure 8.16 but for the first 10 years only.

8.4 Discussion and conclusion

From these results no single strategy can be selected as the best for incorporating worm resistance into a breeding program. Strategies varied in their economic returns depending on the time frame over which they were assessed. The comparison of testing strategies in both the short and long-term is important, as breeders have to work with relatively short-term economic horizons in terms of setting budgets to ensure their economic survival. The best strategy in the long-term may not be the most economical during the period in which returns are negative, and it may be the level of funds available during this period that is the limiting factor in deciding which testing strategy is the most viable. Therefore, a large range of results has been presented, as different strategies will prove optimal to different breeders depending on the availability of funds and the relative emphasis the breeder wishes to place on parasite resistance. However, some general conclusions can be made.

Over both the long and short-term, single-stage selection that tests all rams for FEC was relatively inefficient in terms of net discounted returns when compared to testing for FEC at second-stage selection on a reduced number of animals, especially where there was a repeat FEC test at the second stage to improve the accuracy of the measurement. Currently the most common strategy used by ram breeders is to test all young rams for FEC, usually prior to their first fleece measurement. One argument for testing animals at this age, which unavoidably means all of them, is that they are the most vulnerable class of livestock and the desired trait to change in the breeding objective is the FEC of animals of this age. There are no published estimates of genetic correlations between FEC at different ages, but there is good evidence that this correlation should be high (Eady, unpublished data; Woolaston 1992). In the simulations presented here the genetic correlation between an early FEC and a FEC later in life was assumed to be 0.8, so some allowance has been made for the fact that the two measurements may represent slightly different traits.

The economic merit of including FEC in the breeding objective is shown to be a function of the selection differential achieved for FEC under the prevailing strategy, the cost of testing for that strategy and, additionally, the assumed merit of FEC in the breeding objective. The low cost but low genetic gain strategy of only testing for FEC once at the second-stage of selection showed good relative returns when there was low emphasis on FEC in the breeding objective, but reduced in relative merit as the emphasis increased. Conversely, the expensive strategy of testing all rams for FEC only at first-stage selection gave good genetic response in FEC but negative overall returns unless the REV for FEC was medium or high.

The low cost strategy of only fleece testing at second-stage selection and testing all animals for FEC at first-stage, performed particularly well in the short term for all REVs for FEC but over the longer term the success of such a strategy was very much dependent on the REV for FEC. Given the uncertainty associated with the magnitude of the real REV for FEC it would be advisable to approach such a strategy with extreme caution.

One assumption in the model was that the cost of testing was shared by the stud and base population by means of increased ram values or a levy on the overall improvement in production including the base. When there is low emphasis on FEC in the breeding objective this assumption is critical to the stud achieving additional returns in a reasonable time frame (20 years). However, when there is medium or high emphasis on FEC, over time the stud by itself will reap additional benefits from testing for FEC without the contribution of productivity gains in the base population. The time to break-even point would be extended in this situation.

Further evaluation of testing strategies under different assumptions for the distribution of returns may be useful. As mentioned in the introduction, the model was also simplified by assuming that the selection program commenced for all traits simultaneously. Further examination of the strategies for including FEC may be warranted for the situation where production traits have already reached the asymptote of response. Returns will also vary where the age structure of the base is different to that assumed here, both through the effect age structure has on gene flow as well as the influence the number of expressions of adult fleece traits has on their respective REVs. This study has not sought to investigate the optimisation of measurement strategies for production traits, and it could be that additional improvements in returns are possible by varying production measurement strategies as well as FEC measurement strategies.

The merit of additional testing of ewes for FEC has been questioned by many breeders currently selecting for resistance. Generally in the long-term, the strategy of testing a reduced number of ewes (60%) for second-stage selection, plus all rams once, gave less favourable economic returns compared to zero testing of ewes and a repeat testing for FEC at second-stage selection in the rams. This disadvantage was more apparent when there was lower selection emphasis for FEC and was negligible when there was high emphasis on FEC. In the short to medium-term the testing of ewes in this manner was much less profitable at all REVs for FEC. The best combination of ram and ewe testing strategies was to repeat test rams at second-stage selection and test ewes once at second-stage selection, a combined strategy that resulted in the best overall long-term returns but was relatively expensive in the early stages of selection.

Regardless of the testing strategy or REV for FEC (with the exception of Index 3 and 4 at low FEC emphasis), additional returns were predicted from including worm resistance in the breeding objective. The magnitude of these returns was obviously dependent on the assumed REV for FEC, but even at a relatively low emphasis for FEC (equivalent to a 30% desired gain) additional gains were observed after 10-13 years of selection. From a sheep breeder's point of view, a lag of 10-13 years to start making additional income is reasonable, but probably getting close to the upper limit of an acceptable time horizon. If there was medium emphasis on FEC this time to break-even would be reduced to 7-10 years, depending on the testing strategy used. One index (Index 5) at one REV for FEC (medium emphasis) was used to examine the influence of changing discount rate on returns (Figure 8.16 and 8.17). The effect of varying discount rate from 0 to 25% was to extend the break-even time by two years for this index but at the same time reducing the minimum accumulated return early in the selection program. As expected, returns in the long-term were vastly different as discount rate varied, being highest at the lower discount rates. The pattern on returns, that varying discount rate showed, would apply to all indexes.

The general outcome of this study is that including FEC in a testing program is cost-effective given the REV for FEC is equivalent to, or greater than that implied by a 30% desired gain for the trait. The optimal testing strategy for most studs is likely to be to reduce the number of rams being measured by testing for FEC at a second stage of selection, the accuracy of the FEC test being improved by a repeat measurement. Investing additional funds into testing ewes can result in overall improvements when combined with second-stage ram testing, but this is an expensive exercise in the early years of selection before returns begin to be realised.

The critical issue that is yet to be resolved is what the REV for FEC is likely to be in practice and future work needs to focus on determining, if not an accurate estimate of the REV itself, at least some indication of whether the value is low, medium or high as described in the context of the desired gains framework used in these studies.