

RED DEER:
THE ECONOMIC VALUATION

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"In the 1870's and '80's we imported them for a bit of sport.
In the 1900's we decided to boost the bloodlines.
They thrived. Too well.
In the '30's and '40's we paid people to get rid of them
because they were stripping the bush.
In the '50's we started slaughtering them from the air and
in the '60's it was so profitable we couldn't shoot
enough of them.
In the '70's we couldn't catch enough of them alive.
In the '80's we can't breed them fast enough".

Source: Jim Irvine, 1982

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Introduction

With the current downturn in traditional livestock farming in New Zealand a great deal of interest is being shown in diversification. It is becoming increasingly apparent that few options are open to many farmers. Deer and goats are the two most-quoted livestock alternatives, but both are constrained by biological factors. Goats are still in a feral updating phase, but the era of feral deer recovery is possibly over. Those deer required to build the herds of the future are predominately domesticated livestock.

This last season (1985/86) has seen a dramatic decline in the value of female deer. Controversy exists as to the causes of this decline, as changes to the livestock taxation system were announced during the season. The declared intention of these livestock tax changes has been to obtain neutrality of the taxation system across investment decisions. It is not the purpose of this paper to address the taxation issue, and we will assume that neutrality has been achieved.

Weaner hind prices have declined from a forward sale value of some \$2,600 in November 1985 for March to May 1986 delivery to some \$800 to \$1,200 for the same animals at sales over the March-June 1986 period. (See Appendix 1). Declines of weaner values of this nature will have very little impact upon the future time path of the New Zealand deer herd. Until such time as some female weaners are culled for meat, the expansionary phase of the industry will continue. The major impact the decline will have on herd growth is via an expected decline in live capture animals. These animals are becoming less and less important to the New Zealand deer herd, so this effect will be minimal.

The most important effect of the decline in values is that of equity. Those farmers in deer farming before the decline in values have seen the value of their animals drop dramatically. For those selling this has been a real loss, for those building up herds the drop has been a substantial paper loss. Gainers have been those buying at the reduced prices and those contemplating purchasing deer.

The purpose of this report is to examine the determinants of the economic valuation of female deer and to obtain a valuation to aid those contemplating investing in red deer. Specifically, adult and weaner hind values will be calculated and some sensitivity analyses conducted around the base assumption used.

The determinants of the economic valuation of an animal and the problems associated with quantifying this economic value are discussed in Chapter 2. Included in this section is a discussion on the role of discounting and uncertainty. Ruakura results are used estimating the value of a weaner stag, and these results are presented in Chapter 3. Results from the model developed are outlined in Chapter 4 and a sensitivity analysis is presented around these results in Chapter 5. To obtain an appreciation of the likely "supply" of weaner females available over the next few years, Chapter 6 presents some simulation results of the national deer herd. The summary and conclusion is presented in Chapter 7.

Determinants of Value

2.1 Weaner Hind Values

In an earlier report Sandrey and Zwart derived the mathematical conditions to find the optimal slaughter age of a red deer stag. From this information a present value of a stag was calculated under different price assumptions about both velvet and venison returns. These present values represent the amount of money a rational producer should be prepared to pay for an animal under the different price assumptions outlined in the earlier paper.

The next step was to then estimate the present value of a hind at different ages. This proved much more difficult to achieve. The difficulty associated with measuring the future income stream of a hind is that the value of a female calf is endogenous to such a calculation. Values of a hind are determined by the expected values of female progeny, which are in turn determined by the future value of their progeny. In the Sandrey and Zwart (1984) report a simplifying assumption was made that all calves born have the same value as male calves at weaning.

Under the scenarios C and D used in the earlier report, velvet ceased to be important and venison production at 2 years of age was the optimal value of a weaner stag. Using the present value generated from these animals as the proxy for female weaners gave a present value of between \$230 and \$250 as the economic valuation of a weaner hind. The problem, as stated in the earlier report, is that using weaner stag values understated the value of females as long as the herd is expanding and female calves have a higher marginal value in breeding than in slaughter.

One solution is to use an iterative technique, selecting values of female weaners initially, but replacing these values with computed values until convergence is found. Results from this approach showed that present values are entirely dependent upon the final equilibrium value of an animal and the timing of when that equilibrium is reached. Another problem is the treatment of direct costs associated with maintaining the animal. As discussed later, a 50/50 share of returns between an investor and the farmer is initially used to account for costs. An alternative approach is to incorporate direct costs of, say, \$200 annually into the present value calculation. This would reflect current grazing charges and makes the assumption that these will continue in real terms even if hind weaner values decrease. Since grazing charges are probably some function of deer profitability (which will be influenced by weaner hind values), then grazing charges may well decrease in real terms over time. We are back to the original problem of uncertainty and the need to make some assumptions about future values in order to calculate a present value.

A second approach to the problem of forecasting weaner hind values and calculating back from these to obtain a Present Value is the use of a Monte Carlo simulation model. A range of possible values is used and some probability distribution around that range estimated. Repeatedly running the model enables a range of present values to be calculated, varying from the most optimistic to most pessimistic. Once again, the assumptions about expected means and distributions of future returns will dictate the results. A cumulative probability distribution could be calculated, but the expected present value will represent the deterministic approach. The advantage is that a range of present values could be calculated to show possible outcomes.

The third approach is to estimate future values of weaners (both male and female) and calculate a present value from a range of income streams. This shows clearly what assumptions buyers of animals are making about future returns and indicates whether animals are undervalued or overvalued for a given set of assumptions. Calculating the present value in this way is still dependent upon the assumptions which are made, but at least these assumptions can be clearly outlined. This is the approach used in the present report.

2.2 Other Factors Influencing Value

Other factors which will influence the value of a hind are the discount rate used, the expected calving (or weaning percentage), the probability of death, the residual or slaughter value of the hind at the end of the breeding life and the costs associated with maintaining the animal over its life. Also, the demand for livestock will be influenced by profitability of alternative livestock farming operations and the availability of capital to an individual.

2.2.1 Discounting

The function of discounting is to convert future income and costs into a present value at the time a decision is being made. This enables a comparison to be made between different opportunities facing an investor. Two major issues are involved with the concept of discounting. These are the difference between real and nominal dollars and the appropriate discount rate to use. The two issues are related.

Nominal values refer to actual dollar amounts and take no account of inflation. Real dollars are adjusted for inflation and can be directly compared between different time periods. The effect of inflation is neutralised and a base year or period is established as the reference point. For example, if we have a 10 percent inflation rate, then it would take approximately \$1.10 in actual money terms in one year's time to be equivalent to \$1 today. Possibly the best way to think about discounting is to convert all dollars to real or today's dollars and then apply some discount rate.

The reason that we need to apply a discount rate even after converting to real terms is that society exhibits a time preference for money. People prefer money now rather than later, and a real interest rate, the converse of a discount rate, has to be offered before people will forego present consumption for consumption some time in the future.

The appropriate discount rate to apply to real dollars has been the subject of much discussion. A rate of 10 percent in real terms has been used as the investment criteria for government projects. This is considered to be a high real rate - with 10 percent inflation, this implies 20 percent return on the original investment. Currently (Sept, 1986) in New Zealand interest rates are some 6 percent above the inflation rate, indicating a real interest rate, excluding taxation effect, of the same 6 percent. This is the same as a 15 percent nominal interest rate and a 9 percent inflation - a 6 percent real rate of return.

Both taxation and uncertainty can influence the real discount rate required by investors. This report will consider the effects of taxation to be neutral, and individual investors can adjust the results presented later in the report to their own circumstances. Uncertainty in an investment means that investors will require a premium over and above the next best alternative investment opportunity. This is a common, although somewhat crude, method of handling uncertainty.

The effects of different discount rates are shown in Table 1. This shows how much \$1 in a future year is worth today. After 10 years future income does not make very much difference to the present value - 15 years time \$1 would be worth 41.7 cents at 6 percent and 23.9 cents at 10 percent. Remember that this \$1 is in real terms - at a 10 percent inflation rate we would need about \$4 in nominal (actual dollar) terms to be equivalent to \$1 in real terms in 15 years time.

Table 1: Present Value of \$1 in Future Years Discounted at 6 and 10 per cent

Year	Discount Rate	
	6 per cent	10 per cent
1	0.943	0.909
2	0.890	0.826
3	0.840	0.751
4	0.792	0.683
5	0.747	0.621
6	0.705	0.564
7	0.665	0.513
8	0.627	0.467
9	0.592	0.424
10	0.558	0.386
15	0.417	0.239
20	0.312	0.149

Source: Walsh; 1985, p653.

A base discount rate of 6 percent will be used in this report. This means that all dollars will be kept in 1986 dollars and a further 6 percent discount applied to these figures. A sensitivity analysis will be conducted at different discount rates to show the effects of the 6 percent real discount rate.

2.2.2 Uncertainty

Uncertainty can take many forms. The first and most obvious one is the possibility of an animal dying. These possibilities have been built into the analysis at 2 percent annually and a sensitivity analysis conducted at 1 percent annually.

The concept of expected probabilities is used to overcome the problem of deciding if a particular weaner hind purchased will have a male or female calf or be dry or lose the calf before weaning. This is equivalent to purchasing or owning 100 adult animals and weaning 86 calves. One half of these weaned calves are male and one half female. Alternatively an investor can think of having 0.43 chance of both a male and female calf to sell and 0.14 chance of having nothing to sell.

The other major area of uncertainty is the value of future returns from the sale of weaner animals. This will form the basis of the next 2 chapters.

2.2.3 Costs

Costs of maintaining an operation are obviously an unknown factor over the next ten years. The way in which direct costs have been treated in this report are to assume that the purchaser is an outside investor where a farmer/investor split of 50/50 is used. Once again, some sensitivity around these values will be analysed and the results reported. Farmers purchasing deer for their own operation can think of themselves in a dual role - one as investors and one as graziers of the animals. To the extent that graziers would need more or less than a 50 percent share, the sensitivity analysis can be used. Some investors are starting to pay a per week grazing fee to farmers, and once again this can be encapsulated in a 50/50 split or some variation of this as shown in the sensitivity analysis. A figure of \$200 annually is used, as this was considered to be near the current market rates.

No grazing fees are "charged" for weaner animals in the first year under the farmer/investor share system. Readers can calculate this effect by deducting \$200 from the present values presented later.

2.2.4 Alternative Investments

Although outside of the scope of the analytical model, alternative investment opportunities will obviously influence the demand for deer and subsequent growth of the national herd. These opportunities will consist of both on and off farm investments.

With the drop in deer prices early in 1986 (see Appendix 1), it is likely that a different type of investor may become interested in deer farming. Many New Zealand farmers have the managerial ability and the physical resources to efficiently operate a deer unit - witness the number of deer-fenced pastures running sheep and cattle. If traditional farming continues its current depressed era, deer presents one of the few viable livestock alternatives. The capital barriers to entry have been lowered, and this is likely to create greater interest among what we could (with apologies to investors) regard as "genuine farmers." Using the 50/50 share split still enables farmers to operate the investment component from the managerial aspect of deer farming and evaluate the investment.

Off farm investment opportunities are numerous and difficult to forecast. It is likely that farmers will look to a diversified investment portfolio in future. Whether this will encourage farmers into deer for that diversification or into off-farm investments such as the share market is a moot point. Similarly, the share market and off-shore investments provide alternatives to outside investors considering deer.

2.2.5 Taxation

Taxation is another factor which may influence alternative investment decisions. The declared objective of the changes in the taxation system during 1986 have been to obtain neutrality across investments. If persons buying deer are able to obtain a tax write-off on the original investment and expect to pay tax on profits, then tax indeed is "neutral" if the same rate of tax (48 cents/dollar) is used. Any change to the tax rate will alter the time path of costs and benefits, thus changing the investment criteria. Similarly, the effect of inflation with respect to taxation is a complicated issue beyond the scope of this report. A Research Report prepared by Dr Nigel Williams, Farm Management Department of Lincoln College has been published by the A.E.R.U. at Lincoln. Effects of taxation rates, timing of the tax payment and inflation are discussed in that report. Interested readers are referred to the report for a detailed analysis.

Every investor will have a different taxation position. By treating taxation as neutral, I am saying that a prospective investor should look at deer firstly as an investment, and then secondly, look at possible taxation advantages from that investment. Prior to 1985 many investors looked at taxation advantages firstly and then at the investment. This is unlikely to be the case now, and future decisions should be made on grounds other than taxation advantages.

2.2.6 Inflation

Figures used in this report are in real terms, thus inflation has been taken out of the investment decision (assuming tax neutrality). This is important to keep in mind when evaluating any alternative investment. For example, with a 15 percent inflation rate, the 10 percent real rate of return is roughly equivalent to a 25 percent nominal rate of return. This is a very high rate of return.

Valuation of a Weaner Stag

The economic value of a stag at weaning will be the discounted expected income stream from weaning onwards. With increasing numbers of weaners coming forward from producers it is likely that most stags will be purchased for venison slaughter at either 14 or 24-27 months of age. Some specialist velvet herds will continue to operate, and indeed may be very profitable. Most purchasers of weaner stags from now on will be interested in venison, since it takes some 5 or 6 years before maximum returns can be expected from velvet. Even if some animals are selected for velvet production, it is likely to only be a small percentage of the total cohort group and the values of these animals should not influence the majority of weaner stags. Some weaners will also be required for sire purposes and superior animals can be expected to command a premium. This premium should not influence the weaner stag market any more than one would expect the stud sales to influence the store lamb or weaner calf sales - these are specialist and not generalist operations. The most likely scenario from now on is that velvet will be produced by a few specialist producers and from the national sire herd.

To obtain some idea of the likely economic value of a weaner stag it is necessary to work backwards from venison production data. At the 1986 Ruakura Farmers Conference a paper was presented by Adam et al. on the growth rates and economics of venison production.

Sixty weaner red stags were purchased or loaned in each of March 1982 and 1984. These were stocked at rates of 16, 20 and 24 stags/ha until they reached 14 months of age. Much of the variation in 14 month weight due to stocking rate had showed up by the end of the first autumn. Slaughtering one half at 14 months enabled the trials to continue until 24 months of age and a comparison to be made between the two age classes. Results showed a definite economic superiority of the slaughter at 14 months option.

A market valuation of \$225 per weaner was used as the landed purchase price of animals, and revenue of \$6.25/kg as the venison schedule. The cost of capital was calculated at 15 per cent interest on the landed price of the stags (ie. 15 per cent of \$225, or \$33.75/stag). Winter feed costs were calculated at \$3/bale for hay and 28.8 cents/kg for maize. These winter feed costs varied by stocking rate, with the higher stocking rates requiring more winter feed. Transport to the slaughter premises of \$10/head was assumed, and an expected death rate of 2 per cent was used. The "costs" of death was 2 per cent calculated on the landed value of an animal of \$225. All fixed costs of land and management, as well as some variable costs such as animal health were ignored, as these are assumed to be fixed. Finally, venison levies and inspection fees of \$25/head were used (these were not calculated in the original paper).

Gross margin per hectare results are as shown in Table 2. Little difference exists in profitability, using marginal analysis, between the two lower stocking rates, and both dominate the highest stocking rate.

Table 2: Gross Margins for Red Deer Stags Killed at 14 Months of Age

Stocking Rate (stags/ha)	16	20	24
Venison (gross kg/ha) (kg/stag)	920 57.5	1118 55.9	1234 51.4
Revenue (at 6.25/kg)	5748	6991	7713
Costs (\$/ha) Weaner Stags (at \$225)	3600	4500	5400
Opportunity Cost of Capital (at 15%)	540	675	810
Winter Feed	94	206	322
Transport (\$10/stag)	160	200	240
Expected Deaths (2%)	72	90	108
Inspection Fees and Levies	400	500	600
<u>Total variable cost</u>	4866	6171	7480
<u>Gross Margin (\$/ha)</u>	882	820	233
Gross Margin/animal	55.13	41.0	9.71

Stags at 24 Months

The paper considered that 3 important results are found when red stags were retained beyond 14 months (February). These are:

- 1) There was virtually no liveweight increases over the 7 month period from March to September,
- 2) Average increases in hot carcass weight over the spring varied from 6.5 to 10.5 kg/stag between stocking rates over the 14 to 24 month period,
- 3) Velvet yields at 24 months of age averaged 0.8 kg/head, and these weights were not influenced by stocking rates.

Revenue is calculated at \$6.25/kg, and the "cost" of 14 month stags was calculated at their market value at 14 months from the earlier trials. That is, venison revenue less transport costs and inspection fees and levies. Opportunity cost of capital was calculated at 15 per cent of this value. All other assumptions and costs are as outlined for the 14 month case. Results differ from those reported in Adam et al, as inspection fees and levies have been deducted for the present research. This initially reduces costs, as the \$25 is deducted from the "cost" of 14 month animals, but later reduces gross margins as the \$25/stag is deducted as a direct cost.

Table 3: Gross Margin Analysis for Stags Killed at 24 Months

Stocking Rate (Stags/ha)	12	16	20	24
Venison (gross kg/ha) (kg/stag)	781 65.08	1080 67.5	1190 59.5	1480 61.66
Revenue \$ (at \$6.25/kg)	4879	6750	7438	9256
Costs \$ 14 month stags (on venison returns)	3828	5260	6000	6864
Opportunity Cost of Capital (at 15%)	574	789	900	1030
Winter Feed	274	488	735	1020
Transport to DSP (\$10/stag)	120	160	200	240
Expected Deaths	83	112	131	150
Inspection and Levies	300	400	500	600
Total Variable Cost	5179	7209	8466	9904
Gross Margin (Revenue Cost)	-300	-459	-1028	-648
Gross Margin/Stag	-25	-28.69	-51.4	-27

Table 4: Gross Margin, Stags at 24 Months with Velvet

Stocking Rate (stags/ha)	12	16	20	24
Gross Margin without Velvet (from Table 2, \$/ha)	-300	-459	-1028	-648
Velvet Returns (\$30/stag net)	360	480	600	720
New Gross Margin/ha (\$)	60	21	-428	-72
New Gross Margin/stag (\$)	5	1.3	-21.4	-3
Extra kg/head to equate to Gross Margin of \$882/ha (Table 1)	10.96	8.61	10.48	6.36

Gross margins for the second year are negative in all cases. Adding \$30 per head as returns from velvet enabled 2 of the stocking rates to just break even. Some indication of the superiority of the 14 month stags (or conversely the opportunity cost of not slaughtering at 14 months and replacing with new weaners) is shown by the extra hot carcass weight per stag required to bring gross margins up to the level of 14 month stags. This analysis allows for the extra \$30 net from velvet. These extra weights required vary from 6.36 kg/stag to 10.98 kg/stag. This is an understatement, as the schedule changes at 70.1 kg, from \$6.25/kg to \$5.75 kg. This means on the schedule a 70 kg stag is worth \$437.5 gross, while a 70.1 kg stage is worth \$403. An extra 6 kg/stag is needed to compensate for this change, and a stag is worth the same at 76.1 kg as at 70 kg. This creates a problem, as the "extra kg/head to compensate" would mean stags are in the new grade. Effectively, if the grade differential remains as it currently is, an extra amount of at least 6 kg should be added to the venison per stag needed to compensate for not slaughtering at 14 months. Adding this extra 6 kg plus the amount shown in Table 4 means that animals must be from 74 to 82 kg at slaughter to equate with the 14 month option.

How obtainable are these extra weights? Drew (1986) shows the results of two Invermay trials where red stags reached dressed carcass weights of 76 and 77 kg/stag at 27 months of age. This may be a geographical difference, resulting from different grass growth patterns, or it may be some other factors. Further research may show that enough extra weight can be produced at 27 months to compensate the difference, but the Ruakura research indicates quite clearly that 14 months is the optimal age of slaughter.

Optimal Slaughter Age

The optimal slaughter is reached when the returns from keeping a stag in the herd are equated to the associated costs. This decision derived by Sandrey and Zwart (1984) is:

$$pw + \dot{w}p + PvWv = rpw + ci$$

where pw = venison price times expected carcass weight change

$\dot{w}p$ = carcass weight times expected change in price

$PvWv$ = expected price and yield of velvet

rpw = the opportunity cost of not slaughtering when r is the discount rate and p and w refer to price and weight of venison

ci = other cost including opportunity costs of other resources used

The analysis shown in Tables 3 and 4 demonstrates the components of the above equation. Terms on the left are dominated by the marginal costs of keeping stags for an extra year. Hot carcass weight gains of between 6.56 and 10.96 kg/stag would be required before it is as profitable to keep stags for 2 years as it is to use the same resources for a one year turnover of weaners, even allowing for the \$30/stag return from between 14 and 16 months. The opportunity cost of resources other than capital will vary when a system other than purchasing more weaner stags is the next best alternative. For example given current returns from sheep, if the second year of stags replaced sheep the opportunity cost of "other" resources would be lower. Negative gross margins would still result without velvet but the extra carcass weight/stag needed to equate to sheep would be lower than shown in Table 4.

Sensitivity of the gross margins to changes in any of the data can be calculated. The important information for the purpose of this paper is an estimate of the value of a weaner. Table 2 shows gross margins of \$41 to \$55 for the 20 and 16 stags/ha stocking rate respectively. For each one dollar increase in the purchase price of a weaner, these gross margins will decrease by \$1.15, as the opportunity cost of capital must be considered. Any increase or decrease in other figures will cause the same amount of change in the gross margin. For example, an individual farmer with lower winter feed costs would expect the gross margins to increase, although the farmer must be aware that winter feed also has an opportunity or next-best-use value as well as capital.

Increasing weaner prices to \$250/head will reduce gross margins per head by \$28.75. For the 14 month option this leaves gross margins of \$26.38 and \$12.25 per stag for the 16 and 20 per hectare stocking rates respectively. The 2 year gross margins remain the same, but the amount of extra venison per stag needed to equate with 14 month stags will be reduced. Since these gross margins do not include any allowance for land and labour, it can be seen that it is unlikely that prices of weaner stags would rise on the \$225 used in this analysis.

The other component influencing gross margin is, of course, venison returns. It must be considered extremely unlikely that real returns to producers would rise in the medium term. Realistically, venison prices are more likely to decrease in real terms as supply increases over the next few years. Consequently, a price of \$225 for weaner stags will be used, and that value kept in real terms for the analysis of a hind's value.

The Model

As discussed in previous chapters, the value of a female animal is the discounted expected income stream from that animal. Revenue is expected from the sale of both weaner hinds and stags and a residual value of the carcass at slaughter. Costs are incurred in the form of the possibility of the animal dying and the direct costs of maintaining the animal. This can be expressed mathematically as:

$$PV = f(PVS, PVH, F, DIS, P, S, RES)$$

where

PV = present value of a female,

PVS = expected value of a weaner stag,

PVH = expected value of a weaner hind at time of sale in the future,

F = the probability of having a calf at weaning,

DIS = the real discount rate,

P = probability of the animal living through the year,

S = the direct costs, expressed as a share or as an annual grazing fee,

and RES = the value at slaughter at the end of the animal's lifetime.

Each year the estimated return from an animal is calculated. This is then discounted back to present day values. Summing these values over the lifetime of an animal (taken as 15 years) and adding the discounted residual carcass returns provides the present value.

Using the notation above, the present value is calculated by summing over all years, 1 to 15, the following:

(0.5 PVS plus 0.5 PVH) times F times P times S times DIS. The discounted value of the carcass (RES times DIS times P) is then added to give the Present Value or estimated market value given the assumptions used.

Some estimates of the possible future market value of weaner hinds are shown in Figure 1 and presented in Table 5. These 6 possible sets of values will be used in the Base Model. It must be emphasised that:

- (a) these values are only likely estimates and in no way imply the authors' opinions or any projections about future prices,
- (b) these are in real (inflation adjusted values), and
- (c) are starting points only and can be adjusted by a sensitivity analysis. The one thing we do know about weaner hind prices is that eventually the deer industry will reach an equilibrium and weaner hind values will reach an equilibrium. These weaner hind values will be similar to weaner stag values at the margin, and many weaner hinds will only fetch their venison value.

Let us be clear as to what these 6 scenarios mean. Looking at Figure 1, we can see 6 possible time paths for future weaner hind values. The first, (1), represents an optimistic case, whereby weaner hind progeny can be sold at high prices for the next 5 years, and then decline over the subsequent 5 years to reach a value in 10 years time which is still above possible weaner stag values.

At the other extreme, scenario (vi) represents a more pessimistic approach, whereby weaner hind values drop in real terms rather quickly over the next 5 years, and then gradually approach that of weaner stag values. The other scenarios, (ii) to (v), represent intermediate situations. Readers are invited to select which case they consider to be the most likely.

Premium may well be paid for superior livestock, but at equilibrium, using the calving percentages and death rates used in this model, retaining around 35 to 40 percent of weaner hinds and 95 percent of adult hinds will maintain the herd size. When that equilibrium will be reached is difficult (or even impossible) to predict. Future returns from venison, as well as the profitability of traditional livestock farming will determine the future size of the New Zealand deer herd.

**Table 5: Possible Market Values of Weaner Hinds in the Future
(in Real \$00's) — From Figure 1**

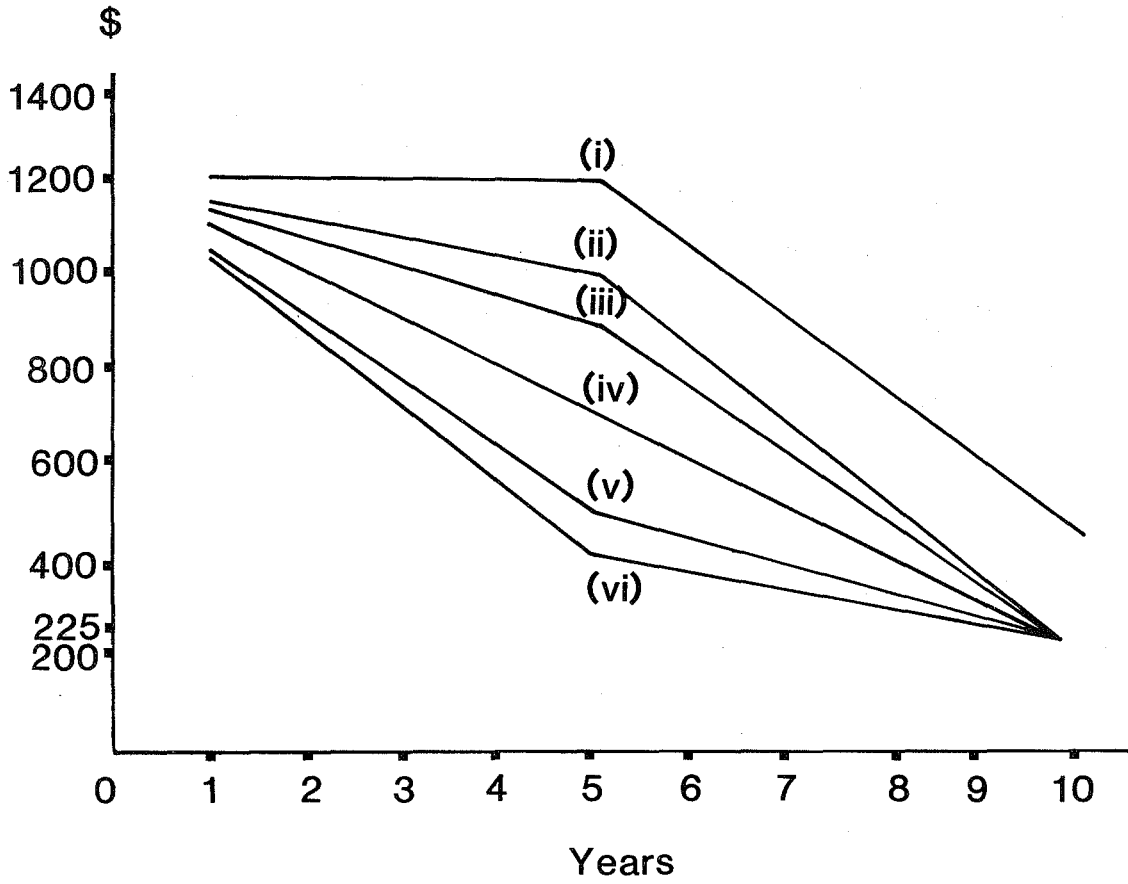
Years	Scenario					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
1	12	11.6	11.4	11	10.6	10.2
2	12	11.2	10.8	10	8.2	8.6
3	12	10.8	10.2	9.1	7.8	7.2
4	12	10.4	9.6	8.1	6.4	5.6
5	12	10	9	7.1	5	4
6	10.5	8.4	7.6	6.2	4.4	3.7
7	9	6.8	6.2	5.2	3.9	3.3
8	7.5	5.4	5	4.2	3.3	3.0
9	6	3.8	3.6	3.2	2.8	2.6
10	4.5	2.25	2.25	2.25	2.25	2.25
11	2.25	2.25	2.25	2.25	2.25	2.25
12	2.25	2.25	2.25	2.25	2.25	2.25
13	2.25	2.25	2.25	2.25	2.25	2.25
14	2.25	2.25	2.25	2.25	2.25	2.25

For the base Model the following values of other variables will be used:

- PVS = \$225 for weaner stags.
- F = 0.77 for yearling and 0.86 for an adult hind (0.00 for weaners)
- DIS = a real 6 percent rate
- P = 0.98, implying a 2 percent death rate
- S = 0.50, giving a 50/50 split to investors and managers respectively. No grazing fee is charged for weaner animals. A deduction of \$200 can be made if readers consider this should be charged.
- RES = \$300 for the carcass.

Sensitivity analysis will be conducted around these values, including using a grazing fee instead of a share system to calculate costs.

Figure 1 : Possible Hind Values (Real Terms)



Results and Sensitivity Analysis

5.1 Results

The so-called Base Model, using the variables given in the previous chapter, has been used to calculate present values for adult, yearling and weaner hinds under the six different future weaner hind value assumptions. Differences between the 3 age groups are accounted for by the probability of a return in the first 2 years. In the first year weaners have no return, while yearlings will have a reduced calving rate. In the second year, weaners become yearlings and yearlings become adults. All animals are assigned a life span of 15 years, and a sensitivity analysis treated later in this chapter shows little difference in results when the breeding life is reduced. It must be remembered that costs are not borne by investors in the first year for weaners, as a 50/50 split of nothing implies no costs! These are borne by the farmer as the 50 percent split of future income. Deducting \$200 from weaner values would represent the case where grazing is charged.

Table 6: Present Value of Females (Using Base Model Assumptions) \$

Scenario (see pages 15-17)	Weaner	Yearling	Adult
(i)	1816	2096	2126
(ii)	1617	1896	1925
(iii)	1550	1829	1859
(iv)	1427	1705	1734
(v)	1269	1546	1576
(vi)	1215	1491	1521

Let us be quite clear as to what these values mean. They are the discounted future income stream generated by an animal under the set of assumptions used. If one accepts these assumptions as the most likely outcome, then these values should reflect current market values. If investors, either farmers or outside investor, are valuing animals by a greater or lesser amount it means they have a different set of expectations about either future returns of progeny or the other variables used. It is also conceivable that an extra value associated with the benefits of diversification may be paid by some people. This is a basic portfolio adjustment approach to handling risk.

5.2 Sensitivity

5.2.1 Discount Rate

Real discount rates of 6 percent were used in the model, and changes to 4 percent and 10 percent real rates used. Results in Table 7 show the dramatic effect of a real discount rate. Investors seeking a 10 percent real rate of return would pay between \$288 and \$440 less than those accepting a 6 percent return other things being equal. Those investors happy with a 4 percent real rate of return could be expected to pay between \$186 and \$276 more than the base model.

Table 7: Sensitivity of the Discount Rate Used (Present Value in \$'s)

(a) <u>Weaners</u>			
Scenario	Base Model (6%)	4% (DIS=0.96)	10% (DIS=0.90)
(i)	1816	2085	1391
(iv)	1427	1640	1094
(vi)	1215	1401	927
(b) <u>Adults</u>			
(i)	2126	2402	1686
(iv)	1734	1955	1388
(vi)	1521	1714	1219

Note

Figures in brackets represent the change from base model.

5.2.2 Calving Rate

Over the next few years we could expect the calving rate of adult hinds to improve. More is becoming known about management and feeding techniques and this should increase productivity. Also, the death rate of 2 percent annually used is possibly conservative, as many producers are obtaining better figures than this. To model technical change in the industry we have increased the adult calving rate to 90 percent (Table 8) and lowered the death rate to 1 percent (Table 9). Once again, everything else is kept constant and only one variable changed at a time. Results are similar, with the expected calving change increasing values by between \$43 and \$94, and the death rate change increasing Present Values by between \$85 and \$127.

**Table 8: Sensitivity of the Adult Calving Rate (Present Value in \$'s)
(Expressed as adult weaning percentage)**

<u>Scenario</u>	Weaners		Adults	
	Base = 0.86	0.90	Base = 0.86	0.90
(i)	1816	1886	2126	2220
(iv)	1427	1479	1734	1811
(vi)	1215	1258	1521	1588

**Table 9: Sensitivity of Death Rate (Present Value in \$'s)
(Expressed as probability of survival each year)**

<u>Scenario</u>	Weaners		Adult	
	Base = 0.98	0.99	Base = 0.98	0.99
(i)	1816	1940	2126	2253
(iv)	1427	1524	1734	1835
(vi)	1215	1300	1521	1610

5.2.3 Costs

Costs are difficult to model, as they will depend on the profitability of both deer farming and other livestock ventures. Currently some investors are running deer on other properties on a fee grazing basis. This is modelled to look at an alternative way to handle costs. Results using a fee of \$200 annually are very similar to base values for weaners in scenario (i), but not for the others. Similarly, a fee grazing system is better for adult animals in scenario (i), not (iv) and (vi). Given the assumptions made about other variables, the grazing fee alternative is not as attractive to investors as the share system. Alternatively, farmers who are grazing animals would be advised to lock into a fee grazing system, and especially so for weaners. Results are shown in Table 10.

**Table 10: Cost Expressed as a Grazing Fee
(in Real \$ over lifetime of animal) (Present Value in \$'s)**

(a) Weaners		
Scenario	Base = Share	Costs = \$200/yr
(i)	1816	1889
(vi)	1427	1111
(iv)	1215	687
(b) Adults		
(i)	2126	2449
(iv)	1734	1667
(vi)	1521	1240

5.2.4 Weaner Stag Values

In Chapter 3 a value of \$6.25 per kg was used to calculate the value of a weaner stag, and the figure of \$225 per head was used in subsequent analysis. Changes of weaner stag values to \$200 and \$250 roughly represent a change of 50 cents in the venison schedule either way from the \$6.25/kg used in Chapter 3. However, it must be remembered that if stags can be purchased at \$200 instead of \$225, the costs involved in producing venison are also reduced, as the opportunity cost of capital decreases, as less money is tied up in the operation. Changing the expected prices for weaner stags by \$25 to \$200 and \$250 makes very little difference to Present Values of either weaners or adults. These Present Value changes vary between \$39 to \$45 between the different scenarios for an increase or decrease. The reason that values do not change much is that in 2 years time a change of \$25 in stag prices will only make \$9.50 difference once the other probabilities and discounting is allowed for. Results are shown in Table 11.

Table 11: Expected Price of Weaner Stags (Present Value in \$'s)

(a) Weaners			
<u>Scenario</u>	Base = \$225	\$200	\$250
(i)	1816	1777	1855
(iv)	1427	1388	1466
(vi)	1215	1176	1254
(b) Adults			
(i)	2126	2081	2170
(iv)	1734	1690	1779
(vi)	1521	1477	1565

5.2.5 Weaner Hind Values

Future weaner hind prices have a greater influence, as can be seen from Table 12. The adults are affected more, as an income stream is generated faster and weaner hind prices fall overtime in real terms. An almost unlimited number of possible future hind values is likely to happen. These sensitivities are a guide, and potential investors can use the formula provided to update the Present Value as more information becomes available.

Table 12: Expected Price of Weaner Hinds (Present Value in \$'s)

(a) Weaners			
<u>Scenario</u>	Base	Plus 10%	Less 10%
(i)	1816	1954	1678
(iv)	1427	1526	1328
(vi)	1215	1293	1137
(b) Adults			
<u>Scenario</u>	Base	Plus 10%	Less 10%
(i)	2126	2289	1962
(iv)	1734	1859	1610
(vi)	1521	1624	1418

5.2.6 Breeding Life

Changing the expected breeding life from 15 years to 10 and 5 years has the effect of changing Present Value by the amounts shown in Table 13. Reducing the breeding life of 10 years (9 possible calvings) lowers Present Value by \$123 to \$143, emphasising the effects of discounting later returns. However, reducing the life to 5 years lowers Present Value by between \$723 and \$372, as only 4 possible breeding years would occur. Both examples allow for a \$300 return on a carcass, so deducting the discounted value of this would indicate returns should the animal die at that stage.

**Table 13: Weaner Present Value with Different Breeding Life (\$)
(Base Model Assumptions)**

Scenario	Base = 15 years	10 years	5 years
(i)	1816	1673	1095
(iv)	1427	1304	945
(vi)	1215	1092	843

5.2.7 Summary

These sensitivity results are summarised in Table 14. The major impact is felt via a change in the real rate of return expected by an investor in deer and a change in future female values.

Changing the basis of costs from a share to a grazing fee has a large impact upon the present values of weaner hinds in the less optimistic scenarios. For adult hinds, an investor is better off with a cost structure of \$200 annually in real terms under scenario i. However, the other reported cases show that investors are better off locking into a share agreement rather than a long term grazing agreement at \$200 a year. Deaths and adult calving percentage changes have a similar impact on Percent Value. Stag prices, as mentioned above, have little impact.

It is important that we have only changed one variable at a time for the sensitivity analysis. Changing more than one becomes rather academic. Discounting effects mean the changes cannot simply be added together. A super optimistic investor who expects an adult weaning of 90 percent, a 1 percent annual death rate, is prepared to accept a 4 percent real rate of return and is convinced that stag prices will be \$250 real in the future and that weaner hind prices will rise by 10 percent can afford to pay up to \$2543 for a weaner hind if he/she can lock into a 50 percent share. If you find such an investor, cultivate them! Conversely, a pessimistic investor taking the low variables will only pay \$836 under scenario vi. This returns a 10 percent real rate.

Table 14: Summary of Sensitivity Results

Variable	(a) <u>Weaners</u>		Change in Present Value (\$)	
	Base Value	New Value	Scenario (i)	Scenario (ii)
DIS	0.94	0.96	269	186
		0.90	-425	-288
Adult Calving	0.86	0.90	70	43
Deaths (Survival)	0.98	0.99	124	85
Costs	Share	\$200 yr	73	-528
Stags	\$225	\$200	-39	-39
		\$250	39	39
Weaner Hinds	Various	+ 10%	138	78
		- 10%	-138	-78

Variable	(b) <u>Adults</u>		Change in Present Value (\$)	
	Base	New	Scenario (i)	Scenario (vi)
DIS	0.94	0.96	276	193
		0.90	-440	-302
Adult Calving	0.86	0.90	93	67
Deaths (Survival)	0.98	0.99	127	89
Costs	Share	\$200yr	323	281
Stags	\$225	\$200	- 45	- 44
		\$250	43	44
Weaner Hinds	Various	+ 10%	163	112
		- 10%	-163	- 94

Future Supply of Animals

A market consists of two "sides" - the "demand" side from those wishing to purchase, and the "supply" side from farmers offering animals for sale. With the deer industry starting from relatively low initial numbers, the supply of animals available for sale has been restricted by biological factors. This supply problem has been accentuated by many producers retaining female animals themselves and not placing them on the market. However, the New Zealand deer herd now forms a well established livestock industry and the number of weaner animals coming on to the market can be expected to increase over the next few years.

The official Department of Statistics figures for the 1981 to 1985 years are shown in Table 15. A breakdown of weaner and adult females is given (where the information is available).

Table 15: Female Deer on New Zealand Farms (30th June)

Year	1 Year and Over	Under 1 Year	Total
1981			64,160
1982	70,919	19,405	90,120
1983	95,743	25,529	121,270
1984	128,595	34,300	162,895
1985	165,690	46,364	212,054

Source: New Zealand Dept of Statistics

A computer simulation population dynamics model was developed by the author for the New Zealand Game Industry Board to project the future growth of the national deer herd. This model will be used with the permission of the Board.

With any model, it is important to realise that the assumptions made in the data input will dictate the final output. The assumptions made regarding both death rates and weaning percentages in the valuation model will be used in the projection model - a 2 per cent death rate and (for red deer) an 86 per cent and 77 per cent weaning rate for adult and first-calving hinds respectively.

The major problem with any population dynamic modelling is trying to predict the percentage of yearling female animals retained in the herd. Until now, all females without obvious breeding faults have been retained. This will remain the case until a female animal's value drops to nearer its slaughter value. Expansion of the herd is totally dependent upon any assumptions made as to when the slaughter of surplus hinds will start and when an equilibrium herd size will eventuate.

The two issues of future weaner hind values and the cull rate of surplus females are, of course, the same issue. While prices are high, all stock will be retained. When prices start to decrease, some female animals will be culled. At an equilibrium herd size, weaner values for females will be very similar to males as some 70 per cent of female progeny will be surplus to breeding requirements.

Two alternative assumptions will be made to present some likely herd growth projections. The first will parallel assumption (i) from the valuation model. High prices for the next 5 years suggests zero culling of females during this period, followed by an approximately 5 year path to equilibrium herd levels. The second will follow assumption (vi), with an equilibrium herd size being reached much faster and female culling beginning earlier. Projections of herd numbers under these two assumptions are presented to show some possible numbers of female weaners available for sale in the medium term future. Once again, it must be stressed that these estimates are reliant upon the assumptions used and are only illustrative of the possible future supply of weaner hinds. Once female culling commences in each case, a 5 per cent culling of adult females occurs each year. This is a variation on the assumptions made in the valuation model, where no allowance is made for adult female culling.

The most likely case in the authors opinion, is the second case, where no culling starts until 1991 (and indeed, it may well be later than this). The reader can note from Table 16 an estimated 450,000 weaner hinds could well be available in the year ending June 1996 - less than 10 years away. This is around 7 times the estimated number of weaner hinds available for the year ending June 1986, and demonstrates clearly the potential of the industry to develop. If the reader refers back to Table 5 (Figure 1), it can be seen that under scenario (vi) weaner hind values used of \$400 are approaching that of weaner stags at \$225. Even if some culling is taking place before 1991, around 200,000 weaner hinds will be born during the 1990/91 season.

Table 16: Possible Future Female Deer Numbers (Year Ending June)

Case 1 (culling starts 1988)					
('000s)	1984	1985	1986	1987	1988
Total Females	163	215	280	363	444
Weaner Females	38	51	66	86	110
	1989	1990	1991	1992	1993
Total Females	533	629	728	829	926
Weaner Females	134	160	188	216	245
	1994	1995	1996		
Total Females	1016	1094	1156		
Weaner Females	278	298	320		
Case 2 (culling starts 1991)					
('000s)	1984	1985	1986	1987	1988
Total Females	163	215	280	363	467
Weaner Females	38	51	66	86	110
	1989	1990	1991	1992	1993
Total Females	599	766	937	1113	1281
Weaner Females	142	185	233	282	333
	1994	1995	1996		
Total Females	1428	1538	1607		
Weaner Females	380	422	450		

Discussion

Results reported in the report show, under the assumptions used, weaner hinds have been undervalued over the most recent selling season. Taxation changes are expected to be neutral across all investments, so these have not been taken into account in the calculations.

The problem of valuing an animal which is, in effect, dependent upon its own future value is a difficult problem. Like investors, we must make some assumptions about these future returns. No one value is presented as the value of a weaner hind, but a scenario of possible future weaner hind prices and a set of production assumptions is used to generate a range of present values. These should reflect the willingness of an investor who accepts these assumptions to pay for an animal.

Sensitivity analysis was conducted over a range of variables. Investments were most sensitive to the discount rate used and least sensitive to future weaner stag values.

The obvious flaw in results presented in this paper is that Present Value are above current market prices and also above future expected weaner hind prices used to generate Present Value. Thus, do we expect that if investors accept our assumptions, would the future weaner prices used to generate Present Value also rise? To partially overcome this problem, we developed an iterative model. An initial set of Present Value for a weaner hind is generated for each year from the expected prices given. These expected prices are then replaced by the new Present Value generated and the cycle repeated. Convergence was reached reasonably quickly, and results were entirely dependent upon the final equilibrium value of a weaner hind. In scenario i, an equilibrium value of \$450 was used, and the iterative Present Value of \$2517 was obtained. For all other scenarios an equilibrium value of \$225 was used. These other scenarios (ii to vi) converged to a present value of \$1914. This reflects adjustment changes as weaner hind prices used move to their estimated present values each year.

Finally, deer farming will not provide a guaranteed return to investors. The objective of this paper is to provide a framework for individuals to evaluate that investment decision. The best estimates of the factors influencing the "price" to pay have been documented. It is hoped that these estimates will provide some information on the "economic value" of an animal.

Appendix 1

Deer Prices

Table A.1. Quarterly Female Deer Prices, 1978-1986

		Weaner Hinds	Rising 2 Yr Hinds	Mixed Age Hinds
1978	Jan	-	-	-
	March	550	750	-
	June	800	1,000	800
	Sept	1,050	1,750	1,050
1979	Jan	-	1,350	-
	March	1,050	1,500	1,550
	June	1,200	2,000	1,850
	Sept	1,550	2,500	2,750
1980	Jan	-	2,300	-
	March	1,200	1,700	1,900
	June	1,200	1,500	1,400
	Sept	500	950	800
1981	Jan	-	750	-
	March	550	700	700
	June	600	900	1,025
	Sept	700	1,200	1,150
1982	Jan	-	1,200	-
	March	800	1,400	1,350
	June	1,000	1,600	1,500
	Sept	1,000	1,600	1,050
1983	Jan	-	1,200	-
	March	950	1,450	1,400
	June	900	1,500	1,500
	Sept	1,100	2,000	1,800
1984	Jan	-	2,000	-
	March	1,500	2,600	2,300
	June	1,800	2,900	2,600
	Sept	2,400	3,000	2,750
1985	Jan	-	3,000	-
	March	3,200	4,200	3,800
	June	3,600	5,500	4,500
	Sept	2,850	3,900	4,000
1986	Jan	-	1,500	-
	March	1,000	1,700	1,700
	June	1,200	1,800	1,600
	Sept	1,100	1,800	1,700

Source: Geoff Erskine, Southland Farmers

Table A.2.: Monthly Female Deer Prices, 1984-1986

	Weaners	Yearling	15 month	18/24 month	M/A
1984					
June	1877			3123	2711
July	1701			2800	2162
Aug	1597			2139	2294
Sept	1600			3018	2616
Oct		2165			3064
Nov		1995		2100	3289
Dec		2538			
1985					
Jan					
Feb		2800			
Mar	2681		2972		
Apr	2023		3069		
May	2509			3527	3979
June	2608			4877	3270
July	2467			3980	4142
Aug	2692			3890	4083
Sept		2656		3331	3655
Oct		3270		4250	3884
Nov				4482	3333
Dec		3440			
1986					
Jan					
Feb			1562		
Mar	1180		1966		1932
Apr	1522			2000	1600
May					
June	1157			2119	1413
July	1125			1018	1436
Aug	1031			1600	1794
Sept					

Source: Ron Schroeder, Pyne Gould Guinness

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