There is value in improving genetics, but just what is the return on investment for venison production?

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Genetic improvement is paying off for New Zealand deer farms, and the reward can be significant if farmers get more stags to slaughter at peak schedule prices. Our analysis of two scenarios indicates that a 10 kg improvement in calf growth achieved through use of a superior sire can be worth up to $32 per calf born on an intensive farm targeting the peak spring schedule, or $7 per calf born on a more extensive farm killing deer later in the season.

Deer farmers invest in genetic improvement, through purchasing superior stags or semen. Most deer farmers believe genetic improvement is worthwhile, but few work out what that investment is worth to their farm. Quantifying the benefits requires complex calculations, and it is very difficult to get an intuitive idea of its value, particularly when selecting genetics to breed replacement hinds.

We have developed a model to analyse of the value of genetic improvement in growth to a commercial venison production system. In a venison system where deer are killed at a relatively constant weight, improving growth performance effectively brings forward kill dates, with two potential pay-offs:

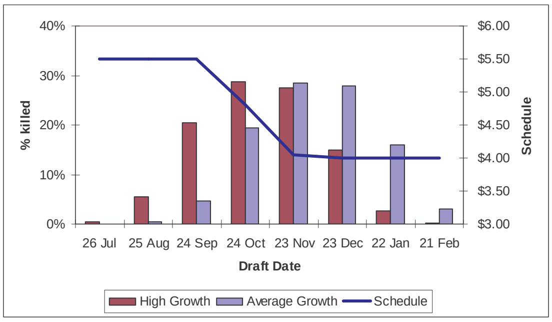
- More animals may achieve a premium price in spring, improving average price received.
- Feed costs may be reduced. Animals not slaughtered consume feed, which has a variable value depending on time of the year and whether the feed can be profitably used for alternative production.

The value of these two potential pay-offs depends on the current farm performance. Using case study scenarios, we have quantified the benefit from improved growth genetics which apply to two typical commercial venison production systems. We do this by comparing economic returns from herds of high or average growth genetics under each scenario. While each deer farm is unique, the scenarios we have used will provide broad guidelines for farmers to evaluate their investment in improved growth genetics.

Scenario 1 – Intensive farm

The first scenario we have described is a deer farm situated on a more intensive class of land and achieving moderate to high animal performance. This farm kills most yearlings from October to January, and drafts deer for slaughter at 30 day intervals. By further improving growth performance, a greater proportion of the kill will move into the peak venison schedule season, improving average price received. In Figure 1a, the numbers of animals killed in each draft (30 day draft intervals) for this farm using average or high growth genetics are shown.

Figure 1a. Schedule and kill pattern for an intensive-type farm using average or high-growth genetics.



By killing animals earlier, the farm will also save some feed costs. Figure 1b shows the quantity of feed eaten by yearlings in each draft interval, and demonstrates feed savings from improved growth. However, the feed savings for this farm occur in spring and summer, when feed is in surplus, or has only limited opportunity for use by other stock classes. Hence the value of feed saved is set by the cost of feed at this time of year, generally around 10 c/kg dry matter. Other basic assumptions around herd structure, schedule and cost of feed are given in Table 1.

Figure 1b. Feed requirements of finishing stock, and assumed cost of feed on an intensive-type farm using average or high-growth genetics.

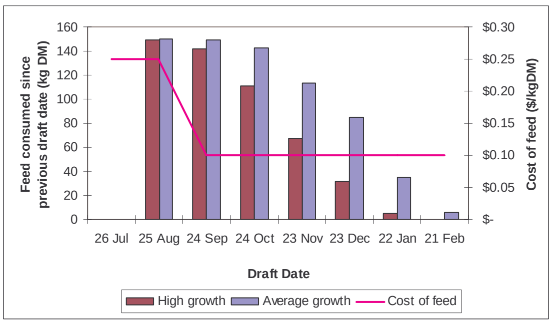


Table 1. Assumptions used to model the economic impact of high growth genetics.

Parameter	Value assumed
Standard deviation of slaughter date within sex	25 days[A]
Typical growth rate over finishing period	350 g/day stags 275 g/day hinds
Discount rate (farm mortgage less inflation)	7%
Proportion of hinds culled or dead per year	10%
Proportion of hinds dying	2%
Proportion of calves born surviving to slaughter age	95%
Hind mature weight at joining	120 kg
Cull hind dressing percent	55%
Cull hind schedule price	$3.50/kg
Base Schedule (prime stock)	$4.00 kg
Premium at peak schedule	$1.50 kg up to 26th September, declining 2.5 c/day to base schedule by 25th November.
Cost of feed – Spring (65 days)	$0.10 /kg DM
Cost of feed – Summer (100 days)	$0.10 /kg DM
Cost of feed – Autumn (100 days)	$0.15 /kg DM
Cost of feed – Winter (100 days)	$0.25 /kg DM

[A] 96% of progeny will be killed over a period of 4 standard deviations – hence this assumption translates to a kill period of 100 days for each sex.

Scenario 2 – Extensive farm

The second scenario we have chosen is a deer farm located in a more extensive class of country, which is reflected in lower performance of young stock (hind reproductive rates may still be excellent). Because of the type of farming system used, this farm is killing most yearlings from December through to March, drafting in 30 day intervals. For this farm, an improvement in growth of the sort of magnitude gained from selecting high-growth replacement-type genetics (i.e. not a terminal sire) will have little impact on average price, as few of the animals will be killed when premiums are available (see Figure 2a). However, by killing animals earlier this farm will benefit from feed savings. In this case some of the feed savings will occur in autumn where saved feed can be translated into savings in winter feed costs (Figure 2b). Hence these feed savings are potentially more valuable than feed savings earlier in the season.

Figure 2a. Schedule and kill pattern for an extensive-type farm using average or high-growth genetics.

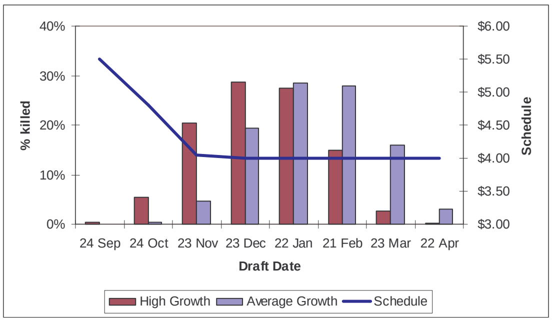
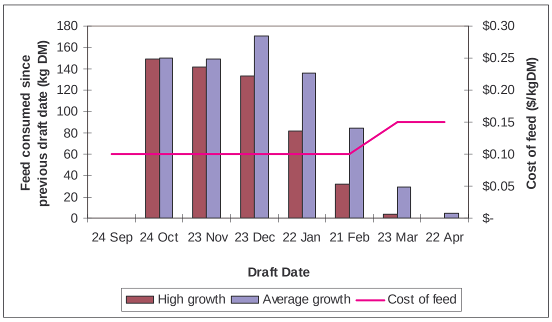


Figure 2b. Feed requirements of finishing stock, and assumed cost of feed on an extensive-type farm using average or high-growth genetics.



For both situations, we initially modelled a 10 kg improvement in weight of calves at 12 months of age. This is the type of improvement we might achieve when purchasing a superior sire which we will use to breed replacement hinds. A 10 kg improvement in progeny growth performance could be achieved by using stags with DEERSelect breeding values for 12-month weight which were 20kg above the average of the commercial herd. The impact of this 10 kg improvement in calf growth is to bring the average kill date forward by approximately 30 days. We have also assumed that both farms are killing all stag progeny, and are not taking a part in multiplying improved genetics other than retaining superior hinds.

Valuing genetic improvement in growth

There are two major issues in valuing genetic improvement.

1. What are the benefits and costs associated with an improvement in growth performance for a commercial deer farm? (Most of these benefits and costs apply to improvement in growth achieved via either genetics or management).
2. Given that we have used superior genetics, how many times can we obtain the benefits from the improved genes, and over what time-frame? To accurately quantify the economic benefits arising, we need to take into account the role of the sire (terminal vs replacement), structure of the herd (e.g. replacement rate, survival of calves, etc) and interest rates.

1. Economics of improved growth

Table 2 shows the impact of the high growth genetics on farm returns and costs. Taking the intensive farm scenario as an example, an increase in growth of 10 kg improves the average price by $32.92 for each stag killed, or $3.29 per kg increase in growth (see Table 2). The feed savings from slaughtering stags earlier are $8.29, or $0.83 per kg increase in growth. This gives a total benefit of $4.12 per kg of additional growth for each stag killed.

The total benefit per hind killed is $1.94. This is lower than the benefit to stags, because the relative contribution of increased price vs feed savings differs. Hinds are killed later on average, so an increase in growth performance of hinds has less impact on the numbers killed during the high schedule period. However, there are some feed savings in autumn when the feed saved can be translated into lower wintering costs.

Retaining hind progeny with improved growth genetics will, however, increase hind size and feed requirements. The expected increase in mature weight and annual feed costs can be calculated using known genetic relationships between 12 month and mature hind weights, together with assumptions on feed intake and seasonal cost of feed. The resulting increase in annual feed costs for each hind retained is $8.14, or $0.81 per kg of additional genetic growth potential at 12 months.

The hind will also pass half of her improved genes on to her calf. This is worth $1.56 per calf for every kg of the original 10 kg growth improvement. We calculate this by taking half of the average improvement for stags and hinds killed in the first generation, as the generation gets only half of its genes from the improved hind (we have also accounted for different proportions of stags vs hinds slaughtered in the subsequent generation). Benefits from retained replacements also include a higher cull value. The increase in cull value of the larger hind is calculated as $2.31 per kg of additional growth to 12 months.

Table 2. Economic impact of improved growth for an intensive farm using a replacement sire and an extensive farm using a replacement or a terminal sire.

	Average growth	High growth	Difference	Difference per kg
Relative weight at 12 months	0.0	+10.0		
Intensive Farm – Replacement sire				
Average stag kill date	26-Oct	24-Sep	-32 days	-3.20 days
Average hind kill date	15-Dec	13-Nov	-32 days	-3.20 days
Slaughtered progeny				
Average Price (stags)	$ 245.56	$ 78.48	$ 32.92	$ 3.29
Feed opportunity cost (stags)	$ 38.21	$ 29.92	$ 8.29	$ 0.83
Total per stag killed			$ 41.21	$ 4.12
Average Price (hinds)	$ 215.81	$ 25.92	$ 10.10	$ 1.01
Feed opportunity cost (hinds)	$ 52.39	$ 43.10	$ 9.28	$ 0.93
Total per hind killed			$ 19.39	$ 1.94
Retained Hinds				
Hind annual feed cost (per hind retained)	-$ 113.00	-$ 121.14	-$ 8.14	-$ 0.81
Progeny of retained hind (half of dam's superior genes)				$ 1.56
Hind cull value	$ 231.00	$ 254.10	$ 23.10	$ 2.31
Extensive Farm – Replacement sire				
Average stag kill date	25-Dec	23-Nov	-32 days	-3.20 days
Average hind kill date	13-Feb	12-Jan	-32 days	-3.20 days
Slaughtered progeny				
Average Price (stags)	$ 220.55	$ 226.44	$ 5.89	$ 0.59
Feed opportunity cost (stags)	$ 29.13	$ 19.69	$ 9.45	$ 0.94
Total per stag killed			$ 15.33	$ 1.53
Average Price (hinds)	$ 214.50	$ 214.59	$ 0.09	$ 0.01
Feed opportunity cost (hinds)	$ 45.09	$ 34.63	$ 10.46	$ 1.05
Total per hind killed			$ 10.55	$ 1.06
Retained Hinds				
Hind annual feed cost (per hind retained)	-$ 113.00	-$ 121.14	-$ 8.14	-$ 0.81
Progeny of retained hind (half of dam's superior genes)		$ 0.66		
Hind cull value	$ 231.00	$ 254.10	$ 23.10	$ 2.31
Extensive Farm – Terminal sire				
Relative weight at a constant date	0.0	25.0		
Average stag kill date	25-Dec	6-Oct	-80 days	-3.20 days
Average hind kill date	13-Feb	25-Nov	-80 days	-3.20 days
Slaughtered progeny				
Average Price (stags)	$ 220.65	$ 266.54	$ 45.89	$ 1.84
Feed opportunity cost (stags)	$ 53.38	$ 30.09	$ 23.29	$ 0.93
Total per stag killed			$ 69.17	$ 2.77
Average Price (hinds)	$ 214.50	$ 221.27	$ 6.77	$ 0.27
Feed opportunity cost (hinds)	$ 70.25	$ 44.29	$ 25.96	$ 1.04
Total per hind killed			$ 32.73	$ 1.31

2. Realising the economic benefits

Having described the economic benefits and costs for different stock classes, we now need to calculate out how many times, and over what time-frame, we can capture the benefit of superior genes. Table 3 shows the major factors taken into account when calculating the total economic benefit, expressed as dollars at the time the initial calf crop is killed.

- How many times different benefits are realised depends on herd structure, survival of calves born to slaughter age, culling rates and replacement rates, and the proportion of hind progeny retained from the higher growth stag. Proportion of hinds retained might range from zero for a terminal sire, up to 80-90 percent where a stag's specialist purpose is to breed replacement females and terminal sires are used for the balance of matings.
- Discount factors are used to account for delays in capturing benefits, by converting dollars earnt (or spent) in the future into Net Present Values (i.e. equivalent value to today's dollars). This common economic technique used in many business and investment analyses accounts for the fact that a dollar gained next year is worth less than a dollar this year, depending on interest rates.
- We have calculated the realisation of economic benefits on a "per calf born" basis, which expresses all benefits per calf born in the first generation. The impact of a stag's growth genes can then be calculated by multiplying the results by the number of calves the stag is expected to sire in his lifetime, or in the case of Artificial Insemination we can adjust for the expected conception rate to AI.

Stag calves at slaughter

For stag calves which are all killed, we account for the survival of calves from birth to sale, and that only half the calves born are stags. For every calf born, 0.475 stag calves are killed, with an increased economic worth of $4.12 per stag killed (calculated in Table 2) giving a net benefit of $1.96 per calf born from this source.

Hind calves at slaughter

Hind calves may become replacements, and it is assumed that 70 percent of hind calves are retained, as we are valuing a replacement-type sire in a herd which is also using terminal sires. Only 0.1425 hind calves are killed per calf born, at a benefit of $1.94 per hind killed, giving an overall benefit of $0.28 per calf born.

Retained hind calves

Retained hind calves will be larger with increased maintenance costs. We previously calculated this as $0.81 per kg of additional growth per year the hind is retained. This needs to be multiplied by the average hind productive lifetime (i.e. the time she is in the breeding herd) - assuming 10% losses from culls and deaths and a cull-for-age policy at 13 years, the average hind productive lifetime works out at 6.86 years. A discount factor of 0.73 is applied to correct for future costs. Multiplying by the number of hinds retained per calf born (0.35) gives a cost for additional hind maintenance of $1.43.

However, this larger hind also has a higher cull value which will be realised after 6.86 years. The relevant discount factor to be applied is 0.59. Of the 0.35 hinds retained, two percent are lost due to deaths, giving 0.34 saleable culls at $2.31 per cull sold – multiplied together these give an economic benefit of $0.47.

The larger hind will also pass on genes which increase the growth rate of her calves. The economic benefit per calf killed (in the second generation) was calculated at $1.56. To calculate how many of these calves are killed per calf born in the first generation, multiply the number of hinds retained (0.35) by the average productive lifetime of the hind (6.86 years), and the proportion of second generation calves killed (0.81 - this accounts for survival rates and the need to retain some replacements). This is then multiplied by a discount factor of 0.64 to account for the delay in receiving these returns, giving a return from killing superior second generation calves of $1.59 per calf born (in generation one) and per kg of additional 12 month growth.

Benefits to the intensive farm

With the economic returns and costs from the different stock classes and generations, all expressed on a "per calf born and per kg

Table 3. Economic value of high growth genetics for a sire to breed replacements on an intensive and extensive farm (10 kg increase in progeny weight at 12 months) and a terminal sire on an extensive farm (25 kg increase in progeny weight).

	Economic benefit per animal	No hinds retained per calf born	Average Hind lifetime (years)	No. calves slaughtered per calf born	Discount factor	Economic Value[A]
Intensive Farm - Replacement						
Stag progeny slaughtered	4.12			0.475		1.96
Hind progeny slaughtered	1.94			0.1425		0.28
Replacement hind maintenance	0.81	0.35	6.86		0.73	1.43
Replacement hind cull value	2.31			0.343	0.59	0.47
Progeny of replacement hinds	1.56	0.35	6.86	0.81	0.64	1.93
Total						**3.21**
Extensive Farm - Replacement						
Stag progeny slaughtered	1.53			0.475		0.73
Hind progeny slaughtered	1.06			0.1425		0.15
Replacement hind maintenance	0.81	0.35	6.86		0.73	1.43
Replacement hind cull value	2.31			0.343	0.59	0.47
Progeny of replacement hinds	0.66	0.35	6.86	0.81	0.64	0.82
Total						**0.73**
Extensive Farm - Terminal						
Stag progeny slaughtered	2.77			0.475		1.31
Hind progeny slaughtered	1.31			0.475		0.62
Total						**1.94**

[A] *Economic value is per calf born and per kg of additional growth to 12 months.*

additional growth at 12 months" basis, we can calculate the overall benefit from the investment in improved growth genetics. To do this we add the components, giving a total value of $3.21 per calf born and per kg additional growth on the "intensive farm". If purchasing genetics which improved the overall growth performance of progeny by 10 kg, the net benefit to the intensive venison commercial farm is $32.10 per calf born. This calculation has not included the impact of retaining grand-daughters into the breeding herd, but this is relatively small due to the low number of grand-daughters retained, the halving of their genetic impact on the subsequent generation and the long time delay in realising their returns.

Impact on the extensive farm

Tables 2 and 3 also give the equivalent values for the extensive farm described. An additional 10 kg of growth has relatively little impact on the average price received for either stags or hinds on the extensive farm – very few additional calves are killed at peak schedule. There are slightly bigger feed savings, as some of these are in autumn when feed value is higher, but these do not compensate for the lack of additional seasonal price premiums. Genetic improvement in growth performance for this type of farm is worth approximately $0.73 per kg additional growth and per calf born, or $7.30 per calf for a 10 kg improvement. While this is still beneficial, it is less than a quarter of the value gained by the intensive farm.

A much larger shift in growth potential is needed to significantly increase calf numbers killed at higher schedule prices for the extensive scenario. This is more likely to be achieved using a Wapiti/Elk terminal sire than by selecting a replacement type sire, assuming this herd is maintaining a red hind breeding base. To demonstrate this impact, terminal sire use was modelled in the extensive herd, with Tables 2 and 3 showing the results. The basic herd performance remains unchanged, but progeny growth is up by 25 kg, and daughters are not retained in the herd. The net improvement is $1.94 per calf born for every kg of additional growth, or a total of $48.50 per calf. The use of a terminal sire has shifted significantly more stag progeny into the peak schedule range, improving the average price for stags. The average hind price has not changed greatly. There are also substantial feed savings from killing stags and hinds earlier. However, to make a fair comparison between terminal and replacement systems, the results need to be multiplied by the number of calves weaned when using terminal vs replacement sires.

Summary

- Every situation is different, but value of genetic improvement in growth is generally determined by how many additional calves will be killed at peak schedule prices.
- A moderate shift in genetic growth potential has a significant value to the farm when the farm is close to killing stags in the peak season, or is actually achieving a proportion in this season.
- Where the farm is some way off achieving peak schedule prices, a moderate increase in growth will have some value, but value is mainly due to saving feed costs.
- In extensive farms, a large increase in growth in sale progeny is required, but it can be disadvantageous if this increase is accompanied by heavier mature size of hinds with associated feed costs, particularly in winter. Use of a high growth terminal siring system is the way to achieve this. These gains are potentially very valuable, but the farm must provide the nutritional inputs to support the additional genetic growth potential.
- This is not a panacea for sub-optimal management.
- These calculations are based only on the value of genetic gains in growth. Other genetic traits are also economically important, especially for sires to breed replacement hinds, and should be factored into the value of improved genetics.