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Breeding Objectives for the New Zealand Deer Industry

July 2007

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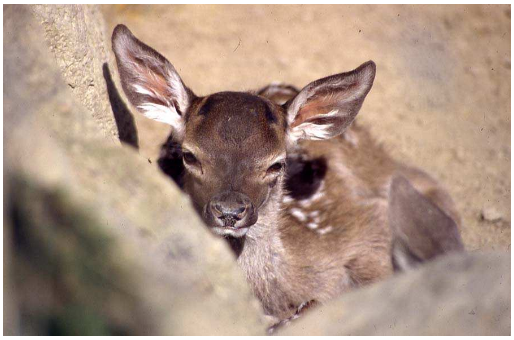

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Client Report

Report prepared for DEEResearch

Contract 6.06

Breeding Objectives for the New Zealand Deer Industry

July 2007

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Breeding Objectives for the New Zealand Deer Industry

For DEEResearch Ltd

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Contents

1 Executive Summary

- This report defines economic weighting factors which can be used to create selection indexes and sub-indexes for the selection of deer within New Zealand farming systems.
- A model is described, which has been developed within an Excel spreadsheet. The model computes both economic values for unit trait changes per animal expressing the trait, and discounted genetic expressions coefficients which count the relative numbers of expressions of various types of traits, and discounts those traits which tend to be expressed relatively later than others. A detailed list of the assumptions used is presented in the report.
- The units of the indexes are in dollars per fawn born, and index values need to be halved when predicting the difference in performance of the progeny of two sires, just as is required when predicting progeny performance using EBVs from parents of one sex only.
- Live weight for age traits have economic values based on the changes in feed costs associated with them, whereas carcase weight for age has an economic value based on additional early season premiums that can be captured with early slaughter at a target carcase weight of 57kg. The model also calculates economic values for velvet production traits, seasonality of breeding, mature weights and maternal traits linked to reproductive success and calf survival.
- The model has been parameterised to define separate selection indexes for breeding programmes supplying breeding stags to early kill, late kill and terminal sire production systems. Early kill and terminal sire production systems have higher feed costs, but also better opportunities to capture early season carcase price premiums than late kill systems.
- This study has revealed meaningful differences in the amount of selection emphasis to be placed on maternal versus growth versus carcase yield traits for early kill maternal, late kill maternal and terminal production systems. Growth rate is relatively more important in early kill and terminal systems; whereas carcase composition, maternal reproduction and fawn survival traits are relatively more important in late kill systems. Early season breeding is of much higher importance in the early kill system than the late kill system.
- The relative economic importance of velvet depends largely on the proportion of male progeny retained for velveting purposes. Because of the high heritability of velvet weight, it is expected that velvet traits will tend to dominate candidate rankings on the velvet index, but not to the point where recording, genetic evaluation, and inclusion in the selection index of growth, seasonality and carcase traits should be abandoned.
- Issues of varying accuracy, particularly for mature weight BVs, can potentially influence the economic index and favour animals with high accuracy BVs for 12-month weight but lower accuracy for mature weight BVs. It is suggested that this issue is considered for implementation of the indices, particularly for presenting sire summary information for public release.
- DEERSelect currently only calculates BVs for growth and velvet (with a limited number of herds submitting velvet data). The venison indices suggest that significant benefits would arise from considering traits related to carcase yield and maternal ability (reproduction related traits). Further development of DEERSelect to include such traits is recommended. Once available, the indices have been calculated to enable inclusion of these traits without requiring further modification.

2 Background

The development of a breeding objective involves the definition of weighting factors used to combine estimated breeding values into indexes of either overall merit, or merit for a specific subset of animal characteristics. The economic weighting factors define the appropriate amount of selection emphasis to apply to estimated breeding values for each trait of interest for improvement. Each estimated breeding value is multiplied by its weight in such a way that high merit for economically important traits can offset poorer merit for less important traits. These economic weighting factors are one of three important drivers of the direction of genetic change. The other two drivers are 1, the amount of genetic variation in the trait, and 2, the degree of accuracy to which estimated breeding values can be predicted for the trait in selection candidates.

This report describes the general approaches used, and the results of a study into the breeding objectives for a range of representative deer farming systems in New Zealand. All of the calculations described are conducted in an excel spreadsheet which can be modified to compute economic weights under various sets of assumptions. Detailed lists of the assumptions used are provided as an appendix to this report.

Breeding objectives are developed separately for Early Kill, Late Kill, Terminal Sire and Velvet focussed genetic improvement systems. Particular focus is placed on difference in economic weights in early versus late kill systems. The main difference between the two systems is that early kill systems can use improvements in calving seasonality and growth rate to exploit early season slaughter schedule price premiums which exist in New Zealand. These premiums exist because of a heavy dependence on export to European markets which are highly seasonal in their demand for venison. The model is also capable of deriving economic weights for traits associated with male progeny of breeding stags retained for velvet production.

Economic weights are made up of at least two components; the first component is the economic value of a unit change in the trait of interest, the second component is the number of discounted trait expressions of the genes of a candidate type of interest. For this study, the candidate type upon which the index is focused is a stag being chosen from a breeding program to mate to hinds on a commercial farm unit. The indexes give the dollars of profit per fawn born to the candidate sire relative to the average of base animals in the genetic evaluation system. They are expressed on an EBV basis, as opposed to an EPD basis, which means that index values need to be halved when predicting the performance of progeny, just as is necessary when predicting progeny performance based on differences between EBVs of sires.

This report first provides some details of background calculations; it then provides an overview of the calculation of economic weights and discounted genetic expressions coefficients. Summary tables are then provided of sets of index weights for Early Kill, Late Kill, Terminal Sire and Velvet focussed genetic improvement systems. Detailed lists of trait definitions are provided in Appendix 1. Detailed lists of assumptions are presented in Appendix 2.

3 Intermediate cost calculations

3.1 The cost of a replacement hind

The cost of a replacement hind is taken as Slaughter cost ,which is calculated as carcass weight multiplied by price per kilo of carcass weight, plus how much it would cost to rear a hind from slaughter age to mature weight, plus an allowance for the mating cost. Stag mating costs are calculated as, cost of buying in a stag minus his cull meat value divided by the no of hinds mated in a lifetime.

3.2 Assumed feed costs

Costing of feed was applied based on the assumption of three distinct feeding periods throughout the year, namely spring (including early summer), autumn (including late summer) and winter. Feed prices (Table 1) were based on opportunity cost in spring and autumn, and for supplements in winter.

Table 1: Seasonal feed costs per MJ of ME[1]

Season	Start date	$ per MJ of ME
Autumn	January 15th	0.015
Winter	April 15th	0.025
Spring	September 15th	0.005

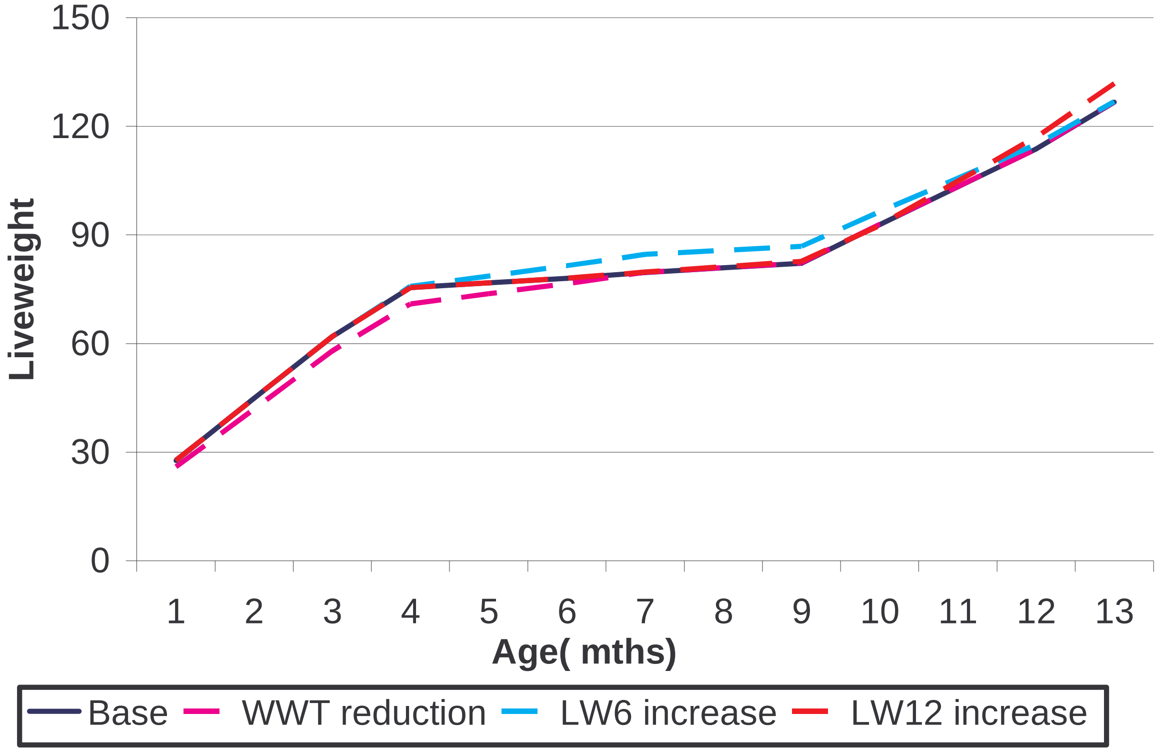
[1]Translates to approximately 15, 25 and 5 cents per kg of dry matter for autumn, winter and spring respectively assume M/D of 10 MJ of ME per kg of dry matter.

4 Calculation of economic values

4.1 Feed costs for stag growth traits until slaughter age

Figure 1 shows growth profiles of different hypothetical stags from birth until slaughter for an early kill production system. The growth profiles are structured so that only one weight is changed per profile. Thus, when LW6 is increased, a faster growth rate from weaning to 6 months is modelled, followed by a slower growth rate from 6 months to 12 month weight.

Figure 1: Growing stag growth profiles for alternative live weight trait genotypes modelled.



Feed costs are computed from birth to slaughter for stags following each of the 4 profiles shown above, and each of the new profiles compared with the base profile. When these differences are expressed per kg change in the live weight trait that has shifted, we have the economic value of a partial change in the trait due to changes in feed costs.

Feed requirements for maintenance (MJ of ME) were calculated as 0.7 multiplied by live weight to the power 0.75. It was assumed that 19 MJ of ME are required for a 1kg increase in live weight. Calculations were done on a weekly basis and then divided by 7.

Table 2: Summary of changes in feed costs that arise from changes in live weight growth profiles for stags.

	Base	WWT Reduction by 5kg	LW6 Increase by 5kg	LW12 Increase by 5kg
Feed costs				
Birth-weaning	12.53	11.87	12.53	12.53
Absolute change		-0.66	0.00	0.00
Change per kg increase		0.13	0.00	0.00
Weaning -6 months	26.36	26.52	27.76	26.36
Absolute change		0.16	1.40	0.00
Change per kg increase		-0.03	0.28	0.00
6months-12months	46.70	46.70	44.40	46.72
Absolute change		0.00	-2.30	0.02
Change per kg increase		0.00	-0.46	0.00
Total feed costs	85.59	85.11	84.70	85.61
Absolute change		-0.48	-0.90	0.02
Change per kg increase		0.10	-0.18	0.00

Stag weaning weight

The economic value of weaning weight in stag fawns was calculated by evaluating the change in feed costs to weaning when the normal rate of growth from birth to weaning is adjusted so that animals are 5kg lighter at weaning; this change in feed costs is subsequently divided by the change in weaning weight (i.e. -5kg) to express the economic value per unit increase in weight. Table 2 provides a summary of the calculations. Note that the extra feed costs up until weaning are not fully compensated for by savings in feed costs from weaning to 6 months. Animals heavier at weaning have higher average maintenance costs than animals lighter at weaning, even when they achieve the same weight at 6 months of age.

Thus, the economic value of weaning weight is taken as the net change in total feed costs from birth to slaughter expressed per 1 kg increase in weaning weight, and because it is a positive cost, the economic value of weaning weight takes a negative value in the breeding objective (Table 2).

Stag weight at 6months

Table 2 shows the changes in feed costs for the different growth periods for a growing stag fawn with a growth profile that result in it being 5 kg heavier at 6 months of age. The extra feed costs from weaning to 6 months are more than offset by reductions from 6 months to 12 months because of a corresponding reduction in slaughter age. For this reason, LW6 of hinds fawns takes a positive economic value in the breeding objective.

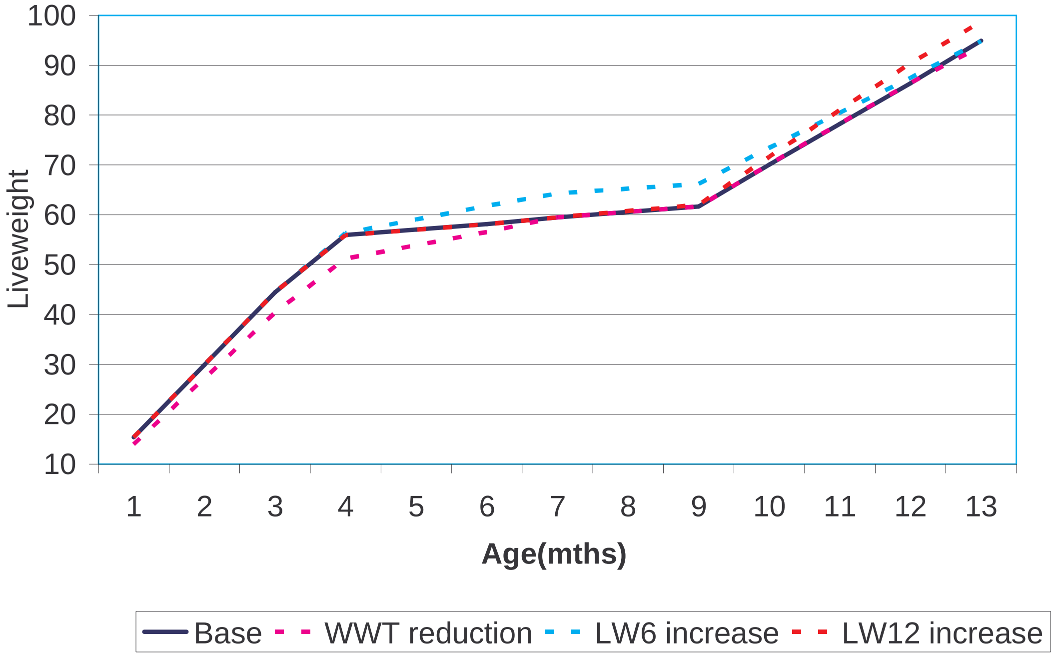
Stag weight at 12months

When stags are 5kg heavier at 12months of age there is minimal affect on feed costs because these stags would be slaughtered prior to spring surplus feed being available, and are growing relatively slowly in the winter from 6 months of age until slaughter. Increases in feed requirements per day for the higher growth rate are compensated for by less days to reach target slaughter weight. The live weight they achieve at 6 months of age is more critical than the live weight they achieve at 12 months of age.

4.2 Feed costs for hind growth traits until slaughter age

Figure 2 shows growth profiles of different hypothetical hinds from birth until slaughter for an early kill production system. The growth profiles are similar to those considered for stags, with the exception that weight for age is much lower in hinds than it is in stags.

Figure 2: Growing hind growth profiles for alternative live weight trait genotypes modelled



Feed requirements for maintenance (MJ of ME) were calculated as 0.6 multiplied by live weight to the power 0.75. The multiplier was lower than what was used for stags (0.7) to reflect lower maintenance costs hinds relative to stags. It was assumed that 19 MJ of ME are required for a 1kg increase in live weight. Calculations were done on a weekly basis and then divided by 7.

Table 3: Summary of changes in feed costs that arise from changes in live weight growth profiles for hinds.

	Base	WWT Reduction by 5kg	LW6 Increase by 5kg	LW12 Increase by 5kg
Feed costs				
Birth-weaning	**12.30**	**11.34**	**12.30**	**12.30**
Absolute change		**-0.97**	**0.00**	**0.00**
Change per kg increase		**0.19**	**0.00**	**0.00**
Weaning -6 months	**21.62**	**22.42**	**23.70**	**21.62**
Absolute change		**0.80**	**2.08**	**0.00**
Change per kg increase		**-0.16**	**0.42**	**0.00**
6months-12months	**54.94**	**54.94**	**56.58**	**53.53**
Absolute change		**0.00**	**1.64**	**-1.41**
Change per kg increase		**0.00**	**0.33**	**-0.28**
Total feed costs	**88.86**	**88.69**	**92.58**	**87.46**
Absolute change		**-0.17**	**3.71**	**-1.41**
Change per kg increase		**0.03**	**0.74**	**-0.28**

Hind weaning weight

The economic value of weaning weight in hind fawns was calculated by evaluating the change in feed costs to weaning when the normal rate of growth from birth to weaning is adjusted so that animals are 5kg lighter at weaning; this change in feed costs is subsequently divided by the change in weaning weight (i.e. -5kg) to express the economic value per unit increase in weight. Table 2 provides a summary of the calculations. Note that the extra feed costs up until weaning are not fully compensated for by savings in feed costs from weaning to 6 months. Animals heavier at weaning have higher average maintenance costs than animals lighter at weaning, even when they achieve the same weight at 6 months of age.

Thus, the economic value of weaning weight is taken as the net change in total feed costs from birth to slaughter expressed per 1 kg increase in weaning weight, and because it is a positive cost, it takes a negative value in the breeding objective (Table 3).

Hind weight at 6months

Table 3 shows the changes in feed costs for the different growth periods for a growing hind with a growth profile that result in it being 5 kg heavier at 6 months of age. The extra feed costs from weaning to 6 months are not offset by reductions from 6 months to 12 months because of extra maintenance requirements. For this reason, LW6 takes a negative economic value in the breeding objective.

Hind weight at 12months

When hinds are 5kg heavier at 12months of age there is a savings in feed costs because these hinds would be slaughtered earlier with a corresponding saving in maintenance feed requirements. The target slaughter weight was taken as 97kg.

4.3 Combined economic weights for growth traits until slaughter age

The above calculations were repeated for late kill and terminal sire production systems and animals. In the late kill system, growth rates are much lower, while in the terminal system, growth rates are much higher. Results are summarised in Table 4 below, and were found to be highly variable across production systems and sexes. On average, increasing live weight 6 resulted in increases in feed costs because there are more maintenance costs in the winter, whereas increasing live weight 12 decreases feed costs because with the earlier slaughter dates, feed costs are saved.

Table 4: Combined changes in feed costs per kg change in live weight profiles due to genetic changes in three live weight traits.

Trait	System	Hinds	Stags	Average across sexes
Weaning weight	Early kill	0.03	0.10	0.07
	Late kill	0.04	0.09	0.07
	Terminal	0.05	0.23	0.14
Live weight 6	Early kill	0.74	-0.18	0.28
	Late kill	0.61	0.17	0.39
	Terminal	0.69	-0.84	0.07
Live weight 12	Early kill	-0.28	0.00	-0.14
	Late kill	-0.47	-0.11	-0.29
	Terminal	0.12	-0.07	0.02

4.4 Hind mature weight

There are 3 factors to take into consideration for the economic value of mature weight.

These are as follows;

- The increase in annual maintenance feed requirements for breeding hinds.
- The increase in feed costs to rear a hind replacement to heavier liveweight.
- And the heavier hinds result in more cull value for those hinds that do not die prior to slaughter

Annual maintenance feed cost component

The annual feed cost component of the EV for mature weights (hinds and also stags) is calculated by first computing the difference in daily maintenance requirements for a hind or stag per day at standard mature weight, versus a mature weight 1kg heavier (Maint_req_hinds and Maint_req_stags). This is then multiplied by the sum of the days for each season multiplied by the cost per MJ of ME in each season to give the annual maintenance feed cost component of the economic value of mature weight for hinds (EV_HMW_afc and EV_SMW_afc).

For example EV_HMW_afc= (Days of spring x price of spring feed+ days of autumn x price in autumn+ days in winter x price in winter)* Maint_req_hinds

Note that EV_SMW_afc is only relevant when male progeny of the breeding stag are retained to generate velvet.

The cull hind salvage value

The cull hind salvage value is the value received for the hind at slaughter. It is the only positive figure obtained when calculating the costs and benefits of a heavier mature weight. It can be calculated by multiplying the dressing percentage of a hind by the price per kg carcass weight.

e.g. EV_HMW_csv=DP%/100 * price /kg CW

Cost to rear a heavier replacement

A disadvantage of a heavier mature weight is the extra costs to rear the hind from the age she would have been slaughtered to the age where she will reach mature weight. The extra feed requirements are taken as the total feed costs post slaughter until mature weight is reached (assumed to be 130kg for hinds) compared with the total feed costs with a 10kg heavier mature weight. This difference in total feed costs to maturity is then divided by the difference in mature weight (i.e. 10kg). This gives a negative figure because higher mature weight gives higher rearing costs.

4.5 Stag (for velveting) mature weight

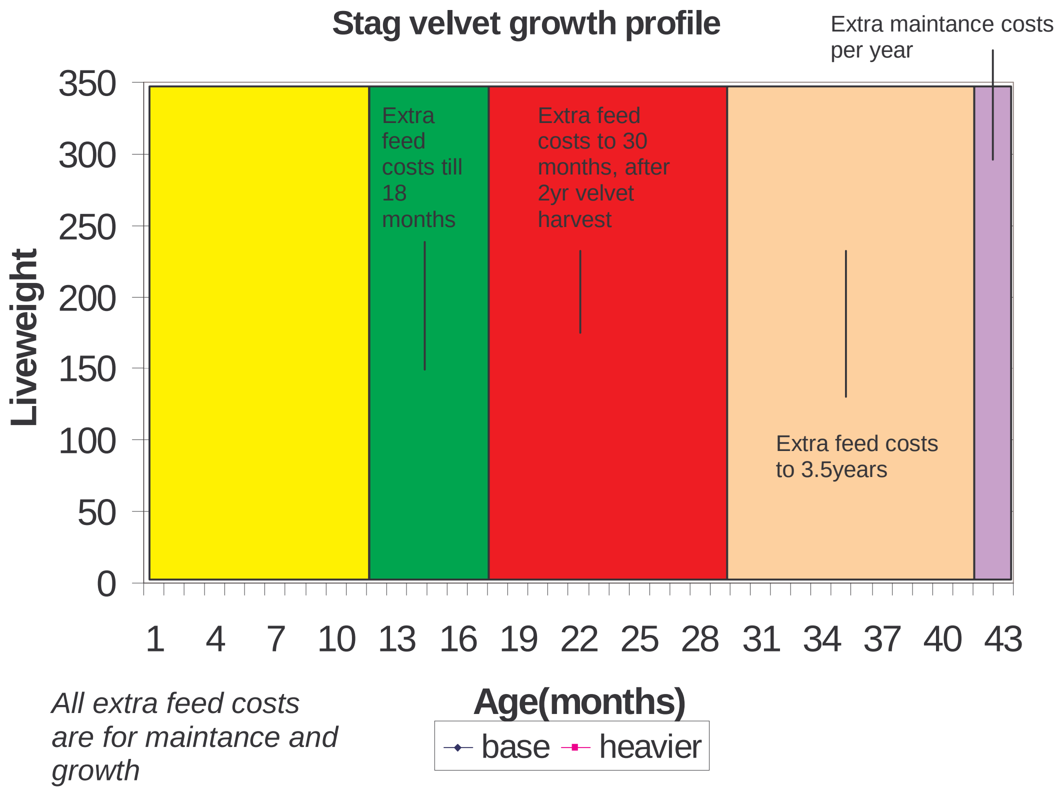
There are four factors to take into consideration when evaluating the feed costs associated with rearing stags to a mature weight.

These are

- The opportunity cost of rearing stags from replacement to two years
- The increase in feed costs to achieve mature weight in a stag to 3.5yrs old
- The increase in maintence costs to maintain these higher mature weights
- The higher cull value of a stag at mature weight

Figure 3 shows the different growth profiles modelled when considering the effects of mature weight on feed requirements for maintenance and growth.

Figure 3: Growth profile modelled for stags differing in their mature weight



The extra feed costs to rear heavier replacement velvet stags

A disadvantage of a heavier mature weight is the extra costs to rear the stag from the age he would have been slaughtered to the age where he will reach mature weight. The extra feed requirements are taken as the total feed costs post slaughter until mature weight is reached (assumed to be 260kg for stags) compared with the total feed costs with a 10kg heavier mature weight. We further partition these costs to consider effects from slaughter age until 2 years of age, and then from two years of age until maturity at 3.5 years of age.

This difference in total feed costs to maturity is then divided by the difference in mature weight (i.e. 10kg). This gives a negative figure because higher mature weight gives higher rearing costs.

The higher salvage carcase value of cull mature velveting stags

This is calculated in a similar manner as for mature adult weight for breeding hinds.

4.6 Seasonality and carcase weight

Economic weights for seasonality and carcase traits were calculated separately for the three different deer farming system types, early kill, late kill and terminal sire. The primary difference between the systems is that the early kill and terminal sire systems have animals slaughtered at a time when the price per kg is declining, whereas with the late kill system, slaughter prices have plateaued at a low level.

A distribution of slaughter dates (numbers of animals per week) was simulated deterministically based on a distribution of fawning dates, and age adjusted standard deviations for fawning weight. It was assumed that 8, 33, 25, 20 and 14 % of fawns are born during weeks 1 to 5 of the fawning season respectively.

The schedule price per kg carcase weight was assumed to be at its highest ($5.50 per kg carcase weight) prior to late September, and to decline (linearly) over a period of two months to a constant seasonal minimum ($4.00 per kg carcase weight).

A median fawning date, and median slaughter dates for stags and hinds were specified as 23 November, 6th of October and 6th of December for the early kill system. For the late kill system, median slaughter dates for stags and hinds were specified as 6th of December and 6th of February.

A target carcase weight of 57kg was assumed, so that changes in seasonality of fawning, or growth rate to slaughter do not result in higher slaughter weights, rather, they affect feed costs (covered in the growth to slaughter sections), and the value per kg of carcase weight. Base growth rates at time of slaughter were also required for stags and hinds in the early and late kill systems, as it is these growth rates which drive the price change resulting from either greater weight for age, or earlier season fawning. Values were assumed to be 0.3 and 0.25 kg/day for late kill, 0.4 and 0.3 kg/day for early kill, and 0.5 and 0.44 kg/day for terminally sired fawns of stag and hind fawns respectively.

Carcase weight

Using the assumptions described above, economic values for carcase weight were calculated by working out the change in average price per kg and therefore average value per animal slaughtered resulting from earlier slaughter with improved growth rate as determined by the goal trait carcase weight at a constant age.

Seasonality

Economic values for seasonality were calculated by shifting the mean fawning date forward by two weeks, and then multiplying the resulting increase in value per fawn slaughtered by 0.59 fawns slaughtered per hind mated and dividing by -14 days to express the economic value per day increase in mean fawning date of a breeding hind in one fawning season.

4.7 Carcase composition traits

The values of carcase components per kg were derived so as to give a carcase value equivalent to the value based on the carcase weight price to the farmer assuming that loin cuts and hind quarter cuts have prices per kg which are 4 times, and 1.6 times respectively greater than the price of fore quarter cuts. These give economic values for the relative carcase cut weights at an age constant slaughter endpoint. However, a target carcase weight endpoint is more relevant, even though the results of CT scanning are estimated on an age constant basis. Thus the effects of a 1 kg increase in cut weight breeding value at an age, on slaughter value at a constant weight were derived by increasing each cut, but then scaling the weight of the whole carcase back to create a constant carcase weight. In this way, an increase in loin weight displaces lower value cuts at the target carcase weight, while an increase in forequarter cuts weight displaces higher value cuts at the target carcase weight.

4.8 Reproductive success

Economic values of reproductive success were calculated as the average (across sexes weighted to account for replacements of breeding hinds and in some situations velvet stags) value of animals slaughtered minus the average feed costs (also weighted by proportion of each sex slaughtered). The same economic values were used for fawn/calf survival.

4.9 Velvet weight

Economic values of velvet weight traits were taken simply as the farm gate market price for the relevant type of velvet as specified in the assumptions.

5 Calculation of discounted genetic expressions

Discounted expressions are used in the formulation of economic weights to account for differences in the frequency and timing of expressions of different trait types. Gene flows were modelled from a breeding stag sold from a deer breeding program but expressed per fawn (progeny of the stag) born. The coefficients account for the halving of expressions of the sires genes through successive generations following the generation of progeny and assume that breeding values of the stags in the breeding program are expressed on an EBV basis, rather than an EPD basis. Indexes are also expressed on an EBV basis, and should be halved when predicting the differences in economic performance of progeny of two sires.

Trait types considered included

- Birth traits
- Weaning traits
- Yearling traits
- Slaughter traits
- Traits of replacement hinds at first mating
- Trait of replacement hinds that calve at 2yo
- Traits of hinds expressed at 3 years of age or older
- Hinds at culling or death
- Spiker stags (1 year of age)
- 2yo velvet stags
- 3yo and older velvet stags
- Cull velvet stags

A planning horizon of 25 years was modelled, and gene flows through generations down to great grand daughters and the performance of their fawns excluding female traits beyond slaughter age.

For terminal sires, expressions were restricted to a single generation, with indexes again expressed on an EBV basis and the trait groups considered restricted to

- Birth traits
- Weaning traits
- Yearling traits
- Slaughter traits

No account is taken for the value of production of the breeding stag itself for velvet, or for its value as a trophy stag at the completion of its breeding life.

6 Index formulation for alternative systems

Tables 5, 6, 7 and 8 describe the index formulations for early kill, late kill, terminal and velvet systems respectively. The assumptions used for all four systems are compared in detail in Appendix 2. There are three major differences between the early and late kill systems, namely, the early kill system has

1. higher feed costs per kg of ME supplied,
2. the opportunity to exploit early season premiums in a significant proportion of fawns slaughtered

3. slightly higher hind mature weights relative to the late kill system.

As a result of these differences, the penalty on mature weight is relatively lower in the late kill system (due to lower feed costs per unit), whereas the costs and benefits for weight for age traits are of greater magnitude (because of the seasonal breakdown of the costs) except for carcase weight which is smaller, because of less options to catch early season premiums. Carcase yield traits have similar weights for early versus late kill, which means that relative late kill systems should have more emphasis placed on yield and less emphasis placed on growth rate than early kill systems. Maternal traits have higher values in the late kill system because although slaughter values were slightly higher for the early kill system, feed costs were also much higher. The exception is calving date, where earlier calving in the late kill system is still insufficient for significant numbers of slaughtered fawns to capture early season premiums.

The discounted genetic expressions coefficients are different for the terminal system, and a number of the traits are redundant. In general, the relative weightings for the carcase yield traits are proportionately lower again for the terminal sire system, largely because of the big gains that can be made through even higher growth rates allowing better capture of early season premiums.

For the velvet system, the retention of males as velvet animals instead of for slaughter means that growth and carcase composition traits diminish in importance. Maternal traits also diminish in importance because this system is unlikely to incorporate a terminal sire, so that a higher proportion of daughters from the velvet/maternal breeding stag are required to maintain breeding herd size. In addition to these factors, the relative importance of velvet traits in the breeding objective will be accentuated by the high heritability's of these traits.

7 Implications

This study has revealed meaningful differences in the amount of selection emphasis to be placed on maternal versus growth versus carcase yield traits for early kill maternal, late kill maternal, terminal sire and velvet production systems. Because a separate terminal sire breeding program already exists, it makes sense to have a distinct breeding objective for them. The relative differences in weightings for early kill versus late kill are probably not sufficient to justify separate breeding objectives unless there is substantial uptake of CT scanning for carcase merit and/or recording and genetic evaluation of seasonal calving date.

Table 5: Index formulation for an early kill system

Goal Trait	Economic Value	Discounted Genetic Expressions	Economic weight
Replacement index			
Growth rate			
Weight 3months kg	-0.07	0.85	-0.06
Weight 6months kg	-0.28	0.85	-0.24
Weight 12months kg	0.14	0.77	0.11
Hind mature weight kg			-0.45
Replacement Hind feed (kg)	*-0.25*	*0.24*	
Adult annual Hind feed(kg)	*-0.68*	*0.95*	
Cull hind salvage value (kg)	*1.65*	*0.16*	
Carcass weight kg	2.81	0.54	1.53
Carcass yield			
Loin cuts (kg - age constant BV)	11.40	0.54	6.15
Hindquarter cuts (kg - age constant BV)	1.66	0.54	0.89
Forequarter cuts (kg - age constant BV)	-0.45	0.54	-0.24
Maternal index			
Scanned pregnant (2yrs)	122.33	0.24	29.24
Scanned pregnant (mixed age)	122.33	0.76	93.52
Calf survival (2yr old)	122.33	0.19	23.22
Calf survival (mixed age)	122.33	0.76	93.52
Calving date	-0.40	0.95	-0.39

Table 6: Index formulation for a late kill system.

Goal Trait	Economic Value	Discounted Genetic Expressions	Economic weight
Replacement index			
Growth rate			
Weight 3months kg	-0.39	0.85	-0.33
Weight 6months kg	-0.12	0.85	-0.10
Weight 12months kg	0.45	0.77	0.35
Hind mature weight kg			-0.37
Replacement Hind feed (kg)	*-0.22*	*0.24*	
Adult annual Hind feed(kg)	*-0.61*	*0.95*	
Cull hind salvage value (kg)	*1.65*	*0.16*	
Carcass weight kg	1.67	0.54	0.91
Carcass yield			
Loin cuts (kg - age constant BV)	11.85	0.54	6.40
Hindquarter cuts (kg - age constant BV)	1.72	0.54	0.93
Forequarter cuts (kg - age constant BV)	-0.47	0.54	-0.25
Maternal index			
Scanned pregnant (2yrs)	137.81	0.24	32.94
Scanned pregnant (mixed age)	137.81	0.76	105.35
Calf survival (2yr old)	137.81	0.19	26.16
Calf survival (mixed age)	137.81	0.76	105.35
Calving date	-0.17	0.95	-0.16

Table 7: Index formulation for a terminal sire system.

Goal Trait	Economic Value	Discounted Genetic Expressions	Economic weight
Terminal Index			
Growth rate			
Weight 3months kg	-0.07	0.85	-0.06
Weight 6months kg	-0.28	0.85	-0.24
Weight 12months kg	0.14	0.82	0.11
Carcass weight kg	2.69	0.82	2.22
Carcass yield			
Loin cuts (age constant BV)	11.23	0.82	9.26
Hindquarter cuts (age constant BV)	1.63	0.82	1.35
Forequarter cuts (age constant BV)	-0.45	0.82	-0.37

Table 8: Index formulation for a velvet focussed system

Goal Trait	Economic Value	Discounted Genetic Expressions	Economic weight
Replacement index			
Growth rate			
Weight 3months kg	-0.07	0.85	-0.06
Weight 6months kg	-0.28	0.85	-0.24
Weight 12months kg	0.14	0.77	0.11
Hind mature weight kg			-0.28
Replacement Hind feed (kg)	*-0.25*	*0.15*	
Adult annual Hind feed(kg)	*-0.68*	*0.60*	
Cull hind salvage value (kg)	*1.65*	*0.10*	
Carcass weight kg	1.35	0.32	0.44
Carcass yield			
Loin cuts (age constant BV)	11.71	0.32	3.79
Hindquarter cuts (age constant BV)	1.70	0.32	0.55
Forequarter cuts (age constant BV)	-0.47	0.32	-0.15
Maternal index			
Scanned pregnant (2yrs)	128.19	0.15	19.30
Scanned pregnant (mixed age)	128.19	0.48	61.73
Calf survival (2yr old)	128.19	0.12	15.33
Calf survival (mixed age)	128.19	0.48	61.73
Calving date	-0.17	0.60	-0.10
Velvet production			
Spiker velvet weight (12months kg)	25.00	0.31	7.67
Velvet antler weight (2yrs kg)	60.00	0.20	12.03
Velvet antler weight (mixed age kg)	80.00	0.70	56.36
Adult stag weight (kg)			-0.56
Replacement feed - slaughter to spiker (kg)	*-0.60*	*0.31*	
Replacement feed - spiker to 2yo Velvet (kg)	*-0.26*	*0.20*	
Replacement feed - 2yo Velvet to maturity (kg)	*-0.61*	*0.20*	
Annual velvet stag feed (kg)	*-0.67*	*0.90*	
Cull velvet stag salvage value (kg)	*1.65*	*0.24*	

8 Testing and implementation

A summary of BVs for sires on DEERSelect was extracted and the four indices tested on these animals. The indices developed include more traits than DEERSelect currently calculates BVs for. Thus the application of BVs to the indices requires some alterations to the economic weights reported above. These alterations include:

1. The economic weight applied to 12 month weight was calculated as the sum of the direct economic weight for 12 month weight, plus the economic weight for carcase weight multiplied by 0.55 to allow for dressing percent.
2. For the velvet index, the economic weight applied to mature weight was calculated as the sum of the direct economic weight for mature weight, plus the economic weight for adult stag weight multiplied by 1.5 (to allow for the weight of stags relative to the weight of hinds, as the mature weight EBV represents the hind, not the stag).
3. For the velvet index, the economic weight applied to 2-year old velvet was calculated as the sum of the direct economic weight for 2-year-old velvet weight, plus the economic weight for spiker velvet multiplied by 0.5 (to account for the relative weights of spiker vs 2-year old velvet).
4. Economic weights for carcass yield traits and maternal index traits were not used as no EBVs currently are calculated for these traits. However, they can be implemented as soon as appropriate EBVs are available and will have significant effects on the index outcomes as traits appropriate to the breeding goals are added (e.g. maternal traits will have significant impact on maternal indices and will increase the calculated economic returns from selection for maternal genetics).

Application of indices raises the issue of accuracies of the component BVs going into the index. For example, the maternal venison indices have a positive weighting for increased weight at 12 months which is balanced by a negative weighting for increased mature size. As accuracy of BVs increases, so does the spread of BVs. Hence, a BV close to zero for a trait like mature weight can occur two ways – either the animal has a genuinely low mature weight and the BV is highly accurate, or little information is available on mature weight and so the BV is regressed towards zero to account for low accuracy.

When the maternal indices are applied, animals with highly accurate 12-month weight BVs but low accuracy mature weight BVs can be advantaged over animals with accurate BVs for both traits. These animals might be young sires without daughters old enough to have mature weights recorded, or they might be sires used in herds which do not record and submit mature weight records.

To avoid the system being manipulated one option is to ensure that a minimum accuracy level for BVs is specified before the index is calculated. This is relatively easily implemented for published sire summaries, where the data can be filtered outside of the DEERSelect system prior to reporting. However, where reports are generated directly from DEERSelect no function exists which will allow this level of filtering, and so this issue is potentially problematic. Applying such a filtering rule will also mean that young stags will be unlikely to have indices calculated until such a time as they have adult progeny recorded for mature weight an velvet, and in instances some potentially elite stags will not have indices calculated.

The correlations between the indices, and between indices and the BVs are given in Table 9 below. The two venison maternal indices are highly correlated, but the economic index values tend to be more extreme for the early kill index vs the late kill index. This reflects the greater value proposition for genetic gain in herds trying to achieve early spring premiums compared to herds with a later kill pattern, but also suggests that the same sires will be suitable for both systems and so different breeding objectives are not required. The venison terminal index is primarily driven by 12-month weigh BVs, as might be expected with no economic penalty for higher mature weight (since all progeny are killed). Likewise the velvet index is primarily driven by velvet weight BVs, and economic values are very high. This matches observed behaviour of the industry, where velvet yield is the primary selection goal and the value of elite genetics for velvet is very high (and reflected in the money which farmers will pay for superior velvet genetics).

Table 9: Correlations between Economic indices and Breeding values for all sires with recent progeny and minimum accuracies of 75% applied for growth traits and velvet.

	Venison Maternal Early kill	Venison Maternal Late Kill	Venison Terminal	Velvet
Venison Maternal Late Kill	0.97			
Venison Terminal	0.84	0.78		
Velvet	0.18	0.21	0.05	
BV wwt	0.65	0.47	0.84	-0.01
BV awt	0.75	0.64	0.91	0.09
BV w12	0.84	0.76	1.00	0.06
BV mwt	0.56	0.49	0.91	-0.07
BV vw2	0.33	0.31	0.33	0.98
BV mvw	0.30	0.28	0.30	0.99

Appendix 3 contains tables of the top 20 animals for each index, with a minimum accuracy of 75% for all contributing traits applied. DEERSelect currently publishes across-herd BVs for growth traits, so the venison indices can be applied to these tables immediately. However, DEERSelect does not publish across-herd BVs for velvet at this point, due to uncertainties around the quality of linkage and to the very small amount of data recorded and submitted for velvet. Hence the table containing the velvet index rankings is for demonstration purposes only, and should not be taken as a valid list of across-herd rankings.

9 Appendix 1: Trait definitions

9.1 Growth rate

Weight at 3 months-average weight at 3 months of age

Weight at 6 months-average weight at 6 months of age

Weight at 12months-average weight at one year of age

Hind mature weight- Average weight of hinds when they reach maturity

9.2 Carcass yield

Carcass weight (kg) - The weighted (by sex) average carcass weight of slaughtered progeny at a constant age assumed to be 12mths of age

Loin cut weight (age constant BV - kg) - The economic value of this trait quantified the effect of a change in loin cut weight in kg at a constant age on carcase value at a target carcase weight

Hind quarter cut weight (age constant BV - kg) - The economic value of this trait quantified the effect of a change in hind quarter cuts weight in kg at a constant age on carcase value at a target carcase weight

Fore quarter cut weight (age constant BV - kg) - The economic value of this trait quantified the effect of a change in fore quarter cuts weight in kg at a constant age on carcase value at a target carcase weight

9.3 Maternal index

Scanned pregnant 2yrs- The amount of hinds at two years of age that are confirmed pregnant by scanning

Scanned pregnant mixed age- The amount of hinds at mixed ages that are confirmed pregnant by scanning

Calf survival 2yrs- The number of calves surviving to weaning per confirmed pregnant hind of 2 year of age.

Calf survival mixed age- The number of calves surviving to weaning per confirmed pregnant hind of mixed age.

Calving date- The average number of days from the beginning of the calendar year at which calving takes place.

9.4 Velvet production

Spiker velvet weight (12mths kg) - The average weight of the spiker velvet at twelve months old

Adult stag weight- The average weight of a adult stag when he reaches mature weight

Spiker feed- The average feed costs to rear a stag to 12mths

Annual velvet stag feed- The annual cost of rearing a stag from post slaughter to mature weight

Cull velvet stag salvage value- The average price received for a cull velvet stag

10 Appendix 2: Table of assumptions for the early and late kill systems

Terminal	Early kill	Late kill	Velvet	Parameter description
Survival and demographic assumptions				
40	40	40	40	Number of hinds mated per stag per year
4	4	4	4	Maximum number of years a stag is retained for
0.8	0.8	0.8	0.8	Survival rate from one year to the next for breeding stags
0.9	0.9	0.9	0.9	Fawns born per hind mated
0.85	0.85	0.85	0.85	Fawn survival from birth to weaning
0.97	0.97	0.97	0.97	Fawn survival from weaning to 1 year of age
0	0.8	0.8	0.4	Proportion of female fawns alive at 1 year of age that are daughters of the reference breeding stag and that get mated with intention to become breeding hinds
0	0	0	0.9	Proportion of male fawns alive at one year of age that are sons of the reference stag and that are kept for Velvet production to spiker stage
0	0.85	0.85	0.85	Proportions of yearling hinds mated that successfully calve at 2 years of age
0	0.92	0.92	0.92	Proportions of hinds calving at 2yo that calve at 3 yo
0	0.9	0.9	0.9	Retention rate of hinds from one calving to the next after 3yo calving and before 9 yo calving
0	0.5	0.5	0.5	Retention rate of hinds from one calving to the next after 9yo calving and before 12 yo calving
0	0.3	0.3	0.3	Proportion of daughters of overall herd hinds that are alive at 1 year of age that get mated with intention of becoming breeding hinds
0	0	0	0.5	Proportion of male fawns alive at one year of age in the whole herd that are kept for Velvet production to spiker stage
0	0	0	0.7	Proportion of spiker stags retained for 2yo velvet harvest
0	0	0	0.8	Proportion of 2yo velvet stags retained for 3yo harvest
0	0	0	0.9	Survival of 3yo and older velevt stags to next velvet harvest
0	0.07	0.07	0.07	Discount rate

Terminal	Early kill	Late kill	Velvet	Parameter description
Feed price assumptions				
0.015	0.015	0.01	0.015	$ per MJ of ME autumn Stag
0.015	0.015	0.01	0.015	$ per MJ of ME autumn Hinds
0.005	0.005	0.005	0.005	$ per MJ of ME spring Stag
0.005	0.005	0.005	0.005	$ per MJ of ME spring Hinds
0.025	0.025	0.015	0.025	$ per MJ of ME winter Stag
0.025	0.025	0.015	0.025	$ per MJ of ME winter Hinds
Stag input assumptions				
1500	1500	1500	3000	Purchase value of stag
$3.00	$3.50	$3.00	$3.00	stag cull price per kilo carcase weight
Velvet price assumptions				
$80	$80	$80	$80	Price per kg of mature velvet
$60	$60	$60	$60	Price per kg of 2 yr old velvet
$25	$25	$25	$25	Price per kg of spiker velvet
Weight assumptions				
130	130	120	130	Hind mature wt
260	260	230	260	Stag mature wt
97.00	97.00	97.00	97.00	Draft liveweight for slaughter (kg)

Terminal	Early kill	Late kill	Velvet	Parameter description
Drafting assumptions				
8	8	8	8	% of fawns born in week 1 of fawning
33	33	33	33	% of fawns born in week 2 of fawning
25	25	25	25	% of fawns born in week 3 of fawning
20	20	20	20	% of fawns born in week 4 of fawning
14	14	14	14	% of fawns born in week 5 of fawning
0	0	0	0	% of fawns born in week 6 of fawning
15	15	15	15	Standard deviation of live weight in young stags at slaughter age
12	12	12	12	Standard deviation of live weight in young hinds at slaughter age
0.45	0.45	0.3	0.4	Average growth rate in kg per day at slaughter for stags
0.35	0.35	0.25	0.3	Average growth rate in kg per day at slaughter for hinds
23/11/2006	23/11/2006	23/11/2006	23/11/2006	Median fawning date
6/10/2006	6/10/2006	6/10/2006	6/12/2006	Median slaughter date stags
6/12/2006	6/12/2006	6/02/2006	6/02/2006	Median slaughter date hinds
Price schedule				
24/09/2006	24/09/2006	24/09/2006	24/09/2006	Date seasonal price drops
24/11/2006	24/11/2006	24/11/2006	24/11/2006	Date seasonal price plateaus
5.50	5.50	5.50	5.50	Peak price/kg CW
4.00	4.00	4.00	4.00	Base price/kg CW
55.00	55.00	55.00	55.00	Carcase weight kg

Terminal	Early kill	Late kill	Velvet	Parameter description
Carcass cut assumptions				
1.6	1.6	1.6	1.6	Relative value of hind quarters relative to forequarters
4	4	4	4	Relative value of loin quarters relative to forequarters
50%	50%	50%	50%	Percent of carcass lean that is hind quarter
35%	35%	35%	35%	Percent of carcass lean that is fore quarter
15%	15%	15%	15%	Percent of carcass lean that is loin
65%	65%	65%	65%	Yield of lean meat from the carcass
Maintence assumptions				
0.6	0.6	0.6	0.6	MJ of ME for maintence for a hind per day
0.7	0.7	0.7	0.7	MJ of ME for maintence for a Stag per day
Hind input assumptions				
$3.00	$3.00	$3.00	$3.00	hind price per kilo cw
Stag input assumptions				
$3.00	$3.00	$3.00	$3.00	Stag price per kg cw
Carcass as a proportion of LW assumptions				
57	57	57	57	Carcass kg
Dressing% assumptions				
55	55	55	55	Mature hind
55	55	55	55	Mature stag
Growth assumptions				
19	19	19	19	ME growth per kg hinds
19	19	19	19	ME growth per kg stag

11 Appendix 3. Tables of the top 20 stags ranked for each index.

Top 20 ranked sires for Venison Maternal – Early Kill Index. Only Sires with minimum accuracy of 75% for component BVs are reported in this table.

Birth Flock Prefix	Current Tag	No. Progeny	WWTBV	acc %	W12BV	acc %	MWTBV	acc %	Current Flock Prefix	Index
Peel Forest Estate	ADMIRAL/00	72/87	12.95	94	19.1	94	12.42	79	Deer Improvement	$8.03
Black Forest Park	SAMURAI/99	131/226	5.15	96	15.14	97	11.45	89	Black Forest Park	$6.67
Black Forest Park	NESKEY/94	42/364	3.49	97	9.58	98	1.75	95	Black Forest Park	$6.34
Doncaster Deer Partnership	CARL/96	160/178	9.41	97	15.28	97	11.31	81	Deer Improvement	$6.18
Danish Royal Park	DAN/83	2/245	6.59	96	11.27	97	5.76	77	Arawata Deer Stud	$6.07
Black Forest Park	KABUL/99	196/289	12.1	97	21.13	98	20.39	91	Black Forest Park	$5.95
Black Forest Park	LUGAR/99	13/24	7.25	87	13.53	89	8.43	80	Black Forest Park	$5.88
Stanfield English	HENRY JAMES/99	43/93	6.68	94	9.15	94	1.68	83	Foveran Deer Stud	$5.80
Black Forest Park	ROMEO/97	229/426	9.57	98	15.37	98	11.99	94	Black Forest Park	$5.80
Black Forest Park	KURGAN/02	48	7	89	19.54	92	19.54	80	Black Forest Park	$5.72
Peel Forest Estate	STRAUSS/99	75/98	4.29	94	12.59	96	10.39	80	Peel Forest Estate	$5.61
Black Forest Park	REGAL/02	33	9.28	87	14.51	90	11.02	78	Deer Improvement	$5.54
Stanfield Eastern	MOSSIMO/01	87	12.05	94	20.51	94	21.47	79	Deer Improvement	$5.48
Black Forest Park	SUPER NOVA/02	25	10.64	85	18.1	89	15.81	78	Black Forest Park	$5.43
Foveran Deer Stud	1367/97	125/368	1.75	97	8.6	97	5.39	81	Foveran Deer Stud	$5.09
Maranoa	BRANKO/88	38/51	4.5	79	10.85	90	5.67	78	Maranoa	$5.06
Canterbury Imp Red Deer	CRUSADER/01	103	10.01	95	16.36	96	15.65	82	Deer Improvement	$4.99
Stanfield Eastern	MAXIMILIAN II/02	58	8.78	90	18.37	91	20.72	80	Stanfield Eastern	$4.96
Pelorus Deer	TOBY/98	32/98	6.29	94	9.77	95	3.58	82	Peel Forest Estate	$4.79
Landcorp Stuart	127/97	40/195	8.47	97	13.86	97	10.93	85	Landcorp Stuart	$4.64

Top 20 ranked sires for Venison Maternal – Late Kill Index. Only Sires with minimum accuracy of 75% for component BVs are reported in this table.

Birth Flock Prefix	Current Tag	No. Progeny	WWTBV	acc	W12BV	acc	MWTBV	acc	Current Flock Prefix	Index
Black Forest Park	SAMURAI/99	131/226	5.15	96	15.14	97	11.45	89	Black Forest Park	$5.99
Peel Forest Estate	ADMIRAL/00	72/87	12.95	94	19.1	94	12.42	79	Deer Improvement	$5.80
Black Forest Park	NESKEY/94	42/364	3.49	97	9.58	98	1.75	95	Black Forest Park	$5.61
Black Forest Park	KURGAN/02	48	7	89	19.54	92	19.54	80	Black Forest Park	$5.55
Pelorus Deer	BENTLEY/99	56/90	-5.15	93	6.49	93	4.86	77	Foveran Deer Stud	$5.41
Peel Forest Estate	STRAUSS/99	75/98	4.29	94	12.59	96	10.39	80	Peel Forest Estate	$4.85
Black Forest Park	LUGAR/99	13/24	7.25	87	13.53	89	8.43	80	Black Forest Park	$4.84
Black Forest Park	KABUL/99	196/289	12.1	97	21.13	98	20.39	91	Black Forest Park	$4.66
Maranoa	BRANKO/88	38/51	4.5	79	10.85	90	5.67	78	Maranoa	$4.63
Danish Royal Park	DAN/83	2/245	6.59	96	11.27	97	5.76	77	Arawata Deer Stud	$4.59
Doncaster Deer Partnership	CARL/96	160/178	9.41	97	15.28	97	11.31	81	Deer Improvement	$4.58
Foveran Deer Stud	1367/97	125/368	1.75	97	8.6	97	5.39	81	Foveran Deer Stud	$4.51
Black Forest Park	SUPER NOVA/02	25	10.64	85	18.1	89	15.81	78	Black Forest Park	$4.35
Black Forest Park	ROMEO/97	229/426	9.57	98	15.37	98	11.99	94	Black Forest Park	$4.29
Stanfield English	HENRY JAMES/99	43/93	6.68	94	9.15	94	1.68	83	Foveran Deer Stud	$4.23
Black Forest Park	REGAL/02	33	9.28	87	14.51	90	11.02	78	Deer Improvement	$4.05
Stanfield Eastern	MOSSIMO/01	87	12.05	94	20.51	94	21.47	79	Deer Improvement	$4.00
Stanfield Eastern	MAXIMILIAN II/02	58	8.78	90	18.37	91	20.72	80	Stanfield Eastern	$3.95
Pelorus Deer	TOBY/98	32/98	6.29	94	9.77	95	3.58	82	Peel Forest Estate	$3.86
Black Forest Park	ICON/00	109/140	4.18	94	11.11	95	8.84	82	Arawata Deer Stud	$3.81

Top 20 ranked sires for Terminal Venison Index. Only Sires with minimum accuracy of 75% for component BVs are reported in this table.

Birth Flock Prefix	Current Tag	No. Progeny	WWTBV	acc %	W12BV	acc %	MWTBV		Current Flock Prefix	Index
Stanfield Eastern	MAXIMILIAN/97	187/361	11.09	97	20.26	98	27.34	92	Stanfield Eastern	$23.30
Black Forest Park	KABUL/99	196/289	12.1	97	21.13	98	20.39	91	Black Forest Park	$23.14
Stanfield Eastern	MOSSIMO/01	87	12.05	94	20.51	94	21.47	79	Deer Improvement	$22.92
Black Forest Park	KURGAN/02	48	7	89	19.54	92	19.54	80	Black Forest Park	$21.93
Stanfield Eastern	MAXIMILIAN II/02	58	8.78	90	18.37	91	20.72	80	Stanfield Eastern	$21.26
Peel Forest Estate	ADMIRAL/00	72/87	12.95	94	19.1	94	12.42	79	Deer Improvement	$20.87
Black Forest Park	SUPER NOVA/02	25	10.64	85	18.1	89	15.81	78	Black Forest Park	$19.41
Canterbury Imp Red Deer	COSSAR/02	76	11.09	93	17.6	91	19.39	76	Deer Improvement	$18.95
Canterbury Imp Red Deer	CRUSADER/01	103	10.01	95	16.36	96	15.65	82	Deer Improvement	$18.24
Stanfield Eastern	COLOSSUS/01	87	9.74	94	16.51	94	16.81	81	Deer Improvement	$18.06
Black Forest Park	SAMURAI/99	131/226	5.15	96	15.14	97	11.45	89	Black Forest Park	$17.57
Doncaster Deer Partnership	CARL/96	160/178	9.41	97	15.28	97	11.31	81	Deer Improvement	$17.07
Black Forest Park	ROMEO/97	229/426	9.57	98	15.37	98	11.99	94	Black Forest Park	$17.02
Black Forest Park	SHIRAZ/01	56/60	10.03	90	15.05	93	19.92	81	Black Forest Park	$16.75
Black Forest Park	REGAL/02	33	9.28	87	14.51	90	11.02	78	Deer Improvement	$16.00
Black Forest Park	VIRGO/02	27	11.92	84	14.4	87	14.43	76	Black Forest Park	$15.77
Stanfield Eastern	92/002	15/196	9.76	95	14.53	96	17.03	90	Canterbury Imp Red Deer	$15.73
Peel Forest Estate	STRAUSS/99	75/98	4.29	94	12.59	96	10.39	80	Peel Forest Estate	$15.06
Black Forest Park	ALPHA/01	55	7.95	91	13.67	92	13.15	81	Deer Improvement	$14.91
Landcorp Stuart	127/97	40/195	8.47	97	13.86	97	10.93	85	Landcorp Stuart	$14.82

Top 20 ranked sires for Velvet Index. This data is for demonstration purposes only, as DEERSelect does not have sufficient data to enable valid across-herd comparisons for velvet. Only Sires with minimum accuracy of 75% for component BVs are reported in this table.

Birth Flock Prefix	Current Tag	No. Progeny	WWT BV	acc %	W12 BV	acc %	MWT BV	acc %	VW2 BV	acc %	MVW BV	acc %	Current Flock Prefix	Index
Black Forest Park	LEGACY/01	75	1.7	93	5.8	94	4.2	79	1.9	83	2.9	82	Deer Improvement	$189.57
Black Forest Park	LOGAN/01	23	0.2	82	3.8	89	1.6	79	1.8	87	2.8	86	Black Forest Park	$184.19
Foveran Deer Stud	1367/97	125/368	1.8	97	8.6	97	5.4	81	1.8	89	2.8	88	Foveran Deer Stud	$184.13
Foveran Deer Stud	WREDESON/92	226/505	1.8	98	-4.7	97	-4.9	80	1.7	88	2.7	88	Foveran Deer Stud	$180.60
Pelorus Deer	TOBY/98	32/98	6.3	94	9.8	95	3.6	82	1.6	88	2.5	87	Peel Forest Estate	$162.57
Black Forest Park	LUGAR/99	13/24	7.3	87	13.5	89	8.4	80	1.6	83	2.6	83	Black Forest Park	$161.86
Foveran Deer Stud	1529/97	101/229	-3.4	97	-4.3	94	-4.4	78	1.5	90	2.4	90	Foveran Deer Stud	$160.34
Black Forest Park	NESKEY/94	42/364	3.5	97	9.6	98	1.8	95	1.5	97	2.4	96	Black Forest Park	$159.68
Black Forest Park	ALEKSIN/99	45/177	7.9	96	11.1	97	9.8	92	1.5	90	2.3	90	Black Forest Park	$140.00
Black Forest Park	SAMARA/97	39/201	6.5	96	3.3	97	1.3	90	1.2	94	2.0	94	Black Forest Park	$128.60
Black Forest Park	BERWICK/95	39/158	0.0	95	2.4	95	0.5	86	1.2	94	1.9	94	Black Forest Park	$126.80
Black Forest Park	TANA/99	14/60	5.8	91	7.7	94	6.5	86	1.2	83	1.9	83	Black Forest Park	$119.82
Black Forest Park	KUTANA/00	76/99	5.2	93	9.2	95	6.4	83	1.2	84	1.9	85	Black Forest Park	$116.96
Black Forest Park	SAMURAI/99	131/226	5.2	96	15.1	97	11.5	89	1.2	90	1.8	90	Black Forest Park	$111.62
Black Forest Park	ROMEO/97	229/426	9.6	98	15.4	98	12.0	94	1.2	95	1.9	95	Black Forest Park	$111.54
Black Forest Park	SHIRAZ/01	56/60	10.0	90	15.1	93	19.9	81	1.3	87	2.0	87	Black Forest Park	$111.36
Peel Forest Estate	MIKEY/97	7/78	0.3	93	3.5	95	4.2	85	1.1	95	1.7	94	Peel Forest Estate	$108.15
Black Forest Park	ICON/00	109/140	4.2	94	11.1	95	8.8	82	1.1	83	1.7	82	Arawata Deer Stud	$106.34
Australia	203 O/96	25/128	2.8	94	2.9	96	1.7	82	1.0	93	1.6	93	Peel Forest Estate	$105.39
Black Forest Park	ENDURANCE/01	17	6.3	84	6.2	87	8.9	76	1.1	82	1.7	81	Black Forest Park	$105.30