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Valuing improved deer genetics
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Abstract

New Zealand deer breeders have made rapid genetic progress in growth traits over the previous decade. A farm-systems analysis was performed using real growth data, to compare sires of differing breed-type and genetic merit for growth traits. Scenarios used red deer maternal sires, of average or high genetic merit, and wapiti terminal sires of high genetic merit. The base scenario of all average-genetic-merit maternal sires was compared against all other systems. Capital stock numbers were adjusted to maintain starting winter pasture covers and total average pasture covers to be as similar as possible; all other core parameters were kept consistent. All high-growth merit scenarios were 6.1%-8.4% more profitable. Median age to slaughter decreased by between 37-61 days, resulting in an increase in average sale value ($/kg) of 5.5%-7.7%. Average carcass weights increased by 2.7%-4.2% with an increase in efficiency (kg product/kg DM consumed) of 1.6%-3.1% over the base scenario. These gains in productivity, profit-ability and efficiency, relative to the base scenario were all achieved with reductions of between 5.6% and 8.0% in the capital hind base. This farm-systems analysis demonstrates that there are favourable gains to be made by deer farmers investing in genetics for improved growth traits.

Keywords: deer; genetics; farmax; breeding value

Introduction

Deer have been farmed in NZ for over 40 years uniquely for livestock, the foundation stock were originally from wild captured sources (Archer 2003). Genetic improvement was primarily from imported strains sourced from game parks and estates from the United Kingdom or Europe (red deer), or from North American wild stock (wapiti). The early breeding focus was mainly on antler improvement (Pearse & Amer 2001), which achieved genetic progress (Archer 2003) as antler traits generally have high heritabilities (Van den Berg & Garrick 1997).

The availability of across-herd estimated breeding values (eBV), with the introduction of DEERSelect (Archer et al. 2005), has enabled the industry to make rapid genetic progress for growth traits in the past decade (Ward et al. 2016). Anecdotally, there has been trepidation by many producers to utilise modern genetics with high eBV for growth traits. The deer industry has established a Primary Growth Partnership (PGP) to increase productivity and profitability. Achieving many objectives of this PGP will require the use of new genetic lines with high genetic merit for growth.

There has been poor adoption of multiple-trait economic selection indexes (Ward et al. 2016), and so alternative methods of quantifying the value of improved growth genetics for a deer-farming system were sought. There is a desire from industry leaders to increase the uptake of modern deer genetics to improve industry profitability. To investigate the potential impact of using changed genetics for venison production, growth curves of rising-yearling (R1) offspring of three sire groups, of differing sire-type and genetic merit were assessed in a farm-systems analysis.

Methods

Progeny of six sires used in a 2014-birth cohort were managed in two mobs separated by sex, at AgResearch Invermay from weaning onwards in the 2015 season. The progeny liveweight data of each sire was combined into sexed groups based on the three different sire-types and genetic merit for growth, those being classified as average-red, high-red and high-wapiti. These sire groups had very different genetic merit for growth traits as estimated by DEERSelect (Table 1). While wapiti and red deer eBV are not directly comparable, the difference between the red sire groups was large, from 12.1 kg at weaning (WWT) to 22.8 kg at 12 months (W12).

Farmax® (v. 7.1.0.19) (Bryant et al. 2010), was selected as the modelling platform, as it is a commercially used economic simulation model that many farmers and

Table 1 Breed, growth genetic-potential and mean DEERSelect growth trait estimated breeding values (eBV), and economic indexes of the red deer and wapiti sires whose progeny produced growth curves, in a New Zealand venison finishing system.

<table>
<thead>
<tr>
<th>Sire breed</th>
<th>Sire growth</th>
<th>WWT eBV</th>
<th>AWT eBV</th>
<th>W12 eBV</th>
<th>CWT eBV</th>
<th>R-EK</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Average</td>
<td>4.6</td>
<td>3.6</td>
<td>4.0</td>
<td>2.3</td>
<td>$31.11</td>
<td>$6.97</td>
<td></td>
</tr>
<tr>
<td>Red High</td>
<td>16.7</td>
<td>20.4</td>
<td>26.8</td>
<td>14.1</td>
<td>$214.3</td>
<td>$44.83</td>
<td></td>
</tr>
<tr>
<td>Wapiti High</td>
<td>11.2*</td>
<td>12.6*</td>
<td>14.8*</td>
<td>8.4*</td>
<td>$280.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WWTeBV = weaning weight eBV, AWT = autumn weight (start-winter) eBV and W12eBV = 12-month-of-age eBV, CWeBV = carcass weight all in kg, R-EK = replacement index, Term = terminal index in $ profit/hind mated. *wapiti values are not directly comparable with those for red deer.
consultants have had exposure to, and understand the outputs from. Scenarios were set up as single-year steady-state scenarios. Four scenarios were developed based around the six growth profiles of R1 deer from the 2014-born progeny. Scenarios were as follows: (1) base maternally system, progeny all red deer of average genetic merit for growth (MAR), (2) maternal system progeny, all red deer of high genetic merit for growth (MHR), (3) 50% maternal 50% terminal system, ½ progeny average growth red ½ wapiti (MAT), and (4); 50% maternal 50% terminal system, ½ progeny high growth red ½ wapiti (MHT).

The Invermay deer farm and herd were used as a base farm for all scenarios as this is where the progeny were born and raised and is represented as a single 143 hectare block of hill country land with an average annual pasture production of 9080 kg DM/ha. Breeding hind numbers were adjusted to keep pasture covers at the start of winter (1 June) at approximately 1500 kgDM/ha (Figure 1), with the mean annual pasture cover being approximately 2000 kg DM/ha.

A 12-hectare winter swede crop was planted on the 16th November and yielded 11 t DM/ha with an utilisation rate of 80% and an average ME of 12.8 MJME/kg DM. Crop was fed during June, July and August. Pasture silage was closed on the 21st September and harvested on 6th December from 30 hectares yielding a total of 105 tonnes (3.5 t DM/ha) with an utilisation rate of 85% and an ME of 10.0 MJME/kg DM. This was fed to deer during June and July.

The hind herd used in all scenarios was the same as the actual dams of these progeny, the Invermay mixed-age hind breeding herd, with a mean start-winter live weight of 127 kg. This breeding hind herd had a mean DEERSelect eBV for the majority of traits of just above average (i.e. zero). The scan pregnancy and weaning rates were the same for all scenarios, being 95% and 87% respectively for the mixed-aged hinds assuming all mating was natural i.e. by stags, not artificial means. The weaning rate was the number of calves weaned at 90 days of age to the number of hinds presented to the stag. In all scenarios, rising-two year old (R2) hind replacements were selected from the heaviest red hind calves in the middle of October at 10-11 months of age at a replacement rate of 21% of the mixed-age hind-breeding herd. Scan pregnancy and weaning rates for R2 hinds were 90% and 80% respectively and their progeny were weaned at 92 days of age on 1st March. Weaning date for MA progeny was set at 25th February when the real calves were approximately 85 days of age. Simulated calves were older as naturally mated mixed-age hinds calved on average 10-14 days earlier than the birthdate from artificial insemination of the real calves. The pregnancy and weaning rates used were from the red deer on Invermay, and were not altered for different sires, as alternative recent published data could not be found specifically for red- or wapiti-sired progeny of high genetic merit for growth traits. Three new replacement sires were purchased annually at the same cost ($3500 each) for each scenario.

All weights used were from real Invermay 2014 progeny data, but used the standard Farmax co-efficient of variation (CV) of 15% to simulate the spread of weights, not the actual spread. Rising-yearling monthly live weights were compiled into six groupings, three male and three female as discussed previously. Live weights for all males and wapiti females for November through to January were predicted based on measured October growth rates, as in reality these animals were slaughtered on a single day in late October.

In all scenarios, R1 progeny were drafted for slaughter every two weeks from the 16th September through to the 9th of February, at which point all that remained were sold to slaughter. R1 stags were drafted at ≥100 kg on all dates except the 28th October when they were drafted at ≥95 kg to increase the number of animals going into the chilled market (attracting peak price). The same drafting protocol was used for the (non-replacement) hinds but at weights of ≥95kg for all dates except 28th October which was ≥90 kg. Drafting at these live weights allowed maximum payment schedules to be achieved for carcass weights ≥45 kg. Velvet data remained the same for all scenarios, as there was insufficient real data to model any sire or breed difference. In reality, velvet was cut from approximately a quarter of the

*Figure 1* Mean pasture covers (kgDM/Ha) for the four scenarios modelled in Farmax for the Invermay deer farm over a twelve-month period. The four scenarios involve the same red deer hinds mated to sires of differing breed-type and/or genetic merit for growth traits where Average-red, all sires red deer of average-genetic-merit for growth, High-red, all sires red deer of high-genetic-merit for growth, Average-red + wapiti, half sires red deer of average- and half sires wapiti of high-genetic-merit for growth, High-red + wapiti, half sires red deer, and half sires wapiti all of high-genetic-merit for growth.
individuals prior to slaughter, and the average velvet weight for all sires from this small subsample was essentially the same. All other parameters, such as expenses, were kept as the default for Farmax. Annuities were calculated over a 20-year investment period, using a discount rate of 5%, based on the single-year profit before tax and capital stock numbers from each scenario.

Table 2 Numbers of mixed age (MA) red deer breeding hinds, productivity and profitability outputs from Farmax modelling of four deer breeding and finishing systems using different sire breed-type and genetic merit for growth traits (Average-red, all sires red deer of average-genetic-merit for growth, High-red, all sires red deer of high-genetic-merit for growth, Average-red + wapiti, half sires red deer of average- and half sires wapiti of high-genetic-merit for growth, High-red + wapiti, half sires red deer, and half sires wapiti all of high-genetic-merit for growth).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average-red (base)</th>
<th>High-red</th>
<th>Average-red + wapiti</th>
<th>High-red + wapiti</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA breeding hinds (n)</td>
<td>475</td>
<td>450</td>
<td>450</td>
<td>440</td>
</tr>
<tr>
<td>Median age to slaughter (days)</td>
<td>392</td>
<td>355</td>
<td>348</td>
<td>331</td>
</tr>
<tr>
<td>Mean carcass weight (kg)</td>
<td>55.0</td>
<td>56.8</td>
<td>56.5</td>
<td>57.4</td>
</tr>
<tr>
<td>Mean venison sale price ($/kg)</td>
<td>6.91</td>
<td>7.31</td>
<td>7.35</td>
<td>7.49</td>
</tr>
<tr>
<td>Gross margin/kg product ($)</td>
<td>4.57</td>
<td>5.01</td>
<td>5.12</td>
<td>5.24</td>
</tr>
<tr>
<td>Production (kg venison/Ha)</td>
<td>204.0</td>
<td>200.1</td>
<td>193.5</td>
<td>194.9</td>
</tr>
<tr>
<td>kg DM eaten</td>
<td>1057896</td>
<td>1017178</td>
<td>987748</td>
<td>980063</td>
</tr>
<tr>
<td>kgDM consumed/kg product</td>
<td>36.26</td>
<td>35.45</td>
<td>35.70</td>
<td>35.17</td>
</tr>
<tr>
<td>Farm profit before tax ($/Ha)</td>
<td>790.00</td>
<td>844.00</td>
<td>841.00</td>
<td>862.00</td>
</tr>
<tr>
<td>Profit per MA breeding hind ($)</td>
<td>237.72</td>
<td>268.23</td>
<td>267.16</td>
<td>280.21</td>
</tr>
<tr>
<td>Annuity over 20-years ($/yr)</td>
<td>100522</td>
<td>120624</td>
<td>120222</td>
<td>123293</td>
</tr>
</tbody>
</table>

Results
It was necessary to reduce capital stock numbers in the scenarios that utilised sire genetics of higher growth to maintain similar start-of-winter and total pasture covers and to ensure that scenarios remained feasible. The overall pasture production was the same across the four scenarios, but the utilisation was different to maintain the 1st June covers (Figure 1). The mixed-age breeding-hind numbers in alternative scenarios reduced from 475 in the base scenario by 5.6%-8.0% to either 450 or 440 (Table 2), at the same time the profitability per MA breeding hind increased between 11.0%-15.2% (Table 2). The MHR and MAT systems were very similar in most production and profitability outcomes, except for kg venison per hectare in which the MHR was 3.4% higher (Table 2). All three scenarios using sire genetics for improved growth rate resulted in increases of profit per hectare between 6.1% and 8.4% over the base scenario (Table 2). Annuities based on a 20-year investment cycle were 20-23% above the base for all improved genetics scenarios (Table 2).

The slaughter profile of the alternative scenarios differed markedly from the base scenario (Fig. 2) with median sale dates up to eight weeks earlier for the three alternative scenarios. Consequently >50% of R1 progeny exit the farm before 12 months of age (Table 2), leaving only around 5% of R1 progeny to quit in February, compared to the base scenario, where almost 30% remain until that time (Figure 2). Average carcass weights were 2.7%-4.2% higher contributing in part to sale prices per kg of carcass weight that were 5.5%-7.7% higher, while gross margins per kg product were 8.8%-12.8% higher than that of the base (Table 2). The base scenario produced 1.9%-4.7% more product (kg venison) per hectare than the improved genetic merit scenarios (Table 2), but each kg of product took longer to produce. Conversely, the higher the genetic merit of the sires used, the more efficient the alternative scenarios became, consuming less dry matter and producing more kg venison (Table 2). The MHT scenario consumed 7.9% or 77833 kg DM less than the base, allowing pasture covers to build to higher levels from October to March, as did MHR and MAT (Figure 1).
Discussion

Farmax® is not an optimisation model and, therefore, does not automatically adjust stocking numbers to optimally utilise the feed resource. Manual adjustments to capital stock numbers were made to target similar pasture covers at the start of winter as would be commonly seen in many farming systems. The three alternative scenarios showed that improved sire genetics for growth can be used in venison breeding and finishing systems, but that capital stock numbers need to be adjusted to accommodate increased feed demands of faster-growing young stock (Thompson et al. 2015). This reduction in capital stock increases the annuity by at least 20% (over a 20-year investment cycle) as the investment in capital stock is reduced, while profit is increased.

Currently the venison price schedule declines over time, after peaking in September and the use of improved genetics increases the profitability of the system due to the earlier selling of R1 deer at higher carcass weights when the schedule is higher, than the more traditional red deer genetics used in the base model. The base scenario is more productive (i.e., produces more venison/ha) but it is not a more profitable enterprise, as the progeny are growing slower and reach target slaughter weights later when the schedule is declining. The higher the genetic potential of the progeny for growth, the more feed efficient the system became. All alternative scenarios were more profitable than the base scenario, which offers producers options to adopt different types of improved sire genetics depending on their management skills, preferences or systems. These scenarios were modelled as a steady state 12-month simulation, so it was not possible in the confines of this study, to investigate the on-going or cumulative impacts of improving the genetic merit of the breeding hind herd in the two high-red scenarios.

The New Zealand deer industry is currently suffering a shortage of breeding hinds so it is exciting to show that by using sires with high genetic merit for growth traits individual farms can be more profitable, even with the current hind base, at appropriate stocking rates. Hopefully, communicating this improved profitability, coupled with right-sizing of the breeding herd will encourage more venison producers to invest in sire stags of proven high genetic merit for growth traits, and move the industry towards the productivity and profitability targets set by the Deer Industry PGP.

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