The influence of dam live weight on the carcass weight of rising-yearling farmed red deer and wapiti crossbreds.

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Abstract

The New Zealand Deer Industry set productivity improvement targets in 2012 for the following 10 years, many related to breeding hinds. Increasing progeny carcass weight was the key trait of interest outside of hind reproductive performance. In this study, the productive output of dams was investigated. Data were collected from red deer and wapiti crossbred progeny (n=2289) born and raised on three farms over five years (2011-2015) from red deer dams (n=1353), mated to 51 red or wapiti stags. Data were analysed using a restricted-maximum likelihood (REML) mixed-model approach to produce predictive models of dam production outputs across a range of dam live weight. The most influential fixed effect in the model was sex, followed by dam mature weight. Predictions were made for progeny carcass weight of male red deer, and of male and female wapiti crossbreds at a mean slaughter age of 348 days from dam mature live weight. For the PIP target 115 kg red deer dam, the goal of a 64 kg progeny carcass was not achieved in this population, with a 115kg red deer dam predicted to produce 58.0, 63.0 and 54.5 (SEM 0.7, 0.9 and 0.9) kg carcasses for red male, wapiti crossbred male and females respectively. Industry should increase selection for hind productive efficiency.

Keywords: deer; hind; live weight; carcass; red deer; wapiti

Introduction

The NZ Deer Industry Productivity Improvement Programme (PIP) identified a number of key targets for improved productivity from 2012-2022 (O'Conner 2012). A number of these targets are direct production outputs (i.e., progeny) of the breeding hind (i.e., dam). Four key targets relevant to this study are, increased carcass weight, increased hind live weight, decreased time of progeny kill, and increased dam productive-efficiency (i.e., kg output/kg hind) (Table 1). Research datasets generated by the Deer Progeny Test (DPT), (Ward et al. 2014) and DEERLink were available to investigate the relationship between dam live weight and progeny productivity in a venison production system. The questions addressed here were: what progeny carcass weights could be expected from dams of a given live weight, and are there minimum or optimal dam live weights to achieve target progeny carcass weights (CW) in present or future venison production systems?

Methods

Dams and sires

Data were available from three farms with progeny born over five years, each farm was not represented across the entire five years. Two farms contributed two years of data and one farm four years. All dams (n=1353) were red deer ranging in age from 2 to 13-years, with a mean age of 6.4 years, half of them had ≥2 progeny in the dataset. The progeny were by 51 different red deer (n=36) or wapiti (n=15) stags, 88% were conceived by synchronised artificial insemination (AI), and the remaining 12% conceived by natural mating (NM). Dams were weighed at progeny weaning (LWWean) and at the start of winter (LWWinter), and were also body-condition scored (BCS) at these times using the methodology of Audige et al. (1998). All dams had at least one live weight and BCS record for each year in which they produced progeny, but some did not have records at both time periods. A third dam live weight trait was included in the analysis in order to align the datasets with the DEERSelect dam live weight trait, called mature live weight (MWT), this was a construct of recorded dam live weights, which used LWWinter if available, otherwise LWWean was used. The mean MWT was 116.5 kg (SD 12.2) ranging from 78.2 to 166.6 kg. The mean DEERSelect (Archer et al. 2005) carcass weight estimated breeding value (CWeBV) for the red deer sires was +8.1 kg (range +0.5 to +15.0 kg), and for the wapiti sires +8.9 kg (range +0.9 to +16.0 kg), the two estimated breeding values (EBV) are not directly comparable between breeds, however, for the purposes of this study, a single set of across-breed EBV was produced. The mean number of progeny per sire was 52 for the red sires and 39 for the wapiti sires.

Progeny data

The progeny birth years were 2011-2015; across those years 2289 singleton-born progeny contributed to the full dataset from three farms, Whiterock Station n=536 (2011, 2012), Haldon Station n=523 (2012, 2013) and Invermay Research Farm n=1230 (2011, and 2013-2015). Progeny were weighed at weaning (three months of age), start and end of winter, and in spring prior to slaughter. All male red deer, and all wapiti crossbred progeny were slaughtered at the same deer slaughter plant. Female red deer were retained for breeding, therefore the CW data is not presented for red deer females. All slaughter was between 10-12 months of age, mean slaughter date and age were 06 November, and 348 days respectively. Data reported here is from 1187 slaughtered progeny with CW records, the full

Table 1 Dam-related productivity as of 2012 and ten-year targets from the NZ deer industry Productivity Improvement Programme.

Target trait name	2012 mean value	2022 target value
Survival to sale	72%	80%
Carcass weight	55kg	64kg
Hind live weight	110kg	115kg
kg output/kg hind	0.36	0.44
Time of kill	(1 Feb)	-16 days

dataset was analysed for progeny CW, 12 month weight, weaning weight and ultrasonic eye-muscle area, but for brevity those other three traits are not reported here.

Data analysis

Data was analysed using restricted maximum likelihood (REML) model fitting, carried out in two phases in Genstat (18th edition; VSN international, Hemel Hempstead, UK). Phase 1 included fitting various sire factors for the three key sire terms, Sire identity (ID), Sire Breed (i.e., red deer or wapiti) and Sire EBV (for CW). This first phase of model fitting consisted of automated forward selection allowing main effects (but excluding Sire ID which disguises sire breed and EBV information) and two-way interactions, from which the 16 most important terms were selected via change-in-deviance testing. Sire ID was returned to the model and three-way and further two-way interactions were added to the model. Non-significant terms (i.e., F-statistic probability >0.1) were removed from the model, then main effects were added back in as necessary. Further non-significant terms were removed and the models were checked for non-linear terms, and finally sire breed was moved in the hierarchy above Sire ID if necessary. The second phase, of model fitting was necessitated by possible confounding of the sire EBV component, as the EBV had been calculated from a dataset including data from this present analysis as a subset. In the second phase Sire ID and Sire Breed were fitted as random terms. The models used terms from the first phase of REML testing with Sire EBV removed, and also herd and mob due to model convergence problems. The most appropriate model was selected using chi-squared testing. This final REML model for the prediction of progeny carcass weight was as follows with the fixed terms being Constant + MWT + Sire Breed + MWT*Sire Breed + Birth Year + Sex + Age of Dam + LWWinter + MWT*LWWinter + Birth Year*LWWinter + MWT.Sex + MWT*Sire Breed*Sex and the random term Sire ID.

Results

The most influential term in the model as determined by the size, from largest to smallest, of the Wald statistic, was progeny sex, followed by dam mature weight (MWT), Birth Year and Age of Dam were the next two most influential terms, but had much less influence. All of these terms were significant (F-pr. <0.001), Wald statistics 344.8, 130.9, 44.4 and 29.9 respectively. Other significant terms were all two and three-way interactions: MWT* sire breed, MWT*LWWinter, birth year*LWWinter and MWT*sire breed*sex (F-pr. <0.001, <0.001, 0.007 and 0.088 respectively). DamBCS, but was not a statistically significant term so was excluded from the final model, there was limited variation in the DamBCS across the dams with a mean of 3.76 and SEM of 0.11. The absence of female red deer in the CW data may have had an effect on the relative influence of sex on the REML model. The mean dam MWT in the progeny CW dataset was 118.0 (SE 0.8) kg and mean progeny CW was 57.5 (SE 0.2) kg. The relationship for the CW of the progeny was positive, increasing with increasing red deer dam MWT (Table 2, Figs 1, 2). Wapiti crossbred male progeny were predicted to achieve the 64 kg CW target, born to 120 kg dam, red deer males >140 kg dam and wapiti crossbred females a 150 kg dam in this population (i.e., slaughtered at 11 months of age) (Table 2). There was a negative relationship for dam productive-efficiency as dam MWT increased her relative productive output (i.e. kg progeny CW/kg dam MWT) decreased, for a fixed slaughter date. Using the PIP defined target (i.e., kg product/kg hind at 80% survival to sale in 2022), an 80 kg MWT dam is predicted to produce 0.51, 0.52, and 0.45 kg progeny CW/kg MWT, for red male, wapiti male and female progeny respectively. At 120 kg MWT this figure is reduced to 0.40, 0.43 and 0.37 kg progeny CW/kg MWT. Within the raw data there was generally a range >20kg in progeny CW at any given dam MWT, for either red deer, or wapiti crossbred progeny (e.g., red male progeny CW range approximately 45-75 kg at dam MWT 120 kg). There were approximately 30 dams with MWT ≤115 kg whose progeny CW ≥64 kg across both sire breed types.

Discussion

Increasing dam live weight increased the CW of their progeny in this population; dam MWT and several other dam-related factors were influential and statistically significant terms in the REML model. Sex was the most influential term, which is not surprising as red deer and wapiti are both very sexually dimorphic sub-species. Dams

Table 2 REML-predicted carcass weights (kg) at 11 months of age for male red deer, and male and female wapiti breed-type progeny of red deer dams based on the dam mature live weight (MWT).

Sire breed	Progeny sex	Dam MWT (kg)								
		80	90	100	110	120	130	140	150	160
Red	M	50.7	52.8	55.0	57.1	59.3	61.4	63.5	65.7	67.8
Wapiti	M	51.7	54.9	58.1	61.2	64.4	67.6	70.8	73.9	77.1
Wapiti	F	45.0	47.7	50.4	53.1	55.8	58.5	61.2	63.9	66.6

Figure 1 REML-model prediction of the relationship between progeny carcass weight (CW) and dam mature live weight (MWT) for red deer male (solid line) progeny of red deer dams sired by red deer sires, shown with 95% confidence intervals (dotted lines).

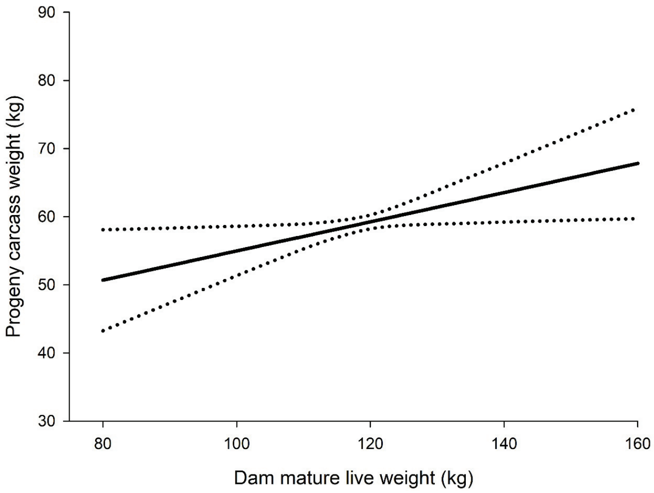
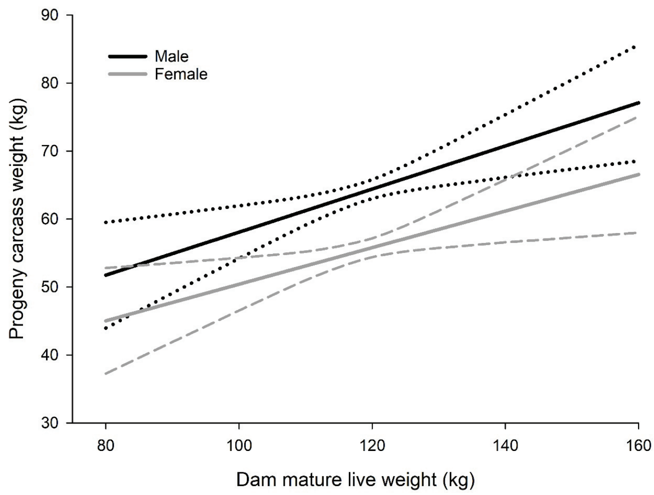


Figure 2 REML-model prediction of the relationship between progeny carcass weight (CW) and dam mature live weight (MWT) for wapiti crossbred male (black solid lines) and female (grey solid lines) progeny of red deer dams, sired by wapiti sires, shown with 95% confidence intervals (dotted or dashed lines).



with heavier MWT were predicted to produce progeny with heavier CW at the same slaughter time and age. At the PIP target of a 115 kg red deer dam was predicted to produce a 58.2 kg red deer male, or 62.8 kg and 54.4 kg wapiti crossbred male or female progeny carcass respectively, at 11 months of age, all below the PIP 64 kg target. To produce 64 kg CW progeny in this population required a dam of ≥120 kg. The sires used in the study had on average genetic merit above the current national average for sires recorded on DEERSelect (Table 1), so the sire genetic contribution can be considered equal to, or higher than, sires currently used industry. There was considerable variation in the productivity between dams within this dataset. Approximately 2% produced progeny ≥64 kg CW at ≤115 kg MWT. While there is a negative trade-off between increased progeny carcass weight and dam productive-efficiency, there are opportunities to improve, through improved recording of dam productivity, to shift the industry average by selection and/or culling. In the raw data 21% of progeny achieved or exceeded 64kg CW, within that were 30% of all wapiti crossbred progeny and 15% of the red deer male progeny. More use of wapiti terminal sires is another solution to shift industry average CW, but this would still require dams of approximately 135 kg MWT to achieve a mean 64 kg CW across both sexes in this population.

The slaughter date for the progeny in this population was almost three months earlier than the industry mean slaughter date target of 01 Feb, which would allow progeny more time to gain carcass weight. The industry is potentially in a transitional phase at present, where the payment schedule is flattening out beyond the traditional six-week peak which ends at the end of October: this may shift production systems to retain slaughter stock longer and potentially increase CW. Whether the CW targets could be met on 01 Feb is unknown from this dataset, as the seasonal nature of deer growth makes it difficult to extrapolate growth rates through summer.

The dam-productive-efficiency target is potentially antagonistic with the progeny CW target, as the most productively-efficient dams are the lightest but these are also predicted to produce progeny CW 12-19 kg less thanthe 64 kg target in this population, so regardless of the dam productive-efficiency, their progeny will likely never achieve a 64 kg CW by 01 Feb. Furthermore in a venison-production system, most dams usually enter the venison supply chain as they are culled from the breeding herd, so their CW is an important contributor to overall industry mean CW, e.g., a 115 kg live weight hind would be expected to produce a CW of 63 kg at 55% dressing out, but an 80 kg hind only 44 kg of CW. Assuming a 10% replacement rate in the national herd means that breeding hinds contribute >10% of the total annual slaughter. The industry could also improve productive-efficiency by improving reproductive parameters and survival to sale, but this will not achieve the CW target.

This study was not able to identify an optimum for a mature red deer breeding hind live weight, but showed that it is an important factor in determining progeny CW. The predicted relationships with progeny carcass weight provides a guide to venison producers of average productive outcomes from red deer hinds of a given live weight. This study sought of investigate the feasibility of a selection of the industry's productivity targets, and found key targets to be unachievable relative to each other, with a focus on a 64 kg CW. Optimal breeding hind live weights will need to be determined using a systems-modelling approach. There will be a range of different inputs and efficiencies, along with seasonality of the deer, within the farm-system that need to be considered in order to determine such an optimum.

The industry should not be afraid to target a higher dam live weight than the current 115 kg, Ward & Thompson (2017) showed that improved sire genetics for live weight, with a lower number of dams, of mean live weight 127 kg, improved profitability by 6-9%. There would be value in the industry placing increased emphasis on the productive outputs of breeding hinds, which was one of the goals of the PIP strategy, although the CW target for 2022 based on a 115 kg live weight breeding hind would appear to be an optimistic one based on this study.

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