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# The importance of date of birth records in genetic evaluation of deer

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## ABSTRACT

This paper addresses one particular difficulty associated with performance recording and genetic evaluation of deer, that is, the problem of recording pedigrees. A deterministic simulation was carried out using parameters based on deer populations where birthday has been recorded. For weaning weight, failure to record birth date resulted in reductions by 29% and 19% in selection accuracy, with selection on the records from the individual or from 20 progeny respectively. Corresponding reductions for yearling weight were 11% and 5% respectively. It was concluded that while genetic progress in deer will be compromised by lack of date of birth records, selection for growth traits can still be effective.

**Keywords:** deer; breeding; genetic evaluation; date of birth.

## INTRODUCTION

As the New Zealand deer industry moves towards maturity pressure for widespread performance recording and genetic evaluation is increasing. However, the extensive nature of deer production systems and difficult behaviour around fawning pose challenges to the collection of records such as sire and dam, parentage and date of birth. While the development of DNA parentage matching tools has lead to alternatives to the collection of accurate pedigree information at birth, it remains impractical to collect exact date of birth records in many situations. Date of birth is typically used in the genetic evaluation process to correct performance traits such as weaning and yearling weight for the non-genetic advantage of being born earlier in the season. The objective of this paper was to investigate the effect of not having date of birth records, or of having date of birth records grouped into 2 to 5 categories, on the accuracy of genetic evaluation of deer.

## MATERIALS AND METHODS

### Effect of correction for date of birth on trait heritability

Consider a trait which has a given heritability $h^2$ when records are correctly adjusted for date of birth. Failure to account for variation in date of birth leads to a reduction in the heritability to a value which can be shown to be approximately:

$$h^{2*} = \frac{h^2}{1 + k \cdot (1 - p)}$$

where p is the proportion of variation in true date of birth which might be explained using some sort of proxy variable (for example based on udder development prior to fawning) as an alternative and k is the proportion of phenotypic variation in the trait which is due to variation in date of birth. For example, if the variance of true date of birth (in units of day of the year), $\sigma_D^2$ and the regression of the trait on birth day, b, are known, then:

$$k = \frac{\sigma_D^2 \cdot b^2}{(\mu \cdot CV)^2}$$

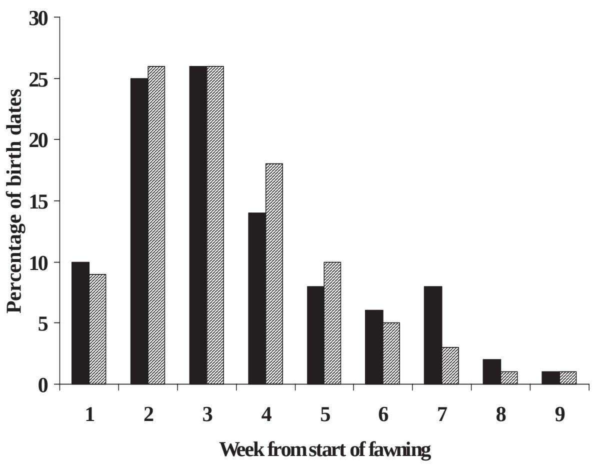
where $\mu$ and CV are the trait mean and phenotypic coefficient of variation respectively. Parameters required to derive k are readily computed from data sets where date of birth has been accurately recorded. For some proxy date of birth variables, specification of p could be based on field tests whereby both birth dates and the proxy variable were recorded simultaneously. An alternative used in this study was to simulate proxy variables under the assumption that animals could be assigned to a certain number of equally sized groups with similar dates of birth.

### Simulation

A set of 100,000 true dates of birth were simulated by sampling from a log normal distribution with shape parameters chosen to reflect the degree of over-dispersion normally observed in dates of birth in seasonal breeding farmed livestock. Figure 1 shows a comparison between distributions of simulated dates of birth versus average observed dates of birth over 9 seasons in the recorded red deer breeding herd of Landcorp Farming Ltd. With the exception of the bump in the observed distribution at 7 weeks, which was apparent over 6 of the 9 seasons, the simulated distribution of birth dates closely matches the observed distribution, and is much more representative than a normal distribution. A distribution of deer date of birth observations of similar shape was presented by Wilson *et al*., (1998). The bimodal distribution might reflect the fact that deer have natural synchrony in their breeding cycles as Pleasants and Macmillan (1998) predicted a tri-modal distribution of calving dates for a herd of cows after oestrus synchronisation.

A number of proxy date of birth variables were assigned to each simulated date of birth based on the assumption that animals could be accurately assigned to two, three, four or five, equally sized groups with similar dates of birth.

**FIGURE 1:** Observed (solid) versus simulated (shaded) percentages of dates of birth by week from the start of fawning.




Less than perfect assignment to groups was also simulated for the two and three group situations by randomly miss-assigning half of the 20% of animals born closest to each category-determining threshold. Correlation coefficients between proxy date of birth variables and true dates of birth were then computed and squared values of the correlation coefficients used in the formula for $h^{2*}$ described above in place of p to determine effects on heritability.

The effects of increases in heritability on selection accuracy (defined as the correlation between true genetic merit and predicted genetic merit) in the case of mass selection, and with selection based on records from 20 or 50 progeny, were quantified using standard quantitative genetics formulae (Falconer, 1981).

Results were applied in the context of selecting to increase weaning weight and yearling weight. For both traits, the phenotypic coefficient of variation was assumed to be 15% and the regression of the trait on birth date .4kg per day. Trait heritabilities were assumed to be .2 for weaning weight and .3 for yearling weight while means were assumed to be 40kg and 80kg for the two traits respectively.

## RESULTS

Table 1 summarises the effects of approximate, or no correction for date of birth on selection accuracies for weaning weight and yearling weight. Failure to correct for date of birth had greatest effect when selection was assumed to be on the basis of an animals own record. Lower effects on accuracy with selection based on progeny records reflected the lesser importance of a high heritability when selecting using family information. In each situation, approximately half of the lost selection accuracy was recovered when animals could be assigned to two groups based on date of birth, and appropriate adjustment made in the estimation of breeding values. Further recovery of the lost selection accuracy occurred with increases in the number of equally sized categories but with decreasing returns for each additional category. Random error in the assignment of animals to categories had only very trivial effects on erosion of accuracy and so results are not presented.

**TABLE 1:** Selection accuracy for weaning weight (WWT) and yearling weight (YWT) with alternative correction factors for date of birth and alternative sources of information for selection.

| Date of birth correction | WWT | | | YWT | | |
|---|---|---|---|---|---|---|
| | Own record | 20 progeny | 50 progeny | Own record | 20 progeny | 50 progeny |
| None | .32 | .58 | .75 | .49 | .75 | .87 |
| 2 categories | .37 | .64 | .80 | .52 | .77 | .89 |
| 3 categories | .39 | .67 | .82 | .53 | .77 | .89 |
| 4 categories | .40 | .68 | .83 | .53 | .78 | .89 |
| 5 categories | .41 | .69 | .83 | .54 | .78 | .89 |
| Full correction | .45 | .72 | .85 | .55 | .79 | .90 |

## DISCUSSION

Provided fawn parentage can be assessed by DNA parentage matching, or by accurately mothering up fawns to mothers prior to weaning, the results of this study suggest that tagging and date of birth recording are not prerequisites to effective genetic progress in growth traits for farmed deer. High potential for genetic improvement in deer velvet antler weight has already been demonstrated (Garrick and Van den Berg, 1996) where systematic environmental effects such as date of birth can be ignored. These are important results for an industry where systematic genetic improvement within and among current breeds and strains is likely to become increasingly important as international sources of superior strains become exhausted.

In the absence of date of birth records, it should be worthwhile to make some attempts to assign hinds based on a best estimate of timing of parturition. This could be achieved, for example, by making several drafts through the fawning season of hinds with fawns at foot into separate management groups although in many instances this might not be practical. Where pregnancy scanning is a routine part of herd management, it should be possible for an experienced scanner operator to predict date of birth. For example, Wilson *et al*., (1988) suggest that date of birth can be predicted to within $\pm$ 0.9 days on average. However, the results of this study suggest that much less rigorous estimates of birth date, which might be achieved with little additional effort over that required for pregnancy detection, might be adequate in many situations. Observation of udders prior to fawning might offer another alternative.

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