‘DEER IMPROVEMENT’ – A BREEDING PROGRAM FOR FARmed RED DEER IN NEW ZEALAND.

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Summary

‘Deer Improvement’ is a commercial red deer breeding program based in the South Island of New Zealand. The breeding program utilises progeny testing, AI, MOET, foetal aging, DNA parentage testing, computer tomography and ultrasound carcass scanning, to maximise genetic progress towards the objective of improving the profitability of venison production. Annual genetic trends (based on the industry DEERSelect breeding values) of +1.3kg/yr in weaning weight, +2.02kg/yr in yearling weight, +1.0kg/yr in carcass weight and -0.18 days/yr in conception date have been realised and the Deer Improvement herd has bred 18 of the top 20 stags on the DEERSelect replacement index (August 2017 across herd evaluation). This paper discusses how ‘Deer Improvement’ was founded, and the current structure of the breeding program.

Keywords: red deer, Cervus elaphus, venison, breeding program, farmed, livestock

Introduction

Deer were first intensively farmed in 1969. In New Zealand (NZ), there are currently ~835,000 farmed deer, from which 12,911 tonnes of venison ($164 million), $14.5 million of hides and leather, 3,947 tonne of co-products ($24.2 million) and 603 tonnes of deer velvet (soft antler, $42.5 million) was exported in 2016 (DINZ 2017). With a short history of domestication, farming and breeding deer has its challenges. First, there is little prior knowledge/research on the species that can be utilised; second, deer exhibit marked seasonality in reproduction and in growth, with little or no growth during winter; and third, domesticated deer retain wild behaviours that can adversely affect production and/or farmer safety. With venison responsible for most of the industry revenue, the breeding program has focussed on venison production at the expense of antler traits. The objective of this paper is to profile the ‘Deer Improvement’ breeding program and illustrate some difficulties encountered...
in the genetic improvement of this recently domesticated livestock species.

**Design of the breeding program**

The ‘Deer Improvement’ breeding program started with the purchase of 20 stags in 2004 and 15 in 2005, from a range of NZ bloodlines. These stags were selected on the basis of their estimated breeding values for growth and, as a consequence, were predominantly of the recently imported Eastern European subtype (*Cervus elaphus hippocrepis*), which is faster growing than the English subtypes (*Cervus elaphus scoticus*) that were originally captured from the wild for farming purposes in New Zealand. The selected stags were then progeny tested using progeny obtained from 1,000 artificial inseminations (AI) on 4 farms and the top 2% of the resulting yearling stags and 6% of the yearling hinds were selected to form a nucleus herd in Southland, New Zealand. Currently, the nucleus has approximately 1,000 hinds, of which the top 3% are used in a multiple ovulation and embryo transfer (MOET) program, the remaining 1st and 2nd fawners (2 & 3 year old hinds) are naturally mated, and the mixed age older hinds are mated via a single round of AI backed up by natural matings. Sexed semen was successfully used in 2014 to generate a large cohort of stags for sale. For more details on the reproductive performance of the herd, see Gudex et al. (2013a).

Natural mating of the 1st and 2nd fawners allows the recording of each hind’s naturally occurring conception date via ultrasound foetal aging, and avoids the lower AI conception rates that occur in these hind age groups (Gudex et al., 2013a). Conception date is currently the only reproductive trait for which estimated breeding values are available and selection on that trait allows earlier mating than would normally be possible. This allows more time for fawns to reach target weights before the venison price premiums expire in late spring and the next cohort of fawns are born (Archer & Amer 2009).

**Genetic evaluation and breeding objectives**

Provision of estimation breeding values for the New Zealand deer industry is the responsibility of DEERSelect (Ward et al., 2016). DEERSelect estimates breeding values for four growth, six lean meat and two maternal traits, which it then utilises to form the Replacement - Early Kill, and Terminal indexes (Archer & Amer 2009). Unfortunately, these selection indexes have not been widely adopted by the commercial industry, which has a stated preference and trust of growth EBVs over indexes containing other traits that are often poorly recorded in some stag breeding herds (Ward et al., 2016).

“Deer Improvement’ uses DEERSelect estimated breeding values to select predominantly on growth, with some consideration given to other traits contained in the industry selection indexes, as well as traits that are currently outside the existing genetic evaluation system, such as parasite resistance, temperament, conformation, and fertility traits other than conception date. In addition, a second line of animals has been bred with a focus on the high country
farming areas, in response to market feedback. As most of New Zealand's farmed deer genetics were derived from "English" subtypes that were originally captured from the wild, there is a market perception that their adaptation to the wild environment makes them more suitable to the adjacent high country farming areas. Therefore 'Deer Improvement' has responded by crossing high growth "Eastern European" subtypes with “English” subtypes to produce stags that are suitable for these high country areas. The creation of these animals has been greatly assisted by the availability of technology to estimate genomic breed proportions that are now available as part of DNA parentage product offered by Genomnz (Rowe et al., 2015).

**Parentage and birth date identification**

Physically matching red deer fawns to their mothers and accurately determining birth dates is difficult due to the ‘wild’ origins of the species. Hinds typically hide their new-born offspring and human interaction at this time adversely affects fawn survival (Asher & Pearce 2002). As a consequence, the parentage of each live fawn is established via DNA parent matching, in conjunction with mating, foetal age and mob information. Each fawn was DNA sampled at approximately 3 months of age and DNA parent matched (for more detail, see Gudex et al. 2013b). Knowledge of birth dates is required for the accurate evaluation of growth (Amer et al., 1999) and is determined from the date of artificial breeding and/or foetal ages determined by ultrasonic pregnancy scanning, plus the gestation length of red deer (232 days). Prior to foetal aging, the conception date of naturally born fawns was determined by rotating stag teams between mobs of hinds, such that each possible mating could only have occurred in a specific 2 week period. Unfortunately, this process adversely affected conception rates, in addition to suffering from the practical problem that stags are difficult to handle during the mating season.

**Trait recording**

In total, just under 110,000 growth, lean meat and parasite resistance records from approximately 15,000 animals on 7 farms have been collected by ‘Deer Improvement’ in 13 years. For growth, up to 8 weight records are recorded during each animal’s first year, and mature weights are also collected on adult hinds. The collection of lean meat measurements involves yearlings having their eye muscle ultrasound scanned. Prior to this, any stags identified as potential sires are scanned by computed tomography (CT). With the CT scanner only able to physically handle animals under 100 kg, and ultrasound scanning only possible once a deer’s winter coat has been shed, CT scanning occurs before ultrasound and prevents the pre-selection of animals for CT scanning based on the cheaper but less accurate ultrasound measurements. The issue with the winter coat is that it contains hollow fibres that are not present on the ‘normal’ coat and these interfere with the ultrasound waves (Ward et
Parasite resistance is recorded via a Carbohydrate Larval Antigen (CarLA) test, which has been found to be associated with parasitism in both sheep and deer (Mackintosh et al., 2014). Fertility is assessed through ultrasound pregnancy scanning and both conformation and behaviour are observed subjectively and recorded by the farm manager.

‘Deer Improvement’ has also contributed sires, slaughter animals, and data towards numerous industry research projects, including the Deer Progeny Test (Ward et al., 2016) and a project to identify variation between sires in the seasonality of winter growth (Ward et al., 2014). The latter was only possible due to high frequency of weight recording that is unique to the ‘Deer Improvement’ herd.

Genetic progress and inbreeding

Since ‘Deer Improvement’ began in 2004, its genetic trend in the DEERSelect replacement index has been almost twice that of the industry average ($1.59 vs. $0.85). This gain is reflected in the August 2017 DEERSelect across herd evaluation sire list, where 18 of the top 20 stags ranked on the replacement index were bred by ‘Deer Improvement’. Underpinning the increase in the index, weaning weights have risen by 1.3 kg per year (19 of top 20 sires), yearling weight by up by 2 kg per year (all of top 20, trend shown in Figure 1), carcass weight up by 1 kg per year (19 of top 20 sires), and conception date down by 0.02 days per year (8 of top 20 sires). Commercial farmers benefit from the increased growth and earlier conception dates, as it makes it easier to target finishing in the early spring, where price premiums exist, there is greater feed availability, and before the next cohort of fawns are born (Archer & Amer 2009). At the same time, there has been a 5% increase in inbreeding within the herd, although it is not known how much of this increase is due to selection and how much is an artefact of the more accurate and deeper pedigrees that are now available for the younger animals. In figure 1 and other unpublished genetic trends, the increase in genetic gain in recent years has been greater in the industry than in the ‘Deer Improvement’ herd. This could be due to the lack of outside genetics of sufficient merit to introduce into the program, a reduced selection intensity with the introduction of the high country line, or the 135 stags and ~1,000 straws (actual 2016 sale figures) of semen being sold into the industry each year, giving the industry a larger short term rate of gain.
Figure 1. Genetic trends for the DEERSelect W12EBV (yearling weight EBV) for the ‘Deer Improvement’ main herd, high country line and across the whole industry.

References


