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# Examination of New Zealand sport horse performance records and their suitability for the calculation of breeding values

FE Creagh[a,b]*, N Lopez-Villalobos[a], RE Hickson[a] and CW Rogers[a]

*[a]Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11-222, Palmerston North 4442, New Zealand; [b]Present address: Livestock Improvement Corporation, Private Bag 3016, Hamilton 3240, New Zealand*

**Corresponding author. Email: fcreagh@lic.co.nz*

## Abstract

Currently there is no genetic evaluation of sport horses in New Zealand. The aim of this study was to develop a prototype model for genetic evaluation of New Zealand sport horses. Official performance data for the 2008/09 and 2009/10 seasons were obtained from Equestrian Sport New Zealand. Data on dressage points per start (Dpps), eventing points per start (Epps,) and show jumping total prize money (Stpm) were examined using descriptive statistics. There were between 902 and 1,472 horses registered in each discipline. All three data sets were skewed but approached normality after a $\log_{10}$ transformation. Overall between two and eight percent of sires in each discipline had five or more progeny records available for genetic analysis. A sire model with fixed effects of season, gender and age and a random effect of animal were used to calculate estimated breeding values (EBVs) for each discipline. EBVs for Dpps ranged from -0.066 to 0.158, for Epps from -0.076 to 0.182, and for Stpm from -0.523 to 0.993. The use of EBVs could lead to increased genetic gain and improved performance of New Zealand sport horses. However, the current data recording has several limitations.

**Keywords:** horse; breeding; sport; genetics; breeding values

## Introduction

Equestrian Sport New Zealand (ESNZ) is responsible for registering horses and organising registered competitions in all disciplines within New Zealand. ESNZ has approximately 5,000 horses registered for competition each year (Equestrian Sports New Zealand, 2009).

Sport horse competition data tends to be highly skewed by nature of the competition structure as there are large numbers of horses which earn few or zero points and little or zero prize money, and a small number of horses that are exceptionally competitive (Creagh et al. 2010; Whitaker & Hill 2004). Therefore, sport horse data must be transformed in order to approach a normal distribution and be useful for genetic analysis (Langlois & Blouin 1998). Common transformations applied to sport horse performance data are logarithmic, power and square root (Arnason 1999; Langlois & Blouin 2004).

In New Zealand, most male horses are gelded before reaching maturity as it is considered the ‘norm’ to compete gelded horses. Competitions do not accommodate for housing many stallions. Hence, only the select few males who are chosen as breeding stallions remain entire. This leads to one of the major problems with utilising competition results for stallion selection as there is very intense genetic selection at an early age due to the gelding of horses to be used in competition (Rogers & Firth 2005).

An estimated breeding value (EBV) is a prediction from a model which can be used to estimate true breeding value (Lynch & Walsh 1998). However, the reliability of an EBV as a predictor depends on the quality of the data. Reliability of EBVs calculated from datasets with wrong or missing sire information, small progeny groups or data with incomplete records for the model effects, such as age and gender, will be low (Woolliams 2006). Utilising pedigree and progeny records in conjunction with the sire’s own competition records, increases the reliability of EBVs. EBV calculations in sport horses are generally based on either a single trait animal model, multi trait animal model or a sire model (Langlois & Blouin 1998; Tavernier 1991). Although EBVs have not previously been calculated for New Zealand sport horses, they are utilised in many European sport horse industries including in Germany, France and the Netherlands (Tavernier 1990).

Many fixed and random effects have been included in sport horse models. The most common are age of the sire or progeny, gender and season (Huizinga & Vandermeij 1989; Langlois 1980). Use of reasonably reliable EBVs, with a reliability of approximately 14% or higher based on Interstallion guidelines, complements the use of a detailed breeding objective in animal breeding programmes, as choices of animals selected for breeding can be made more effectively (Harris & Newman 1994; Interstallion 2005).

The purpose of this investigation was to analyse the suitability of New Zealand sport horse data for genetic evaluation and to calculate estimated breeding values in the New Zealand sport horse population.

**Table 1** Description of the dataset for the equestrian disciplines of dressage, eventing and show jumping during the 2008/09 and 2009/10 competition seasons.

| Parameter | Discipline | | | | | |
|---|---|---|---|---|---|---|
| | Dressage | | Eventing | | Show jumping | |
| | 2008/09 | 2009/10 | 2008/09 | 2009/10 | 2008/09 | 2009/10 |
| Number of horses registered | 1,123 | 1,472 | 902 | 1,255 | 1,326 | 1,331 |
| Number of riders | 860 | 1,200 | 583 | 835 | 950 | 836 |
| Horses with no sire listed (%) | 13.2% | 14.2% | 15.0% | 10.5% | 16.3% | 17.2% |
| Number of sires represented | 511 | 621 | 434 | 236 | 533 | 566 |
| Sires contributing only 1 progeny record (%) | 70.8% | 69.4% | 63.6% | 75.0% | 63.8% | 67.7% |
| Sires with five or more progeny records (%) | 3.9% | 6.3% | 5.3% | 2.1% | 6.8% | 8.1% |

**Table 2** Top ten dressage sires based on EBV ± standard error for points per start, ranking for decreasing EBV for points per start, number of progeny records and ranking based on number of progeny records for data derived from a combination of the 2008/09 and 2009/10 seasons.

| Sire | EBV for points per start | Standard error | Ranking for EBV | Number of progeny records | Ranking for number of progeny records |
|---|---|---|---|---|---|
| Dream Boy | 0.158 | 0.062 | 1 | 46 | 2 |
| Gymnastik Star | 0.156 | 0.064 | 2 | 37 | 4 |
| Anamour | 0.152 | 0.040 | 3 | 193 | 1 |
| Voltaire II | 0.079 | 0.061 | 4 | 45 | 3 |
| Worldwide P.B | 0.078 | 0.071 | 5 | 21 | 7 |
| HP Corlando | 0.072 | 0.066 | 6 | 31 | 5 |
| Injustice | 0.059 | 0.081 | 7 | 4 | 89 |
| Woodstock Recaro Reel | 0.054 | 0.081 | 8 | 5 | 61 |
| Riverman | 0.053 | 0.083 | 9 | 2 | 203 |
| Horace | 0.052 | 0.081 | 10 | 4 | 90 |

## Materials and methods

Official performance records for the 2008/09 and 2009/10 seasons for the disciplines of eventing, dressage and show jumping were obtained from ESNZ. Data on dressage points per start (Dpps), eventing points per start (Epps,) and show jumping total prize money (Stpm) were examined using descriptive statistics. Data were cleaned for analysis, including correction of misspelling of sire names, and transformed via a $\log_{10}$ transformation. Due to the lack of dam information, the data were analysed with a sire model in AIREML (DL Johnson, Personal communication). The model was as follows:

$$Y_{ijkm} = \text{Season}_i + \text{Gender}_j + \text{Age}_k + \text{Animal}_m + e_{ijkm}$$

where $Y_{ijkm}$ is data on points per start (Dpps and Epps) ($\log_{10}$(points/start+1)) or total prize money (Stpm) ($\log_{10}$(Stpm + 1)) for the $m^{th}$ animal of the $j^{th}$ sex class and the $k^{th}$ age class making a record in the $i^{th}$ season. The animal effect was considered as random and the effects of season, gender and age were considered as fixed. Season was either 2008/09 or 2009/10. Gender was either mare or gelding. Progeny records of stallions were excluded due to small numbers of between two and 30 stallions competing in each discipline. As a consequence of these small numbers of competing stallions, the average points and prize money earned was zero for stallions in most disciplines and seasons. Categorising stallions and geldings together as 'male' could potentially overvalue the stallions, as there could be selection for stallions remaining entire because they are believed to be superior individuals. In dressage and show jumping, horses between five and 18 years, age were defined in steps of one year. Horses that were three and four years of age, and were 19 to 24 years of age were considered as two single age classes. The same procedure was followed for the eventing dataset but with horses six to 17 years of age defined in steps of one year while four- and five-year-old horses, and 18- to 21-year-old horses were considered as two single age classes. Age classes are different for Eventing as the distribution of ages was different from that of dressage and show jumping. The assumptions of the model were no inbreeding, no genetic groups, no covariates, unrelated sires and no full sibs. Half sibs were considered. The assumption that there were no full sibs was made in the absence of dam details.

Heritability was assumed to be 0.15 for all traits (Bruns 1981). These values were estimated from previous research (Bruns 1981; Huizinga & Vandermeij 1989; Ducro et al. 2007; Olsson et al. 2008), as they could not be calculated from the ESNZ data due to lack of convergence.

**Table 3** Top ten eventing sires based on EBV ± standard error for points per start, ranking for decreasing EBV for points per start, number of progeny records and ranking based on number of progeny records for data derived from a combination of the 2008/09 and 2009/10 seasons.

| Sire | EBV for points per start | Standard error | Ranking for EBV | Number of progeny records | Ranking for number of progeny records |
|---|---|---|---|---|---|
| A Touch of Hillbilly | 0.182 | 0.099 | 1 | 2 | 131 |
| Grosvenor | 0.136 | 0.077 | 2 | 15 | 3 |
| Turbulent Dancer | 0.135 | 0.090 | 3 | 6 | 24 |
| Voltaire II | 0.130 | 0.075 | 4 | 17 | 1 |
| Waikiki Star | 0.129 | 0.089 | 5 | 6 | 25 |
| Lantham | 0.120 | 0.099 | 6 | 2 | 132 |
| Telesun | 0.111 | 0.093 | 7 | 4 | 53 |
| Bahhare | 0.108 | 0.096 | 8 | 3 | 78 |
| Haajiisan | 0.101 | 0.096 | 9 | 3 | 79 |
| Engagement | 0.094 | 0.099 | 10 | 2 | 133 |

**Table 4** Top ten show jumping sires based on EBV ± standard error for total prize money, ranking for decreasing EBV for points per start, number of progeny records and ranking based on number of progeny records for data derived from a combination of the 2008/09 and 2009/10 seasons.

| Sire | EBV for total prize money | Standard error | Ranking for EBV | Number of progeny records | Ranking for number of progeny records |
|---|---|---|---|---|---|
| Wishing Well | 0.993 | 0.307 | 1 | 16 | 12 |
| Salute the Stars | 0.712 | 0.318 | 2 | 13 | 18 |
| San Mateo Second Chance | 0.619 | 0.383 | 3 | 4 | 100 |
| Cabdula du Tillard | 0.600 | 0.339 | 4 | 9 | 35 |
| Omnicorp | 0.577 | 0.331 | 5 | 11 | 23 |
| Kahurangi Valiant | 0.546 | 0.296 | 6 | 18 | 8 |
| Indoctro | 0.486 | 0.372 | 7 | 5 | 80 |
| Zig Zag | 0.478 | 0.383 | 8 | 4 | 101 |
| Fetiche du pas | 0.472 | 0.348 | 9 | 8 | 42 |
| Leo Caylon | 0.449 | 0.336 | 10 | 10 | 28 |

## Results

The number of horses registered in each discipline during the season was between 902 and 1,427. These horses were ridden by between 583 and 1,200 riders. Within this group of horses between 64% and 75% of their sires had only one progeny record and 2% to 8% had five or more progeny records. The percentage of horses registered without sire information ranged from 10% to 17% (Table 1). Across all disciplines and seasons, 21% of horses were registered with an incorrectly spelt sire name. Dam information was absent in 38% of cases.

EBVs for Dpps ranged from -0.066 to 0.158, EBVs for Epps ranged from -0.076 to 0.182 and EBVs for Stpm ranged from -0.523 to 0.993. The standard errors of all EBVs were relatively large (Tables 2, 3 and 4). It was found that the most popular sires, as reflected in the number of progeny records, did not have the highest EBVs (Tables 2, 3 and 4).

## Discussion

### *Heterogeneity*

Sport horse populations tend to be relatively heterogeneous with a large number of sires having extremely small numbers of progeny (Wallin et al. 2003). However, the New Zealand dataset was found to be particularly heterogeneous with the majority of sires contributing only one progeny record and few sires having five or more progeny records (Table 1). A minimum of between five and ten progeny records are required to achieve sufficient reliability in EBV calculation (Sun et al. 2009). Hence, the reliability of the EBVs for the majority of sport horse sires in New Zealand, based on current data, would have been extremely low (Woolliams 2006). This heterogeneity will be exacerbated by missing information on sires.

### *Missing records*

Progeny records of horses registered with an 'unknown' sire were excluded from the genetic analysis. Information from these horses is therefore missing from the 'true' sire's progeny records. This affects the variance of that sire's EBV leading to a potential reduction in the estimated response to selection (Harder et al. 2005). Information on the sire was not available as either it was not provided when the horse was registered or the sire was simply not known.

Inaccurate spelling of sire names was a large problem within the New Zealand dataset. The impact of wrong sire information on reliability and genetic gain has been found to be twice that of missing sire information (Woolliams 2006). If spelling of sire names is not corrected prior to analysis, different versions of the same sire will be counted as different sires as no sire identification number is provided in the dataset. Hence the sport horse population will appear more heterogeneous and EBVs will be based on incomplete progeny samples.

### *Rider effect*

Equestrian sport is unique in the animal breeding sector in that there is a confounding effect of the rider on sport horse performance (Kearsley et al. 2008). The rider effect makes it difficult to separate a horse's own talent from that of its rider, as more experienced riders tend to achieve better results on less talented horses than less experienced riders. Horses which are thought to be better performers are also often ridden by better riders (Bruns 1981). To address this problem, horses are often categorised as being ridden by either an amateur or a professional rider when data is incorporated into a genetic analysis. In New Zealand there is no way to accurately distinguish between amateur and professional riders as rider 'status' is not recorded by ESNZ. Hence, rider effect could not be included in the model for genetic analysis.

### *Interpretation of estimated breeding values*

The use of EBVs by the New Zealand sport horse population could potentially lead to improvements in the selection of competition sires, as sires with a reasonable EBV can be used more effectively to achieve genetic gain within the population. However, more accurate and complete recording of sport horse pedigree information is required in order for the New Zealand dataset to be used to calculate breeding values with reasonable reliability. Issues of normality and heterogeneity are common to all sport horse breeding industries. As such they must be dealt with in the genetic model (Langlois & Blouin 1998). The range of breeding values was very small for all variables and all disciplines; therefore, there appear to be limited opportunities to achieve genetic gain in the current New Zealand sport horse population (Tables 2, 3 & 4) (Van Vleck et al. 1992).

Many traits analysed in sport horse competition data are subjective and difficult to measure. This is a major issue which must be addressed when calculating EBVs in sport horse populations (Koenen et al. 2003). Positive EBVs are desireable, as positive increases in the number of points and amount of prize money won would be indicative of improved performance in the respective disciplines.

### *Heritability value assumptions*

As the dataset was not sufficiently complete to calculate values for heritability, a heritability value of 0.15 was assumed for each of the three parameters of Dpps, Epps, and Stpm. This lack of convergence was also encountered by Koerhuis & van der Werf (1994) in the bivariate analysis of a simulated horse population. A heritability value of 0.15 was chosen based on heritability values which have previously been calculated for sport horse competition variables from overseas data which ranged from 0.10 to 0.27 (Ducro et al. 2007; Olsson et al. 2008). As European sport horses are commonly from uniform environments, heritability values may be higher than those applicable to New Zealand's more heterogeneous environment (Rogers 1993). To account for this a lower heritability estimate than is generally seen in Europe was used, namely 0.15.

## Recommendations

Due to limitations of the current sport horse performance dataset in New Zealand, the EBV calculations reported here are aimed to be an initial template for future calculation rather than a basis for comparing current sires.

The following recommendations have been made with the objective of improving the data available for use in future genetic analyses:

1. ***Recording sires on registration*****:** The number of horses registered with a sire needs to be increased. An incentive to include sire name, such as a discount on registration fees or an additional charge for registering a horse without a sire could improve completeness of these records.
2. ***Accurate sire names*****:** The implementation of a system to improve the accuracy of spelling of sire names would help reduce inaccurate heterogeneity in the sport horse population. One way to do this would be for ESNZ to utilise a programme which stores sire names that have been entered before and comes up with past options which can be selected when a new record is added. Alternatively, a unique sire identification number could be assigned to each sire so that there is no longer any reliance on the spelling of sire names.
3. ***Accurate recording and inclusion of dam information in ESNZ records*****:** Would permit the use of all genetic relationships, including dam relationships, to be considered in a full animal model.
4. ***More stallions competing*****:** Encouraging riders to compete with stallions would help reduce the high selection prior to competition. This could be achieved by improving the facilities to keep stallions at competitions, such as having a greater number of stallion yards on offer at competition venues.
5. ***Differentiating amateur and professional riders*****:** It could be advantageous to record whether a rider is an amateur or professional in the ESNZ database. This could be achieved by asking riders whether equestrian sport is their main source of income and recording those who respond with 'yes' as professional riders.

## Conclusion

Implementation of these recommendations could help to improve the accuracy and completeness of the data available on sport horses in New Zealand for use in genetic analyses. This would improve the accuracy of calculating EBVs for sport horse sires. If reasonably accurate EBVs could be obtained for New Zealand sport horse sires, their use could lead to increases in genetic gain and improved performance of New Zealand's sport horses on the international stage.

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