Interstallion - on the way to an international genetic evaluation of sport horses

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Summary

Many horse breeding organisations aim at improving the genetic ability of sport horses based on various types of performance tests for young horses and sport competition data. Over the past ten years there has been a dramatic increase in the use of artificial insemination within and across breeding organisations, countries and even continents. Therefore, information on testing and genetic evaluation of sport horses has to become more transparent which was the basic for founding INTERSTALLION as a working group of WBFSH, EAAP and ICAR. INTERSTALLION has published details on a number of European breeding populations and programmes on the Internet. Reviews on breeding objectives, testing and evaluation methods have been prepared as prestudies of improved genetic evaluations across countries. On-going studies investigate the similarities in genetic proofs of stallions used in various European countries and their genetic connectedness. For comparing the genetic proofs across breeding organisations genetic correlations between similar traits recorded in different countries are to be estimated and the availability and usage of data on internationally performing horses are to be tested.

Introduction

Many horse breeding organisations aim at improving the genetic ability of warmblood riding horses for performance in sport competitions, such as dressage, show jumping and eventing. In horse breeding as in other livestock breeding there has been a dramatic increase in the use of artificial insemination, except for Thoroughbreds which allow natural mating only, over the last decades. As a consequence exchange of genetic material in warmblood riding horses across breeding organisations, countries and even continents has become more common and has made countries with large breeding populations such as Germany and France the main exporters of fresh and chilled semen. Breeding organisations and individual breeders have to deal with foreign information on performance data recording, testing and evaluation more frequently. Based on their demand INTERSTALLION was founded as a working group of the World Breeding Federation for Sport Horses (WBFSH), the European Association for Animal Production (EAAP), and the International Committee for Animal Recording (ICAR) back in 1998. The main aims of INTERSTALLION are (1) to review national breeding objectives, testing and evaluation systems, (2) to improve access and understanding of breeding information across countries and (3) to explore ways of harmonising and comparing EBVs across countries. This paper gives overviews of the past and current activities of INTERSTALLION that lead to improved transparency and understanding of national testing and genetic evaluations which are fundamental for an international genetic evaluation of sport horses.

Breeding objectives

Breeding objectives of 19 WBFSH breeding organisations have been reviewed (*Koenen et al., 2004).* In contrast to other livestock species, trait definitions in horse breeding are more subjective. The review showed that the main performance traits of most breeding organisations include show jumping, dressage and eventing performance; also some breeding organisations specify the level of performance within the sport discipline (e.g. national vs. international competition). In practice breeding objectives vary largely across countries as organisations put different weightings on the individual traits of the breeding objective. For example, the Holstein, Irish Sport Horse and Selle Français studbooks emphasise show jumping, whereas the Trakehner studbook emphasises dressage. In other studbooks like in the Hanovarian multiple breeding programmes exist and the population is divided into subgroups; in one subgroup emphasis is on dressage, whereas in the other group show jumping is the main breeding objective.

The main non-performance traits recorded are conformation, gaits, behaviour, health (including soundness, durability and robustness) and fertility (Table 1). Conformation is the most important non-performance trait but is defined differently between organisations. Some organisations mention aesthetic conformation ("noble", "expressive", "well-shaped") as a breeding objective since it affects the financial value of a horse, other organisations indicate functional conformation to be relevant due to its relation to sport performance, longevity and health.

Table 1. Frequency of performance and non-performance traits recorded in the breeding objectives of 19 breeding organisations for warmblood sport horses
(Koenen et al., 2004)

Performance traits	Frequency	Non-performance traits	Frequency
Show jumping	15	Conformation	15
Dressage	13	Gaits	12
Eventing	10	Behaviour	10
Driving	4	Health / fertility	9

Young horse testing schemes

European breeding organisations use three types of tests to record performance data of young, 3-5 years old sport horses: station performance tests, field performance tests and competition tests (Table 2). In most countries testing capacity at station is used for testing young stallions for at least 70 days, except for Great Britain, Hungary and Sweden, where the tests include no more than 8 days counting all repetitions. Also some breeding organisations run performance tests at station for testing young mares between 14 to 50 days. At station performance tests gaits, rideability and jumping are commonly scored repeatedly over the testing period by the trainer and at the final day of test by external judges. The field performance test is a one-day test, in most countries used to test young mares and/or geldings. Similar traits as in the station tests are scored once by external judges. Finally, most countries use competitions as an additional test for young stallions, mares and/or geldings. France and Belgium use competitions as the only source of testing, known as the "Cycle Classique" which consists of a series of competitions for young horses including young stallions grouped in age-classes. In these two countries competition data are the only source of information for selecting stallions. Horses participating in field tests and/or competitions are less preselected than young stallions which are performance tested at station and preselected due to conformation, gaits in hand and jumping. The absolute number of young horses tested per year varies across countries, but also the annual number of horses tested relative to the number of foals registered is between 10% (Ireland) and 45% (France).

Table 2. Young horse testing procedures being part of national evaluation systems
Thoren et al. (2004)

	Belgium	Denmark	France	Germany	Ireland	The Netherlands	Sweden
Testing procedure[1]	C	F , S	C	F , S , C	S , C	F , S	F
Age at test (years)	4-7	3-4	4-6	3-4	3-5	3-4	3-5
No. horses tested / year	1000	700	3600	3600	475	3400	1300
No. of foals reg. / year	4000	2500	8000	26700	4800	12000	3000
Prop. of horses tested / year	25	28	45	13	10	28	43

[1] S = station performance test, F = field test, C = competition

With reference to non-performance traits most breeding horses are scored for conformation at studbook entrance and/or during performance testing applying scores on a subjective (*Christmann, 1996*) or linear scale (*Koenen et al., 1995*). Testing for health traits is often limited to stallions before or during their performance tests, except in Sweden where all four-years old horses entering the Riding Horse Quality Tests are tested on orthopaedic and medical status (*Wallin, 2000*). Fertility data are often restricted to semen quality, and foaling percentages of stallions are published only in The Netherlands and Sweden. Finally on behaviour, data are sometimes available on character and temperament scored during station performance tests.

National evaluation systems

National genetic evaluation systems vary largely across countries because of the large variety in breeding objectives and testing schemes. Current genetic evaluations are based on performance data on jumping, dressage, eventing and conformation. Belgium, France and Ireland use competition results, Denmark and Sweden use performance test results, whereas Germany and The Netherlands combine competition and test results *(Koenen et al., 2002*).

The statistical models applied in the evaluation are animal models considering one, two or many traits (up to 15 in Germany) simultaneously. Observations are commonly adjusted for the non-genetic effects of age and sex since performance results increase with age and stallions and geldings have a higher performance than mares. Some statistical models also adjust for location/time of test, rider and permanent environment. Examples for combining data from different variables and tests are given by the Dutch and German evaluations. In the Netherlands a bivariate model combines competition results (highest level) and station performance results (score for riding ability). In Germany the model considers simultaneously results on dressage and jumping competitions (4 variables), stallions performance tests (6) and mare performance tests (5) (*Jaitner and Reinhardt, 2003*). For publication, the EBVs are transformed to a scale with a mean of 100 and a standard deviation of 20, except in France where the mean of the transformed EBVs is 0. The definition of the base population varies largely between countries, some countries include all horses with an EBV, others select animals for the base population based on sex, year of birth, reliability, and others define a moving base.

International evaluation systems

Due to the varying national systems in data recording, testing and evaluation, horse breeders cannot easily compare EBVs across organisations. In dairy cattle, methods of the international genetic evaluation have been driven by INTERBULL and are often based on multi-trait across country evaluation (MACE) similar to *Schaeffer (1994*). Essential requirements for successfully applying MACE are well established. Validated national proofs and good genetic connectedness among countries are essential for MACE (*Arnason and Ricard, 2001*).

The quality of national proofs is crucial for an international comparison of EBVs. However, detailed information on the quality of the statistical models used for national evaluations are rare. The methods developed for validating national proofs as developed for dairy cattle (*Reverter et al., 1994*; *Boichard et al., 1995*) may also be considered in horse breeding. One example was given by *Arnason (1999*) for validating the national proofs of Swedish Standardbred trotters.

Another prerequisite for international comparisons of EBVs is genetic connectedness across populations. In practice, this connectedness is based on the usage of genetic material across countries, mainly through artificial insemination and export of animals. The connectedness between two countries can be quantified as the average prediction error variance of differences in EBVs between both countries (*Kennedy and Trus, 1993*). Such estimates are not yet available in sport horse breeding. They are expected to be lower than in dairy cattle as progeny groups of sires are much smaller and genetic ties may only be traced through pedigree information. A second reason can be seen in the lower genetic correlations between traits in the different countries due to large variation in breeding objectives and in defining and recording data. Also possible genotype*environment interactions between countries may reduce genetic similarities. At present, estimating genetic connectedness among horse populations is complicated since unique horse identification numbers are not applied across countries. So far, the unique equine identification number (UELN) as proposed by the WBFSH and the FEI in 2000 has been introduced only in some countries.

Procedures for genetic evaluations across country have mainly been developed to improve international genetic evaluations in dairy cattle. Based on the work by *Schaeffer (1994*) multi-trait linear models are tested in which different independent variables are used. Options for choosing independent variables include unregressed measures of progeny performance which can be derived from the national evaluations based on an animal model and de-regressed genetic evaluations (*Sigurdsson and Banos, 1995*). Alternatively, MACE procedures are based on adjusted phenotypic deviations formed on the basis of the national evaluations or all data are incorporated in a common (global) linear model. The latter allows fitting different effects and traits in different countries provided reasonably good estimates of the genetic parameters exist both within and across country. An example was given by *Arnason and Ricard (2001*) for Icelandic horses to study the genetic trend in three different countries.

The most common problems in across country evaluation of stallions, also in contrast to dairy bulls, are

- Breeding objectives are differently and insufficiently defined and communicated among countries, also for the same discipline of sport;
- Discrepancies exist sometimes between breeding objectives as practised by breeders and as theoretically calculated;
- Performance testing of stallions is of major relevance, but methods differ with respect to type and length of test, traits measured, and age of tested horses;
- National breeding values based on progeny performance are estimated on small (as compared to dairy cattle) samples of horses selected at various degrees and causing biased breeding values;
- Unique identification of stallions and progeny is not fully implemented;
- Published information on test results, breeding values and their reliabilities is incomplete;
- Methods and models for estimating breeding values vary and are often not well known among breeding organisations.

INTERSTALLION activities in evaluation

INTERSTALLION has designed a pilot study to investigate the similarities in national proofs for similar traits based on progeny and grand-progeny of the same stallions used in several countries. This study carried out by *E. Thorén, Sweden*, is based on data of young horse tests provided by five breeding organisations (Danish Warmblood, Hanover, Holstein, KWPN and Swedish Warmblood) confirming that genetic connectedness is largly caused by German stallions (Table 3). The pilot project will focus on two aspects:

- The degree of genetic connectedness between the five studbooks; and
- The comparison of national proofs of the same traits through estimates of correlations between traits tested in different countries.

The main problem identified so far in studying the genetic links is the non-existent recording of original identification number and name when stallions are exported or used in another country. This, of course, is a prerequisite for exchange of computerised horse data between studbooks. For the participating organisations this will mean a thorough review of their pedigree files with regard to foreign animals and an improved quality and completeness of those files for a better follow-up of exported animals. Additionally, the study will compare national proofs and study country-wise ranking of stallions which is important for the licensing committees in different countries.

Table 3. Percentage of breeding stallions and their sires with German origin
(*Koenen et al., 2003*)

country	breeding stallions	sires of breeding stallions
Denmark	50	75
The Netherlands	18	47
Sweden	27	42

The second study proposed and headed by *A. Ricard, France*, will investigate possibilities for an international evaluation of stallions based on jumping competition results. The participating countries in this study are Belgium, France, Germany, Ireland and The Netherlands. As in the first study this project will also begin with analysing the genetic connectedness between countries based on jumping competition data. Thereafter, the second step will concentrate on estimating genetic correlations between countries whereby de-regressed proofs are to be computed from the national evaluation of the sire in his original country and the amount of information used for this evaluation derived from its reliability. Finally, the study may also look into possibilities of using international results that may or may not be used in the national evaluations. After all, the effect of genetic trend within populations may be studied. As shown by *Ducrocq et al. (2003*) it seems that average deviation is to be preferred to de-regressed proof for robustness against inconsistencies of genetic trend in national evaluations.

Conclusions

INTERSTALLION, which started as a working group of EAAP, ICAR and WBFSH in 1998, has become the driving force in documenting and reviewing horse breeding activities in Europe and its successful activities over the last few years have widely been recognised. A systematic overview of the current situation in European sport horse breeding was the first step to increase the transparency of the various breeding programmes. Starting with a questionnaire, 19 WBFSH organisations have provided details on their breeding populations, objectives, testing and evaluation methods. INTERSTALLION has now published these results in a standardised format on the Internet (www.interstallion.org)

Reviews of current breeding objectives and testing methods (*Koenen et al., 2004; Thorén et al., 2004*) in Europe provide useful information of practical relevance for breeding organisations and basic scientific information for geneticists.

INTERSTALLION has recently started two research projects dealing with international comparisons of sport horses; other acitivities on the usage of the international sport data of FEI and on ranking and genetic base are equally of greatest interest due to the continuously growing usage of breeding stock across countries. More effective and scientifically based use of national breeding values combined with international sport data will improve national evaluation systems and selection of stallions. The road to international genetic evaluation of stallions is a long one and breeding organisations greatly benefit from the past and current activities of INTERSTALLION.

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