NEW STRATEGIES IN GENETIC EVALUATIONS AND TOOLS TO PRESERVE THE DIVERSITY IN HORSE BREEDS. A REVIEW.

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Horse breeding program: selection

- **Aim**: more competitive animals in high level sport competitions.
- **Particularities in performance controls:**
  - Subjectivity
  - Rider effect
- **Nature of the traits:**
  - Discontinuous
  - Continuous-no normal distribution
Genetic Models: BLUP

- Univariate models.
- Repeteeability models.
- Multitrait models.

\[
\begin{bmatrix}
X'X & X'Z \\
Z'X & Z'Z + A^{-1} \alpha
\end{bmatrix}
\begin{bmatrix}
\hat{b} \\
\hat{u}
\end{bmatrix}
= \begin{bmatrix}
X'y \\
Z'y
\end{bmatrix}
\]
Genetic Models: Threshold models

- Discontinuous traits.
- An underlying normal distribution is assumed and a threshold indicates the discontinuity in the visible scale (Gianola and Foulley 1983; Sorensen and Gianola 2002).
- Number of thresholds (e.g. rank).

\[
P_i = \begin{cases} 
1 & \text{if } y_i > T \\
0 & \text{if } y_i \leq T 
\end{cases}
\]
Genetic Models: Thurstonian models

- The ranking of the horses in the competition is independent from the level of such competition.
- This model fixes the event effect including a correction of predicted breeding values by the quality of animals competing together.
- Bayesian approach (Gianola and Simianer, 2006).
Genetic Models: Thurstonian models

Breeding values for participants in the best and worst race (Gómez et al., 2011).
Genetic Models: Random Regression

- These models are aimed at using longitudinal data (Hill and Brotherstone, 1999; Kirkpatrick et al., 1990).
- It is assumed that the animal performance is a time function.
- It allows measuring the plasticity or adaptability of the animal.
Genetic Models: Random Regression

Variation of the breeding value over the distance in 4 animals (Gómez et al., 2010).
Genomic Selection

- Decrease the generation interval.
- It is useful in low heritability functional traits.
- Animal castration at a very young age, low selection intensities in subsequent steps.
- It requires enough number of animals in the reference population with phenotypes and genotypes.
- High cost.
Cross-Validation

- A cross-validation approach is useful to evaluate the prediction ability (Efron and Tibshirani, 1993).
- This method has been used in other species as dairy cattle.
- The methodology applied in horse performance models has demonstrated its usefulness (Olsen et al., 2012; Sánchez et al., 2013).
Horse Breeding programs: Conservation

- In small populations the preservation of the maximum genetic diversity is one of the main objectives.

- Two-steps:
  - To assess the present state.
  - To decide a management strategy.
Conservation: state of the population

- Analysis of the genetic variability and structure.
  - **Genealogical Analysis:**
    - Inbreeding, coancestry
    - Effective population size
    - Probability of gene origin
  - **Molecular Analysis:**
    - Expected/observed heterozigosity
    - Allelic diversity

Photo: Jesús Martínez Saiz
The critical $N_e$ varies between 50-100 individuals. Values depend on the methods. Same method across populations to define the risk status. Caution interpreting estimated effective population sizes. Parameters like census, geographical situation, sanitary risk management, etc.
Conservation: management strategy

- **Minimum coancestry** mating (Toro et al., 1988; Sonesson and Meuwissen, 2000, 2002; Fernández et al., 2001).

- The **compensatory mating** (Caballero et al., 1996).

- To select as reproducers animals with the lowest **Average Relatedness** (Goyache et al., 2003; Gutiérrez et al., 2003).

- **Both** minimizing the coancestry of the individuals that act as parents and equalizing contributions (Ballou and Lacy, 1995; Caballero and Toro, 2000; Fernández et al., 2008).

\[
\min \sum_{i=1}^{N} \sum_{j=1}^{N} c_i c_j f_{ij}
\]
Conservation: management strategy

- **Optimum Contributions** (Meuwissen, 1997) is not exclusive to conservation programmes.
- Minimize the rate of inbreeding, or constrain it and maximize **genetic gain** simultaneously.

Solé et al., 2013
Conservation: management strategy

- Direct practical implementation of these methodologies is not always straightforward.
- All these methods require genealogical and/or molecular data and computation.
Conservation: Ex situ

- Cryopreservation is a very useful tool in the management of genetic variability.
- Germplasm bank creation.
- Donors and number of samples to get to store the highest levels of genetic variability.
THANK YOU!

Photo: Menorca Breeder's Association

Photo: Jesús Martínez Sáiz

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