# 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

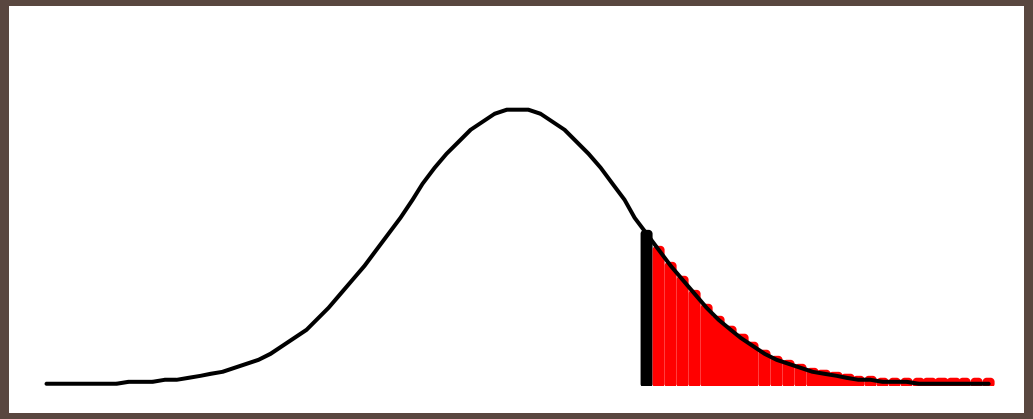
# Genetic Models: BLUP

- Univariate models.
- Repeteability models.
- Multitrait models.

$$\begin{bmatrix} \mathbf{X'X} & \mathbf{X'Z} \\ \mathbf{Z'X} & \mathbf{Z'Z} + \mathbf{A}^{-1}\alpha \end{bmatrix} \begin{bmatrix} \hat{\mathbf{b}} \\ \hat{\mathbf{u}} \end{bmatrix} = \begin{bmatrix} \mathbf{X'y} \\ \mathbf{Z'y} \end{bmatrix}$$

# 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).



$$P_i = \begin{cases} = 1 \text{ if } y_i > T \\ \\ = 0 \text{ if } y_i \leq T \end{cases}$$

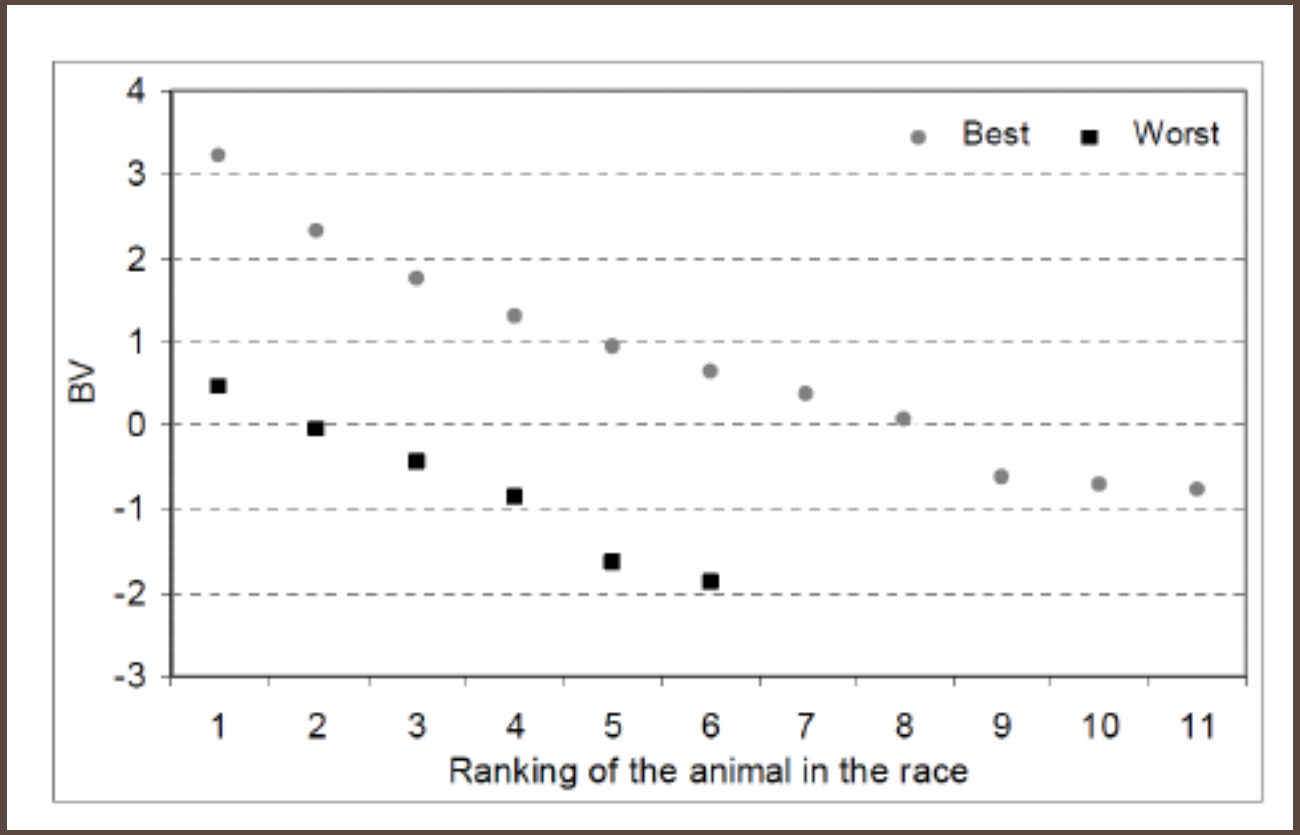
# Genetic Models: Thurstonian models

- 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).

Photo: Menorca Breeder 'sAssociation

# Genetic Models: Thurstonian models

Breeding values for participants in the best and worst race (Gómez et al., 2011).

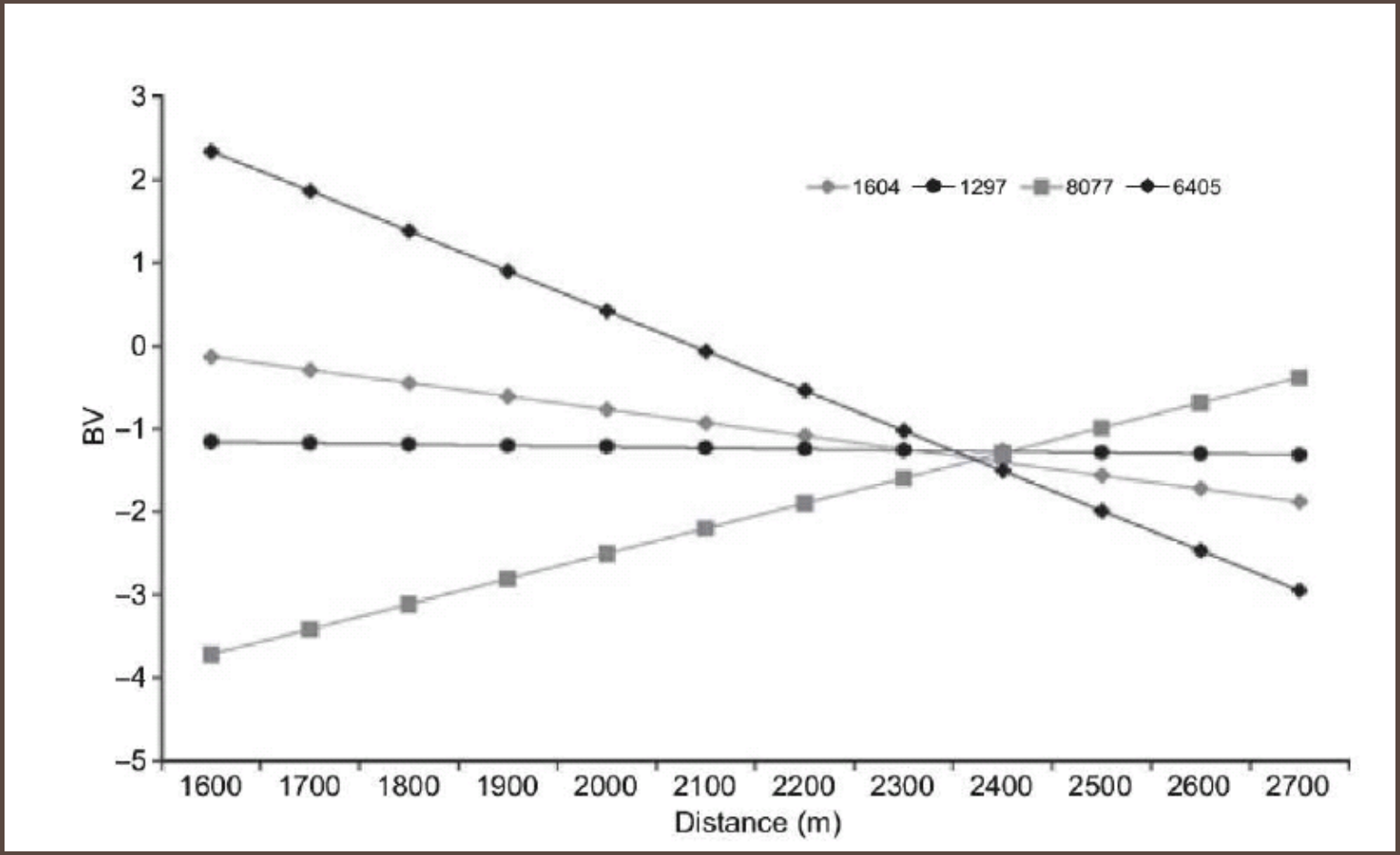


# Genetic Models: Random Regression

- 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

# Conservation: Effective Population Size

- The **critical $N_e$** varies between **50-100** individuals.
- Values **depends** 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.

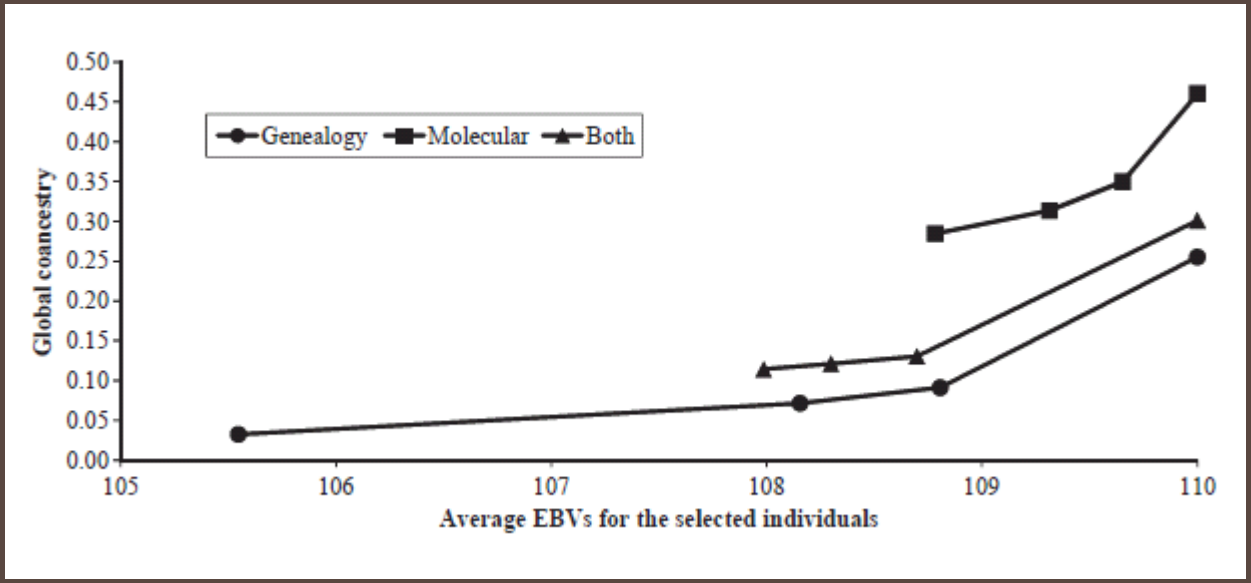
# Conservation: management strategy

- **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

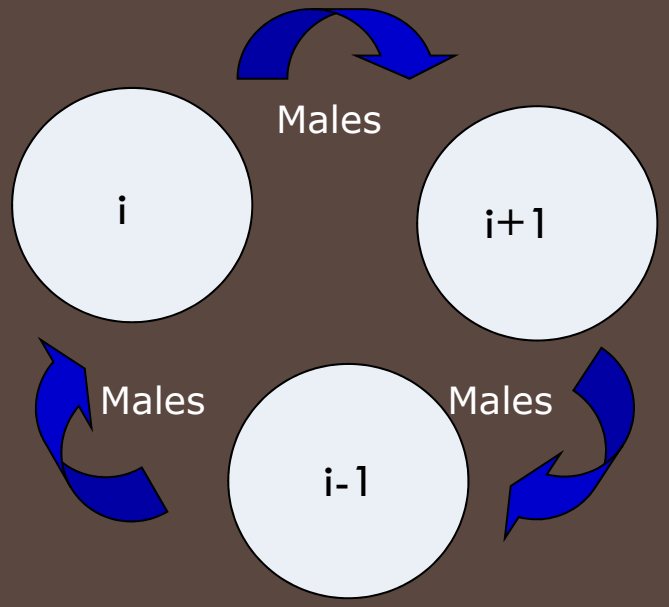
- **Optimum Contributions** (Meuwissen, 1997) is not exclusive to conservation programmes.
- Minimize the rate of inbreeding, or constrain it and maximize **genetic gain** simultaneously.




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.



Photo: Jesús Martínez Sáiz


Photo: Menorca Breeder's Association

# THANK YOU!