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MONITORING SMALL POULTRY POPULATIONS USING SIMULATED ANNEALING ALGORITHMS

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Introduction

Breeding schemes have to produce immediate genetic gain without impairing genetic variability, in order to preserve future gains.

Two strategic steps require attention:

- ***Breeder selection.*** Results from an equilibrium between average EBV and coancestry of selected individuals.
- ***Mating plan design***. Aims at achieving minimization of expected inbreeding in the next generation.

In poultry breeding, where schemes are built under a hierarchical mating design, genetic contributions are both equal and discrete : once selected, each sire is mated with *d* dams, and egg collection period length is identical for all females.
These characteristics are stressed in the case of small populations, which may be local breeds or experimental populations.

Simulated Annealing (SA) methods prove to be effective tools in order to achieve :

- Maximization of genetic level of selected breeders, subject to a constraint on their average coancestry.
- Minimization of average coancestry of selected breeders, subject to a constraint on their average EBV.
- Minimization of expected coancestry in the next generation, allowing or not sisters to be mated to the same male.

Material & Methods

Simulated Population

Demographic parameters: $15\ [(1♂ \times 3♀) \rightarrow 3 \times (3♂ + 3♀)]$

2 traits :

1. MAIN OBJECTIVE (*e.g.* growth) $h^2 = 0{,}4$ ← TO BE MAXIMIZED

$$\rho_G = \rho_E = -0{,}25$$

2. ANCILLARY OBJECTIVE (*e.g.* egg number) $h^2 = 0{,}2$ ← TO BE CONSTRAINED TO ZERO

3 methods for breeder selection:

1. REF : 1 male offspring /sire & 1 female offspring /dam are selected among candidates exhibiting an EBV> -0,5 σ_G for the ANCILLARY TRAIT.
2. BLUP50 : maximization of the MAIN OBJECTIVE, while keeping the ANCILLARY TRAIT equal to zero and aiming at and inbreeding trend equal to half the value obtained in the case of an unconstrained selection.
3. INBREDMINT : minimization of coancestry for selected animals, while aiming at achieving: 1) a gain on the MAIN OBJECTIVE equal to what is obtained with REF, and 2) a null trend for the ANCILLARY TRAIT.

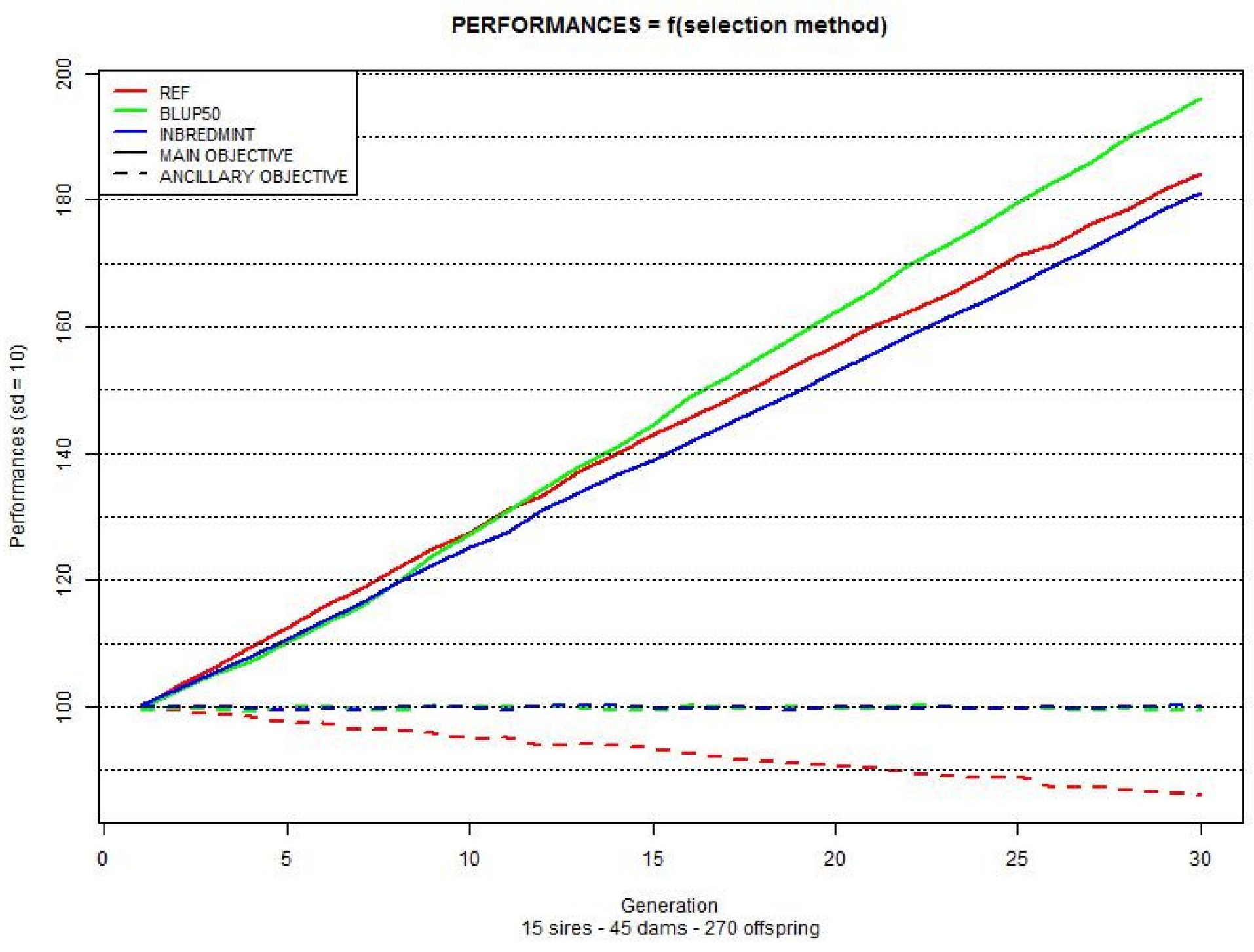
3 mating strategies:

1. Random.
2. Optimized and unconstrained ➔ minimization of expected inbreeding.
3. Minimization of expected inbreeding BUT two related dams (full-sibs sisters) can't be mated to the same sire.

Indicators

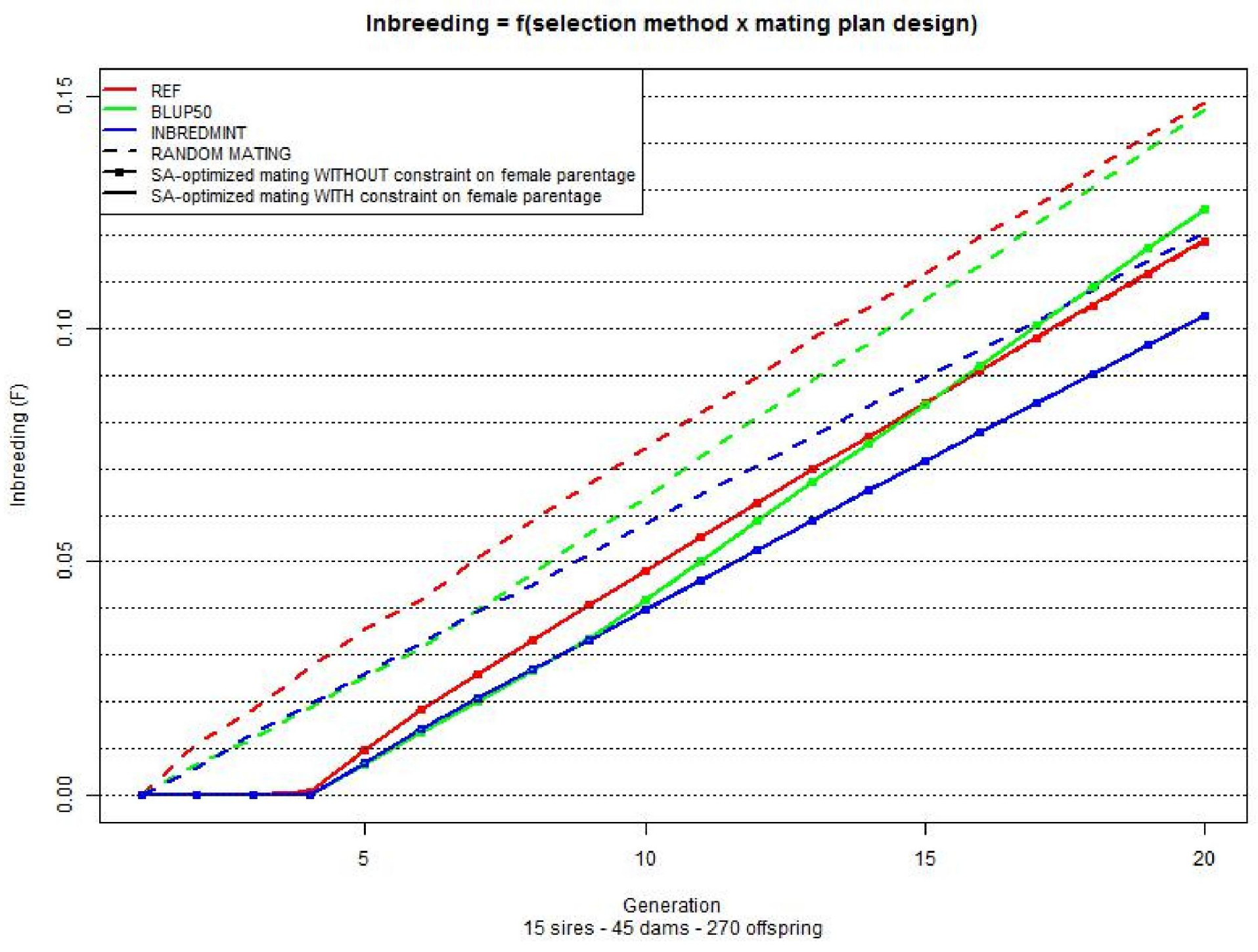
Average EBV, average coancestry, effective populationsize (N_e).
(« démographic Ne» = 45)

Results



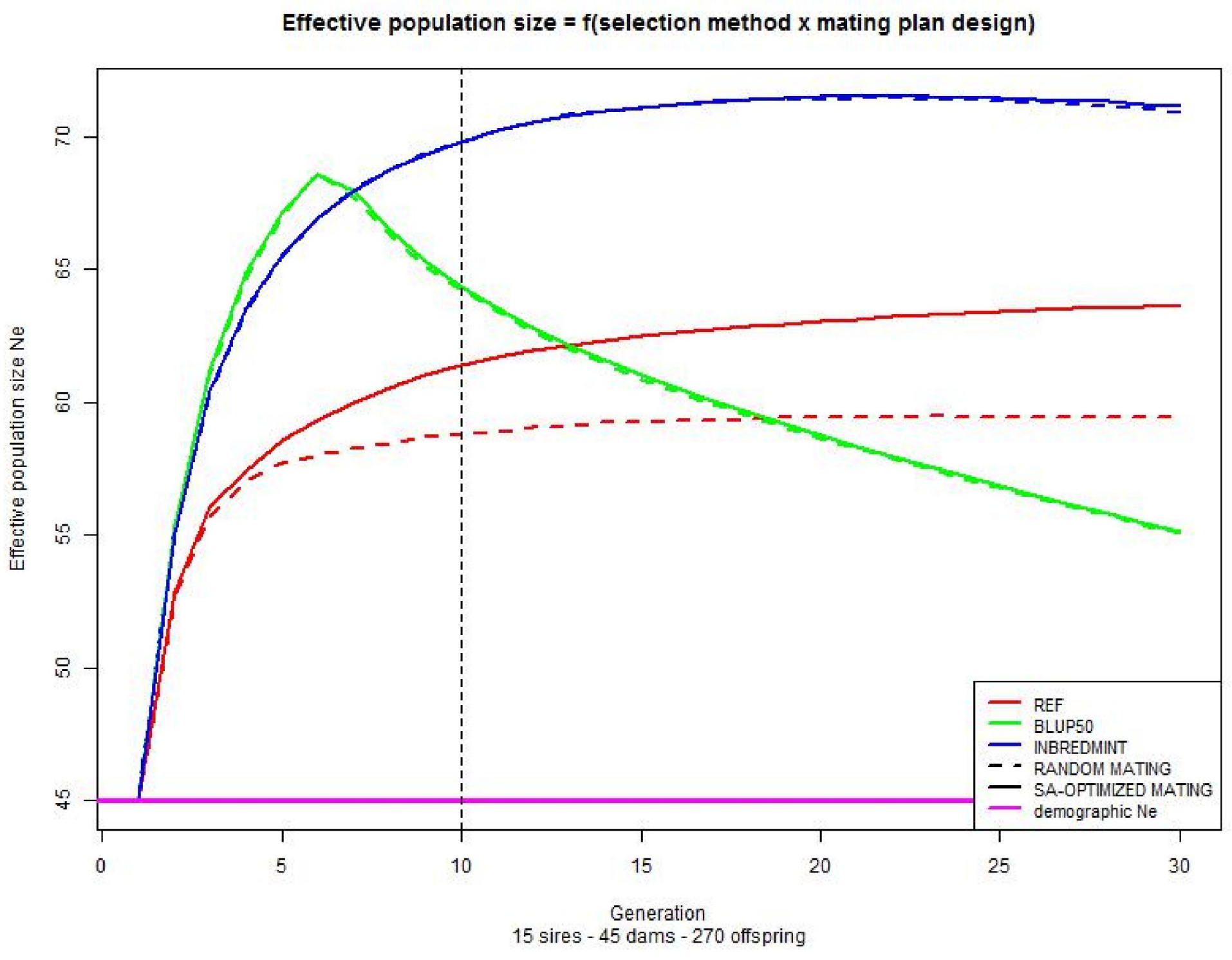
SELECTION RESPONSE

- Only SA methods can achieve the desired null trend for the ANCILLARY TRAIT.
- In the short term, REF provides a better gain on the MAIN OBJECTIVE.
- Beyond 10 generation, BLUP50 clearly outperforms REF.



INBREEDING

- SA methods clearly outperform REF.
- Mating optimization does not affect the slope of the inbreeding trend.
- The main effect is on the intercept, as it delays the onset of inbreeding.
- Preventing the mating of related females to the same sire is ineffective (the two curves overlap).



EFFECTIVE POPULATION SIZE

- INBREDMINT leads to the highest value of N_e. REF remains stable. N_e decreases with BLUP50.
- The mating design has no effect on N_e when SA methods are used for breeder selection.
- No reliable conclusion should be drawn from pedigree data when less than 7-10 generations are available .

Conclusions

- SA methods proved to be effective tools in order to monitor small populations.
- Further studies should be carried out in the case of selection without individual cages, when pedigree is only known *a posteriori*, after parentage assignment.
- An additional optimization will certainly be required, in order to insure the preservation of the marker panel assignment power.

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