Costs of selection schemes in small cattle populations

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ABSTRACT: The objective of this study was to compare selection costs in cattle populations of 1,000 to 15,000 females, with the constraint of 1% of inbreeding per generation. Three selection schemes were analysed: no progeny test, with selection of sires on pedigree index (NPT); progeny test of sires of sires (PT3); classical progeny test of sires of sires and sires of dams (PT4). With the progeny test schemes, bulls were either culled after semen collection for progeny testing, or kept alive. Costs per year increased linearly with population size and showed divergent trends among strategies. PT4 was the most expensive scheme, ranging from 125,700 Euro (1,000 females) to 318,900 Euro (15,000 females) with the alive bull strategy, and from 20,200 Euro to 206,300 Euro with the cull bull strategy. NPT was generally cheaper than PT3 when bulls were culled. Costs per female and per semen dose were also analysed.

Key words: Selection, Small populations, Costs of selection, Cattle.

INTRODUCTION - Genetic management of local breeds is generally addressed to maintenance of current genetic profiles, although genetic improvement could increase their sustainability (Gandini et al., 2005). Selection schemes in these populations must consider risks associated to inbreeding. A theoretical framework has been developed in the last years to maximise genetic gain at constant rates of inbreeding (e.g. Meuwissen, 1997; Villanueva, 2006; Woolliams, 2006). High costs can be an additional constraint in the implementation of selection in small populations. The objective of this study was to analyse costs of selection in simulated small cattle populations.

MATERIAL AND METHODS – Genetic progress in a milk trait was deterministically computed in simulated cattle populations from 1,000 to 15,000 females undergoing three alternative selection schemes, with a constraint on inbreeding rate. The following selection schemes were analysed: i.) absence of progeny test, with sires and dams selected on pedigree index (NPT); ii.) progeny test on young males to select sires of sires (PT3); classical progeny test of sires of sires and sires of dams (PT4); with the progeny test schemes, bulls were either culled after semen collection for progeny testing, or kept alive. Costs per year increased linearly with population size and showed divergent trends among strategies. PT4 was the most expensive scheme, ranging from 125,700 Euro (1,000 females) to 318,900 Euro (15,000 females) with the alive bull strategy, and from 20,200 Euro to 206,300 Euro with the cull bull strategy. NPT was generally cheaper than PT3 when bulls were culled. Costs per female and per semen dose were also analysed.

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lection, number of collections, bull maintenance or semen storage (Gandini et al., 2007). Costs for the first collection included buying bulls (800 Euro per bull), health tests (120 Euro per bull), quarantine and training (570 Euro per bull), and collection (15 Euro per collection) and processing (0.09 Euro per dose) of the ejaculate. Costs for subsequent collections included period between subsequent collections (14 Euro), and collection and processing of the ejaculate. Costs of bull maintenance (10,730 Euro) and costs of semen storage (0.57 Euro per dose) were added respectively for the alive and cull bull management strategies.

RESULTS AND CONCLUSIONS - Cost analysis revealed large differences among selection schemes and bull management strategies (Figure 1). Costs per year generally increased linearly with population size and showed divergent trends among strategies. With the PT4 scheme, costs varied from 125,700 Euro (1,000 females) to 318,900 Euro (15,000 females) with the alive bull strategy, and from 20,200 Euro to 206,300 Euro with the cull bull strategy. With the PT3 alive bull strategy, costs increased from 99,400 Euro (1,000 females) to 137,700 Euro (7,000 females), thereafter remained on this value. When bulls were culled, costs ranged from 13,700 Euro to 21,200 Euro.

Figure 1. Cost per year (CY), by selection scheme (NPT, PT3, PT4), bull management strategy (cull, alive) and number of females.

Figure 2. Cost per female per year as a function of selection scheme, bull management strategy and number of females.

Figure 3. Cost of the semen dose as a function of selection scheme, bull management strategy and number of females.

Costs of the NPT strategy were higher than PT3 bull cull strategy, and below 37,000 Euro at all population sizes. By increasing population size from 1,000 to 15,000 females, costs in PT4 increased of about 10 and 2.5 times respectively with the cull and the alive bull strategy. Then, the ratio of CY between bull strategies decreased as number of females increased, from 6.2 (1,000 females) to 1.5 (15,000 females). This suggests that at higher population sizes the two bull strategies could be used alternatively. The trend of CY in PT3 alive bull strategy shows how the number of bulls influences costs when they are kept alive: costs became constant when number of bulls also became constant (11 bulls). The higher costs of NPT compared to the PT3 scheme cull bull strategy can be explained by the higher number of bulls selected per year, 17 versus 11 (at 15,000 females).
To better understand trends of costs per year we analysed cost per female and cost of semen dose. Figure 2 shows CY per female as function of selection scheme, bull management strategy and female population size. Costs decreased exponentially in all schemes by increasing population size from 125.7 Euro (PT4), 99 (PT3) and 18 (NPT) with 1,000 females to 21 (PT4), 9 (PT3) and 2.4 (NPT) at 15,000 females.

Figure 3 shows the cost of the semen dose as a function of selection scheme, bull management strategy and number of females. The unitary cost of the semen dose decreased as population size increased for all schemes and both bull strategies. With the cull bull strategy, costs varied from 8.4 (NPT), 8.8 (PT3) and 2.6 Euro (PT4) at 1,000 females to 1.1 (NPT), 1.8 (PT3) and 1.3 Euro (PT4) at 15,000 females. This variation is function of the number of doses collected per bull, 200 (NPT), 196 (PT3) and 775 (PT4) with 1,000 females up to 1,940 (NPT), 1,047 (PT3) and 11,255 (PT4) with 15,000 females. When the alive bull strategy was applied the cost of the semen dose varied from 63.4 (PT3) and 16.2 Euro (PT4) at 1,000 females to 12.1 (PT3) and 2 Euro (PT4) at 15,000 females.

In conclusion, costs should be attentively taken into account in programming selection schemes for cattle populations of small sizes. The analysis of costs with respects to genetic gains is in progress.

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