

Estimating heritability in small populations in the genomics era: a case study on Istrian sheep

I. Pocrnic¹, A. Kasap², J. Ramljak², D. Ceranac³, Z. Barac⁴, C. M. Rochus¹, D. Tolhurst¹, M. Špehar³

¹ University of Edinburgh, Roslin Institute, Easter Bush Campus, EH25 9RG Midlothian, United Kingdom, ² University of Zagreb, Faculty of Agriculture, Svetošimunska 25, 10000 Zagreb, Croatia, ³ Croatian Agency for Agriculture and Food, Svetošimunska 25, 10000 Zagreb, Croatia, ⁴ Ministry of Agriculture, Grada Vukovara 78, 10000 Zagreb, Croatia

Accurate and reliable estimation of variance components is crucial in animal breeding programmes, as it guides selection and conservation strategies. Estimation can be particularly complicated in small-scale programmes at the start of or transition from traditional to genomic selection. In this study, we evaluate heritability estimates for milk, fat and protein yield in a local Croatian sheep breed using four approaches: pedigree- and genomic-based residual maximum likelihood (REML), single-step REML (ssREML), and REML using imputed data. We also explore how data availability and genetic relationships impact variance estimation for flocks of varying sizes and pedigree depth. Our dataset consisted of ~9500 lactation records (milk, fat and protein yield) for ~4500 Istrian sheep across ~40 flocks (ranging from 5 (6) to 430 (1129) animals (records)), ~63K in pedigree, ~1300 genotyped with 50K SNP array and 15 key animals sequenced with 30X coverage. The results demonstrate that while pedigree-based estimation is reliable for well-recorded flocks with many individuals, it becomes unreliable for smaller and more fragmented flocks. In such cases, genomic-based estimation, which captures additional genetic relationships, provides more reliable heritability estimates. Our study highlights the importance of reliable heritability estimation in small-scale breeding programmes and contributes to optimising cost-effective phenotyping and genotyping strategies where large-scale actions may not be feasible due to economic constraints.