

Integrating Advanced Genomics and Phenomics in Dairy Cattle Breeding: A Modern Approach for Croatian Dairy Farming

Ino Curik^{1,2}, Mario Shihabi¹, Nataša Mikulec¹, Maja Ferenčaković¹, Dario Domović¹, Zvonimir Mijadziković¹, Nikola Raguz³, Boris Lukic³, Mihaela Oroz³, Marko Oroz³, Marija Spehar⁴, Mato Cacic⁵, Dalibor Hrsak⁶, Dinko Novosel⁷, Ivana Drzaic¹, Vlatka Cubric-Curik¹, Vladimir Brajkovic¹

¹*University of Zagreb Faculty of Agriculture, , Svetošimunska cesta 25, Zagreb, Croatia (icurik@agr.hr)*

²*Institute of Animal Science Hungarian University of Agriculture and Life Sciences (MATE), Guba Sándor u. 40, Kaposvár, Hungary*

³*Faculty of Agrobiotechnical Sciences Osijek, Josip Juraj Strossmayer University of Osijek, Vladimira Preloga 1, Osijek, Croatia*

⁴*Croatian Agency for Agriculture and Food, Kardinala Alojzija Stepinca 17, Osijek, Croatia*

⁵*Ministry of Agriculture, Forestry and Fisheries, Ulica grada Vukovara 78, Zagreb, Croatia*

⁶*Ruđer Bošković Institute, Bijenička cesta 54, Zagreb, Croatia*

⁷*Croatian Veterinary Institute, Savska cesta 143, Zagreb, Croatia*

Abstract

In response to the emerging challenges in dairy cattle breeding, we have developed an interdisciplinary strategy that integrates cutting-edge technologies into breeding programs in Croatia. Our approach combines advances in phenomics and genomics to develop innovative methods for routine use in dairy cattle breeding. A key component of this effort is DaMoS (Dairy Multi-Omic Strategy), a cost-effective approach tailored to large-scale genotyped dairy cattle populations, such as Holstein cattle. DaMoS is built upon 1X low-pass whole-genome sequencing (lpWGS) of milk samples, a strategy that not only generates genomic SNP data, but also enables the retrieval of complete mitogenomes, milk microbiota profiling (including mastitis pathogen detection) and estimation of mtDNA copy number, a potential new phenotype associated with milk production and health. Remarkably, all this is achieved at a cost of less than 40 euros per sample, making it an accessible and practical tool for modern dairy cattle breeding. Beyond genomics, DaMoS aligns with state-of-the-art phenomics leveraging machine learning techniques and large-scale data analytics. In this presentation we introduce use of FTIR spectral data, focusing on the coagulation properties of milk and other milk components, offering a powerful framework for big data management. While our main focus is on the practical implementation of novel breeding tools in Croatian dairy farming, our concept also has an innovative underlying scientific component.

Key words: Dairy cattle breeding, Phenomics, Genomics, Machine learning