

The Genetic Transformation of the Italian Mediterranean Buffalo: Five Years of Progress and New Frontiers

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The objective of the present study is to describe and analyze the principal structural and methodological changes that have characterized the IMB genetic improvement program over the last five years, highlighting the transition from genetics to genomics and outlining the new frontiers shaping the future of this globally relevant dairy breed.

Over the last five years, the Italian Mediterranean Buffalo (IMB) breeding program has undergone a profound genetic transformation driven by the integration of genomic technologies and the development of new selection indices. The present study describes the structural and methodological changes implemented within the national genetic program. Genetic evaluations transitioned from pedigree-based BLUP models to a single-step genomic BLUP (ssGBLUP) framework, integrating pedigree, phenotypic, and genomic information within a unified evaluation system. The adoption of genomic evaluation improved the reliability of estimated breeding values for production and morphological traits and supported the implementation of the Genomic Italian Mediterranean Buffalo Index. Between 2021 and 2025, the breeding objective was further expanded through the development of 23 additional indices encompassing reproductive efficiency, animal welfare, sustainability, and disease resistance. Heritability estimates for these functional traits ranged from low to moderate, indicating exploitable genetic variability despite the complexity of these phenotypes. This strategic shift reflects a transition from production-centered selection toward an integrated and sustainability-oriented breeding framework. The IMB program now represents one of the most advanced buffalo genetic systems worldwide, demonstrating how genomic integration can accelerate genetic progress while aligning animal production with long-term efficiency, resilience, and environmental responsibility.

Over the last five years, the Italian Mediterranean Buffalo breeding program has undergone a substantial genetic transformation driven by the integration of genomic evaluation into the national selection scheme. The implementation of ssGBLUP improved the reliability of estimated breeding values and enabled the transition from a pedigree-based framework to a genomic-oriented strategy. This methodological advancement supported the development of the Genomic Italian Mediterranean Buffalo Index and strengthened the capacity for early and more accurate selection decisions. The breeding objective was structurally redefined through the introduction of 23 additional indices encompassing reproductive efficiency, animal welfare, environmental sustainability and disease resistance. Although many functional traits exhibit low to moderate heritability, their inclusion within a genomic multi-trait framework allows balanced and cumulative genetic progress. This multidimensional approach positions the Italian Mediterranean Buffalo breeding program among the most advanced buffalo genetic systems worldwide and establishes a forward-looking model aligned with sustainability, resilience, and long-term productivity goals.