Smarter Genomic Selection to Improve Cattle While Protecting Genetic Diversity

SHORT SUMMARY FOR PRACTITIONERS:

Cattle breeding has achieved major gains using genomic selection, but focusing too narrowly on a limited breeding stock will reduce genetic diversity through inbreeding. This leads to lower animal fitness, increased deleterious recessive disease incidence, and reduced ability to adapt to future challenges.

New tools address this by balancing genetic progress with diversity. The main innovation, Discrete Optimal Selection (DOS), selects parent animals based not only on performance but also on their genetic relationships. It ensures more equal contributions from selected parents, making it simpler than previous methods and more practical even when farmers make the final breeding decisions.

Simulations show DOS delivers near-optimal results, with only 3.6% less genetic gain than the theoretical maximum, while effectively controlling inbreeding. It also helps preserve rare but valuable gene variants that may be important for future adaptation. A complementary allele-reweighting approach further improves the retention of beneficial rare alleles compared to conventional selection.

Practical recommendations: use tools like DOS to balance performance and genetic diversity; monitor and manage inbreeding levels actively; and apply allele-reweighting methods to retain valuable rare genes. These approaches enable steady genetic progress without the long-term downsides of a shrinking gene pool, random genetic drift of traits, and inbreeding depression.

Funded by
the European Union