

Predictive Breeding Fails Most Often in Deployment, Not in Principle



This month (April 2026) marks the 25th anniversary of Meuwissen et al.'s 2001 foundational Genetics paper showing the conceptual feasibility of genomic prediction and selection. Time has shown that while the science of predictive breeding is robust, the practical value is often spoiled by poor implementation and system-design errors.

Predictive breeding often fails not because genomic prediction is unsound, but because deployment is inconsistent across data, objectives, and execution. Predictive breeding is not a single statistic such as a GEBV; it is a framework built on alignment among markers, phenotype data, product goals, and breeding decisions. This framework rests on the durable principle that genotype values are the heritable units of breeding, and that allele inheritance across progeny sets is predictable enough to support planning and improvement.

That is why implementation matters. Even as genotyping costs continue to fall, deployment errors can turn genomic prediction programs into costly boondoggles rather than reliable engines of breeding progress.

Common pitfalls in deployment strategy:

- **Treating markers as disconnected expenses rather than reusable infrastructure.** Marker systems should support fingerprinting, traceability, selection, and prediction.
- **Expecting biology to be fully explained before value can be created.** Breeders may want models that capture epistasis, epigenetics, and genotype-by-environment interaction. But in many settings, additivity and dominance capture enough signal to improve decisions without diverting resources from product-focused crosses and trials.
- **Expectations not defined relative to a program's starting point.** Predictive breeding does not need certainty to create value. Its contribution is a reproducible gain in speed and resource efficiency. That value cannot be judged without understanding the program: trial design, plot costs, bottlenecks, and success measures.
- **Prediction does not equal decision.** Predictive technologies expand breeder options, but more options do not guarantee better outcomes. Without a framework for translating predictions into strategy, programs can stall. This is why design specifications and Operations Research matter. Before prediction can improve execution, a program must define what the next product must be and under what constraints.

Many visible failures of predictive breeding are not failures of science, but failures of deployment. The better question is not whether predictive breeding works. It is whether the prerequisites for successful deployment have been met. When they are, predictive breeding becomes a practical system for making breeding decisions more scalable, reproducible, and effective.

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