

Optimization and Breeding



Plant breeders continually must make decisions in the context of conflicting objectives, vast but imperfect data, short deadlines, and consequences that can take years to be realized. NSIP tackles uncertainty and indecision using optimization to enable breeders to make better, faster, and more reproducible decisions, transforming both efficiency and outcomes.

Predictive breeding technologies dramatically expand the options available to breeders: beyond trialed material, predictions of untested genetics are also in play. The decision space expands even more with NSIP's set-selection framework. Set selection focuses not only on the selection of the highest performers, but also on the complementary properties of the material within the set. The advantage is extraction of more value from existing data, allowing breeders to minimize risk with robust networks of high-performing individuals.

However, a mathematical reality is that the set-selection framework massively expands the number of possibilities. If a breeder selects the 10 best-yielding entries from a trial, there is only one possible set of 10 entries. But if a breeder wants to advance 10 of the top 20 yielding entries, allowing consideration of additional selection criteria, there are 184,756 possible solutions. Clearly, having more options does not guarantee progress, it can be overwhelming!

This is where optimization is essential. NSIP's optimization framework uses design specifications — formalized performance goals and constraints — to focus the search. For example, a program may want a new variety that yields 10% more than the current standard, resists a specific disease, matures earlier, and maintains a certain height for mechanical harvest. By integrating these multi-trait goals into mathematical optimization models, NSIP identifies the crosses, selections, and advancement strategies most likely to achieve these targets, while balancing trade-offs between performance, genetic diversity, and operational feasibility.

A key strength of this approach is reproducibility. By grounding decisions in explicit, quantified objectives and optimization models, NSIP reduces reliance on gut feeling or ad hoc decisions. This not only leads to more consistent outcomes over time but also strengthens internal communication. Breeders, managers, and stakeholders can clearly articulate why specific decisions were made, what trade-offs were accepted, and what results are expected. This shared understanding improves alignment and helps manage expectations about breeding targets and timelines.

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In short, NSIP's optimization approach empowers breeders to unlock the full potential of predictive breeding — turning a flood of new options into focused, evidence-based decisions that accelerate product development, deliver measurable genetic gains, and make breeding programs more transparent, efficient, and impactful.

<https://genetics.nsiplants.com/>

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