Building Better Berries: Inside the Australian Strawberry Breeding Program

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An update from the project 'Australian Strawberry Breeding Program (BS22000)'

- Developing a new strawberry variety takes years of crossing, testing, selection and validation
- This article explains how the Australian Strawberry Breeding Program turns industry priorities into new variety candidates, using field data, grower feedback, plant health testing, DNA tools and long-term genetic improvement to deliver strawberries that are productive, reliable, high quality and suited to Australian growing conditions

Breeding for the Next Generation of Australian Strawberries

Developing a new strawberry variety is a long-term investment in the future of the Australian strawberry industry. Growers need varieties that yield well, taste great, handle local conditions, resist key diseases, robustly move through the supply chain, and fit commercial production systems. Consumers expect fruit that look beautiful, taste excellent and are consistent. Nurseries need clean, true-to-type planting material that can be multiplied reliably. A successful breeding program sits at the centre of these needs.

The Australian Strawberry Breeding Program (ASBP) works across this whole pathway. Each year, new crosses are made, seedlings are assessed, selected accessions (breeding lines) are tested in trials, and the strongest candidates move toward on-farm evaluation (Figure 1). Every stage has a distinct purpose. Early stages help sort through large numbers of genetically different plants. Later stages test whether the best accessions are consistent, commercially useful, and worth progressing towards release.

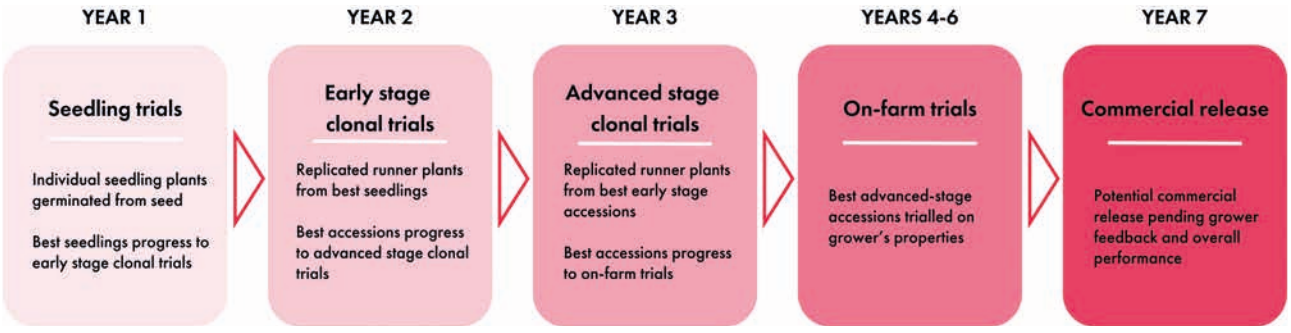

Figure 1. Australian Strawberry Breeding Program breeding pipeline trial stages

Two priorities: population improvement and product development

A breeding program has two main, and linked, priorities. The first is population improvement. This means choosing which parents to use in cross-pollinations, and why. Some parents are chosen because they carry useful genetics for flavour, yield, fruit size, disease tolerance, early production, plant architecture or regional adaptation. These parents may not be suitable as commercial varieties themselves, but they can still be valuable if they help produce better seedlings in the next generation.

The second is product (variety) development. This is the process of advancing individual accessions through the breeding pipeline to test whether they are commercially viable. A potential variety needs more than one good trait. It must combine yield, timing, fruit size, quality, flavour, firmness, shelf life, disease tolerance, harvest efficiency, regional fit and grower acceptance.

In summary: population improvement builds the genetic base for future progress, whilst product development assesses whether individual accessions are ready for industry.

The breeder's equation

The breeder's equation describes the main factors that determine how quickly a breeding program can improve a population. It can be summarised as:

$$\text{Genetic gain} = \frac{\text{Selection intensity} \times \text{Selection accuracy} \times \text{Genetic variation}}{\text{Generation length}}$$

Genetic gain: improving the population over time

Genetic gain is the cumulative improvement achieved in the breeding population over time. For strawberries, this may mean improving yield, fruit size, flavour, firmness, disease tolerance, harvest efficiency or consistency across regions. The aim is not simply to find one good plant, but to shift the breeding population in a positive direction so that each generation gives the program a better chance of producing varieties that meet industry needs.

In the ASBP, genetic gain is pursued through both long-term parent selection and short-term commercial testing. The program uses field data, grower feedback, disease screening, pedigree information, DNA marker data and statistical analysis to make selection decisions. This gives us more than one line of evidence when deciding which parents to use and which accessions to progress.

Selection intensity: balancing progress and diversity

Selection intensity describes how stringently the breeding program selects from the available population. Because strawberry varieties must combine many traits, selection needs to be narrow enough to remove accessions with limited breeding or commercial value but broad enough to retain individuals that carry useful trait combinations for future improvement. Screening many seedlings increases the chance of finding rare combinations of useful traits. In the breeding pipeline, early selection removes clearly unsuitable material before resources are invested in clonal trials, while later selection becomes more detailed and evidence-based.

High selection intensity must be balanced with long-term diversity, however. If selection is too narrow, useful genetics can be lost and relatedness can increase. Parent choice therefore considers complementary traits, pedigree, relatedness and breeding purpose. One parent may be used for flavour, another for disease tolerance, and another for early yield or fruit size.

Selection accuracy: making better choices from better evidence

Selection accuracy is about how well selection decisions identify the best genetics. A plant can look strong in one season because conditions were favourable, or weak because it was exposed to a local stress. Replicated trials, repeated harvest data, multi-year testing and sound statistical analysis help separate genetic performance from seasonal and environmental noise.

The ASBP also uses improved trial design, better statistical analyses and grower feedback to improve selection accuracy. Statistical analysis helps the ASBP make fairer comparisons between accessions, especially when trial seasons or harvest conditions differ. Grower feedback from on-farm trials adds a commercial reality check, because growers test whether accessions work under real production conditions. For industry, the practical benefit is better confidence that the accessions moving forward are genuinely useful, not just the plants that happened to look good in one place or one season.

Genetic variation: maintaining useful diversity

Genetic variation is the raw material of breeding. Without useful differences between plants, there is little opportunity to improve the population. The Australian industry also needs varieties suited to different regions and production systems, so the program must maintain enough diversity to respond to subtropical, temperate and Mediterranean growing conditions.

Maintaining variation does not mean keeping everything; it means using the right diversity. Parents are chosen to combine complementary strengths, such as high yield with strong flavour, larger fruit with firmness, or disease tolerance with good commercial fruit quality. The ASBP also brings in new genetics through seed exchange programs, including material from the University of Florida for the subtropical and Mediterranean breeding nodes, and Vissers Plant Innovators in the Netherlands for the temperate node. These exchanges help introduce useful traits, including excellent flavour, disease resistance and broader adaptation, while pedigree and DNA marker information help monitor relatedness, check identity and manage the breeding population over time.

Generation length: reducing time between breeding cycles

Generation length is the time between choosing parents and using their offspring as parents in the next cycle. Shorter cycles can increase genetic gain per year, but only if selection decisions remain robust and reliable. In practice, this means moving faster for population improvement where the evidence supports it, while still applying rigorous testing before commercial release.

Genomic prediction is one tool that can help reduce breeding cycle time. It uses DNA marker information from across the genome, together with past trial data, to estimate how an accession is likely to perform for important traits. In practical terms, it gives breeders an earlier indication of which seedlings may be worth using as parents, before several seasons of clonal trial data are available. This is different from releasing a variety earlier. Using an accession as a parent can accelerate long-term improvement, but commercial release still requires field data, on-farm validation, grower feedback and clean plant material.

From candidate variety to clean planting material

Once an accession has strong trial performance and grower support, the work does not stop. A commercial candidate must also be ready for reliable propagation. Nurseries need disease-free, true-to-type mother stock so that planting material can be multiplied with confidence.

The ASBP conducts in-house virus indexing to test for the presence of viruses before material is supplied for propagation. Biological virus indexing involves grafting leaflets from test plants onto indicator plants, which show disease symptoms if virus is present. Molecular testing uses laboratory methods to look for specific viruses or pathogens directly in the plant material. Once plants have passed these tests, they are sent to AgriBio, an agricultural systems biology research centre in Victoria. AgriBio provides a second independent testing step for viruses and other pathogens, adding confidence in the health status of candidate varieties and mother stock. The ASBP also maintains material in tissue culture, which provides a secure source of clean material for future multiplication.

Continuous improvement, guided by industry

The breeding program is a continually improving system. Industry feedback shapes breeding targets, trial design, selection decisions and commercialisation priorities. Reference groups, field days, on-farm trials and direct grower feedback help identify what is working, what is missing, and which traits need more attention.

The ASBP also works with external research and industry groups to strengthen different parts of the breeding pipeline. We are continuously looking for practical ways to improve each part of the breeder's equation, including better parent choice, stronger trial data, improved statistical analysis, useful new genetics, disease screening and tools such as genomic prediction.

Conclusion

Breeding is a continuous cycle of crossing, testing, selection and validation, supported by many people and many types of evidence. Field, nursery, tissue culture and pathology teams help generate and maintain the plant material, collect trial data and check plant health. Geneticists, biometricians and data analysts help turn complex results into information breeders can use for parent choice and selection. Growers, commercial partners and industry representatives then provide the practical test: whether potential varieties perform under real production and market conditions.

The aim is not simply to release more varieties, but to release better varieties that are productive, reliable, high quality, suited to Australian production systems, and supported by clean planting material for nurseries and growers. Each season adds new data, feedback and challenges, helping the ASBP make better decisions and keep improving the value it delivers to industry.

If you'd like more information or have feedback to share, please contact Jodi Neal at jodi.neal@dpi.qld.gov.au or on 07 5381 1352. Your insights are crucial to the success of the program, and we look forward to continuing this journey together.

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