Agvocacy Program

An Overview: Innovation in Plant Breeding

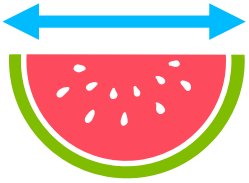
Modern plant breeding blends traditional ways of developing crops with the latest in science and technology to achieve improved crops – enabling more choices for both farmers and consumers, and producing crops that can better cope with evolving pests, diseases and a changing climate.

The Basics

- **What:** The simplest definition of plant breeding is crossing two plants to produce offspring that share the best characteristics of the two parent plants. Breeders make crosses then select which offspring to advance in the pipeline based on their desired characteristics.
- **Why:** Even the earliest farmers understood that, in order to survive, they needed plant varieties specifically adapted to their environmental conditions and cultivated to produce the best foods to nourish their livestock and communities.
- **How:** Through generations of research and discovery, plant breeding has advanced beyond selecting a parent plant simply based on its appearance. It now includes an in-depth understanding of plants' genetic makeup, enabling breeders to better predict which plants will have the highest probability of success in the field and the grocery store before making a cross.

Most of the fruits, vegetables, and grains that we eat today are the result of generations of plant breeding. About 5,000 years ago, watermelons were only

2 inches in diameter



and had a bitter taste, vastly different from the large, sweet-tasting fruit we enjoy today.

The Background

The earliest farmers were plant breeders who understood the value of identifying crops that showed beneficial characteristics to plant in future seasons. Later, they learned they could cross two plants to develop an even better plant. Over time, scientific understanding of crop genetics continued to improve, and led to new varieties and hybrids that could grow enough food on less land, were more nutritious or even easier to eat. Consumer demands, a growing global population[1] and on-farm challenges create an even greater need to be able to breed more resilient crops. Plant breeders today can leverage centuries of breeding knowledge in combination with new methods and technologies, to bring new crop varieties to market for the benefit of farmers, consumers and the planet. Most of the fruits, vegetables and grains that we eat today are the result of generations of plant breeding, including carrots, bananas, corn, cauliflower, broccoli, cabbage, Brussels sprouts and kale.

The Highlights

Plant breeding techniques blend the old with the new.

- In the past, people selected parent plants with traits they found valuable and continued to select and improve that trait for several hundred generations of breeding. Detecting traits with visual inspection is called phenotyping, and is a technique still used today.
- Now rather than just being able to see the results of breeding through phenotyping, we can detect differences in the DNA sequence in order to predict how these variants will affect plant performance even before plants begin to grow – this is called genotyping.

The right crops for the right growing environment.

- Plant breeding leverages the best plant genetics to produce a more consistent and reliable harvest in the face of evolving pressures from pests, weeds, diseases and adverse weather.
- The result can be better quality, higher yield potential and a more environmentally sustainable crop to the benefit of both farmers and consumers.
- Today, we serve farmers with more than 2,000 vegetable seed varieties covering 22 crops for diverse growing environments.

References
1. FAO. 2017. World Population Prospects, the 2017 Revision. https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html

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The Highlights

Time is of the essence.

- Traditional breeding methods require breeders to work at the speed of a crop's growth cycle, with new varieties requiring a decade or more to create.
- By using new understanding of a crop's genetic code, and modern technologies like greenhouses and predictive analytics, plant breeders today can better select and breed for just the traits they want much more efficiently.
- Bayer uses a proprietary device called a seed chipper to shave and analyze small pieces from millions of seeds per year, while keeping the seeds viable, reducing the time it takes to develop a new crop variety by more than two years.

Today, the breeding process is driven by technology.

- Plant breeding involves some of the world's most sophisticated methods, including cell biology, genome research, gene mapping and marker-assisted breeding, which have led to the development of techniques like gene editing.[2]
- Gene editing is a breeding method that enables scientists to make targeted improvements within a plant using its own genetic material to produce a better crop.[3]
- Today's breeding technologies are highly accessible to laboratories of all sizes, which has increased the likelihood that improved seeds for smaller-acre crops, such as cassava and cowpea, will be brought to the market, expanding choice and opportunity.[4]

Safe and sustainable.

- All new varieties and hybrids developed through plant breeding undergo rigorous testing to ensure quality, performance and resiliency.[5]
- Plant breeders develop improved plant varieties which can maximize resource use efficiency (water, land, nutrients) and can be bred to ensure higher quality and more uniformly-shaped crops which also leads to a reduction in food loss and waste. As a result, innovation in plant breeding can increase yields while decreasing greenhouse gas emissions and reducing environmental impact.[6]
- At Bayer, we've built a more informed, more efficient seed pipeline using genomics, data science and AI tools. As a result, we've brought new varieties to market more quickly, decreasing the environmental impact in both the breeding R&D process and on the farm.

Key Things to Remember

- Plant breeding has been the foundation of plant improvement in agriculture for millennia. Almost everything we've ever eaten has evolved and changed through generations of breeding.
- Plant breeding provides farmers with crops that are better suited for their environment and more likely to meet consumer demand by making use of the genetic diversity that exists naturally within each crop family.
- Biotechnology is a complimentary science to plant breeding, which allows scientists to create genetically modified organisms (GMOs) by using their knowledge of naturally occurring genetic diversity to integrate new genes into plants to enable beneficial traits.
- By using new tools that mimic the processes that have been used by plant breeders for hundreds of years, new varieties can be developed more efficiently and just as safely as crops that are bred using traditional methods.

References

2. International Seed Federation. https://www.worldseed.org/resources/faqs/#plant-breeding-innovation
3. Ibid.
4. NOAH. 2016. https://www.noah.co.uk/briefingdocument/antibiotic-resistance-2
5. International Seed Federation. https://www.worldseed.org/resources/faqs/#plant-breeding-innovation
6. Ibid.