



Plant Breeding: Historical Perspectives

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Plant breeding

- Practiced for thousands of years ever since the beginning of human civilization.
- Babylonians and Assyrians artificially pollinated the date palm as early as 700 BC.
- Initial development: selection of naturally occurring variants in the wild and thereafter in the cultivator's fields.
- The genetic variation available in the populations was continuously subjected to the selection pressure of food gathering or planting-harvesting cycles.

Teosinte

- Development of maize from teosinte, a group of 4 annual and perennial species of the *Zea* native to Mexico & Central America.
- Maize and teosinte: similar growth forms, but female inflorescences are strikingly different.

Teosinte ear

- 5-12 kernels, each sealed tightly in a stony casing.
- Disarticulates at maturity with individual fruitcases becoming the dispersal units.

Maize ear

- Can bear ~500 kernels, naked without protection.
- Kernels firmly attached to cob; ear does not disarticulate.

Plant Breeders

R.J. Camerarius (1665-1721)

- German botanist
- Credited with first reporting sexual reproduction in plants in 1694 in his work 'De sexu Plantarum epistola'.
- *Ricinus communis* (castor) and *Zea mays* (maize).
- Cut off the sterile tassel (staminate flowers) in maize and observed that no seeds were formed.
- Cutting buds of sterile flowers before maturity of stamens led to seed abortion.
- Obtained same results in dioecious plants.
- Mulberry: female plants not near to male plants produced seedless fruits.
- **Conclusion:** pollen from male flowers was indispensable to fertilization and seed development on female plants.

Cotton Mather (1663-1728)

- New England Puritan minister, and pamphleteer.
- Worked on scientific identification of hybrids and known for promotion of inoculation for disease prevention.
- 1716: Described corn/maize (*Zea mays*) and squash (*Cucurbita* spp.) plants as being of hybrid origin.
- Suggested the occurrence of natural cross-pollination that emanated from the fact that yellow corn grown next to blue or red corn had blue and red kernels in them.

Thomas Fairchild (1667-1729)

- Nurseryman and florist.
- 1717: Produced the first artificial hybrid by crossing a carnation pink (*Dianthus caryophyllus*) with a Sweet William (*Dianthus barbatus*).
- Resulting plant: *Dianthus caryophyllus barbatus* (Fairchild's Mule).
- Thus, through hybridization, Fairchild created the first-generation sterile *Dianthus* hybrids (which today would be referred to as F1 hybrids).
- 1722: published *The City Gardener*, devoted to a description of the trees, plants, shrubs, and flowers.

Joseph Gottlieb Kölreuter (1733-1806)

- German botanist.
- Pioneer in the study of plant hybrids.
- First to detect self-incompatibility in *Verbascum phoeniceum* plants.
- First to develop a scientific application of the discovery of sex in plants carried out by Camerarius in 1694.
- First to document male sterility
- 1763: Examined pollen characteristics of over 1000 plant species was the in 1763.

- Conducted the first known systematic investigations into plant hybridization and conducted nearly 500 different hybridization experiments across 138 species.
- Made extensive crosses in *Tobacco* and *Solanum* between 1760 and 1766.
- Produced interspecific hybrids- specifically the tobacco plants *Nicotiana rustica* and *Nicotiana paniculata*.
- Conclusion: early-generation hybrids tend to be phenotypically intermediate between parents but may be more luxuriant, while later-generation hybrids more closely resemble parental forms.

Thomas Andrew Knight (1759-1838)

- British horticulturalist and botanist.
- First to produce several new fruit varieties by using artificial hybridization.
- Published over 100 papers in horticulture.
- Knight applied scientific principles and techniques to practical horticultural problems
- Conducted breeding of plants including strawberries, cabbages and peas.

Le Coutier

- New Jersey farmer.
- Initiated wheat breeding by individual selection of spikes of superior individuals and sowing the seeds from each spike separately.
- The extensive efforts of Coutier led to the identification of the variety 'Talevara'.
- Published his results on selection in wheat in 1843 and concluded that progenies from single plants were more uniform.

Patrick Shireff

- A Scotsman of Mungoswells farm.
- Shireff began his experiment in 1819 and the results were published in 1873.
- Practiced individual plant selection in cereals like wheat and oats.
- Developed varieties: 'Shirreff's Bearded Red', 'Shirreff's Bearded White', 'Pringle', and 'Shirreff's Squarehead'.
- Conclusion: only the variation of heritable nature responded to selection, and this variation arises through 'natural sports' and by 'natural hybridization'.

Louis de Vilmorin

- 1856: Vilmorin published his "Note on the Creation of a New Race of Beetroot and Considerations on Heredity in Plants.
- 1857: formulated '*Vilmorins principle of progeny testing*' wherein he proposed individual plant selection based on progeny testing.
- Proposed this concept in sugar content in sugar beets (*Beta vulgaris*).
- However, the method was ineffective in wheat which clearly demonstrated the difference between effect of selection in cross and self-pollinated crops.

Gregor Johann Mendel (1822-1884)

- 'Father of Modern Genetics'.
- 1866: published the scientific foundation for the post-crossing segregation of offspring in garden pea.
- Conducted experiments between 1856 and 1863 that enabled breeders to discover new, improved combinations.
- Explained the concepts of heredity by introducing the concept of dissecting how traits are transferred from one generation to the next.
- Mendel selected an androgynous plant species, *Pisum sativum* for his study which afforded many advantages with respect to genetical work.

Advantages of using pea plant

- (i) Convenience in handling
- (ii) Short life cycle.
- (iii) Inexpensive, easy to obtain, take up little space and produce abundant offspring.
- (iv) Flowers: bisexual, hermaphrodite, predominantly self-fertilizing.
- (v) Many pairs of contrasting characters which makes distinction quite easy.

- Mendel presented his findings to the Brünn Natural History Society in two lectures in the spring of 1865 and then published the lectures in 1866 as a single paper under the title 'Versuche über Pflanzen-Hybriden' (Experiments on Plant Hybrids).
- However, his intention was not to offer any laws of heredity, but only a 'law of the development of hybrids' in plants.

Walfrid Weibull

- A farmer and an entrepreneurial sea captain.
- Realized the potential development of new varieties adapted to the local growing conditions.
- Started a plant breeding company in the city of Landskrona in the south of Sweden in 1870 that later came to be known as the limited company W. Weibull AB.
- In 1886, the experimental breeding station at Svalöv was established from resources of the Swedish Seed Association, founded by private entrepreneurs, state officials, and agricultural co-operatives.

Wilhelm Johansen (1857-1927)

- In 1903 Wilhelm Johansen (1857-1927) proposed the famous 'pure line theory' based on his studies in *Phaseolus vulgaris*.
- Pure line theory: Pure line is progeny of a single self-fertilized homozygous plant.
- Johansen also coined the terms phenotype, genotype and gene.
- Conclusion: techniques of selection could be used to produce uniform, true-breeding cultivars by selecting from the progeny of a single self-pollinated crop to obtain highly homozygous lines (true breeding).

George Harrison Shull (1874-1954)

- American botanist and geneticist.
- Described heterosis in maize in 1908.
- Played an important role in the development of hybrid maize which had a tremendous impact upon global agriculture.
- His breeding work in maize increased the corn yields per acre to the tune of 25-50% and made possible the production of seed capable of thriving under various soil and climatic conditions.

Nils Heribert-Nilsson (1883-1955)

- Geneticist and Professor of Botany in Southern Sweden.
- Researched on *Salix* and its taxonomy.
- Hybridization studies on *Salix viminalis* and *Salix caprea*.
- 1909: Published a paper demonstrating how results between crosses, or hybrids, yielded plants that outperformed either parent.
- This concept later came to be known as hybrid vigor, which formed the foundation of today's hybrid crop production programs.

Donald Forsha Jones (1890-1963)

- United States maize geneticist and corn breeder.
- President of the Genetics Society of America in 1935.
- Made high-yielding hybrid corn practical by his invention of the double-cross hybrid.
- Commercial production of corn hybrids was accomplished by the efforts of Donald Forsha Jones of the Connecticut Agricultural Experiment Station who made the 'double cross' in maize involving four inbred lines.

Thank you