

HISTORY OF CORN



CORN – A GLOBALLY IMPORTANT CROP

Corn (*Zea mays*), also known as maize, is an essential crop to a rapidly growing world population. Globally, corn is grown across six of the seven continents, occupying more than 20% of the land devoted to crop production. The history of corn is a 9,000-year journey of significant breakthroughs, from early domestication to modern advancements that have occurred over the last decade.

ORIGIN, DOMESTICATION AND SPREAD

The journey of modern-day corn started around 7000 BCE in southern Mexico with the domestication of a wild grass plant called teosinte (*Figure 1*). Research conducted in the early 1930s pointed to teosinte as corn's wild progenitor, due to similarities in chromosomes and the ability of the two species to produce fertile hybrids. Phylogenetic analysis has placed the timing of genetic divergence between wild teosinte and domesticated corn at around 9,000 years ago.

The domestication of corn from teosinte was accomplished by the inhabitants of the area. These ancient corn breeders practiced selective breeding techniques by saving seed from the plants that had desired traits and replanting the seeds for the next harvest season. Dramatic changes in plant appearance were quickly accomplished and what would be considered recognizable corn was widely present across the Americas by 2500 BCE. When Christopher Columbus arrived on the eastern shores of the Americas in 1492 CE, corn was already being cultivated throughout both North and South America. On Columbus' return voyage to Spain, the explorer brought back corn seed to be cultivated in Europe and Northern Africa.



Figure 1. Teosinte (*Zea mays* subsp. *Mexicana*), the ancestor of modern corn, is native to Mexico and Central America.

EARLY BREEDERS AND IMPROVEMENTS

From its domestication until the 1800s, improvements were made to corn through mass selection and geographical isolation. In mass selection, seed is selected and planted based on visual characteristics of the plant, such as size of the ear, plant height or kernel color. Much of this work was done by natives of the Americas as they identified and planted seeds of corn plants that fit their local climate, soil, production practices and food preferences. The two primary groups of corn when European colonization occurred along the Atlantic Coast of what today is the United States were the northern flints and the southern dents.

Common varieties of northern flint corn include Longfellow and Tama Flint. Gourdseed, a common variety of southern dent, was grown along the southeastern U.S. coastline reaching as far north as Virginia. In the 19th century, farmers discovered that when crossbreeding occurred between the northern flints and southern dents it resulted in superior-yielding corn with traits desirable for animal feeding. The combination of northern flints and southern dents resulted in the formation of the Corn Belt dents (*Figure 2*). The creation of the Corn Belt dents is extremely significant to modern corn production, as the bulk of commercial corn varieties worldwide are derived from Corn Belt dent genetics. New open-pollinated corn varieties can be created by crossing two varieties and saving the seed of the plants that have certain desired traits. Corn plants have separate male and female flowers, which naturally leads to open, or cross, pollination when wind blows the pollen from one plant to the silks of another.



Figure 2. Ears from a northern flint (Longfellow), southern dent (Gourdseed) and Corn Belt dent (Reid Yellow Dent) variety.

James Reid was a renowned farmer-breeder located in central Illinois in the mid-1800s. Reid planted a Gourdseed variety that went through many years of cross breeding with a local northern flint variety known as "Little Yellow Corn." Careful selection of each generation over many years eventually led to the development of the Reid Yellow Dent corn variety. Reid gave seed to his neighbors to ensure the genetic purity of his corn by limiting pollen contamination from other strains of corn. Reid Yellow Dent became exceedingly popular very quickly, being adapted to nearly every corn producing state and comprising around 75% of all corn acres at its peak.





ADVENT OF HYBRID CORN

Even with the use of improved breeding techniques beginning in the mid- to late-1800s, average U.S. corn yields remained relatively unchanged, averaging between 20 to 30 bu/acre from 1860 through the 1930s. In the later part of the 19th century and the early 20th century, seed selection by farmers was visually based on the size and consistency of corn ears.

While the breeding techniques used by farmers were effective at improving easily observed traits, such as plant height, maturity, ear size, and kernel color, they were not suited to improving yield. It was the advent of hybrid corn in the early 1900s that put corn on a trajectory of ever-increasing yields that continues today. Scientific research by academics Edward East and George Shull was key to the development of hybrid corn. East and Shull individually initiated research on self-pollinating individual corn plants to produce purified lines. Their pursuits did not turn out as planned as they quickly discovered that just a couple generations of inbreeding resulted in plants with significantly less yield and vigor than the original parent. However, Shull crossed inbred lines he had created and made an interesting discovery—the hybrid offspring had growth superior to the inbred parents and had comparable or better yields and greater uniformity than the varieties from which the inbreds were derived.

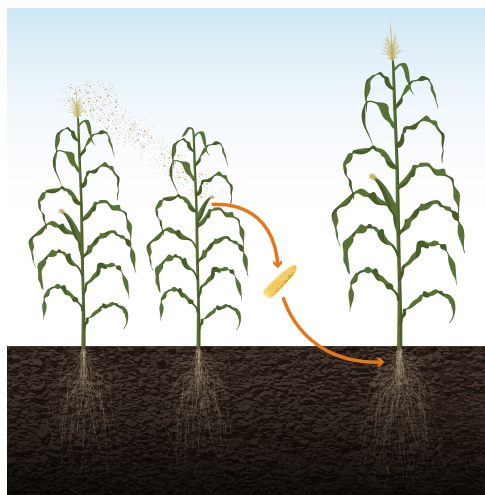


Figure 3. Cross pollination of two corn inbreds to produce a hybrid with agronomic characteristics and yield superior to those of either of the parent lines.

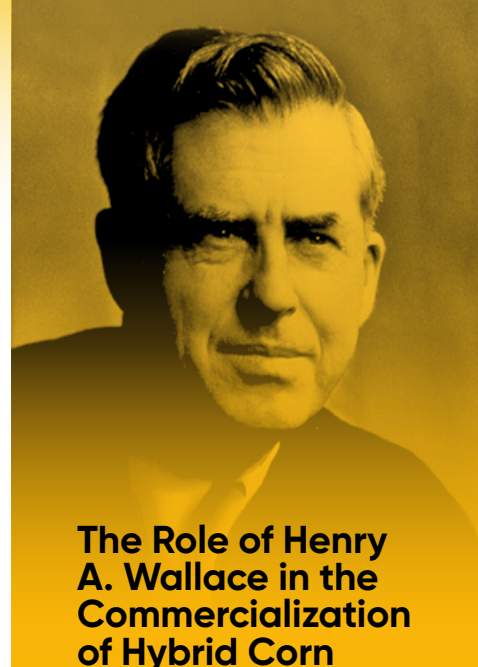
Shull had observed the effects of heterosis (also called hybrid vigor) in corn and began immediately applying it in further breeding investigations. In a paper published the next year, he outlined procedures that later became standard in hybrid corn breeding programs (*Figure 3*).

HYBRID ADOPTION BY FARMERS

Adoption of hybrid corn was slow during the first decade after its commercial introduction in the mid-1920s. By 1935, only around 6% of Iowa corn acreage was planted to hybrids. Farmers were not accustomed to purchasing new seed each year, the seed was expensive to produce and it was in short supply. The situation began to quickly change in the mid-1930s. Yield tests and farmer experience during the “Dust Bowl” years from 1934 to 1940 demonstrated hybrids to be vastly superior to open-pollinated varieties under severe drought. Once farmers had solid evidence of the benefits of hybrid corn, the transition away from open-pollinated varieties was astonishingly rapid. Ten percent of acres in Iowa were planted with hybrid corn in 1936; two years later in 1938 it was more than half. By 1942, virtually all corn planted in Iowa was hybrid seed. Within another 20 years, hybrid corn would achieve essentially 100% adoption across all U.S. corn acres.

ADOPTION OF SINGLE CROSS HYBRIDS

The next significant innovation in corn production was the wide-scale availability of seed for single-cross hybrids. A single cross hybrid results from the controlled crossing of two distinctly different inbred parents. In the early days of hybrid corn, the creation of an inbred required self-pollinating plants for 7 or more generations until they were nearly genetically pure (each successive generation is genetically identical to the previous generation if no outside pollen is introduced). As documented by Shull, the inbreeding process results in a loss of vigor and seed number per plant. The production of inbred seed was too inefficient when hybrid corn commercialization initially began making the cost of hybrid seed out of reach for most farmers.



The Role of Henry A. Wallace in the Commercialization of Hybrid Corn

After attending a corn show at the age of sixteen, Henry A. Wallace began his first corn experiment by planting seed from 25 award-winning ears and 25 ears that were marked the poorest-looking at the corn show. After collecting yield data from the three-acre plot located in his backyard, the results showed that the highest yielding corn did not come from an award-winning ear, but an ear that was near the bottom of the rankings. These results challenged conventional thinking at the time by demonstrating there was no relationship between appearance of the ears and yield.

While in college, Henry A. Wallace became fascinated with the relatively new science of genetics. After graduation, he began working on corn-breeding experiments and started breeding hybrid corn in 1920. Convinced that hybrid corn had a bright future, Wallace continued to produce and market small quantities of hybrid seed. With the help of several friends, the Hi-Bred Corn Company was organized and incorporated in Iowa on April 20, 1926, the first company devoted solely to the production of hybrid seed. No person was more important to commercialization and farmer acceptance of hybrid corn than Henry A. Wallace.





The problem of too little seed produced by corn inbreds was overcome using double-cross hybrids. Creation of a double-cross requires successive stages of crossing with two pairs of inbreds. In the first stage, inbreds A and B are crossed to create a single-cross hybrid and inbreds C and D are crossed to produce a second single-cross hybrid. In the second step, the two single-cross hybrids created in step 1 are crossed to produce the double-cross hybrid. Production of a double-cross requires an extra step compared to single-cross hybrids, but results in more saleable seed at a lower cost. While the plants produced from double-cross hybrid seed are not as uniform and high yielding as those for a single-cross, they exhibited greater vigor and performance than the open-pollinated corn varieties that preceded them. Plant breeders steadily improved the seed production of inbred lines over time to where double-cross corn hybrids became available for purchase by farmers in the 1960s. By the early 1970s, the changeover from single-cross to double-cross corn hybrids was mostly complete.

SEED CORN MARKETPLACE

The structure of the seed corn marketplace during the first five decades after hybrid corn was introduced consisted of four main players: land grant universities, private foundation seed companies, farmer seed companies and larger commercial seed companies. The private foundation seed companies and the universities focused their efforts on population improvement, inbred line development, inbred seed increase and hybrid testing. The farmer seed companies produced hybrid seed from university or private foundation inbred lines and sold these hybrids in their local area and sometimes in neighboring counties and states. The larger commercial seed companies developed their own proprietary inbreds and combined them with public lines to create hybrids. They sold seed more widely than farmer seed companies, typically across many states and countries.



Figure 4. Corn harvest with a tractor-drawn corn picker.

CONCLUSIONS

The adoption of hybrid corn combined with improved breeding techniques and agronomic practices resulted in a steady increase of the average U.S. yield from around 26 bushels per acre before the 1930s to 125 bushels per acre in 1995. This rate of gain continued in subsequent years with the introduction of several key technologies, including insect and herbicide resistance traits as well as molecular-assisted breeding, adding another 2 bushels per acre per year since 1995. After 9,000 years of human manipulation to domesticate, adapt and develop, corn has become essential to the success of humankind.

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