Corn

Botanical Description

Corn, *Zea mays*, derives its name from the Arawak *mahiz*[i] which literally means 'that which sustains life.'[ii] The name corn was added by the Europeans who referred to all small-seeded cereal grains as corn; they used the term 'Indian Corn' when referring to this American grain denoting its connection with the Native Americans.

Raising two to twenty feet high, corn stalks can have anywhere from eight to forty-eight leaves and multiple ears. Each stalk produces ears that contain many rows of kernels that grow off of the cob of the ear and are enclosed by a leafy husk.

Zea mays is an annual grass of the Maydeae family of the genesis Gramineae.[iii] Other grasses in this family include wheat, barley, rye, sugarcane, sorghum, and rice[iv]. One main difference between corn and other cereals is that it bears seed heads, ears, that are larger than any other grass[v]. Also corn has a higher yield of food per unit than any other grain. This productivity is one of the main contributing factors of corn's appeal to farmers.

Each corn plant contains both male and female reproductive organs. The tassels, the terminal flowers, ordinarily develop only male spikelets which grow in pairs with one being sessile, having no stalk, and the other pedicellate, a single blossom on a lean stalk.[vi] Each tassel contains some twenty-five million pollen grains.[vii] The lateral organ or female inflorescence is the ear. Each ear of corn contains upwards of one thousand potential kernels. Like the male tassels, the ears also bear spikelets, once again with only one of the flowers developing. Each of these flowers has one ovary "terminated by a long style known as the 'silk.'"[viii] Fine hairs cover the end of the silks to catch the pollen that is blowing in the wind[ix]. If the silk, which will develop into one kernel, is not pollinated, the

kernel will not appear.[x] The pollen grains, that the silk catch, are about 1/250th of an inch in diameter[xi] and barely visible to the naked eye. Due to their size and their lightweight, the pollen grains can easily be carried by the wind for long distances.

The kernels that develop as a result of the pollination of the silk are firmly attached to the solid core of the ear, the cob. A mature kernel has three parts: the pericarp or thin shell, the endosperm or food storage organ, and the embryo or germ. The pericarp is a thin layer of maternal tissues that encloses the entire seed. The pericarp is usually colorless but can be red, brown, orange, and cherry. These colors can appear in a variety of patterns especially in corn varieties common in parts of Mexico and Guatemala[xii]. The endosperm or food storage organ consists primarily of starch, which is digested into sugar upon germination and growth. One primarily useful scientific trait is the microscopically thin outer-layer of the endosperm known as the aleurone (which can be various shades of color) is most useful in genetic studies of corn. Finally, the embryo or germ contain most of the fat, vitamins, and minerals. They can vary in color, shape, and chemical composition. Also for a seed to germinate it must contain a living embryo which has the capacity to stay alive for around three to five years. Though if kept in a cooled storage location, a corn seed has the potential to last for twenty-five years or more.[xiii]

A unique characteristic of corn is that unlike most plants the kernels are completely enclosed by the outer layer known as the husk or shuck. These are leaf sheaths that tightly surround the kernels en masse. The number of leaves in the husk is a direct result of the number of joints on the corn stalk.[xiv] These husks prevent seed dispersal by wind, birds, or other natural means* and are the main reason why corn is so dependant on humans. Since the husk encloses all the kernel, or seeds, the dispersal of the

kernels is reliant on humans to remove the husk. Though it might seem possible for the husk to decompose over time and therefore free the seeds, this would also not work for corn seeds require spacing which only humans can provide.[xv]

Though corn is heavily reliant on humans for its survival, it is a self-pollinating plant. It disperses pollen from the male tassels to the female silks. Pollination continues with the desent of two sperm down the silk; one which fuses with the egg and the other with a double nucleus to produce the embryo and the endosperm of each kernel.[xvi] Since pollen is carried by the wind, corn can be very easily cross-pollinated and mutated naturally. This characteristic results in the process of *xenia* in which the two breeds of corn combine, generally with the kernels taking on the characteristics of the male pollen.[xvii]

Since maize is so easily cross-pollinated new varietals continue to appear and the vast similarities and differences make them hard to classify. In fact, the number of varietals on record for corn far exceeds that of any other crop.[xviii] There are currently twenty-five 'primary' races in Mesoamerica, none of which are pure[xix] and about three hundred races in the Western Hemisphere[xx]. Despite the numerous varietals, corn can be separated into seven broad categories determined by the grain starch, appearance, and end uses. These are dent, flint, flour, sweet, pod, wax, and popcorn.

D**ent corn** derives it's name from the dent or depression that is visible it's dried, matured kernel[xxi]. This dent is caused by the shrinking of the soft, floury starch within the hard starch which is contained to one side of the kernel[xxii]. Most dent corn is yellow or white in color and is used primarily a livestock feed. Though white dents are a preferred food in Mexico, Central America, the Caribbean, and southern Africa[xxiii]. As a result,

dent corn is by far the most produced type of corn and accounts for about 95% of all maize produced.[xxiv]

Flint corn has a smooth kernel due to a limited to non-existent amount of soft starch contained within the hard endosperm[xxv]. It ranges in color from white to deep red. Flint corn thrives in cool climates with wetter soil and generally performs better at higher altitudes[xxvi]. It matures earlier than other varietals of maize. Flints also store more durably than other varietals because the kernels absorb less moisture and are more resistant to fungi and insects[xxvii].

Flour corn resembles flint corn in size and shape but is mostly white or blue in color. Soft, mealy starch dominates the endosperm so the kernel can easily be crushed into flour[xxviii]. Flour corn is cultivated primarily in the southwestern United States and Andean highlands of South America[xxix]. One interesting characteristic of flour corn is that in South America it is used for beer making and used in special food preparations[xxx].

Sweet corn, which is what most Americans commonly identify with, is easily recognized by their wrinkled kernels, which are typically white or yellow. The sweetness is a result of a genetic defect in metabolism that prevents the sugars from being completely transformed into starch[xxxi]. It has a soft, sugary endosperm and thus is bred especially for consumption in an immature state[xxxii] like corn on the cob. It is grown mainly in the United States.

Pod corn is grown almost exclusively for scientific research in an effort to trace the genetic roots of corn. Each kernel of pod corn is enclosed in a glumes, or husk[xxxiii].

Popcorn has small, hard kernels that contain high levels of starch in the endosperm[xxxiv]. They are extremely hard kernels of the flint variety.[xxxv] A fascinating

characteristic of popcorn is that when heated the water in the starch steam-pressure the endosperm to explode causing the small kernels to swell and burst producing an edible white flake[xxxvi]. Though the pericarps of popcorn can be multicolored, the most common are yellow and white.

Finally, the starch in **wax corn** is made solely of amylopectin without the 22% amylose which is characteristic of dent corn"[xxxvii]. Thus wax corn is used in industrial starches in the United States and for a few specific dishes in Asia[xxxviii].

Nutrition

Another factor that helped maize to win favor with humans is its nutritional value. Though it is economically and agriculturally defined as a grain, it has the nutritional qualities of a vegetable, for it is deficient in the lower B vitamins that are characteristic of grains[xxxix]. Maize contains many vitamins including A, C, and E; though white corn is lower in vitamin A[xl]. It also has a high carbohydrate content and therefore is a good source of calories and thus energy. In fact, because of its elevated fat content, corn is superior to other grain as a source of energy[xli]. In addition, since both the grain itself, the ear, and the stalk possess nutritional value, it exceeds all other plants for 'digestible nutrients per hectare[xlii].

Unfortunately, despite all the good nutrients in corn, it does have some deficiencies. The proteins in corn are unable to combine into a mass even when mixed with water rendering it unaffected by yeast or baking powders, which is why corn bread is thicker and will not rise like the breads of other grains. Also, Corn is low in calcium

and usable protein, specifically the amino acids lysine and tryptophan that are essential to human nutrition.

The ancient Aztecs, who relied heavily on maize as a primary staple of their diet, inadvertently found a way to increase the nutritional potential of corn through a practice known as *nixtamalization*. This is the alkaline processing of corn kernels[xliii]. More specifically, the procedure involves the soaking or cooking of the kernels in a bath of crushed limestone, wood ash, or seashells after they had been removed from the cob[xliv]. This not only loosens the outer hulls of the kernels so that they can be easily removed by washing, which facilitates the task of grinding the grains into flour, but also strongly increases the calcium, niacin, and tryptophan content of the corn. Since corn already contains adequate amounts of the other essential amino acids, after undergoing nixtamalization it becomes the one food source that is rich in all seven essential amino acids[xlv] essentially transforming it into a nutritional "super-hero." Another benefit of nixtamalization, which is most likely the main motive behind the Aztec practice (since the technologies identifying the nutritional scientific transformations did not appear until much later) is that the removal of the outer hull not only makes the kernels easier to grind but helps to ensure that the resulting flour will produce a flexible flatbread or tortilla, one of the past and present mainstays of Mexican diets, when cooked[xlvi].

Despite its ability to transform into a nutritional "super-hero", many problems can occur if one's diet is too heavily reliant on corn. The disease most commonly associated with corn-heavy diets is pellagra. It is caused by a niacin deficiency which is due not only to the lack of niacin in non-nixtamalized corn but also to its high leucine content which blocks the absorption of niacin into the body[xlvii]. Its main symptoms include diarrhea,

dermatitis, and dementia. Pellagra has four stages of ailment which start with depression and then advance to digestive and skin disorders. From there it develops into neurological and mental problems until eventually the victim will experience wasting, dementia, and death[xlviii]. Other diseases associated with corn include vitamin A deficiency, and scurvy(vitamin C deficiency), and rickets. In addition, improper storage conditions with high levels of moisture can foster the growth of dangerous fungi[xlix].

Corn has found its way into most products on supermarket shelves and has become a fundamental ingrediant in livestock feed. Due to its richness in fat and high caloric content, corn has quickly become the favored feed-grain for livestock across America, many other countries still favor grass-fed practices. Proof of this fact is demonstrated by the overwhelming statistic that 95% of all corn grown is dent corn, which while white dents are a preferred food in Central America and southern Africa[l], yellow dents which are prevalent in the United States are the varietals used for livestock feed[li] and is referred to by many as “cow corn” or “cattle corn”[lii]. Another contributing factor to its popularity are its high-starch and low-fiber levels that make corn easier for livestock to digest than other grains[liii]. Yet, the corn is still altered from its raw form to create the feed which is generally made with whole, cracked, or steam-flaked grains enhanced with vitamins and minerals to meet the specific needs of the animal it is intended for[liv].

Cultivation

Corn requires human cultivation in order to survive. Though corn is a fairly resilient plant, continually cross-pollinating and hybridizing itself adjusting to new

climates and conditions as it migrated around the world, it does require full sun, nutrient rich (specifically nitrogen) soil, and adequate amount of water[lv]. Preparation of the soil by weeding, churning, and generous composting is generally necessary. Due to the countless varietals that span continents, different agricultural processes have been developed to nurture corn in a variety of vastly diverse climates. But in all of these regions some general characteristics remain the same when cultivating corn. These are that: corn should be protected from frost; crop rotation will generally produce a better yield due to the extremely high amounts of nitrogen and other nutrients that corn extracts from the soil and that a rotational crop such as legumes would replenish; the use of fertilizers, manure, or crop residue to enrich the soil; and finally, a good system of irrigation and drainage is useful. It is easy to tell if maize is not being properly cared for or nourished for the leaves will start to change shade from a light green to a yellowish color before beginning to 'fire'(die completely and curl in). A healthy corn plant will be dark green[lvi].

When growing corn, the first aspect that one must approach is the land on which the corn is to be planted, specifically at the quality of the soil. Sandy soils and clay soils generally have too many irrigation problems, the former being too dry and the later hard to drain, as well as nutrient deficiencies to be useful for corn growing unless heavily fertilized and even then it is questionable. Optimal soils for cultivating maize are well-drained, rich in nutrients, and 'deep,dark silt loams(***fix this!)***.[lvii] Corn is the most destructive plant to soil nutrients and fertility and demands rich or heavily fertilized soil. Also because of its destructive impact, without the use of modern fertilizers produced by

such companies as Monsanto, it is unwise to plant corn on the same field twice in a row and never exceeding that if one wishes a productive yield.

There are several steps that should be taken to prepare the land for planting which can start as early as the November before. The first is the clearing off of the remains of the previous crop post-harvest. While some farmers choose to burn their fields which may alter the humus levels in the soil, the more common practice is that of 'shredding' the left-over stalks. But before this takes place, a round of fertilizer is applied to the ground. This process is postponed until the temperature is below 50 degrees in order to help diminish/prevent the leaching of the chemicals into the groundwater[lviii]. Modern fertilizing utilizes a chisel applicator that is attached to a tractor. This chisel has the ability to inject chemical nutrients directly into the soil and can fertilize as many as fifteen rows at a time[lix]. Though fertilizing of the soil can be done in the spring, the tractor may compact the dirt which should be slightly looser around planting time. For corn the majority of the fertilizer will supply extra amounts of nitrogen, which is directly associated with protein levels of the maize, to the soil. Though the nitrogen in the fertilizer will generally only last for the first month to six weeks after planting, leaving the majority of the nitrogen to be obtained from the original top soil, manure, or a supplementing crop of clover[lx]. Should all sources run dry, nitrogen deficiency is identifiable by a yellowing of the corn plant and the drying of the lower leaves[lxi]. Other nutrients or chemicals commonly found in fertilizers for corn include phosphoric acid and potash.

Once the soil has been rejuvenated, a tractor with a shredder in tow will comb the fields. The shredder will first cut up the stalks from the previous harvest and then through

a disk attachment, churn the stalks into the top layer of soil to create a compost[lxii]. The shredding process will also stunt weed growth as it slashes the stalks and the resulting compost will protect the ground, shading it and preventing wind erosion.

Planting begins in the early spring, but not before once again churning the land to loosen the soil and break up the weeds. The device used for this is a cultivator which is essentially multiple shovels that are rotated to replicate the old method of hand-tilling. This also breaks up any solid crust that may have formed over the winter and rainy season so that the bed is primed for planting.

Modern planters can seed up to sixteen rows at a time. The machine uses a drive wheel to control the release of kernels into furrows that are simultaneously dug by the planter and then covered over with dirt by a packer wheel[lxiii]. The fields are then tended with herbicides and pesticides that are applied through spraying, and continuing cultivation until the stalks are ready for harvesting.

Three weeks after the tassels appear, corn plants are ready to be harvested[lxiv], dried, and stored. Today, storage of corn has become equally as profitable as selling corn. This is partially due to the Grain Reserve Program which supplies a government paycheck for personal storage of the harvested corn. Techniques for storage, have like the tools for planting, have also become more high-tech. These include glass-lined steel storage tanks that can automatically monitor the moisture content within and keep it an optimal level for corn storage. There are also holding tanks for fresh, still wet, grain that slowly monitor the drying process preparing the grain for lengthy storage[lxv].

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