[Template:Redirect](/wiki/Template:Redirect" \o "Template:Redirect) [Template:Pp-semi-indef](/wiki/Template:Pp-semi-indef) [Template:Use mdy dates](/wiki/Template:Use_mdy_dates) [Template:Taxobox](/wiki/Template:Taxobox) **Maize** ([Template:IPAc-en](/wiki/Template:IPAc-en) [Template:Respell](/wiki/Template:Respell); *Zea mays* subsp. *mays*, from [Template:Lang-es](/wiki/Template:Lang-es) after [Taíno](/wiki/Taíno_language) *mahiz*), also known as **corn**, is a large [grain](/wiki/Grain) plant first domesticated by [indigenous peoples](/wiki/Indigenous_peoples) in [Mexico](/wiki/Mexico)[[1]](#cite_note-1) about 10,000 years ago. The six major types of corn are [dent corn](/wiki/Dent_corn), [flint corn](/wiki/Flint_corn), [pod corn](/wiki/Pod_corn), [popcorn](/wiki/Popcorn), [flour corn](/wiki/Flour_corn), and [sweet corn](/wiki/Sweet_corn).[[2]](#cite_note-2) The leafy stalk of the plant produces separate pollen and [ovuliferous](/wiki/Ovule) [inflorescences](/wiki/Inflorescence) or [ears](/wiki/Ear_(botany)), which are fruits, yielding [kernels](/wiki/Corn_kernels) (often erroneously called seeds). Maize kernels are often used in cooking as a [starch](/wiki/Starch).

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## History[[edit](/index.php?title=(none)&action=edit&section=1)]

[thumb|](/wiki/File:Guila_Naquitz_cave.jpg)[Guilá Naquitz Cave](/wiki/Guilá_Naquitz_Cave) in [Oaxaca](/wiki/Oaxaca), [Mexico](/wiki/Mexico) is the site of early [domestication](/wiki/Domestication#plants) of several food crops, including [teosinte](/wiki/Zea_(genus)) (an ancestor of maize).[[3]](#cite_note-3) Most historians believe maize was domesticated in the [Tehuacan Valley](/wiki/Tehuacán_Valley_matorral) of [Mexico](/wiki/Mexico).[[4]](#cite_note-4) Recent research modified this view somewhat; scholars now indicate the adjacent [Balsas River](/wiki/Balsas_River) Valley of south-central Mexico as the center of domestication.[[5]](#cite_note-5) The [Olmec](/wiki/Olmec) and [Mayans](/wiki/Maya_peoples) cultivated maize in numerous varieties throughout Mesoamerica, cooked, ground or processed through [nixtamalization](/wiki/Nixtamalization). Beginning about 2500 BC, the crop spread through much of the [Americas](/wiki/Americas).[[6]](#cite_note-6) The region developed a trade network based on surplus and varieties of maize crops.

Nevertheless, recent data indicates that the spread of maize took place even earlier. According to Piperno,

"A large corpus of data indicates that it [maize] was dispersed into lower Central America by 7600 BP [5600 BC] and had moved into the inter-Andean valleys of Colombia between 7000 and 6000 BP [5000-4000 BC]."[[5]](#cite_note-5)

Since then, even earlier dates have been published.[[7]](#cite_note-7) After European contact with the Americas in the late 15th and early 16th centuries, explorers and traders [carried maize back to Europe](/wiki/Columbian_Exchange) and introduced it to other countries. Maize spread to the rest of the world because of its ability to grow in diverse climates. Sugar-rich varieties called [sweet corn](/wiki/Sweet_corn) are usually grown for human consumption as kernels, while [field corn](/wiki/Field_corn) varieties are used for animal feed, various corn-based human food uses (including grinding into [cornmeal](/wiki/Cornmeal) or [masa](/wiki/Masa), pressing into [corn oil](/wiki/Corn_oil), and fermentation and distillation into alcoholic beverages like [bourbon whiskey](/wiki/Bourbon_whiskey)), and as chemical feedstocks.

An influential 2002 study by Matsuoka *et al*. has demonstrated that, rather than the multiple independent domestications model, all maize arose from a single domestication in southern Mexico about 9,000 years ago. The study also demonstrated that the oldest surviving maize types are those of the Mexican highlands. Later, maize spread from this region over the Americas along two major paths. This is consistent with a model based on the archaeological record suggesting that maize diversified in the highlands of Mexico before spreading to the lowlands.[[8]](#cite_note-8)[[9]](#cite_note-9) Before they were domesticated, maize plants only grew small, [Template:Convert](/wiki/Template:Convert) long corn cobs, and only one per plant. Many centuries of artificial selection by the indigenous people of the Americas resulted in the development of maize plants capable of growing several cobs per plant that were usually several centimetres/inches long each.[[10]](#cite_note-10) Maize is the most widely grown grain [crop](/wiki/Crop) throughout the Americas,[[11]](#cite_note-11) with 332 million [metric tons](/wiki/Tonne) grown annually in the United States alone. Approximately 40% of the crop—130 million tons—is used for corn [ethanol](/wiki/Ethanol).[[12]](#cite_note-12) [Genetically modified maize](/wiki/Genetically_modified_maize) made up 85% of the maize planted in the United States in 2009.<ref name = GMOCompass>[Genetically modified plants: Global Cultivation Area Maize](http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/341.genetically_modified_maize_global_area_under_cultivation.html) GMO Compass, March 29, 2010, retrieved August 10, 2010</ref>

## Names[[edit](/index.php?title=(none)&action=edit&section=2)]

[left|thumb|upright|Many small male flowers make up the male inflorescence, called the tassel.](/wiki/File:Corntassel_7095.jpg) The word *maize* derives from the Spanish form of the indigenous [Taíno](/wiki/Taíno_people) word for the plant, *mahiz*.[[13]](#cite_note-13) It is known by other names around the world.

The word "corn" outside North America, Australia, and New Zealand refers to any [cereal](/wiki/Cereal) crop, its meaning understood to vary geographically to refer to the local [staple](/wiki/Staple_food).[[14]](#cite_note-14)[[15]](#cite_note-15) In the United States,[[14]](#cite_note-14) Canada,[[16]](#cite_note-16) Australia, and New Zealand,[Template:Citation needed](/wiki/Template:Citation_needed) *corn* primarily means maize; this usage started as a shortening of "Indian corn".<ref name=OED\_corn>["corn"](http://oed.com/view/Entry/41586). *Oxford English Dictionary*, online edition. 2012. Accessed June 7, 2012.</ref> "Indian corn" primarily means maize (the staple grain of [indigenous Americans](/wiki/Indigenous_Americans)), but can refer more specifically to multicolored "[flint corn](/wiki/Flint_corn)" used for decoration.[[17]](#cite_note-17) In places outside North America, Australia, and New Zealand, *corn* often refers to maize in culinary contexts. The narrower meaning is usually indicated by some additional word, as in [*sweet corn*](/wiki/Sweet_corn), *sweetcorn*, [*corn on the cob*](/wiki/Corn_on_the_cob), [*baby corn*](/wiki/Baby_corn), the puffed confection known as [*popcorn*](/wiki/Popcorn) and the breakfast cereal known as [*corn flakes*](/wiki/Corn_flakes).

In Southern Africa, maize is commonly called *mielie* ([Afrikaans](/wiki/Afrikaans)) or *mealie* ([English](/wiki/English_language)),<ref name=OED\_mealie>["mealie"](http://oed.com/viewdictionaryentry/Entry/115421), *Oxford English Dictionary*, online edition, 2012. Accessed June 7, 2012.</ref> words derived from the Portuguese word for maize, *milho*.[[18]](#cite_note-18) *Maize* is preferred in formal, scientific, and international usage because it refers specifically to this one grain, unlike *corn*, which has a complex variety of meanings that vary by context and geographic region.[[15]](#cite_note-15) *Maize* is used by agricultural bodies and [research institutes](/wiki/Research_institute) such as the [FAO](/wiki/FAO) and [CSIRO](/wiki/CSIRO). National agricultural and industry associations often include the word *maize* in their name even in English-speaking countries where the local, informal word is something other than *maize*; for example, the Maize Association of Australia, the Indian Maize Development Association, the Kenya Maize Consortium and Maize Breeders Network, the National Maize Association of Nigeria, the Zimbabwe Seed Maize Association. However, in commodities trading, *corn* consistently refers to maize and not other grains.[Template:Citation needed](/wiki/Template:Citation_needed) [Template:Clear](/wiki/Template:Clear)

## Structure and physiology[[edit](/index.php?title=(none)&action=edit&section=3)]

The maize plant is often [Template:Convert](/wiki/Template:Convert) in height,[[19]](#cite_note-19) though some natural strains can grow [Template:Convert](/wiki/Template:Convert).[[20]](#cite_note-20) The stem is commonly composed of 20 [internodes](/wiki/Internode_(botany)) [[21]](#cite_note-21) of [Template:Convert](/wiki/Template:Convert) length.[[19]](#cite_note-19) A leaf, which grows from each node, is generally [Template:Convert](/wiki/Template:Convert) in width and [Template:Convert](/wiki/Template:Convert) in length.

Ears develop above a few of the leaves in the midsection of the plant, between the stem and leaf sheath, elongating by ~3 mm/day, to a length of [Template:Convert](/wiki/Template:Convert) [[19]](#cite_note-19) with [Template:Convert](/wiki/Template:Convert) being the maximum alleged in the subspecies.[[22]](#cite_note-22) They are female [inflorescences](/wiki/Inflorescence), tightly enveloped by several layers of ear leaves commonly called husks. Certain varieties of maize have been bred to produce many additional developed ears. These are the source of the "[baby corn](/wiki/Baby_corn)" used as a vegetable in [Asian cuisine](/wiki/Asian_cuisine).

The apex of the stem ends in the tassel, an [inflorescence](/wiki/Inflorescence) of male flowers. When the tassel is mature and conditions are suitably warm and dry, anthers on the tassel [dehisce](/wiki/Dehiscence_(botany)) and release pollen. Maize pollen is [anemophilous](/wiki/Anemophily) (dispersed by wind), and because of its large settling velocity, most pollen falls within a few meters of the tassel.

Elongated [stigmas](/wiki/Stigma_(botany)), called [silks](/wiki/Corn_silk), emerge from the whorl of husk leaves at the end of the ear. They are often pale yellow and [Template:Convert](/wiki/Template:Convert) in length, like tufts of hair in appearance. At the end of each is a carpel, which may develop into a "kernel" if fertilized by a pollen grain. The [pericarp](/wiki/Pericarp) of the fruit is fused with the seed coat referred to as "[caryopsis](/wiki/Caryopsis)", typical of the [grasses](/wiki/Poaceae), and the entire kernel is often referred to as the "[seed](/wiki/Seed)". The cob is close to a [multiple fruit](/wiki/Multiple_fruit) in structure, except that the individual fruits (the kernels) never fuse into a single mass. The grains are about the size of [peas](/wiki/Pea), and adhere in regular rows around a white, pithy substance, which forms the ear- maximum size of kernel in subspecies is reputedly [Template:Convert](/wiki/Template:Convert).[[23]](#cite_note-23) An ear commonly holds 600 kernels. They are of various colors: blackish, [bluish-gray](/wiki/Blue_corn), [purple](/wiki/Purple_corn), green, red, white and yellow. When ground into [flour](/wiki/Flour), maize yields more flour with much less [bran](/wiki/Bran) than wheat does. It lacks the protein [gluten](/wiki/Gluten) of wheat and, therefore, makes baked goods with poor rising capability. A [genetic variant](/wiki/Mutation) that accumulates more sugar and less [starch](/wiki/Starch) in the ear is consumed as a vegetable and is called [sweet corn](/wiki/Sweet_corn). Young ears can be consumed raw, with the [cob](/wiki/Corncob) and silk, but as the plant matures (usually during the summer months), the cob becomes tougher and the silk dries to inedibility. By the end of the [growing season](/wiki/Growing_season), the kernels dry out and become difficult to chew without cooking them tender first in boiling water.

<gallery mode=packed> File:Cornsilk 7091.jpg|Female inflorescence, with young [silk](/wiki/Corn_silk) File:Corn blooming.jpg|mature silk File:GreenCorn.JPG|Stalks, ears, and silk File:Männliche Blüte einer Maispflanze 2009-08-19.JPG|Male flowers File:ZeaMays.jpg|Full-grown maize plants File:Klip kukuruza uzgojen u Međimurju (Croatia).JPG|Mature maize ear on a stalk </gallery>

Planting density affects multiple aspects of maize. Modern farming techniques in [developed countries](/wiki/Developed_country) usually rely on dense planting, which produces one ear per stalk.[[24]](#cite_note-24) Stands of [silage](/wiki/Silage) maize are yet denser,[[25]](#cite_note-25) and achieve a lower percentage of ears and more plant matter.

Maize is a [facultative short-day plant](/wiki/Long-night_plant) [[26]](#cite_note-26) and flowers in a certain number of [growing degree days](/wiki/Growing_degree_day) > [Template:Convert](/wiki/Template:Convert) in the environment to which it is adapted.[[27]](#cite_note-27) The magnitude of the influence that long nights have on the number of days that must pass before maize [flowers](/wiki/Flower) is genetically prescribed[[28]](#cite_note-28) and regulated by the [phytochrome](/wiki/Phytochrome) system.[[29]](#cite_note-29) [Photoperiodicity](/wiki/Circadian_rhythm) can be eccentric in tropical [cultivars](/wiki/Cultivar) such that the long days characteristic of higher latitudes allow the plants to grow so tall that they do not have enough time to produce seed before being killed by frost. These attributes, however, may prove useful in using tropical maize for [biofuels](/wiki/Biofuel).[[30]](#cite_note-30) Immature maize shoots accumulate a powerful antibiotic substance, 2,4-dihydroxy-7-methoxy-1,4-benzoxazin-3-one ([DIMBOA](/wiki/DIMBOA)). DIMBOA is a member of a group of [hydroxamic acids](/wiki/Hydroxamic_acid) (also known as benzoxazinoids) that serve as a natural defense against a wide range of pests, including insects, [pathogenic](/wiki/Pathogenic) fungi and [bacteria](/wiki/Bacteria). DIMBOA is also found in related grasses, particularly wheat. A maize mutant (bx) lacking DIMBOA is highly susceptible to attack by [aphids](/wiki/Aphid) and [fungi](/wiki/Fungi). DIMBOA is also responsible for the relative resistance of immature maize to the [European corn borer](/wiki/European_corn_borer) (family [Crambidae](/wiki/Crambidae)). As maize matures, DIMBOA levels and resistance to the corn borer decline.

Because of its shallow roots, maize is susceptible to droughts, intolerant of nutrient-deficient soils, and prone to be uprooted by severe winds.[[31]](#cite_note-31) <gallery mode=packed> File:Ab food 06.jpg|Maize kernels File:Maize plant diagram.svg|Maize plant diagram File:Aa maize ear irregular 01.jpg|Ear of maize with irregular rows of seeds </gallery>

[thumb|right|Zea mays "strawberry"—](/wiki/File:Zea_mays_fraise_MHNT.BOT.2011.18.21.jpg)[MHNT](/wiki/MHNT) [thumb|*Zea mays "Oaxacan Green"*](/wiki/File:Dent_Corn_'Oaxacan_Green'_(Zea_mays)_MHNT_2.jpg) [MHNT](/wiki/MHNT) [thumb|Variegated maize ears](/wiki/File:Corncobs.jpg) [thumb|Multicolored corn kernels (](/wiki/File:CSIRO_ScienceImage_3195_Maize_or_corn.jpg)[CSIRO](/wiki/CSIRO)) While yellow maizes derive their color from [lutein](/wiki/Lutein) and [zeaxanthin](/wiki/Zeaxanthin), in red-colored maizes, the kernel coloration is due to [anthocyanins](/wiki/Anthocyanin) and [phlobaphenes](/wiki/Phlobaphene). These latter substances are synthesized in the flavonoids synthetic pathway[[32]](#cite_note-32) from polymerisation of [flavan-4-ols](/wiki/Flavan-4-ol)[[33]](#cite_note-33) by the expression of maize pericarp color1 (p1) gene<ref name=Chopra2003>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> which encodes an R2R3 [myb](/wiki/MYB_(gene))-like [transcriptional activator](/wiki/Transcriptional_activator)[[34]](#cite_note-34) of the A1 gene encoding for the [dihydroflavonol 4-reductase](/wiki/Dihydroflavonol_4-reductase) (reducing [dihydroflavonols](/wiki/Dihydroflavonol) into flavan-4-ols)[[35]](#cite_note-35) while another gene (Suppressor of Pericarp Pigmentation 1 or SPP1) acts as a [suppressor](/wiki/Transcriptional_suppressor).[[36]](#cite_note-36) The p1 gene encodes an Myb-homologous transcriptional activator of genes required for biosynthesis of red phlobaphene pigments, while the P1-wr allele specifies colorless kernel pericarp and red cobs, and unstable factor for orange1 (Ufo1) modifies P1-wr expression to confer pigmentation in kernel pericarp, as well as vegetative tissues, which normally do not accumulate significant amounts of phlobaphene pigments.[[37]](#cite_note-37) The maize P gene encodes a Myb homolog that recognizes the sequence CCT/AACC, in sharp contrast with the C/TAACGG bound by vertebrate Myb proteins.[[38]](#cite_note-38)

### Abnormal flowers[[edit](/index.php?title=(none)&action=edit&section=4)]

Sometimes in maize, [inflorescences](/wiki/Inflorescence) are found containing both male and female flowers, or [hermaphrodite](/wiki/Hermaphrodite) flowers.[[39]](#cite_note-39)

## Genetics[[edit](/index.php?title=(none)&action=edit&section=5)]

[thumb|right|Exotic varieties of maize are collected to add](/wiki/File:GEM_corn.jpg) [genetic diversity](/wiki/Genetic_diversity) when selectively breeding new domestic strains Many forms of maize are used for food, sometimes classified as various subspecies related to the amount of starch each has:

* Flour corn: *Zea mays* var. *amylacea*
* [Popcorn](/wiki/Popcorn): *Zea mays* var. *everta*
* [Dent corn](/wiki/Dent_corn) : *Zea mays* var. *indentata*
* [Flint corn](/wiki/Flint_corn): *Zea mays* var. *indurata*
* [Sweet corn](/wiki/Sweet_corn): *Zea mays* var. *saccharata* and *Zea mays* var. *rugosa*
* [Waxy corn](/wiki/Waxy_corn): *Zea mays* var. *ceratina*
* [Amylomaize](/wiki/Amylomaize): *Zea mays*
* [Pod corn](/wiki/Pod_corn): *Zea mays* var. *tunicata* Larrañaga ex A. St. Hil.
* Striped maize: *Zea mays* var. *japonica*

This system has been replaced (though not entirely displaced) over the last 60 years by multivariable classifications based on ever more data. [Agronomic](/wiki/Agronomics) data were supplemented by botanical traits for a robust initial classification, then genetic, [cytological](/wiki/Cell_biology), protein and DNA evidence was added. Now, the categories are forms (little used), races, racial complexes, and recently branches.

Maize is a [diploid](/wiki/Diploid) with 20 [chromosomes](/wiki/Chromosome) (n=10). The combined length of the chromosomes is 1500 [cM](/wiki/Centimorgan). Some of the maize chromosomes have what are known as "chromosomal knobs": highly repetitive [heterochromatic](/wiki/Heterochromatin) domains that stain darkly. Individual knobs are [polymorphic](/wiki/Polymorphism_(biology)) among strains of both maize and [teosinte](/wiki/Teosinte).

[Barbara McClintock](/wiki/Barbara_McClintock) used these knob markers to validate her [transposon](/wiki/Transposon) theory of "jumping genes", for which she won the 1983 [Nobel Prize in Physiology or Medicine](/wiki/Nobel_Prize_in_Physiology_or_Medicine). Maize is still an important [model organism](/wiki/Model_organism) for genetics and [developmental biology](/wiki/Developmental_biology) today.[[40]](#cite_note-40) The Maize Genetics Cooperation Stock Center, funded by the USDA [Agricultural Research Service](/wiki/Agricultural_Research_Service) and located in the Department of Crop Sciences at the [University of Illinois at Urbana-Champaign](/wiki/University_of_Illinois_at_Urbana-Champaign), is a stock center of maize mutants. The total collection has nearly 80,000 samples. The bulk of the collection consists of several hundred named genes, plus additional gene combinations and other heritable variants. There are about 1000 chromosomal aberrations (e.g., translocations and inversions) and stocks with abnormal chromosome numbers (e.g., [tetraploids](/wiki/Tetraploid)). Genetic data describing the maize mutant stocks as well as myriad other data about maize genetics can be accessed at [MaizeGDB](http://maizegdb.org/), the Maize Genetics and Genomics Database.[[41]](#cite_note-41) In 2005, the US [National Science Foundation](/wiki/National_Science_Foundation) (NSF), Department of Agriculture ([USDA](/wiki/United_States_Department_of_Agriculture)) and the [Department of Energy](/wiki/United_States_Department_of_Energy) (DOE) formed a consortium to sequence the B73 maize [genome](/wiki/Genome). The resulting DNA sequence data was deposited immediately into [GenBank](/wiki/GenBank), a public repository for genome-sequence data. Sequences and genome annotations have also been made available throughout the project's lifetime at the project's official site.[[42]](#cite_note-42) Primary sequencing of the maize genome was completed in 2008.[[43]](#cite_note-43) On November 20, 2009, the consortium published results of its sequencing effort in *Science*.[[44]](#cite_note-44) The genome, 85% of which is composed of [transposons](/wiki/Transposon), was found to contain 32,540 genes (By comparison, the [human genome](/wiki/Human_genome) contains about 2.9 billion bases and 26,000 genes). Much of the maize genome has been duplicated and reshuffled by [helitrons](/wiki/Helitron_(biology))—group of rolling circle transposons.[[45]](#cite_note-45) According to a genetic study by [Embrapa](/wiki/Embrapa), corn cultivation was introduced in South America from Mexico, in two great waves: the first, 5000 years ago, spread through the [Andes](/wiki/Andes); the second, about 2000 years ago, through the lowlands of South America.[[46]](#cite_note-46)

## Breeding[[edit](/index.php?title=(none)&action=edit&section=6)]

[thumb|right|Field of maize in](/wiki/File:Field,_corn,_Liechtenstein,_Mountains,_Alps,_Vaduz,_sky,_clouds,_landscape.jpg) [Liechtenstein](/wiki/Liechtenstein)

Maize reproduces sexually each year. This randomly selects half the genes from a given plant to propagate to the next generation, meaning that desirable traits found in the crop (like high yield or good nutrition) can be lost in subsequent generations unless certain techniques are used.

Maize breeding in prehistory resulted in large plants producing large ears. Modern breeding began with individuals who selected highly productive varieties in their fields and then sold seed to other farmers. James L. Reid was one of the earliest and most successful developing Reid's Yellow Dent in the 1860s. These early efforts were based on [mass selection](/wiki/Selection_methods_in_plant_breeding_based_on_mode_of_reproduction). Later breeding efforts included ear to row selection, (C. G. Hopkins ca. 1896), hybrids made from selected [inbred](/wiki/Inbred) lines (G. H. Shull, 1909), and the highly successful double cross hybrids using 4 inbred lines ([D. F. Jones](/wiki/Donald_F._Jones) ca. 1918, 1922). University supported breeding programs were especially important in developing and introducing modern hybrids. (Ref Jugenheimer Hybrid Maize Breeding and Seed Production pub. 1958) by the 1930s, companies such as [Pioneer](/wiki/Pioneer_Hi-Bred) devoted to production of hybrid maize had begun to influence long term development. Internationally important seed banks such as [International Maize and Wheat Improvement Center](/wiki/International_Maize_and_Wheat_Improvement_Center) (CIMMYT) and the US bank at Maize Genetics Cooperation Stock Center [University of Illinois at Urbana-Champaign](/wiki/University_of_Illinois_at_Urbana-Champaign) maintain [germplasm](/wiki/Germplasm) important for future crop development.

Since the 1940s the best strains of maize have been first-generation hybrids made from inbred strains that have been optimized for specific traits, such as yield, nutrition, drought, pest and disease tolerance. Both conventional cross-breeding and genetic modification have succeeded in increasing output and reducing the need for cropland, pesticides, water and fertilizer.[[47]](#cite_note-47)

### Global maize program[[edit](/index.php?title=(none)&action=edit&section=7)]

[left|thumb|Panorama of cornfields in](/wiki/File:2014_Panorama_Chiang_Klang_District.jpg) [Nan Province](/wiki/Nan_Province), [Thailand](/wiki/Thailand)

CIMMYT operates a conventional breeding program to provide optimized strains. The program began in the 1980s. Hybrid seeds are distributed in Africa by the Drought Tolerant Maize for Africa project.<ref name=nyt14>[Template:Cite news](/wiki/Template:Cite_news)</ref>

### Genetic modification[[edit](/index.php?title=(none)&action=edit&section=8)]

[Template:Main](/wiki/Template:Main)

[Genetically modified](/wiki/Genetically_modified) [(GM) maize](/wiki/Genetically_modified_maize) is one of the 25 [GM crops](/wiki/Genetically_modified_food) grown commercially in 2011.[[48]](#cite_note-48) Grown since 1997 in the United States and Canada, 86% of the US maize crop was genetically modified in 2010[[49]](#cite_note-49) and 32% of the worldwide maize crop was GM in 2011.[[50]](#cite_note-50) As of 2011, Herbicide-tolerant maize varieties are grown in Argentina, Australia, Brazil, Canada, China, Colombia, El Salvador, the EU, Honduras, Japan, Korea, Malaysia, Mexico, New Zealand, Philippines, the Russian Federation, Singapore, South Africa, Taiwan, Thailand, and USA, and insect-resistant corn is grown in Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Czech Republic, Egypt, the EU, Honduras, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Philippines, Romania, Russian Federation, South Africa, Switzerland, Taiwan, USA, and Uruguay.[[51]](#cite_note-51) In September 2000, up to $50 million worth of food products were recalled due to contamination with [Starlink](/wiki/Starlink_corn_recall) genetically modified corn, which had been approved only for animal consumption and had not been approved for human consumption, and was subsequently withdrawn from the market.[[52]](#cite_note-52)

## Origin[[edit](/index.php?title=(none)&action=edit&section=9)]

[Template:See also](/wiki/Template:See_also)

[right|thumb|A *Tripsacum* grass (big) and a teosinte (small)](/wiki/File:Corn_parents1.jpg) Maize is the domesticated variant of [teosinte](/wiki/Teosinte).[[53]](#cite_note-53) The two plants have dissimilar appearance, maize having a single tall stalk with multiple leaves and teosinte being a short, bushy plant. The difference between the two is largely controlled by differences in just two genes.[[53]](#cite_note-53) Several theories had been proposed about the specific origin of maize in Mesoamerica:[[54]](#cite_note-54)[[55]](#cite_note-55)# It is a direct [domestication](/wiki/Domestication) of a [Mexican](/wiki/Mexican_people) annual [teosinte](/wiki/Teosinte), *Zea mays* ssp. *parviglumis*, native to the [Balsas River](/wiki/Balsas_River) valley in south-eastern [Mexico](/wiki/Mexico), with up to 12% of its [genetic material](/wiki/Genetic_material) obtained from *Zea mays* ssp. *mexicana* through [introgression](/wiki/Introgression). This theory was further confirmed by the 2002 study of Matsuoka et al.[[8]](#cite_note-8)# It has been derived from hybridization between a small domesticated maize (a slightly changed form of a wild maize) and a teosinte of section *Luxuriantes*, either *Z. luxurians* or [*Z. diploperennis*](/wiki/Zea_diploperennis).

1. It has undergone two or more domestications either of a wild maize or of a teosinte. (The term "teosinte" describes all [species](/wiki/Species) and subspecies in the genus *Zea*, excluding *Zea mays* ssp. *mays*.)
2. It has evolved from a hybridization of *Z. diploperennis* by [*Tripsacum dactyloides*](/wiki/Tripsacum_dactyloides).

In the late 1930s, Paul Mangelsdorf suggested that domesticated maize was the result of a hybridization event between an unknown wild maize and a species of [*Tripsacum*](/wiki/Tripsacum), a related genus. This theory about the origin of maize has been refuted by modern [genetic testing](/wiki/Genetic_testing), which refutes Mangelsdorf's model and the fourth listed above.[[54]](#cite_note-54)[Template:Rp](/wiki/Template:Rp)

The teosinte origin theory was proposed by the Russian botanist [Nikolai Ivanovich Vavilov](/wiki/Nikolai_Ivanovich_Vavilov) in 1931 and the later American [Nobel Prize](/wiki/Nobel_Prize)-winner [George Beadle](/wiki/George_Beadle) in 1932.[[54]](#cite_note-54)[Template:Rp](/wiki/Template:Rp) It is supported experimentally and by recent studies of the plants' genomes. Teosinte and maize are able to cross-breed and produce fertile offspring. A number of questions remain concerning the species, among them:

1. how the immense diversity of the species of sect. *Zea* originated,
2. how the tiny archaeological specimens of 3500–2700 BC could have been selected from a teosinte, and
3. how domestication could have proceeded without leaving remains of teosinte or maize with teosintoid traits earlier than the earliest known until recently, dating from ca. 1100 BC.

The [domestication](/wiki/Domestication) of maize is of particular interest to researchers—[archaeologists](/wiki/Archaeologist), [geneticists](/wiki/Genetics), [ethnobotanists](/wiki/Ethnobotany), geographers, etc. The process is thought by some to have started 7,500 to 12,000 years ago. Research from the 1950s to 1970s originally focused on the hypothesis that maize domestication occurred in the highlands between the states of [Oaxaca](/wiki/Oaxaca) and [Jalisco](/wiki/Jalisco), because the oldest archaeological remains of maize known at the time were found there.

### Connection with 'parviglumis' subspecies[[edit](/index.php?title=(none)&action=edit&section=10)]

[thumb|](/wiki/File:Maize-teosinte.jpg)[teosinte](/wiki/Teosinte) (top), maize-teosinte hybrid (middle), maize (bottom)

Genetic studies led by [John Doebley](/wiki/John_Doebley) identified *Zea mays* ssp. *parviglumis*, native to the [Balsas River](/wiki/Balsas_River) valley in Mexico's southwestern highlands, and also known as Balsas teosinte, as being the [crop wild relative](/wiki/Crop_wild_relative) teosinte genetically most similar to modern maize.[[56]](#cite_note-56) This has been confirmed by further more recent studies, which refined this hypothesis somewhat. Archaeobotanical studies published in 2009 now point to the middle part of the Balsas River valley as the more likely location of early domestication; this river is not very long, so these locations are not very distant. Stone milling tools with maize residue have been found in an 8,700-years old layer of deposits in a cave not far from [Iguala, Guerrero](/wiki/Iguala,_Guerrero).[[57]](#cite_note-57)[[58]](#cite_note-58)[[59]](#cite_note-59) Also, Doebley was part of the team that is credited with first finding, back in 2002, that maize had been domesticated only once, about 9000 years ago, and then spread throughout the Americas.[[8]](#cite_note-8)[[60]](#cite_note-60) A primitive corn was being grown in southern Mexico, Central America, and northern South America 7,000 years ago. Archaeological remains of early maize ears, found at [Guila Naquitz Cave](/wiki/Guila_Naquitz_Cave) in the [Oaxaca Valley](/wiki/Oaxaca_Valley), date back roughly 6,250 years; the oldest ears from caves near [Tehuacan](/wiki/Tehuacán,_Puebla), Puebla, date ca. 3,450 BC.[[6]](#cite_note-6) Maize pollen dated to 7300 cal B.P. from [San Andres, Tabasco](/wiki/San_Andrés_(Mesoamerican_site)), on the Caribbean coast has also been recovered.[[58]](#cite_note-58) As maize was introduced to new cultures, new uses were developed and new varieties selected to better serve in those preparations. Maize was the staple food, or a major staple – along with [squash](/wiki/Squash_(plant)), Andean region [potato](/wiki/Potato), [quinoa](/wiki/Quinoa), [beans](/wiki/Bean), and [amaranth](/wiki/Amaranth) – of most [pre-Columbian](/wiki/Pre-Columbian) North American, Mesoamerican, South American, and Caribbean cultures. The Mesoamerican civilization, in particular, was deeply interrelated with maize. Its traditions and rituals involved all aspects of maize cultivation – from the planting to the food preparation. Maize formed the Mesoamerican people's identity.

[thumb|left|](/wiki/File:Centeotl.jpg)[Centeotl](/wiki/Centeotl), the Aztec deity of maize

It is unknown what precipitated its domestication, because the edible portion of the wild variety is too small and hard to obtain to be eaten directly, as each kernel is enclosed in a very hard bivalve shell. It is possible that, early on, teosinte may have been gathered as preferred feed for domestic animals.

Also, back in 1939, George Beadle demonstrated that the kernels of teosinte are readily "popped" for human consumption, like modern popcorn.[[61]](#cite_note-61) Some have argued it would have taken too many generations of [selective breeding](/wiki/Selective_breeding) to produce large, compressed ears for efficient cultivation. However, studies of the hybrids readily made by intercrossing teosinte and modern maize suggest this objection is not well founded.

### Spreading to the north[[edit](/index.php?title=(none)&action=edit&section=11)]

Around 2500 BC, maize began to spread to the north; it was first cultivated in what is now the United States at several sites in New Mexico and Arizona, about 2100 BC.[[62]](#cite_note-62) During the first millennium AD, maize cultivation spread more widely in the areas north. In particular, the large-scale adoption of maize agriculture and consumption in eastern North America took place about A.D. 900. Native Americans cleared large forest and grassland areas for the new crop.[[63]](#cite_note-63) This method was replaced by single species hill planting where each hill [Template:Convert](/wiki/Template:Convert) apart was planted with three or four seeds, a method still used by home gardeners. A later technique was "checked maize", where hills were placed [Template:Convert](/wiki/Template:Convert) apart in each direction, allowing cultivators to run through the field in two directions. In more arid lands, this was altered and seeds were planted in the bottom of [Template:Convert](/wiki/Template:Convert) deep furrows to collect water. Modern technique plants maize in rows which allows for cultivation while the plant is young, although the hill technique is still used in the maize fields of some Native American reservations. When maize is planted in rows, it also allows for planting of other crops between these rows to make more efficient use of land space.[[66]](#cite_note-66) In North America, fields are often planted in a two-[crop rotation](/wiki/Crop_rotation) with a [nitrogen-fixing](/wiki/Nitrogen_fixation) crop, often [alfalfa](/wiki/Alfalfa) in cooler climates and [soybeans](/wiki/Soybean) in regions with longer summers. Sometimes a third crop, [winter wheat](/wiki/Winter_wheat), is added to the rotation.

Many of the maize varieties grown in the United States and Canada are hybrids. Often the varieties have been [genetically modified](/wiki/Genetically_modified) to tolerate [glyphosate](/wiki/Glyphosate) or to provide protection against natural pests. Glyphosate is an herbicide which kills all plants except those with genetic tolerance. This genetic tolerance is very rarely found in nature.

In midwestern United States, low-till or [no-till farming](/wiki/No-till_farming) techniques are usually used. In low-till, fields are covered once, maybe twice, with a tillage implement either ahead of crop planting or after the previous harvest. The fields are planted and [fertilized](/wiki/Anhydrous_ammonia). Weeds are controlled through the use of [herbicides](/wiki/Herbicide), and no cultivation tillage is done during the growing season. This technique reduces moisture evaporation from the soil, and thus provides more moisture for the crop. The technologies mentioned in the previous paragraph enable low-till and no-till farming. Weeds compete with the crop for moisture and nutrients, making them undesirable.

[thumb|left|Mature field maize ears](/wiki/File:YellowCorn.jpg) Before [World War II](/wiki/World_War_II), most maize in North America was harvested by hand. This involves a large numbers of workers and associated social events (husking or shucking [bees](/wiki/Bee_(gathering))). Some one- and two-row mechanical pickers were in use, but the maize [combine](/wiki/Combine_harvester) was not adopted until after the War. By hand or mechanical picker, the entire ear is harvested, which then requires a separate operation of a maize sheller to remove the kernels from the ear. Whole ears of maize were often stored in [corn cribs](/wiki/Corn_crib), and these whole ears are a sufficient form for some livestock feeding use. Few modern farms store maize in this manner. Most harvest the grain from the field and store it in bins. The combine with a corn head (with points and snap rolls instead of a reel) does not cut the stalk; it simply pulls the stalk down. The stalk continues downward and is crumpled into a mangled pile on the ground. The ear of maize is too large to pass between slots in a plate as the snap rolls pull the stalk away, leaving only the ear and husk to enter the machinery. The combine separates out the husk and the cob, keeping only the kernels.

For storing grain in bins, the moisture of the grain must be sufficiently low to avoid spoiling. If the moisture content of the harvested grain is too high, [grain dryers](/wiki/Grain_drying) are used to reduce the moisture content by blowing heated air through the grain. This can require large amounts of energy in the form of combustible gases ([propane](/wiki/Propane) or [natural gas](/wiki/Natural_gas)) and electricity to power the blowers.[[67]](#cite_note-67)

### Quantity[[edit](/index.php?title=(none)&action=edit&section=14)]

[thumb|right|Worldwide maize production](/wiki/File:MaizeYield.png) [thumb|right|Harvesting maize during the record 2009 season in](/wiki/File:Iowa_harvest_2009.jpg) [Jones County, Iowa](/wiki/Jones_County,_Iowa) [thumb|Maize in Beijing, China, October 2012](/wiki/File:CORN_ON_THE_COB_BEIJING_CHINA_OCT_2012_(8641099254).jpg)

Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain.[[68]](#cite_note-68) The United States produces 40% of the world's harvest; other top producing countries include China, Brazil, [Mexico](/wiki/Mexico), [Indonesia](/wiki/Indonesia), India, France and [Argentina](/wiki/Argentina). Worldwide production was 817 million [tonnes](/wiki/Tonne) in 2009—more than [rice](/wiki/Rice) (678 million [tonnes](/wiki/Tonne)) or [wheat](/wiki/Wheat) (682 million [tonnes](/wiki/Tonne)).[[11]](#cite_note-11) In 2009, over 159 million [hectares](/wiki/Hectare) (390 million acres) of maize were planted worldwide, with a yield of over 5 tonnes per hectare (80 bu/acre). Production can be significantly higher in certain regions of the world; 2009 forecasts for production in Iowa were 11614 kg/ha (185 bu/acre).[[69]](#cite_note-69)[Template:Refn](/wiki/Template:Refn) There is conflicting evidence to support the hypothesis that maize yield potential has increased over the past few decades. This suggests that changes in yield potential are associated with leaf angle, lodging resistance, tolerance of high plant density, disease/pest tolerance, and other agronomic traits rather than increase of yield potential per individual plant.[[70]](#cite_note-70)

|  |
| --- |
| **colspan=2|Top ten maize producers in 2013**[**[71]**](#cite_note-71) |
| **Country** | **Production (**[**tonnes**](/wiki/Tonne)**)** |
| [Template:Flag](/wiki/Template:Flag) | align=right|353,699,441 |
| [Template:Flag](/wiki/Template:Flag) | align=right|217,730,000 |
| [Template:Flag](/wiki/Template:Flag) | align=right|80,516,571 |
| [Template:Flag](/wiki/Template:Flag) | align=right|32,119,211 |
| [Template:Flag](/wiki/Template:Flag) | align=right|30,949,550 |
| [Template:Flag](/wiki/Template:Flag) | align=right|23,290,000 |
| [Template:Flag](/wiki/Template:Flag) | align=right|22,663,953 |
| [Template:Flag](/wiki/Template:Flag) | align=right|18,511,853 |
| [Template:Flag](/wiki/Template:Flag) | align=right|15,053,100 |
| [Template:Flag](/wiki/Template:Flag) | align=right|12,365,000 |
| [Template:Noflag](/wiki/Template:Noflag)**World** | align=right| **1,016,431,783** |
|  |  |

#### United States[[edit](/index.php?title=(none)&action=edit&section=15)]

[thumb|400px|Corn production by county in the United States, 2010](/wiki/File:Corn_belt.svg) [Template:Main](/wiki/Template:Main) In 2010, the maize planted area for all purposes in the US was estimated at 35 million hectares (87.9 million acres),[[72]](#cite_note-72) following an increasing trend since 2008.[[73]](#cite_note-73) About 14% of the harvested corn area is irrigated.[[74]](#cite_note-74)

## Pests[[edit](/index.php?title=(none)&action=edit&section=16)]

### Insects[[edit](/index.php?title=(none)&action=edit&section=17)]

* [African armyworm](/wiki/African_armyworm) (*Spodoptera exempta*)
* Common armyworm ([*Pseudaletia unipuncta*](/wiki/Pseudaletia_unipuncta))
* [Common earwig](/wiki/Common_earwig) (*Forficula auricularia*)
* [Corn delphacid](/wiki/Corn_delphacid) (*Peregrinus maidis*)
* [Corn leaf aphid](/wiki/Corn_leaf_aphid) (*Rhopalosiphum maidis*)
* Corn rootworms ([*Diabrotica*](/wiki/Diabrotica) *spp*) including [Western corn rootworm](/wiki/Western_corn_rootworm) (*Diabrotica virgifera virgifera* LeConte), Northern corn rootworm (*D. barberi*) and Southern corn rootworm (*D. undecimpunctata howardi*)
* [Corn silkfly](/wiki/Euxesta_stigmatias) ([*Euxesta stigmatias*](/wiki/Euxesta_stigmatias))
* [European corn borer](/wiki/European_corn_borer) (*Ostrinia nubilalis*) (ECB)
* [Fall armyworm](/wiki/Fall_armyworm) (*Spodoptera frugiperda*)
* Corn earworm/Cotton bollworm ([*Helicoverpa zea*](/wiki/Helicoverpa_zea))
* [Lesser cornstalk borer](/wiki/Lesser_cornstalk_borer) (*Elasmopalpus lignosellus*)
* [Maize weevil](/wiki/Maize_weevil) (*Sitophilus zeamais*)
* Northern armyworm, Oriental armyworm or Rice ear-cutting caterpillar ([*Mythimna separata*](/wiki/Mythimna_separata))
* [Southwestern corn borer](/wiki/Southwestern_corn_borer) (*Diatraea grandiosella*)
* [Stalk borer](/wiki/Stalk_Borer) (*Papaipema nebris*)

The susceptibility of maize to the European corn borer and corn rootworms, and the resulting large crop losses which are estimated at a billion dollars worldwide for each pest,[[75]](#cite_note-75)[[76]](#cite_note-76)[[77]](#cite_note-77) led to the development of [transgenics](/wiki/Transgenic_plants) expressing the [*Bacillus thuringiensis*](/wiki/Bacillus_thuringiensis) toxin. "Bt maize" is widely grown in the United States and has been approved for release in Europe.

### Diseases[[edit](/index.php?title=(none)&action=edit&section=18)]

[Template:Main](/wiki/Template:Main)

* [Rust](/wiki/Rust_(fungus))
* [Corn smut](/wiki/Corn_smut) or common smut (*Ustilago maydis*): a fungal disease, known in [Mexico](/wiki/Mexico) as *huitlacoche*, which is prized by some as a gourmet delicacy in itself
* Northern corn leaf blight [(Purdue Extension site)](http://www.extension.purdue.edu/extmedia/BP/BP-84-W.pdf) [(Pioneer site)](https://www.pioneer.com/home/site/us/agronomy/crop-management/corn-insect-disease/northern-leaf-blight)
* [Southern corn leaf blight](/wiki/Southern_corn_leaf_blight)
* [Maize dwarf mosaic virus](/wiki/Maize_dwarf_mosaic_virus)
* [Maize streak virus](/wiki/Maize_streak_virus)
* [Stewart's Wilt](/wiki/Stewart's_Wilt) (*Pantoea stewartii*)
* Goss's Wilt ([*Clavibacter michiganensis*](/wiki/Clavibacter_michiganensis))
* [Grey leaf spot](/wiki/Grey_leaf_spot)
* Mal de Río Cuarto virus (MRCV)
* Stalk rot
* Ear rot

## Uses[[edit](/index.php?title=(none)&action=edit&section=19)]

### Human food{{anchor|Food}}[[edit](/index.php?title=(none)&action=edit&section=20)]

[thumb|Vegetable maize (sweet corn)](/wiki/File:Maiskörner.jpg) [thumb|Maize being](/wiki/File:A_process_of_Maize_dish_making_1.JPG) [roasted](/wiki/Roasting) over an open flame in [India](/wiki/India). [thumb|Cut white sweet corn](/wiki/File:Sweet_White_Corn.jpg) [thumb|Dried maize](/wiki/File:Dried_Maize_Mote_from_Oaxaca.png) [*mote*](/wiki/Mote_(food)), also known as [hominy](/wiki/Hominy), is used in [Mexican cuisine](/wiki/Mexican_cuisine)

Maize and [cornmeal](/wiki/Cornmeal) (ground dried maize) constitute a [staple food](/wiki/Staple_food) in many regions of the world.

Maize is central to [Mexican food](/wiki/Mexican_food). Virtually every dish in Mexican cuisine uses maize. In the form of grain or cornmeal, maize is the main ingredient of [tortillas](/wiki/Tortillas), [tamales](/wiki/Tamale), [pozole](/wiki/Pozole), [atole](/wiki/Atole) and all the dishes based on them, like [tacos](/wiki/Taco), [quesadillas](/wiki/Quesadilla), [chilaquiles](/wiki/Chilaquiles), [enchiladas](/wiki/Enchilada), [tostadas](/wiki/Tostada_(tortilla)) and many more. In Mexico even a fungus of maize, known as [huitlacoche](/wiki/Huitlacoche) is considered a delicacy.

Introduced into Africa by the Portuguese in the 16th century, maize has become Africa's most important staple food crop.[[78]](#cite_note-78) Maize meal is made into a thick [porridge](/wiki/Porridge) in many cultures: from the [polenta](/wiki/Polenta) of Italy, the *angu* of Brazil, the [*mămăligă*](/wiki/Mămăligă) of [Romania](/wiki/Romania), to [cornmeal mush](/wiki/Mush_(cornmeal)) in the US (and [hominy](/wiki/Hominy) [grits](/wiki/Grits) in the South) or the food called [mealie pap](/wiki/Mealie_pap) in South Africa and [*sadza*](/wiki/Sadza), [*nshima*](/wiki/Nshima) and [*ugali*](/wiki/Ugali) in other parts of Africa. Maize meal is also used as a replacement for [wheat](/wiki/Wheat) flour, to make [cornbread](/wiki/Cornbread) and other baked products. [Masa](/wiki/Masa) (cornmeal treated with [limewater](/wiki/Limewater)) is the main ingredient for [tortillas](/wiki/Tortilla), [atole](/wiki/Atole) and many other dishes of Central American food.

[Popcorn](/wiki/Popcorn) consists of kernels of certain varieties that explode when heated, forming fluffy pieces that are eaten as a snack. Roasted dried maize ears with semihardened kernels, coated with a seasoning mixture of fried chopped spring onions with salt added to the oil, is a popular [snack food](/wiki/Snack_food) in Vietnam. *Cancha*, which are roasted maize chulpe kernels, are a very popular snack food in Peru, and also appears in traditional Peruvian [*ceviche*](/wiki/Ceviche). An unleavened bread called [*makki di roti*](/wiki/Makki_di_roti) is a popular bread eaten in the [Punjab region](/wiki/Punjab_region) of India and Pakistan.

[*Chicha*](/wiki/Chicha) and *chicha morada* (purple chicha) are drinks typically made from particular types of maize. The first one is fermented and alcoholic, the second is a soft drink commonly drunk in Peru.

[Corn flakes](/wiki/Corn_flakes) are a common [breakfast cereal](/wiki/Breakfast_cereal) in North America and the United Kingdom, and found in many other countries all over the world.

Maize can also be prepared as [hominy](/wiki/Hominy), in which the kernels are soaked with [lye](/wiki/Lye) in a process called [nixtamalization](/wiki/Nixtamalization); or [grits](/wiki/Grits), which are coarsely ground hominy. These are commonly eaten in the [Southeastern United States](/wiki/Southeastern_United_States), foods handed down from [Native Americans](/wiki/Native_Americans_in_the_United_States), who called the dish [sagamite](/wiki/Sagamite).

The Brazilian dessert [*canjica*](/wiki/Canjica_(dish)) is made by boiling maize kernels in sweetened milk. Maize can also be harvested and consumed in the unripe state, when the kernels are fully grown but still soft. Unripe maize must usually be cooked to become palatable; this may be done by simply boiling or roasting the whole ears and eating the kernels right off the cob. [Sweet corn](/wiki/Sweet_corn), a genetic variety that is high in sugars and low in starch, is usually consumed in the unripe state. Such [corn on the cob](/wiki/Corn_on_the_cob) is a common dish in the United States, Canada, United Kingdom, [Cyprus](/wiki/Cyprus), some parts of South America, and the Balkans, but virtually unheard of in some European countries. Corn on the cob was hawked on the streets of early 19th-century New York City by poor, barefoot "[Hot Corn](/wiki/Hot_Corn) Girls", who were thus the precursors of [hot dog carts](/wiki/Hot_dog_cart), [churro](/wiki/Churro) wagons, and fruit stands seen on the streets of big cities today.[[79]](#cite_note-79) The cooked, unripe kernels may also be shaved off the cob and served as a [vegetable](/wiki/Vegetable) in side dishes, [salads](/wiki/Salad), [garnishes](/wiki/Garnish_(food)), etc. Alternatively, the raw unripe kernels may also be grated off the cobs and processed into a variety of cooked dishes, such as maize [purée](/wiki/Purée), [tamales](/wiki/Tamale), [*pamonhas*](/wiki/Pamonha), [*curau*](/wiki/Curau), [cakes](/wiki/Cake), [ice creams](/wiki/Ice_cream), etc.

Maize is a major source of [starch](/wiki/Starch). [Cornstarch](/wiki/Cornstarch) (maize flour) is a major ingredient in home cooking and in many industrialized food products. Maize is also a major source of [cooking oil](/wiki/Cooking_oil) ([corn oil](/wiki/Corn_oil)) and of maize gluten. Maize starch can be [hydrolyzed](/wiki/Hydrolysis) and enzymatically treated to produce syrups, particularly [high fructose corn syrup](/wiki/High_fructose_corn_syrup), a sweetener; and also fermented and distilled to produce [grain alcohol](/wiki/Grain_alcohol). Grain alcohol from maize is traditionally the source of [Bourbon whiskey](/wiki/Bourbon_whiskey). Maize is sometimes used as the starch source for [beer](/wiki/Beer). Within the United States, the usage of maize for human consumption constitutes about 1/40th of the amount grown in the country. In the United States and Canada, maize is mostly grown to feed [livestock](/wiki/Livestock), as forage, [silage](/wiki/Silage) (made by fermentation of chopped green cornstalks), or grain. Maize meal is also a significant ingredient of some commercial animal food products, such as [dog food](/wiki/Dog_food).

### Nutritional value[[edit](/index.php?title=(none)&action=edit&section=21)]

[Template:Nutritionalvalue](/wiki/Template:Nutritionalvalue)

In a 100-[gram](/wiki/Gram) serving, maize kernels provide 86 [calories](/wiki/Calories) and are a good source (10-19% of the [Daily Value](/wiki/Daily_Value)) of the [B vitamins](/wiki/B_vitamins), [thiamin](/wiki/Thiamin), [niacin](/wiki/Niacin), [pantothenic acid](/wiki/Pantothenic_acid) (B5) and [folate](/wiki/Folate) (right table for raw, uncooked kernels, [USDA](/wiki/USDA) Nutrient Database). In moderate amounts, they also supply [dietary fiber](/wiki/Dietary_fiber) and the [essential minerals](/wiki/Essential_minerals), [magnesium](/wiki/Magnesium) and [phosphorus](/wiki/Phosphorus) whereas other nutrients are in low amounts (see table on right).

### Chemicals[[edit](/index.php?title=(none)&action=edit&section=22)]

Starch from maize can also be made into [plastics](/wiki/Plastics), [fabrics](/wiki/Fabric), [adhesives](/wiki/Adhesive), and many other chemical products.

The [corn steep liquor](/wiki/Corn_steep_liquor), a plentiful watery byproduct of maize [wet milling](/wiki/Wet_milling) process, is widely used in the [biochemical industry](/wiki/Biochemistry) and research as a culture medium to grow many kinds of [microorganisms](/wiki/Microorganism).<ref name=a>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

[Chrysanthemin](/wiki/Chrysanthemin) is found in [purple corn](/wiki/Purple_corn) and is used as a food coloring.

### Bio-fuel[[edit](/index.php?title=(none)&action=edit&section=23)]

[Template:See also](/wiki/Template:See_also) "Feed maize" is being used increasingly for heating;[Template:Citation needed](/wiki/Template:Citation_needed) specialized [corn stoves](/wiki/Pellet_stove) (similar to [wood stoves](/wiki/Wood_fuel)) are available and use either feed maize or wood pellets to generate heat. Maize cobs are also used as a [biomass](/wiki/Biomass) fuel source. Maize is relatively cheap and home-heating furnaces have been developed which use maize kernels as a fuel. They feature a large hopper that feeds the uniformly sized maize kernels (or wood pellets or [cherry](/wiki/Cherry) pits) into the fire.

Maize is increasingly used as a feedstock for the production of [ethanol fuel](/wiki/Ethanol_fuel).[Template:Citation needed](/wiki/Template:Citation_needed) Ethanol is mixed with gasoline to decrease the amount of pollutants emitted when used to fuel motor vehicles. High fuel prices in mid-2007 led to higher demand for ethanol, which in turn led to higher prices paid to farmers for maize. This led to the 2007 harvest being one of the most profitable maize crops in modern history for farmers. Because of the relationship between fuel and maize, prices paid for the crop now tend to track the price of oil. [Template:Citation needed](/wiki/Template:Citation_needed)

The price of food is affected to a certain degree by the use of maize for biofuel production. The cost of transportation, production, and marketing are a large portion (80%) of the price of food in the United States. Higher energy costs affect these costs, especially transportation. The increase in food prices the consumer has been seeing is mainly due to the higher energy cost. The effect of biofuel production on other food crop prices is indirect. Use of maize for biofuel production increases the demand, and therefore price of maize. This, in turn, results in farm acreage being diverted from other food crops to maize production. This reduces the supply of the other food crops and increases their prices.[[80]](#cite_note-80)[[81]](#cite_note-81) [left|thumb|Farm-based maize silage digester located near](/wiki/File:Haase_anaerobic_digester.JPG) [Neumünster](/wiki/Neumünster) in Germany, 2007. Green inflatable biogas holder is shown on top of the digester Maize is widely used in Germany as a feedstock for [biogas plants](/wiki/Anaerobic_digesters). Here the maize is harvested, shredded then placed in [silage](/wiki/Silage) clamps from which it is fed into the biogas plants. This process makes use of the whole plant rather than simply using the kernels as in the production of fuel ethanol.

A [biomass gasification](/wiki/Biomass_gasification) power plant in Strem near [Güssing](/wiki/Güssing), [Burgenland](/wiki/Burgenland), Austria, began in 2005. Research is being done to make [diesel](/wiki/Diesel_fuel) out of the biogas by the [Fischer Tropsch](/wiki/Fischer_Tropsch) method.

Increasingly, ethanol is being used at low concentrations (10% or less) as an additive in [gasoline](/wiki/Gasoline) ([gasohol](/wiki/Gasohol)) for motor fuels to increase the [octane rating](/wiki/Octane_rating), lower pollutants, and reduce petroleum use (what is nowadays also known as "[biofuels](/wiki/Biofuels)" and has been generating an intense debate regarding the human beings' necessity of new sources of energy, on the one hand, and the need to maintain, in regions such as Latin America, the food habits and culture which has been the essence of civilizations such as the one originated in Mesoamerica; the entry, January 2008, of maize among the commercial agreements of [NAFTA](/wiki/North_American_Free_Trade_Agreement) has increased this debate, considering the bad labor conditions of workers in the fields, and mainly the fact that NAFTA "opened the doors to the import of maize from the United States, where the farmers who grow it receive multimillion dollar subsidies and other government supports. (...) According to OXFAM UK, after NAFTA went into effect, the price of maize in Mexico fell 70% between 1994 and 2001. The number of farm jobs dropped as well: from 8.1 million in 1993 to 6.8 million in 2002. Many of those who found themselves without work were small-scale maize growers.").[[82]](#cite_note-82) However, introduction in the northern latitudes of the US of [tropical maize for biofuels](http://www.aces.uiuc.edu/news/stories/news4169.html), and not for human or animal consumption, may potentially alleviate this.

As a result of the [US federal government](/wiki/Federal_government_of_the_United_States) announcing its production target of [Template:Convert](/wiki/Template:Convert) of biofuels by 2017, ethanol production will grow to [Template:Convert](/wiki/Template:Convert) by 2010, up from 4.5 billion in 2006, boosting ethanol's share of maize demand in the US from 22.6 percent to 36.1 percent.[[83]](#cite_note-83)

### Ornamental and other uses[[edit](/index.php?title=(none)&action=edit&section=24)]

[Template:Main](/wiki/Template:Main) Some forms of the plant are occasionally grown for ornamental use in the garden. For this purpose, variegated and colored leaf forms as well as those with colorful ears are used.

Corncobs can be hollowed out and treated to make inexpensive [smoking pipes](/wiki/Smoking_pipe_(tobacco)), first manufactured in the United States in 1869.

[thumb|right|Children playing in a maize kernel box](/wiki/File:CornKernelBox.jpg) An unusual use for maize is to create a "[corn maze](/wiki/Corn_maze)" (or "maize maze") as a tourist attraction. The idea of a maize maze was introduced by the American Maze Company who created a maze in [Pennsylvania](/wiki/Pennsylvania) in 1993.[[84]](#cite_note-84) Traditional mazes are most commonly grown using [yew](/wiki/Taxus) [hedges](/wiki/Hedge_(gardening)), but these take several years to mature. The rapid growth of a field of maize allows a maze to be laid out using [GPS](/wiki/Global_Positioning_System) at the start of a growing season and for the maize to grow tall enough to obstruct a visitor's line of sight by the start of the summer. In Canada and the US, these are popular in many farming communities.

Maize kernels can be used in place of sand in a [sandboxlike](/wiki/Sandpit) enclosure for children's play.<ref name=corn\_box>[Template:Cite web](/wiki/Template:Cite_web)</ref>

Stigmas from female maize flowers, popularly called [corn silk](/wiki/Corn_silk), are sold as [herbal supplements](/wiki/Herbalism).[Template:Citation needed](/wiki/Template:Citation_needed)

Maize is used as a [fish bait](/wiki/Bait_(luring_substance)), called "dough balls". It is particularly popular in Europe for [coarse fishing](/wiki/Coarse_fishing).

Additionally, feed corn is sometimes used by hunters to bait animals such as deer or wild hogs.

### Fodder[[edit](/index.php?title=(none)&action=edit&section=25)]

Maize produces a greater quantity of biomass than other [cereal](/wiki/Cereal) plants, which is used for [fodder](/wiki/Fodder). Digestibility and palatability are higher when ensiled and fermented, rather than dried.

### Commodity[[edit](/index.php?title=(none)&action=edit&section=26)]

Maize is bought and sold by investors and price speculators as a tradable commodity using corn [futures contracts](/wiki/Futures_contract). These "futures" are traded on the [Chicago Board of Trade](/wiki/Chicago_Board_of_Trade) (CBOT) under [ticker symbol](/wiki/Ticker_symbol) **C**. They are delivered every year in March, May, July, September, and December.[[85]](#cite_note-85)

### United States usage breakdown[[edit](/index.php?title=(none)&action=edit&section=27)]

The breakdown of usage of the 12.1-billion-[bushel](/wiki/Bushel) (307-million-tonne) 2008 US maize crop was as follows, according to the World Agricultural Supply and Demand Estimates Report by the USDA.[[86]](#cite_note-86)

|  |  |
| --- | --- |
| **rowspan=2|Use** | **colspan=3|Amount** |
| **million bushels** | **million tonnes** | **percentage** |
| livestock feed | align=right|5,250 | align=right|133.4 | align=right|43.4 |
| [ethanol](/wiki/Ethanol_fuel) production | align=right|3,650 | align=right|92.7 | align=right|30.2 |
| exports | align=right|1,850 | align=right|47.0 | align=right|15.3 |
| production of starch, corn oil, sweeteners ([HFCS](/wiki/High-fructose_corn_syrup), etc.) | align=right|943 | align=right|24.0 | align=right|7.8 |
| human consumption—grits, corn flour, corn meal, beverage alcohol | align=right|327 | align=right|8.3 | align=right|2.7 |

In the US since 2009/2010, maize feedstock use for ethanol production has somewhat exceeded direct use for livestock feed; maize use for fuel ethanol was 5,130 million bushels (130 million tonnes) in the 2013/2014 marketing year.[[87]](#cite_note-87) A fraction of the maize feedstock dry matter used for ethanol production is usefully recovered as DDGS (dried distillers grains with solubles). In the 2010/2011 marketing year, about 29.1 million tonnes of DDGS were fed to US livestock and poultry.<ref name=Hoffman2011>Hoffman, L. and A. Baker. 2011. Estimating the substitution of distillers'grains for corn and soybean meal in the U.S. feed complex. United States Department of Agriculture, Economic Research Service. FDS-11-l-01. 62 pp.</ref> Because starch utilization in fermentation for ethanol production leaves other grain constituents more concentrated in the residue, the feed value per kg of DDGS, with regard to ruminant-metabolizable energy and protein, exceeds that of the grain. Feed value for monogastric animals, such as swine and poultry, is somewhat lower than for ruminants.<ref name=Hoffman2011/>

## Comparison to other staple foods[[edit](/index.php?title=(none)&action=edit&section=28)]

[Template:Nutrient contents of common foods](/wiki/Template:Nutrient_contents_of_common_foods) The following table shows the nutrient content of maize and major staple foods in a raw harvested form. Raw forms are not edible and cannot be digested. These must be sprouted, or prepared and cooked for human consumption. In sprouted or cooked form, the relative nutritional and anti-nutritional contents of each of these staples are different from that of raw form of these staples reported in the table below. [Template:Comparison of major staple foods](/wiki/Template:Comparison_of_major_staple_foods)

## Hazards[[edit](/index.php?title=(none)&action=edit&section=29)]

### Pellagra[[edit](/index.php?title=(none)&action=edit&section=30)]

[Template:Main](/wiki/Template:Main) When maize was first introduced into farming systems other than those used by traditional native-American peoples, it was generally welcomed with enthusiasm for its productivity. However, a widespread problem of malnutrition soon arose wherever maize was introduced as a [staple food](/wiki/Staple_food). This was a mystery, since these types of malnutrition were not normally seen among the indigenous Americans, for whom maize was the principal staple food.<ref name=pellagra\_mystery>[Template:Cite web](/wiki/Template:Cite_web)</ref>

It was eventually discovered that the indigenous Americans had learned to soak maize in [alkali](/wiki/Alkali)-water—made with ashes and lime ([calcium oxide](/wiki/Calcium_oxide)) since at least 1200–1500 BC by [Mesoamericans](/wiki/Mesoamericans) and North Americans—which liberates the B-vitamin [niacin](/wiki/Niacin), the lack of which was the underlying cause of the condition known as [pellagra](/wiki/Pellagra).[[88]](#cite_note-88) Maize was introduced into the diet of nonindigenous Americans without the necessary cultural knowledge acquired over thousands of years in the Americas. In the late 19th century, pellagra reached epidemic proportions in parts of the southern US, as medical researchers debated two theories for its origin: the deficiency theory (which was eventually shown to be true) said that pellagra was due to a deficiency of some nutrient, and the germ theory said that pellagra was caused by a germ transmitted by stable flies. A third theory, promoted by the eugenicist [Charles Davenport](/wiki/Charles_Davenport), held that people only contracted pellagra if they were susceptible to it due to certain "constitutional, inheritable" traits of the affected individual.[[89]](#cite_note-89) Once alkali processing and dietary variety were understood and applied, pellagra disappeared in the developed world. The development of high lysine maize and the promotion of a more balanced diet have also contributed to its demise. Pellagra still exists today in food-poor areas and refugee camps where people survive on donated maize.[[90]](#cite_note-90)

### Allergy[[edit](/index.php?title=(none)&action=edit&section=31)]

Maize contains [lipid transfer protein](/wiki/Lipid_transfer_proteins), an indigestible protein that survives cooking. This protein has been linked to a rare and understudied [allergy](/wiki/Allergy) to maize in humans.[[91]](#cite_note-91) The allergic reaction can cause skin rash, swelling or itching of [mucous membranes](/wiki/Mucous_membranes), diarrhea, vomiting, [asthma](/wiki/Asthma) and, in severe cases, [anaphylaxis](/wiki/Anaphylaxis). It is unclear how common this allergy is in the general population.

## Art[[edit](/index.php?title=(none)&action=edit&section=32)]

[Template:Multiple image](/wiki/Template:Multiple_image) Maize has been an essential crop in the [Andes](/wiki/Andes) since the [pre-Columbian era](/wiki/Pre-Columbian_era). The [Moche](/wiki/Moche_culture) culture from Northern [Peru](/wiki/Peru) made ceramics from earth, water, and fire. This pottery was a sacred substance, formed in significant shapes and used to represent important themes. Maize represented anthropomorphically as well as naturally.[[92]](#cite_note-92) In the United States, maize ears along with tobacco leaves are carved into the capitals of columns in the [United States Capitol](/wiki/United_States_Capitol) building. Maize itself is sometimes used for temporary architectural detailing when the intent is to celebrate the fall season, local agricultural productivity and culture. Bundles of dried maize stalks are often displayed often along with pumpkins, gourds and straw in autumnal displays outside homes and businesses. A well-known example of architectural use is the [Corn Palace](/wiki/Corn_Palace) in Mitchell, South Dakota, which uses cobs and ears of colored maize to implement a mural design that is recycled annually.

A maize stalk with two ripe ears is depicted on the [reverse](/wiki/Obverse_and_reverse) of the Croatian 1 [lipa](/wiki/Croatian_kuna) coin, minted since 1993.[[93]](#cite_note-93)

## See also[[edit](/index.php?title=(none)&action=edit&section=33)]

[Template:Portal](/wiki/Template:Portal) [Template:Div col](/wiki/Template:Div_col)

* [Blue corn](/wiki/Blue_corn)
* [Purple corn](/wiki/Purple_corn)
* [Columbian Exchange](/wiki/Columbian_Exchange)
* [Corn syrup](/wiki/Corn_syrup)
* [Crop circle](/wiki/Crop_circle)
* [Detasseling](/wiki/Detasseling)
* [List of maize dishes](/wiki/List_of_maize_dishes)
* [List of sweetcorn varieties](/wiki/List_of_sweetcorn_varieties)
* [Post-harvest losses (grains)](/wiki/Post-harvest_losses_(grains))
* [Protein per unit area](/wiki/Protein_per_unit_area)
* [Push–pull technology](/wiki/Push–pull_technology), pest control strategy for maize and [sorghum](/wiki/Sorghum)
* [Zein](/wiki/Zein)

[Template:Div col end](/wiki/Template:Div_col_end)

## Notes[[edit](/index.php?title=(none)&action=edit&section=34)]

[Template:Reflist](/wiki/Template:Reflist)

## References[[edit](/index.php?title=(none)&action=edit&section=35)]

[Template:Reflist](/wiki/Template:Reflist)

## Further reading[[edit](/index.php?title=(none)&action=edit&section=36)]

* [Template:Cite book](/wiki/Template:Cite_book)
* Clampitt, Cynthia. *Maize: How Corn Shaped the U.S. Heartland* (2015)
* [Template:Cite web](/wiki/Template:Cite_web)
* [Template:Cite book](/wiki/Template:Cite_book)

## External links[[edit](/index.php?title=(none)&action=edit&section=37)]

[Template:Commons](/wiki/Template:Commons) [Template:Wikispecies](/wiki/Template:Wikispecies)

* [Maize Genetics and Genomics Database](http://www.maizegdb.org/)
* [Maize Genetics Cooperation Stock Center](http://maizecoop.cropsci.uiuc.edu/)
* [Template:GRIN](/wiki/Template:GRIN)

[Template:Corn](/wiki/Template:Corn) [Template:Cereals](/wiki/Template:Cereals) [Template:Agriculture country lists](/wiki/Template:Agriculture_country_lists) [Template:Model Organisms](/wiki/Template:Model_Organisms) [Template:Bioenergy](/wiki/Template:Bioenergy)

[Template:Authority control](/wiki/Template:Authority_control)

[Category:Maize](/wiki/Category:Maize) [Category:Zea (genus)](/wiki/Category:Zea_(genus)) [Category:Agriculture in Mesoamerica](/wiki/Category:Agriculture_in_Mesoamerica) [Category:Crops originating from Mexico](/wiki/Category:Crops_originating_from_Mexico) [Category:Crops originating from Indigenous Americans](/wiki/Category:Crops_originating_from_Indigenous_Americans) [Category:Demulcents](/wiki/Category:Demulcents) [Category:Energy crops](/wiki/Category:Energy_crops) [Category:Flora of Guatemala](/wiki/Category:Flora_of_Guatemala) [Category:Fruit vegetables](/wiki/Category:Fruit_vegetables) [Category:Grasses of Mexico](/wiki/Category:Grasses_of_Mexico) [Category:Plant models](/wiki/Category:Plant_models) [Category:Plants used in Native American cuisine](/wiki/Category:Plants_used_in_Native_American_cuisine) [Category:Staple foods](/wiki/Category:Staple_foods) [Category:Tropical agriculture](/wiki/Category:Tropical_agriculture) [Category:Plants described in 1753](/wiki/Category:Plants_described_in_1753) [Category:Taxa named by Carl Linnaeus](/wiki/Category:Taxa_named_by_Carl_Linnaeus)