Demonstration of soybean history from domestication to modern varieties

_Glycine soja_ is the wild progenitor of soybean. The plant is a vine that twines around other plants and structures for support. Leaflets are much smaller than those of modern soybean varieties. _Glycine soja_ seeds are small, black, and hard.

The USDA began organized introductions of soybean from China and other Asian nations in 1898. Examples of these early introductions are Mukden and Mandarin. The primary purpose for soybean cultivation in the USA was hay and other forage uses until World War II. By 1944, nearly 75% of USA soybean acreage was harvested for grain. Soybean introductions were used as parents to develop new varieties. Soybean breeding at universities and private companies has resulted in hundreds of choices for USA farmers. The MU Gene Zoo displays important varieties released within each decade from the 1920’s through early 2000’s.

Demonstration of the use of biotech and non-biotech trait development

Soybean varieties may possess one or both biotechnology traits that confer resistance to herbicides. The glyphosate resistance trait (e.g. Roundup Ready® and Roundup Ready 2 Yield®) came from a bacterium in the _Agrobacterium_ genus. The glufosinate resistance trait (Liberty Link®) originated in the bacterium _Streptomyces hygroscopius_. Both of these traits allow for the post emergence application of a nonselective herbicide to soybean plants. STS® is a non-biotech trait that increases soybean plant tolerance to a class of herbicides called sulfonyleurea.

Demonstration of special uses

Soybean seeds are rich sources of both protein and oil. One bushel of soybeans (60 pounds) yields about 47.5 pounds of soybean meal (protein) and 10.7 pounds of crude oil. Soy protein possesses a good balance of essential amino acids and is used in balancing feed rations for hogs, poultry, and cattle. Many high quality pet foods contain soy protein. Over 90% of the oil derived from soybean seeds is used for human consumption. Soy oil contains appreciable amounts of five fatty acids. About 15% of the fatty acids are saturated and more than 60% are polyunsaturated. Special use varieties with lower amounts of saturated fatty acids (low palmitic), higher amounts of monounsaturated fatty acids (high oleic), or lower amounts of polyunsaturated fatty acids (low linolenic) have been developed. Seeds of varieties labeled Vistive® Gold produce oil that is lower than normal for polyunsaturated, lower than normal for saturated, and higher than normal for monounsaturated fatty acids. A product of Monsanto Company.

Seeds from all soybean varieties are edible for humans. Some varieties have been developed specifically for use as whole or processed beans for food. The scar where the seed is attached to the pod is called a hilum. These hila can be dark in
color or clear. Many food grade soybeans have clear hila. Tofu varieties are usually large seeded. Tofu is made from coagulated soymilk. It has little flavor or odor on its own and is often added to other foods.

**Natto varieties** are usually small seeded and are used to make a fermented product with high protein content. Fermentation is facilitated by the bacterium *Bacillus subtilis natto*. Natto has a sticky texture and strong odor and taste.

**Edamame** soybeans are harvested, usually by hand, before maturity. The seeds are left in the pod and boiled. Edamame varieties are often large seeded with a milder taste than normal soybean varieties.

### Demonstration of the effects of single genes on plant development and morphology

The MU Gene Zoo illustrates the effects of 12 single gene traits in a common Clark background. **Chlorophyll deficient** reduces the production of the green pigment chlorophyll in leaves. Leaves appear yellow or light green. **Glabrous pubescence** results in stems and leaves with no pubescence. Pubescence are hair-like structures that protect soybean plants from feeding of insects with sucking mouth parts. Plants without pubescence often suffer from viruses that are transmitted by these insects. **Dense pubescence** results in stems and leaves with a greater than normal amounts of pubescence. Soybean growth habit is controlled by two genes. One gene determines if the plant possesses the **indeterminate** (*Dt1Dt1*) growth habit (as in Clark) or **determinate** (*dt1dt1*) growth habit. A second gene (*Dt2*) causes plants to have a **semideterminate** growth habit if combined with *Dt1Dt1*. **Fasciated stem** causes stems to be broader than normal with shorter internodes. **Five leaflet** causes leaves to produce five leaflets instead of the normal three. **Seven leaflet** causes leaves to produce seven leaflets instead of the normal three. **Wavy leaflet** causes a wavy edge on each leaflet.

Specific genes are also used to confer resistance to soybean cyst nematode (SCN). Nematodes are a small, soil-living, round worms that attack soybean roots. Several genes confer resistance to SCN. These genes interfere with feeding and reproduction of the female nematode. The most common source of SCN resistance comes from the plant introduction, **PI88788**. The first variety with this source was released in 1978. Nearly 95% of all SCN resistant varieties in the USA have PI88788 as the source of SCN resistance. Another source of resistance that is used in some varieties is **Peking**. **PI437654** is a plant introduction that confers SCN resistance to all known biotypes. It was first used as a parent of the soybean variety ‘Hartwig’.

### Demonstration of adaptation

Although temperature affects soybean growth and development, soybean plants are also quite sensitive to photoperiod. Because of soybean’s sensitivity to photoperiod, soybean varieties are assigned to one of 13 maturity groups. These maturity groups are adapted to relatively narrow bands of latitude. In North America, MG OOO is adapted to southern Canada; whereas, MG 10 (X) is adapted to Mexico and the Caribbean Islands. Maturity Groups adapted to Missouri are 3, 4 and 5.

![Maturity Groups Map](image)