

# Creating the...

# Roundup Ready<sup>®</sup> Soybean



## Methods of Weed Control:

**Preventative:** Using any method aimed to prevent weeds from ever growing. Examples include using certified weed-free seed or screening irrigation water to diminish seeds traveling through irrigation.

**Cultural:** Maintaining field conditions where weeds are less likely to become established. Examples include crop rotation, avoiding overgrazing, and using competitive crop varieties.

**Mechanical:** Any technique that involves the use of farm equipment to control weeds, such as tillage and mowing.

**Biological:** The use of natural enemies of weed plants to control growth or germination of weeds. Examples include using sheep or goats to control specific types of weeds.

**Chemical:** Any technique involving the application of chemicals, such as an herbicide. Examples include selective herbicides like 2,4-D or non-selective herbicides like glyphosate used in conjunction with herbicide-tolerant GM crops.

## The Soybean

Soybean, also known as *soya bean*, is a species of legume that is native to East Asia. It is widely grown for its edible bean and has many uses for human and animal consumption.

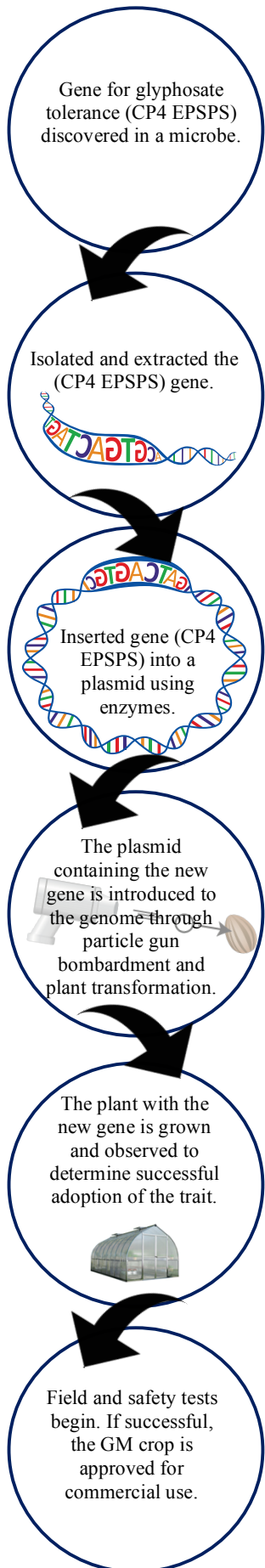
Soybean has the remarkable ability to produce more edible protein per acre of land than any other known crop. On average, dry soybean contains roughly 40% protein and 20% oil, has the highest protein content among cereals and other legume species, and has the second-highest oil content among all food legumes. Soybean is highly versatile and can be processed into a wide variety of food products including tofu, soybean sauce, soymilk, energy bars, and meat substitutes. A major food use for soybean is purified oil for use in margarines, shortenings, and cooking and salad oils.

Soybean *meal* is the portion of the soybean left after oil is extracted. It is used as a supplement in feed rations for livestock. Soybean meal is the most valuable component obtained from processing the soybean, accounting for roughly 50-75% of its overall value. By far, soybean meal is the world's most important protein feed, accounting for nearly 69% of world protein meal supplies (ASA, 2008).

## Weeds and Crop Growth

Weed management is an important factor in agricultural production that impacts crop yield (the amount of a crop that is produced and harvested). Uncontrolled weeds reduce the quantity and quality of a planted crop. Nutrients (found in the soil) and water are necessary, but limited, natural resources for healthy plant growth. Weeds (unwanted plants) compete with planted crops for water and nutrients, thus decreasing the overall harvest and decreasing the efficient use of natural resources.

Farmers can use a variety of weed control methods, which are commonly divided into five categories: preventative, cultural, mechanical, biological, and chemical weed control. Biotechnology is one of many tools helping farmers use these control methods to produce more food, fuel, and fiber while reducing their agricultural footprint. Weeds are a constant challenge for every farmer. Herbicides are the primary and most effective tool for farmers to control weeds and maximize crop yields. Using herbicides (rather than other weed control methods like hand weeding and tillage) can reduce labor, increase convenience, conserve soil, and make food less expensive to produce.



## Creating the Roundup Ready Soybean

The Roundup Ready® soybean was developed to help farmers manage weeds in their fields. When weeds are left to compete with soybeans for the entire growing season, yield losses can exceed 75%. Nearly all soybean fields receive some type of herbicide treatment. Monsanto scientists developed the Roundup Ready® soybean technology as a tool to help farmers control weeds in soybean fields.

The Roundup Ready® soybean began with the discovery of a naturally occurring gene in the environment that was responsible for conferring tolerance to the herbicide glyphosate (which is commercially known as Roundup®). The gene, abbreviated as *CP4 EPSPS*, was found in a microbe. The gene was isolated and extracted from the microbe and then inserted into a plasmid. Using particle gun bombardment and plant transformation, scientists inserted the gene into the genome of the soybean (*Glycine max*).

The particle bombardment method starts with coating tungsten or gold particles (microprojectiles) with plasmid DNA. The coated particles are coated on a macroprojectile, which is accelerated with air pressure and shot into plant tissue on a Petri plate. A perforated plate is used to stop the macroprojectile, while allowing the microprojectiles to pass through to the cells on the other side. As the microprojectiles enter the cells, the plasmid DNA is released from the particle surface. Some of the DNA will then be incorporated into the chromosomal DNA of the cells. The transformed plant cells are then regenerated into whole plants using tissue culture, a common method of plant propagation.

## Plant Testing and Regulation

Once a genetically modified (GM) crop has been developed, the process of field testing and regulation begins. The Roundup Ready® Soybean was developed in 1990, but it was not commercially available to farmers for six more years while these steps were completed. First, the newly engineered seed variety with the chosen trait (herbicide resistance) is grown and observed for any changes to the typical growth habits and appearance of the plant. If the GM crop passes these tests, additional tests are performed and data is collected to assess and ensure the food and feed safety of the crop as well as safety to the environment. GM crops and conventional (non-GM) crops cannot have any compositional differences, such as changes in nutrients, toxins, allergens, or other compounds normally present in the crop. For crops used as animal feed (like soybeans) they must also pass an animal feeding study to show no change in animal growth and nutrition between GM and conventional feed. Once all the regulatory steps have been completed successfully, the genetically engineered seed can be made available to sell to farmers.