

Chapter One: The Soybean, It's History, and It's Opportunities

Soybeans....The Miracle Crop

Soybeans are often called the “miracle crop.” They are the world’s foremost provider of vegetable protein and oil. The bushy, green soybean plant is a legume related to peas, groundnuts (peanuts) and alfalfa. Soybeans are included in the category of oilseed, which is a generic reference to crops with seeds that can produce edible and/or non-edible oil in economic quantities. The most versatile of the world’s major crops, soybeans can be grown in a wider variety of soil and climatic conditions than any other major world crop. Consequently, soybeans are the most widely grown oilseed in the world. In the last 20 years, scientists have learned how to extract a much wider variety of byproducts from soybeans that are proving beneficial in animal feed, human food and industrial applications.

As early as 5,000 years ago, farmers in China grew soybeans. In 1804, a Yankee clipper ship from China brought soybeans to the U.S. And in 1829, U.S. farmers first grew soybeans. They raised a variety for soy sauce. During the Civil War, soldiers used soybeans as “coffee berries” to brew “coffee” when real coffee was scarce. In the late 1800s, significant numbers of farmers began to grow soybeans as forage for cattle.

In 1904, at the Tuskegee Institute in Tuskegee, Alabama, George Washington Carver began studying the soybean. His discoveries changed the way people thought about the soybean; no longer was it just a forage crop. Now its beans provided valuable protein and oil.

By 1929, U.S. soybean production had grown to 9 million bushels. That year, soybean pioneer William J. “Bill” Morse left on a two-year odyssey to China during which he gathered more than 10,000 soybean varieties for U.S. researchers to study. Some of these varieties laid the foundation for the rapid ascension of the U.S. as the world leader in soybean production.

Prior to World War II, the United States imported 40 percent of its edible fats and oil. At the start of the war, this oil supply was cut. Processors in the U.S. turned to soybean oil for their supply. By 1940, the U.S. soybean crop had grown to 78 million bushels harvested on 5 million acres.

In the early 1950s, soybean meal became available as a low-cost, high protein feed ingredient, triggering an explosion in U.S. livestock and poultry production. The U.S. soybean industry began to look at ways to expand export markets. In 1956, the American Soybean Association (ASA), in cooperation with the USDA-Foreign Agricultural Service, opened its first international office in Japan. Today, ASA-International Marketing promotes U.S. soybean and soy product exports in more than 80 countries.

In the past 30 years, the geography of U.S. soybean production and processing has changed. Production in the southern U.S. has declined due to a history of lower than average yields and competition from more profitable crops. This decline has been more than made up by expansion northward and westward, as new seed varieties requiring less growing time and tolerant of drier conditions were developed. Illinois and Iowa are the largest producing states. Northern states such as Minnesota, Nebraska, South Dakota and North Dakota, once considered too far north for soybean production, are now among the top 10 producing states.

Between 1976 and 2005, soybean plantings in the U.S. increased by 50 percent and national average soybean yields increased almost as much. Yield growth is attributed to improved seed varieties, new agronomic practices such as no-till farming and the impact of biotechnology-enhanced seeds that are tolerant of key herbicides.

The market for soybeans has gone global. Soybeans have long been used in food products in Japan. By the 1960s, a small but growing livestock industry in Japan began to use soybean meal as a protein and energy source. Rather than pay relatively higher ocean freight costs for the meal and soybean oil, a Japanese soy processing industry began to expand with imports of whole soybeans from the U.S.

Soybean use in Europe grew slowly in the 1960s and 1970s, but by the 1980s demand for soy meal and soy oil pushed growth in processing capacity. The largest concentration of capacity sprang up in the Rotterdam/Amsterdam/Ghent range that is the downstream terminus of Europe's inland waterway and river system. Products could move upstream by barge to feed manufacturers and edible oil users.

One characteristic of developing economies is that consumer demand for meat and poultry goes up as the population benefits from economic growth. So in the 1980s and 1990s, meat and poultry consumption in countries like China, South Korea, Mexico, Indonesia, Turkey and the Philippines climbed. And as local meat production struggled to keep up with the new consumers, demand for soybean products and capacity to produce them soared as well. Now, a thriving soybean processing industry has arisen throughout Asia and has spread to the Middle East, North Africa and throughout the Americas.

The use of soybean products for feed and food has continued to expand worldwide. China quadrupled its soybean processing capacity in just five years, beginning in 1998. Recent years have seen the increases in world soybean production and world soybean demand keep pace with one another.

Production and Processing Cycle of the Soybean

Production begins in the field with the soybean seed planted as early as April 15th or as late as July 15th. Planting dates vary depending on the latitude and geographic region. Classifications of soybean cultivars into maturity groups help U.S. farmers choose correct varieties for their regions. Farmers can potentially plant 6 to 10 different varieties of soybeans each growing season. Seeds develop in pods with each pod containing 1-5 seeds, but the most common varieties contain 2-3 seeds per pod.

Soybeans are considered mature when seed moisture reduces to less than 14% in the field. Harvesting date depends on the variety, growing regions, planting date, and local weather conditions. The most active harvest periods are during the months of October and November. In the United States, almost all soybeans are harvested by combines. The seeds are threshed out from pods into a hopper and moved into a transport truck. If moisture content is more than 14%, soybeans need to be dried. Once dried to the appropriate moisture content, seeds are transferred to storage facilities. Proper handling of the soybeans during harvest and storage is critical to protect the beans from damage.

Soybeans are stored at farms, elevators, and processing plants in various types of storage facilities before being channeled to the next destination. Local elevators will store and maintain dry conditions for the soybeans before selling and shipping to a soybean processor or export terminal. Farmers may also transport soybeans by truck to a regional transport facility such as a railroad or river terminal for shipment directly to a grain buying station, processing plant, or harbor facility for shipment overseas.

Once the soybeans are sold to local, national or international processors, they are crushed and refined into various products. The process of taking soybeans and turning them into their byproducts has changed over the years as technology has given processors more efficient methods of extraction. Oil and meal were originally extracted from soybeans by hydraulic crushing, a method that left from 4 to 15 percent of the oil in the processed flakes. Today, nearly all U.S. and foreign processing plants use a solvent extraction method that leaves around 1 percent of the oil in the flakes.

The basic soybean processing plant has four primary structures: the elevator, preparation, extraction, and product load out. Some plants also have soybean oil refineries that further process the crude soybean oil into either industrial grade oil or edible oil products.

The elevator is where soybeans are unloaded from trucks, rail cars, and/or barges. They are stored until it is time for processing, and if necessary the soybeans can be dried further to reduce moisture content.

In the preparation phase, the soybeans are prepared for extraction by breaking them into small pieces, removing the hull (outer skin), heating, and rolling the bean into a thin flake.

In the extraction phase, the oil is separated or extracted from the flake by washing it with a hexane solvent. A distillation process removes the solvent and it is reclaimed for reuse. The resulting crude soybean oil can be processed by degumming, deodorizing and bleaching for edible use. The remaining material is referred to as defatted flakes.

The defatted soybean flakes that remain after the extraction of the oil and solvent is toasted and ground into soybean meal containing approximately 44% protein. Removal of the soybean's hull prior to processing produces approximately 48% protein soybean meal, and is referred to as dehulled soybean meal (DHSBM). The soybean hull, essentially the skin of the soybean, is used as ruminant feed with a high energy and residual protein level of approximately 14%. The defatted soybean flakes can also be further processed into soy protein concentrate and other enhanced-value soy products.

In the final phase, product load out, the finished soybean meal, soybean oil and soybean products are temporarily stored, weighed, and loaded into trucks or rail cars for shipment.

Soybean processing has developed into a complex, efficient industrial process that draws on the benefits of economies of scale. A small soybean processing plant will

process at least 1,000 tons of soybeans each day. Average plants process 2,000 tons or more and some of the newest facilities have capacity approaching 5,000 tons of soybeans per day.

Soybean processing plants do more than simply separate the oil from the meal. They also function as a grain elevator that can rapidly unload trucks and rail cars, as well as barges if a plant is located on the U.S. Inland Waterway System. A plant should have soybean storage capacity for at least one or two weeks' worth of its crushing capacity, and the space and equipment to prepare soybeans for processing. A soybean plant must also have the capability to store at least several days' worth of meal and oil production, as well as facilities to load out the products to whatever type of transport conveyance is required to move products to customers.

Soybean Products and Their Uses

The best-known and most widely used products from soybeans are soybean oil and soybean meal. Soybean oil is the most widely used edible oil in the world and soybean meal is the leading protein and energy source for animal feeds.

Soybean oil is used as cooking oil and as the base for shortening, margarine, salad dressings and mayonnaise. Lecithin extracted from soy oil during the refining process performs as an emulsifying agent and when further processed is an important ingredient in confections, baked foods, dairy products and instant foods. Lecithin is also used in animal feed, health and nutrition products, cosmetics and industrial coatings.

A rapidly growing market for soybean oil is found in the manufacture of a variety of pharmaceuticals, such as vitamin E and other anti-oxidants, as inexpensive aids to good health. Soybean oil is also used for industrial applications such as a basic carrier in inks, varnishes, and paints. Many soaps, lubricants and sealants contain soybean oil. Soybean oil shows great potential as an environmentally friendly substitute for petroleum-based diesel fuel, referred to as biodiesel. For more information about biodiesel, refer to the National Biodiesel Board website at: www.biodiesel.org.

Soybean meal is considered a premium product because of its high digestibility, high energy content and consistency. Over 80% of the soybean meal produced in the U.S. is dehulled. Properly processed dehulled soybean meal is an excellent source of protein and is used extensively in feed for swine, poultry, fish, beef and dairy cattle, and specialty animals including pet food. Such feeds must be formulated to fit exact nutritional requirements for each stage of the life cycle.

Soybean meal is also used as the basis for a variety of soy protein products including soy flour, soy concentrate, soy isolates, and textured soy protein. Soy protein not only provides nutritional value and health benefits, but also offers many functional properties including emulsification, gelation, forming, and water holding capacity.

Soy flour is made from roasted soybeans ground into a fine powder containing 50 percent protein by weight. Soy flour comes in three forms: natural or full fat, defatted, and lecithinated. Natural or full fat contains natural oils found in the soybean. Defatted has the oils removed during processing. Lecithinated has lecithin added. Soy flour is gluten-free, so yeast-raised breads made with soy flour are dense in tex-

ture. Soy grits are similar to soy flour except that the soybeans have been toasted and cracked into coarse pieces.

Soy protein concentrates are made by removing a portion of the carbohydrates from defatted and dehulled soy flakes. Concentrates are a highly digestible source of amino acids that retain most of the beans' dietary fiber. By definition, it must contain at least 65 percent protein.

Soy protein isolates are prepared through a process using water extraction and minimum heat on soy flakes. The end product is nearly carbohydrate and fat-free, with no characteristic "beany" flavor. Soy protein isolates prepared this way are 90 percent protein by dry-weight, possessing the greatest amount of protein of all soy products. They are a highly digestible source of amino acids and because of the bland taste can be added to foods without jeopardizing flavor characteristics. Isolated soy proteins are widely used as a nutritional, functional or economic alternative to traditional proteins.

Textured soy protein (TSP) usually refers to products made from textured soy flour and textured soy protein concentrates. It is used as a meat extender or analog and can be added to a meal to increase its protein content. TSP has a texture similar to ground beef or other meat products and must be rehydrated with boiling water before use.

Textured soy flour is made by running defatted soy flour through an extrusion cooker. This allows for many different forms and sizes. It contains 50 percent protein as well as the dietary fiber and soluble carbohydrates from the soybean. When hydrated, it has a chewy texture and is widely used as a meat extender. Textured soy flour is sold dried in granular and chunk form and is bland in flavor.

Textured soy protein concentrates are made by extrusion and are found in many different forms and sizes. Textured soy protein concentrates typically contain 70 percent protein as well as the dietary fiber from the soybean. When hydrated, they have a chewy texture and contribute to the texture of meat products.

Soybeans do not always have to be cracked and flaked to have useful value, nor are they used the same way in all countries. Consumers enjoy roasted and flavored whole soynuts, soy-based milk, yogurt, cheese, protein bars, and cereals. Whole soybeans are used for traditional foods like tofu, miso, natto, tempeh, and edamame.

To learn more about food products developed from soy, refer to the U.S. Soyfoods Guide, available on the Internet at: www.soyfoods.com or contact the Soyfoods Association of North America at 202-659-3520 or visit www.soyfoods.org. In addition, the Soyfoods Council, whose membership represents all facets of the food industry, can be reached at 515-727-0796 or visit www.thesoyfoodscouncil.org.

Advantages of U.S Soybeans

Soybeans first achieved true commercial importance after the oilseed arrived in the U.S. This was due to the combination of available land, modern farming practices, a growing affluent population, large livestock and poultry populations that provided

demand, absence of any other competing and widely grown oilseed, a modern transportation and handling infrastructure and abundant natural resources.

All of these advantages are still actively in place. The U.S. system of handling and transporting soybeans from the point of production to domestic or international markets is emulated by the grain-producing world. An efficient and model rail system, combined with an extensive barge infrastructure and the world's most extensive highway system provide buyers and consumers easy and economical access to U.S. soybeans and soybean products. Soybeans are harvested, stored, handled and transported quickly, safely, efficiently and at a fraction of the cost required in most other producing countries. Modern infrastructure, both on the farm and in processing plants, ensures U.S. soybeans and soybean products are stored at low moisture levels to limit mold attack, heat and insect damage.

The U.S. market for soybeans and soybean products is well established with quality standards specified by either government decree or industry adopted trading rules. These U.S. quality standards are applied with consistency by the U.S. Department of Agriculture, Federal Grain Inspection Service (FGIS) to assure buyers know they are getting the quality for which they both contracted and paid. These quality standards are explained in detail in Chapter 2.

Commercial feed customers and integrated operations appreciate having U.S. dehulled soybean meal in their feed. A consistently improved animal growth rate and feed conversion efficiency will enhance the animal producers' profitability. Reduced susceptibility to disease is another real benefit of U.S. dehulled soybean meal as the meal is made from clean, dry, mold and mycotoxin-free U.S. soybeans. The higher digestibility of nutrients in U.S. dehulled soybean meal when compared to competitive meals enhances the ability of the animal to fend off disease. U.S. dehulled meal is available in any season and can be shipped anywhere in the world.

As the leader of the global soybean industry, it is hardly surprising that most of the technical innovations and advances in soybean production, such as no-till planting and biotechnology, have been developed in the U.S. In the 1990s, privately funded U.S. research led to the discovery that biotechnology could alter characteristics of soybean seeds by gene manipulation. Late in the 1990s, this process produced commercially available seed for soybeans capable of tolerating the most widely used benign and effective herbicide used to control weeds. These biotechnology-derived soybeans quickly became popular with U.S. farmers. From 1996 to 2004, plantings of biotech herbicide-tolerant soybeans rose from zero to 86 percent. After strenuous testing and scientific analysis, the U.S. Food and Drug Administration in cooperation with USDA determined that currently used biotechnology-enhanced crops were perfectly safe and foods made from them were equally safe. This is explained in more detail in Chapter 6 of this Guide.

It is important to understand that seed companies in the U.S. are not free to develop and release any biotechnology-derived soybean seed they choose. The U.S. government strictly regulates all biotechnology-derived seeds. New varieties are released only if the developing companies can prove that the new variety poses no risk to human or animal health or to the environment.

U.S. soybean growers have long practiced the best and most effective crop management systems available to them. Biotechnology-enhanced, herbicide-resistant soybeans provide yet another tool in crop management systems. This technology not only provides improved production, but does so in a proven and sustainable way that helps U.S. growers enhance both the value of their farmland, and the environment in which they work and live.

To meet ongoing customers' demands, the U.S. soybean industry is focused on developing new varieties of soybeans for niche markets. An identity-preserved (IP) system has been developed to assure buyers that the specialty beans they order are distinguished from the commodity bean flow. U.S. soybean farmers and grain handlers have become highly skilled in the IP process. Preferred products are delivered within very tight tolerances, complete with sufficient documentation to trace it back to the producing farm and seed supplier. The IP system will be explained in more detail in Chapter 6 of this Guide.

This industry-wide drive for efficiency and improvement from the farm field to the dinner table is keeping U.S. soybeans and soy products in the forefront of the world market place. It also explains why soybean users around the world prefer to buy and use U.S. soybeans.