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SOY BEANS

An INFOCOMM Commodity Profile

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Notes

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The profile has not been formally edited.

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1. Overview

1.1. Description

Figure 1: The plant of soybean



Source: www.herbeoofficiali.org

Scientific name: *Glycine max*

Common name: large bean, yellow bean, edamame (Japan), Golden bean, miracle bean, soybean, soyabean, soy, soya

Family: Leguminosae

Leaves: oval or lance-like in shape, growing to a length of 3-10 cm

Flowers: small white or purple flowers

Seeds: Almost spherical in shape, are usually light yellow, but some varieties are black, brown or green. They have a black, brown or yellow hilum (seed scar)

Origin: East Asia

1.2. Origins; early trade history

The first historical indication places the appearance of soybean as a food crop in North-eastern China around 1700 – 1100 B.C. By the 16th century, soybeans were used in Burma, India, Indonesia, Japan, Korea, Malaysia, Philippines, Nepal, Thailand, and Vietnam. The first record of soybeans in Europe was in England in 1790.

The first soybean uses in the USA dates back to 1765 in the present-day state of Georgia. Soybeans were

cultivated and processed for export and had gained popularity in Europe and in the United States of America. Soybeans continued to be used in western countries for vegetable oil, primarily in the manufacturing of processed food products. In 1917 came the discovery of soybean uses for livestock feed, which led to the growth of the soybean processing industry, the protein and oil uses of today.

Prior to 1956, the majority of the world's soybeans was produced in Asia. However, the centre of world soybean

production shifted to the western. The United States of America expanded its production and by the 1970s supplied two-thirds of the world's soybean needs.

In the early 1970s, Latin America began to emerge as a major soybean producing area¹.

1.2. Cultivation; harvesting; processing; transportation to consumer

Soybean grows best in temperate, tropical and subtropical regions. They can be grown throughout the year in the tropics and subtropics, if water is available. It requires well-drained and fertile soil, 400 to 500 mm of precipitation in a season for a good crop. High moisture requirement is critical at the time of germination, flowering and pod forming stage. Dry weather is essential for ripening.

The flow of grains from the field to consumers includes several operations. All of these operations have to be appropriately done in order to reduce the risk of altering negatively the quality of the grain.

Because of the availability of harvesting machinery, handling and loading equipment, all operations from cultivation to transportation, are done in the shorter time possible to avoid grain condition changes or damages that might affect its conservation and storage.

It is necessary to highlight the importance cultivation processes, including pre-harvest operations (preparation of the land, planting, irrigation) and post-harvest operations (transport, threshing, drying, cleaning, processing, packaging and storage).

Pre-harvest operations

Crop preparation for harvesting is necessary. Those operations, including cultural practices, diseases and pests control, are associated to soybean cultivation. Among the cultural practices in soybean cultivation are soil preparation and fertilization, planting, irrigation, weeds, diseases and pests control.

Preparation of the land and fertilization.

It is very important to plough and level the soil before planting soybeans². These labours acquire a major

¹ History of World Soybean Production and Trade, William Shurtleff and Akiko Aoyagi. 2004

importance when soybean crop is mechanized. Soybean cropping needs flat and not deeper scratches.

Fertilization is applied only when the soil is known to be deficient in basic nutrients.

Planting

The seeds are planted 1 ½ deep³, close enough to allows the plants to support each other.

Irrigation

Moisture is necessary for germination during early development. Rainfall or artificial watering at the time of their seed-filling period is necessary. However, soybeans can withstand some drought once they are well established.

Growing of Soybeans

Soybean development is characterized by two distinct growth phases: The vegetative stage and the reproduction stage.

The growth of soybean plants is tracked by a system that assigns a (V) to the vegetative stages that cover development from emergence through flowering, and a (R) to the reproductive stages that cover development from flowering through maturation. Plant stages are determined by classifying the development of the seed, pod, leaf and flower.

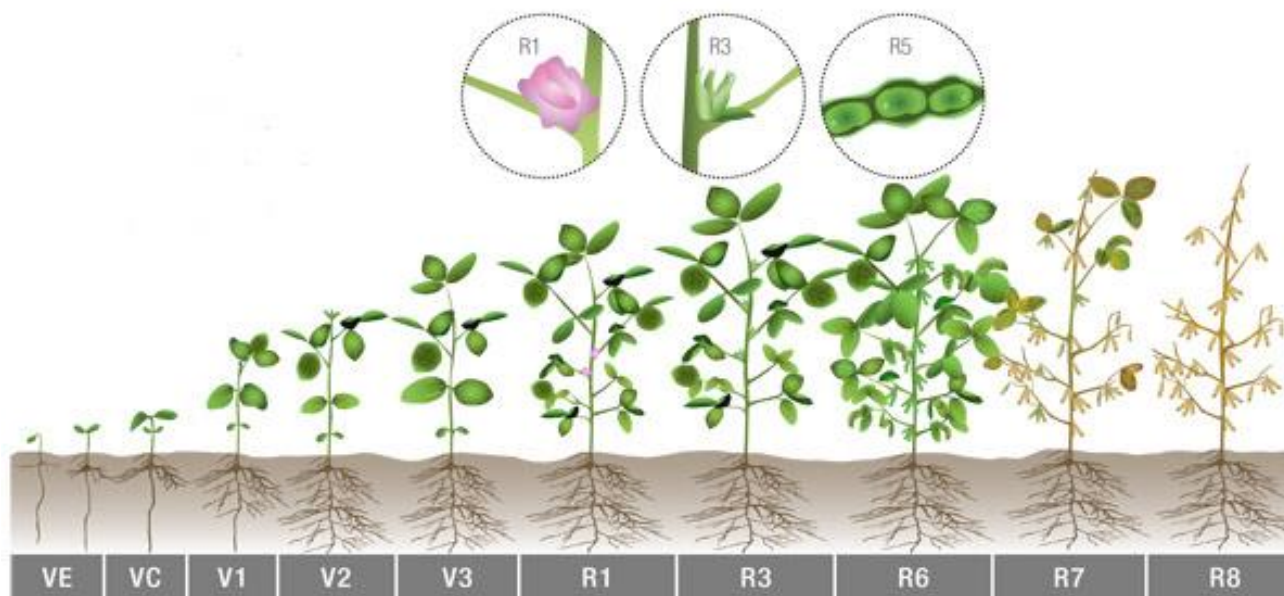
Vegetative and Reproductive stages are described below:

Soybean growth stages:

² FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

³ FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

Figure 2: Soybean growth phases



Source: Soybean Growth and Management Quick Guide, McWilliams, D.A., D.R. Berglund, and G.J. Endres, 1999

Table 1: Vegetative stage

Stage	Description
VE	Emergence, Cotyledons are above the soil surface
VC	Cotyledon with unifoliolate leaves unrolled
V1	First-node and fully developed leaves at unifoliolate node
V(n)	(n)-node (n)= number of nodes on the main stem with fully developed leaves beginning with the unifoliolate leaves

Table 2: Reproductive stages

Stage	Description
R1	Beginning bloom
R2	Full bloom
R3	Beginning pod
R4	Full pod
R5	Beginning seed
R6	Full seed
R7	Beginning maturity
R8	Full maturity

Post-harvest operations

Once the soybeans are mature, they are subjected to several operations in order to keep as much as possible the original quality of the beans. The goal is to maintain

the quality at harvest and ensure a continuous supply to processing industries or consumers. The post-production operations include the following;

Harvesting

Most of the soybeans are mechanically harvested. The length of the growing season varies from 50 to 200 days⁴, depending on the variety, weather, latitude, etc.

Soybeans are harvested over a relatively short period of time. Soybeans production is a highly seasonal activity with the result that the beans are gathered and placed in storage for utilization over the entire year.

Threshing

Threshing consists of separating the beans from the pods. The operation is done manually with simple tools, or with motor-driven machines. It has to be done with care to prevent breakage of the beans or hulls, which can

⁴ FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

reduce the quality, and foster subsequent losses from the action of insects and post harvest diseases⁵.

Drying

This operation consist of rapidly drying the beans with the circulation of natural or artificial drying until they reach the "safe-moisture". Moisture level has to guarantee favourable conditions for storage or for further processing.

Cleaning

After the threshing operations, soil, insect and plant waste, weed seeds, small gravels, or broken soybean seeds may contaminate soybeans. The cleaning is done several times through the post harvest system. Beans are then sorted according to quality.

Packaging

Soybeans can be transported as bulk cargo and also as break-bulk cargo in bags of natural materials such as jute and cotton fibre.

Woven plastic bag is also used as packaging material.

Storage

Storage is an important phase of post harvest operations. It has to conserve soybeans quality as long as possible and availability has to be assured other than during periods of its agricultural production. The storage has to ensure deferred soybean use, to guarantee seed availability for the next harvest cycle. Therefore, a continuous supply of raw soybeans for processing industries is guaranteed. The supply and demand of soybean is balanced, thus stabilizing its market price.

Transport

It is especially important to transport the beans from the field to storage centres as soon as possible to avoid deterioration.

The type of transport used to transfer soybeans depends on the quantity and distance travelled. When road network is undeveloped and agriculture is traditional, transport such as people, horses or donkeys are used.

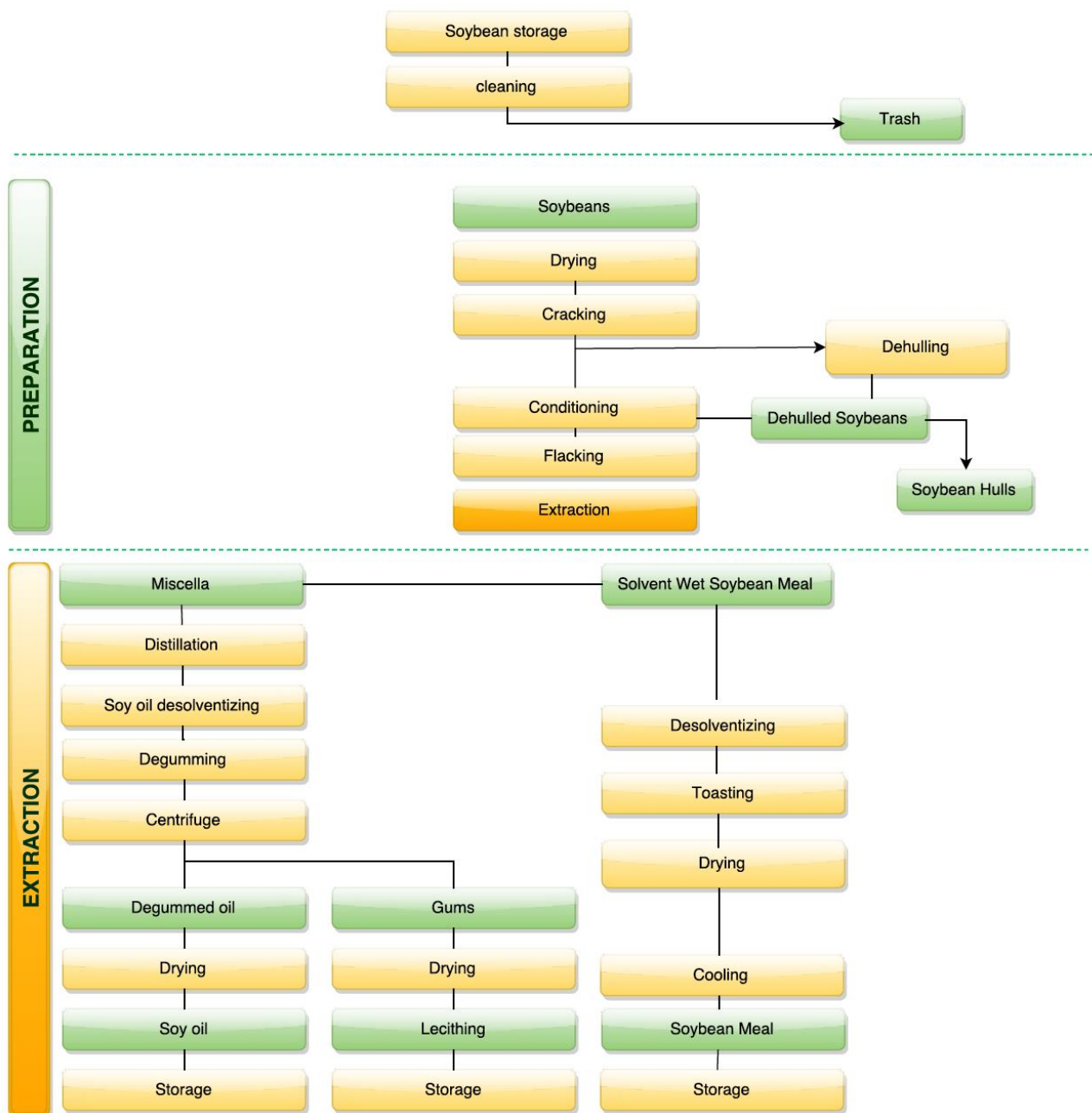
Railcars are used for large amounts of soybeans, and have the advantage of generally being cheaper than road transport (trucks). Ship and rail are used over long distances.

Process

Soybean processing involves a series of steps to produce commodities for food, industrial, and animal feed uses. Additional processing can produce high protein food ingredients such as soy protein concentrates and isolated soy protein.

⁵ FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

Figure 3 Process Chart of preparation and extraction of soybeans



Source: United soybean Board, National Soybean Research Laboratory

Cracking: breaking of the whole seed into several pieces to facilitate dehulling and flacking.

Dehulling : process of removing the outer covering from grains or other seeds.

- **Hull:** The tough exterior skin of a soybean. As a major source of dietary fibre, the hull is processed to create a fibre additive for cereals, breads and snacks. Livestock feed is also manufactured from soybean hulls.

Degumming: elimination of phospholipids from vegetable oil by a water washing.

Flaking: transformation of dehulled oilseeds into thin flakes for solvent extraction or other processing.

1.3. Varieties; quality standards; classification

Variety of Soybean

There are **over 200 soybean varieties**. Aside from maturity and yield, variety selection on resistance or tolerance to disease, other specialty soybeans include varieties with low saturated fat, high oleic acid, high isoflavone, high stearate, high sucrose, or high protein.

Examples of types of Specialty Soybeans

- **Low (reduced) linolenic soybeans** have half the linolenic acid level of regular soybeans. This feature reduces the need for hydrogenation, a process used in transforming vegetable oils to margarine that results in the production of unhealthy trans fatty acids.
- **Natto beans** are small-seeded soybeans used for the fermented soyfoods of the same name. These beans have a thin seed coat, a clear hilum, and high carbohydrate levels.
- **Non-genetically modified organism soybeans** are varieties that have not been genetically improved through bioengineering technology. Due to consumer concern over the hypothetical long-term health risks of consuming genetically manipulated food.
- **Tofu soybeans** with large seed size and high protein levels, they are primarily used for tofu and soymilk production.
- **Triple-null lipoxigenase soybeans** are characterized by the absence of the three enzymes that produce off-flavours usually found in conventional soybeans. Triple-null soybeans can be used for edible soy products, such as tofu and soymilk.

Soybean Quality

The importance of each quality characteristic differs depend on the intended end use.

Quality characteristics can be classified into three general categories:

- Defects
- Shipment and storage factors
- End-use related factors:
 - Physical properties (include germination, hilum colour, seed size, seed count, seed coat cracking, hardness and purity)
 - Chemical composition characteristics (moisture, protein, Nitrogen Solubility Index (NSI), Protein Dispersibility Index (PDI), amino acids, lipoxigenase, Trypsin Inhibitor (TI), oil, fatty acids, fiber, sugars and isoflavones.

Soybean grading

The classification of grain and oil seeds according to quality characteristics or factors is called grading.

The grain standards act defines soybeans as grain that consists of 50% or more of whole or broken soybeans that will not pass through an 8/64-inch round hole sieve and not more than 10% of other grains for which standards have been established⁶.

Grading standards for Soybeans

Grades and grade requirements are similar for exporting countries. Brazil and Argentina have an export grade for soybeans, Brazil's 'Grade Number 1' limits foreign material to 1 %. The base limit for Argentine soybeans is 1 %, although discounts may be applied up to 3%. Their definition of foreign material excludes small pieces of broken beans that are included in United States definitions⁷.

⁶ Quality of soybean and its food products (Gandhi, A. P. 2009)

⁷FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

The United States does not have a specific export grade for soybeans, practically, soybean is exported at any requested specification for foreign material and since its soybean handling technology allows them to meet any specification⁸.

Brazilian grades specify 14 % moisture content as the maximum limit for export quality; Argentine grades use a base of 13 %. In the United States, 14 % is the most common maximum for export.





High quality soybeans have desirable levels of certain characteristics or combination of characteristics. The physical and chemical characteristics are usually measurable and most of the countries are adopting the National Oilseed Processor Association (NOPA) specifications for their domestic soybeans⁹.

Grade determining factors use maximum or minimum limits to assign a numerical grade to a sample.

⁸ FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

⁹ Quality of soybean and its food products (Gandhi, A. P. 2009)

Table 3: Exemple of specific grade standards for soybeans (US grading)

Grading Factors	Grades U.S. Nos.			
	1	2	3	4
				

Minimum limits				
Test weight lbs/bu	56.0	54.0	52.0	49.0
Damaged kernels				
Heat (part of total)	0.2	0.5	1.0	3.0
Total	2.0	3.0	5.0	8.0
Foreign Material	1.0	2.0	3.0	5.0
Splits	10.0	20.0	30.0	40.0
Soybeans of other colors 1/	1.0	2.0	5.0	10.0

Other materials				
Animal waste	9	9	9	9
Castor Beans		1	1	1
Crotalaria seeds	2	2	2	2
Glass	0	0	0	0
Stones 2/	3	3	3	3
Unknown foreign substance	3	3	3	3
Total 3/	10	10	10	10



U.S. Sample grade is soybeans that:

- Do not meet the requirements for the grades U.S. Nos. 1, 2, 3, or 4;
- Or contain 4 or more stones which have an aggregate weight in excess of 0.1 % of the sample weight, 1 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria* spp.), 2 or more castor beans (*Ricinus communis* L.), 4 or more particles of an unknown foreign substance(s)
- Or a commonly recognized harmful or toxic foreign substance(s), 10 or more rodent pellets, bird droppings, or an equivalent quantity of other animal filth in a 1,000 grams of soybeans;
- Or contain 11 or more animal filth, castor beans, crotalaria seeds, glass, stones, or unknown foreign substance(s) in any combination;
- Or Have a musty, sour, or commercially objectionable foreign odor (except garlic odor);

- Or Are heating or otherwise of distinctly low quality.

Source: *Grading Standards for Soybeans*. Center for Crops Utilization Research. 2013

1.4. Uses

Soybeans are grown principally for their meal. Meal is the primary product and oil is secondary. The utilization possibilities for soybeans can be divided into two groups: those based on the utilization of the whole seed and those based on the fraction of the soybean into oil and meal (oil mill operations).

Utilisation of the whole soybean

Traditional soyfoods include the nonfermented and fermented soyfoods.

Nonfermented soy foods

Soymilk: off-white emulsion containing the water-soluble proteins and carbohydrates, and most of the oil of the soybeans. Soymilk has been produced traditionally in China, and in East Asia, even it was never a predominant element in the popular diet. The concept of a milk-like food made with soybeans was introduced to Europe in the beginning the century.

Tofu, Dan fu (Vietnamese), Teou fu or Tou fu ho (Chinese) or bean curd: Cottage cheese-like product formed into a cake, a white protein curd precipitated from soy milk by a calcium salt or, concentrated sea water. Compares with cheese or meat, tofu is much lower in calories because of its higher protein/fat ratio. It is also lactose free, cholesterol free, and lower in saturated fat.

Soya sprouts : Germinated soybeans in dark yellow cotyledons with white sprouts.

Soya film, Yuba : Creamy, yellowish protein-lipid film formed from the surface of boiling soya drink (in sticks, or flakes).

Vegetable soybean, Edamame : Immature green soybeans. They are harvested when the beans are still green and sweet tasting and can be served as a snack or main vegetable dish after boiling in slightly salted water. Edamame is high in protein and fiber.

Roasted soybeans : Dry roasted soybeans, seasoned or non-seasoned.

Fermented oriental soya foods

Miso: Heated water extract of soybeans after grinding and filtration.

Tempeh: Cooked and dehulled soybeans fermented with a fungus named *Rhizopus oligosporus*. The Soft beans are bound by white mycelia, cakelike, nutty flavor. Tempeh is one of the most popular fermented foods in Indonesia, New Guinea and Sumatra. Because of its meat like texture and mushroom-like flavour, tempeh is well suited to Western tastes. It is becoming a popular food for vegetarians in the United States and other parts of the world.

Shoyo, Soya sauce, Soysauce: Extracted from a fermented mixture of soybeans and wheat.

Natto: It is one of the few products in which bacteria predominate during fermentation. When properly prepared, it has a slimy appearance, sweet taste and characteristic aroma.

Utilization of the oil fraction

Soybean oil: Natural oil extracted from whole soybeans. It is the most widely used oil in the United States, and is sold as either pure soybean oil or as an ingredient in vegetable oil..

Lecithin: Extracted from crude soybean oil through the refining process. It is used as a natural emulsifier, lubricant, animal feed, pharmaceuticals, paints, and other industrial applications.

Utilization of the meal fraction

Soybean meal as animal feedstuff: Soybean oil, meal and cake production is used as a protein source in animal feed.

Defatted soybean flours and grits: For human consumption, basis of a variety of soy protein products including soy flour, soy concentrates and soy isolates.

Protein concentrates: soy protein concentrate comes from defatted soy flakes.

Extrusion-textured soybean protein: defatted soybean flour with a specific moisture content is subjected to high shearing forces at high temperature in an extruder, a product with a peculiar laminar structure is obtained. After hydration, this product presents an elastic and chewy texture like meat.

Soy fiber (okara, soy bran and soy isolate fiber): They are excellent sources of high-quality dietary fiber.

- Okara is a pulp fiber by-product of soymilk, with a taste comparable to coconut milk. It contains less protein than the whole soybeans, but the remaining protein is high quality.
- Soy bran is made from hulls, the outer covering of the soybean, which is removed during initial processing. The hulls contain a fibrous material that can be extracted and then refined for use as a food ingredient.
- Soy isolate fiber, is soy protein isolate in a fibrous form.

Textured soy protein: made from defatted soy flour, it is sold in a dried, granular form. It is used as a meat extender or analogue and can be added to a meal to increase its protein content. It has a texture similar to ground beef or other meat products and must be rehydrated with boiling water before use.

Biodiesel

Soy biodiesel is a fuel alternative. It is produced from soybean oil, clean burning ester-based oxygenated fuels made from renewable sources including soybean oil, other vegetable oils and animal fats, for use in compression-ignition (diesel) engines. It can be used instead of petroleum in cars and boats without any modifications to the conventional gas tank.

1.5. Pests, Diseases

Soybeans are susceptible to be attacked by many different organisms, ranging from viruses to nematodes and insects, throughout their growing season. These pathogens and pests can cause damage in seeds, roots, leaves, stems and pods, and usually are tissue-specific. They infect and attack all parts of the plants from roots to seeds. The extent of economic plant damage depends upon the type of pathogen, plant tissue attacked, number of plants affected, severity of attack, environmental conditions, host plant susceptibility, plant stress level, and stage of plant development¹⁰.

¹⁰ Soybean—worldwide production, use, and constraints caused by pathogens and pests. Glen L. Hartman & Ellen D. West & Theresa K. Herman. 2011

Soybeans disease

Soybean rust is a major disease limiting soybean production in many areas of the world. Brown leaf spot, frogeye leaf spot, brown stem rot, stem canker, purple seed stain and pod, and stem blight are major soybean fungal diseases¹¹.

Bacterial blight, pustule, wildfire and wilt are major soybean diseases caused by bacterial. Major viral diseases include soybean mosaic, yellow mosaic, bud blight and bean pod mottle.

Pests of soybeans

Insects are serious pests, particularly in tropical and subtropical areas, because they feed on all parts of the soybean plant. All pests have the ability of decrease soybean yield.

Larvae of lepidoptera (moths) and coleoptera (beetles) are two major groups that attack soybean foliage.

Some strategies for increasing yields include the use of fertilizers and pesticides, while others involve developing new plant varieties that best suit the requirements of the farmers. In soybean, variety development is important so that growers use varieties that are well adapted to local conditions such as weather, preferred agronomic practices etc.

1.6. Environmental and social impacts

Soybean agriculture is one of the world leading export products, providing high economic benefits. The model of soybean culture, based on the large monoculture estate, intensive use of pesticides and low use of labour, lead to raising concern about both environmental and social impacts.

Social impacts

In large-size farms

- Soybeans exploitation provides an important source of income and employment. However, conversion to soy has eliminated farm jobs and tends to benefit a limited group of larger firms rather than smaller farms. Generally, the scale increase generates less work and income per hectare than small-scale farms.

¹¹ FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciapara, 2002)

The expansion of medium and large-scale producers can stimulate land concentration, which may in turn displace local people.

- Health issues due to pesticide and agrochemicals
- Land conflicts: Forests may be cleared illegally when the boundaries are not well documented and identifiable.
- Labour: Local and indigenous people that used to depend on the forests are vulnerable. They depend on soybeans production, while it normally requires few qualified labour. Illegal work issues are also a growing concern.

In small scale farms

- Food security

Lands that was originally used for the cultivation of corn, rice, oats and beans, is used for the cultivation of soybeans, which put the local food supply at risk.

- Scale increases

The increase average farm size has put small-scale farmers under pressure to relocate from their land to make room for large-scale soybeans cultivation. However, cooperative systems enable smallholders to remain competitive.

- Living standards

Soybeans Crop has revolutionized the rural economy by raising the living standards of soybean farmers.

Economical impacts

- For countries with surplus soybean production, it remains an important source of foreign currency.

- Cash income

In some regions of Asia, soybean crop sales represents between 30 % and 60 % of the average cash income, which is used to buy material inputs for the next crop like rice cultivation¹²

- Increase in the unit area profitability

Soybean crop is seen to be useful for the sustainability of the main cereal based cropping systems in the world (crops and crop sequences and the management techniques used)

Introduction of soybean crop to several countries have led to a shift in their cropping systems. This cropping system change has resulted in an enhancement in the cropping intensity and thus increases the unit area profitability from the land use.

Environmental impact

- From biodiverse areas to monocultures

Conversion areas for soybean cultivation threatens biodiversity, endangered species and the livelihoods of local people. Most other natural vegetation is removed which led to erosion and soil degradation.

Water evaporation in soybeans monocultures is four times as high as in natural forests¹³.

Monoculture system over vast areas, minimize ecological services and become more dependent on chemicals to control pests.

- Deforestation and other habitat destruction

Increased demand for soybeans and land for growing soybeans can lead to deforestation. To facilitate the transport of soybeans, governments in producing countries invest in infrastructures such as ports, roads and waterways, may increase deforestation and land conflicts as they are extending new areas.

- Ecological risk

Hydrological cycle changing and new growing pest and disease problems.

- Dangerous runoff

Agrochemical residues (pesticides and chemical fertilizers) Impact water resources. Runoff from soy

¹² FAO, Soybeans Post-Harvest operations (A.R. Islas-Rubio, I. Higuera-Ciajara, 2002)

¹³ In search of responsible soy, Key characteristics and comparison of voluntary soy standards. CREM. 2001

production can carry significant levels of agrochemicals, suspended soil and organic matter. This is a major source of freshwater and groundwater contamination, which can have serious impacts on the health of people and wildlife¹⁴.

- Contamination generated by plantations of Genetically Modified (GM) species

GM species have agronomic advantage such as higher yield, resistant to the herbicide but the risks to human health and environment is a growing concern. Modified genes spread during the process of reproduction of the plants (pollination or horizontal transfer) threatens sovereignty over autochthonous germplasm, since it acquires transgenic characteristics and therefore is subject to international patent laws¹⁵.

1.7. Nutrition properties

Soybeans have an exceptional nutritional and functional food profile. Soy-foods are considered to be nutritious and healthy based on their nutrient composition.

- Soy-foods

Consumption of phytoestrogen-rich diets such as Asian diets, rich in soybeans, is associated with a lower risk of particular diseases, such as osteoporosis, coronary heart diseases, hormone-dependent forms of cancer and menopausal symptoms.

- Soybean oil

Soy oil is intensively consumed as a vegetable oil worldwide. It is used as cooking oil in households but its main use is as key fat ingredient in industrial food manufacturing.

Diets with potentially negative health implications are those where saturated fatty acids and/or trans fatty acids are in excess of certain desirable levels, while diets including oils/fats rich in mono or poly-unsaturated fatty acids tend to be considered as more healthy.

Nutritional properties of soy foods and soy oil are the following:

¹⁴ Environmental & social impacts of soy- www.wwf.org

¹⁵ World Wide Fund For Nature, Soybeans

Fat and Fatty acids

Soybeans are high in fat. Most legumes (except peanuts) contain between 2 to 14 % fat, whereas soybean contains 19 % fat.

Fibre

Fibres help to facilitate the digestive process and put far less strain on the gastrointestinal system. Soluble and insoluble carbohydrates, including dietary fibre, make around 30% of the soybean. The primary soluble carbohydrates in the soybean are the sugars stachyose, raffinose and sucrose.

A serving of soybeans provides approximately 8 grams of dietary fibre. However, processed soy food fibre contents decrease significantly. Tofu and soymilk contain very little amount of fibre, while soy foods that utilize the whole bean such as tempeh, soy flour and textured soy protein have high level of fibre

Macronutrients

- Protein

The level is higher than in other beans, and therefore soybeans protein is equivalent to animal protein in quality. They are highly digestible and are comparable to beef, milk, fish, and egg protein in terms of protein quality. Based on the internationally recognized Protein Digestibility Corrected Amino Acid Score (PDCAAS)¹⁶ soybeans protein isolate receives a rating of 1, which is the highest possible score. It makes soybeans equivalent to animal proteins in quality and higher than other plant proteins foods. Soy foods, if used correctly, contribute significantly toward meeting protein needs.

Micronutrients

- Calcium

Soy foods are a good source of calcium in comparison to the commonly used legumes. However, processing affects the calcium content of soyfoods considerably. Although soyfoods are high in both oxalates and phytates that inhibit calcium absorption, the calcium from soyfoods

¹⁶ The PDCAAS has been adopted by FAO/WHO as the preferred method for the measurement of the protein value in human nutrition (evaluating protein quality for children and adults)

is well absorbed and has an absorption rate equal to that of milk.

- Iron

Soybeans are rich in iron. However, both phytate and soy protein reduce iron absorption which leads to a poor absorption of soyfoods. Iron could be better absorbed from fermented soyfoods such as tempeh and miso.

Other nutrients

- The major mineral components of soybeans are magnesium, potassium, sodium, calcium, sulfur and phosphorus. Mineral content can vary widely due to the type of soil and growing conditions for the soybean.

- Soybean is a good source of enriched Calcium and Vitamin B12.

- Tocopherols are an important constituent of soy oil, due both to the vitamin E supplied for human nutrition and their antioxidant properties.

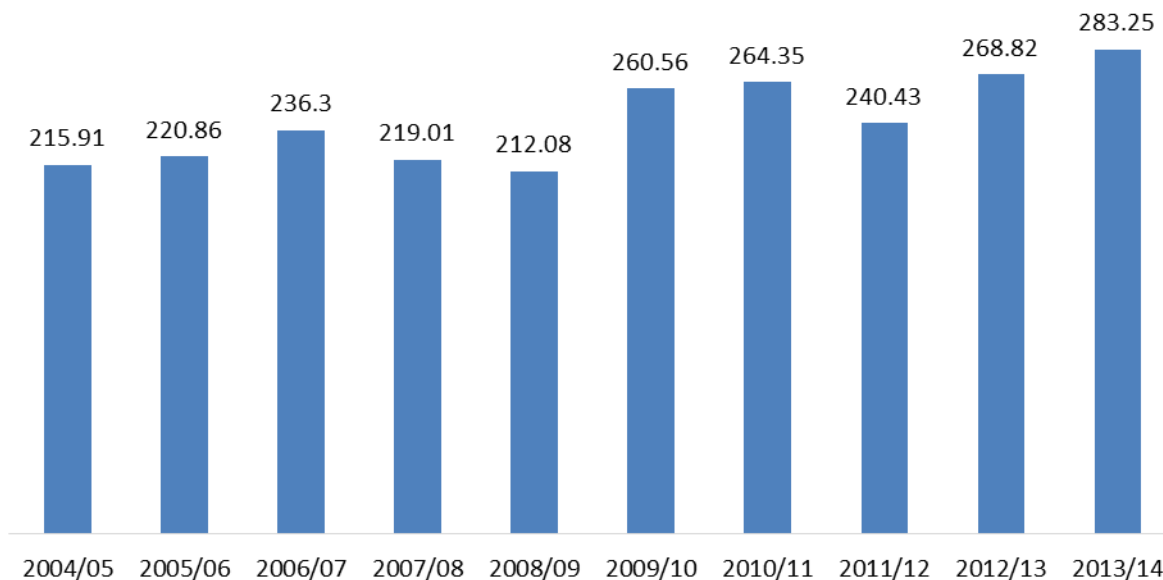
2. Supply

Soybean has two by-products: soybean meal and soybean oil. Each of these by-products has their own supply and demand market and a certain correlation between one other.

2.1. Production

Consistent improvements in reductions of production costs and reduction of average yield levels have increasingly improved the competitive position of soybeans among arable crops. An important factor in this development was the considerable improvement in the yields through plant breeding and advanced agro technical practices. It has led to a growth of 31% from 2004 to 2014. Consideration of the economic advantages of soybeans has led many countries to start large-scale production.

Figure 4: World Production 2004-2014 (Thousand metric tons)



Source: USDFAS, Foreign Agricultural Service's Production, Supply and Distribution (PSD) online database Soybeans: World Supply and Distribution .2015

2.2. Top 10 producers

World soybean production is dominated by three countries: the US, Brazil and Argentina.

The world leading producers are the following:

Table 4: Top 10 Soybeans Producer in 2013

	Production (tonnes)
1 United States of America	89,483,000
2 Brazil	81,724,477
3 Argentina	49,306,201
4 China	11,950,500
5 China, mainland	11,948,000
6 Paraguay	9,086,000
7 Canada	5,198,400
8 Uruguay	3,200,000
9 Ukraine	2,774,300
10 Bolivia (Plurinational State of)	2,347,282

Source: FAOSTAT, 2015

2.3. Factors affecting supply

The high level of concentration observed in global soybean production and exportation can lead to instabilities in the market that are potentially detrimental for both exporters and importers.

The key factors that affecting supply are the following:

Competing commodities, Alternatives

The alternative of soybean meal is corn. If there is excess production of corn, farmers would prefer to use cheaper corn for farm feed rather than soybean.

Weather conditions: Unusual weather conditions and biotic stresses in major producing regions, through their direct impact on production, can lead to increased price volatility.

Government subsidies, national macro-economic policies: Research and development policies, government subsidies such as access to subsidized credit and price support scheme etc., supporting

production, processing, and exports can easily change the trade opportunities.

New agricultural practices, Biotechnology: The Introduction of enhanced farming practices, new seed traits, new seed technologies (genetically modified seeds) and protection for the soybean crop against diseases, increase global processing capacity, enable growers to plant in previously unsuitable regions. It has led to the availability of extensive new areas for soybean cropping.

2.4. Outlook

Improvements in seed technology, and enhanced farming practices, such as soil management and better control of weed growth and pest infestation, are expected to reinforce gains in average world yields.

Brazil appears to hold the greatest potential to increase plantings because of its vast land resources. The soybean area has increased strongly over many years in response to expanding national use and world trade. With the conversion of pastureland expected, the soybean area is seen increasing.

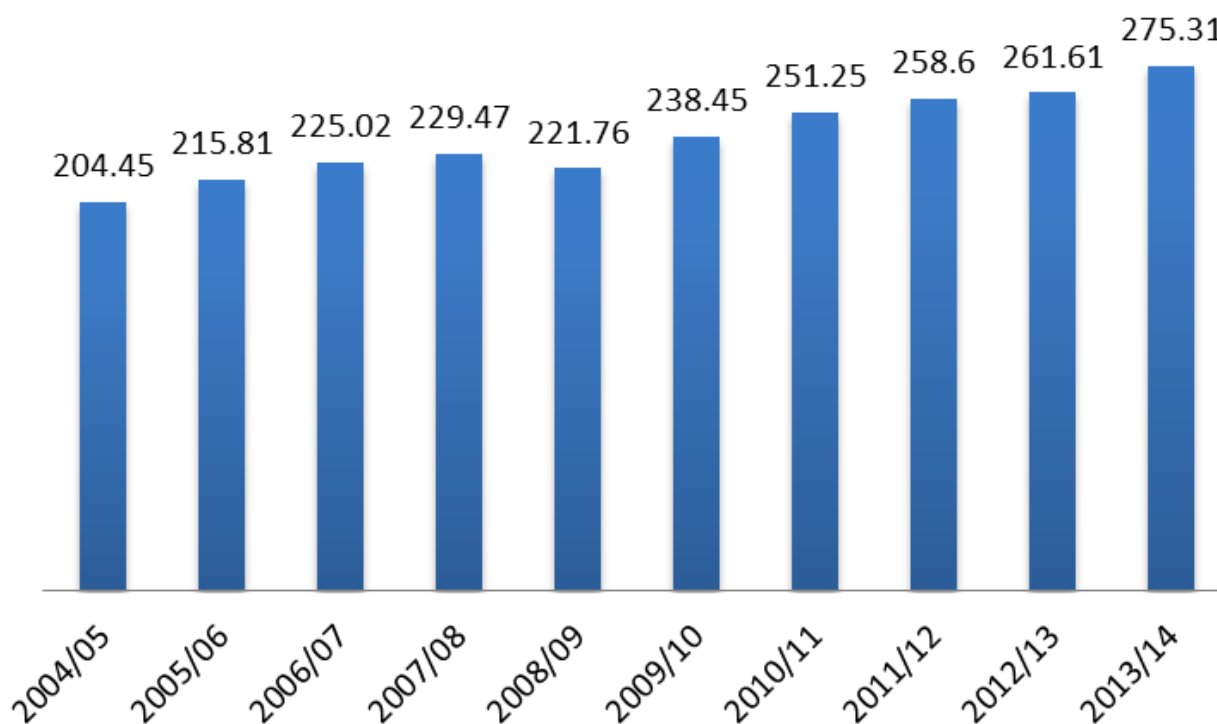
Soybeans are expected to continue being the most lucrative export product with more than half of Brazilian production destined for world markets. Brazil produces a large quantity of soybeans, and has a considerable crushing sector, producing soybean meal and soybean oil.

3. Demand

The demand for soybeans is driven by population growth, either indirectly through the consumption of livestock products or directly through the consumption of soybean products.

3.1. Consumption

World consumption of soybeans was particularly strong in recent years resulting in a significant reduction in world stocks due to the irregularity of production volumes. Inadequate stocks in proportion to the consumption were a source of tension on the soybean market.

Figure 5: World soybeans consumption, million tonnes, 2004-2014

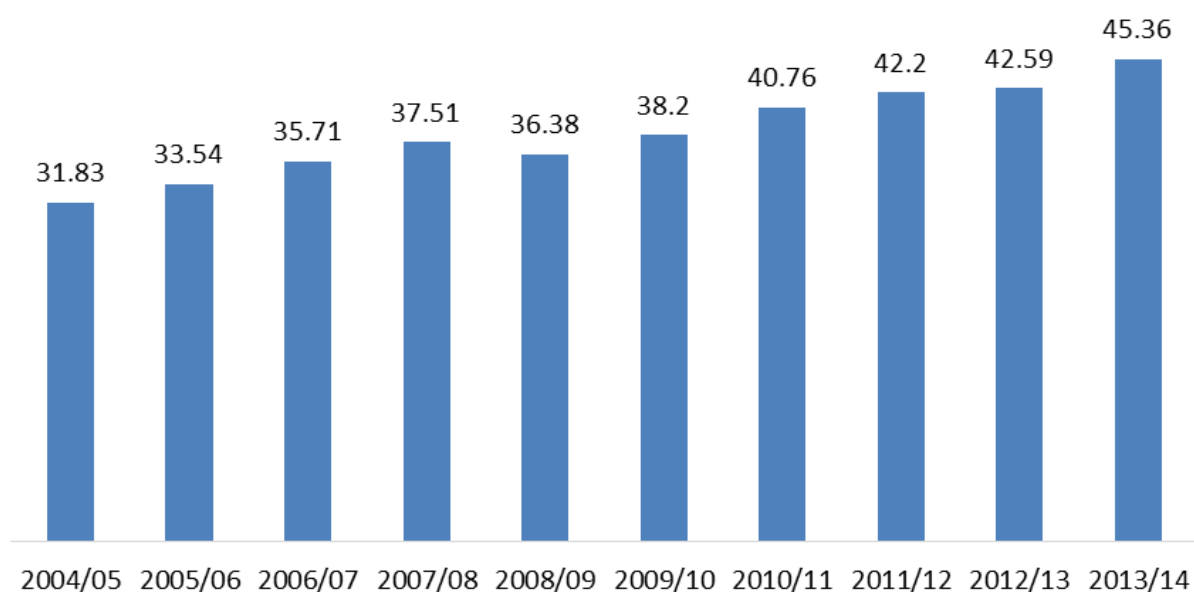
Source: US Foreign Agricultural Service's Production, Supply and Distribution (PSD) online database Soybeans: World supply and distribution. 2015)

Soybeans are widely traded and the soybean oil and meal is available in almost every country in the world. World soybean oil and meal consumption have grown, thanks to rising demand, especially in developing countries where consumption is stimulated by economic growth and expanding population.

Soybeans oil

The share of soybean oil in total vegetable oil consumption or total oils/fats intake varies considerably between regions and countries, depending on numerous factors such as the availability of locally produced oils, consumer habits and preferences, local and international market prices and national trade policies.

Figure 6: Soybeans oil consumption million tonnes, 2004-2014



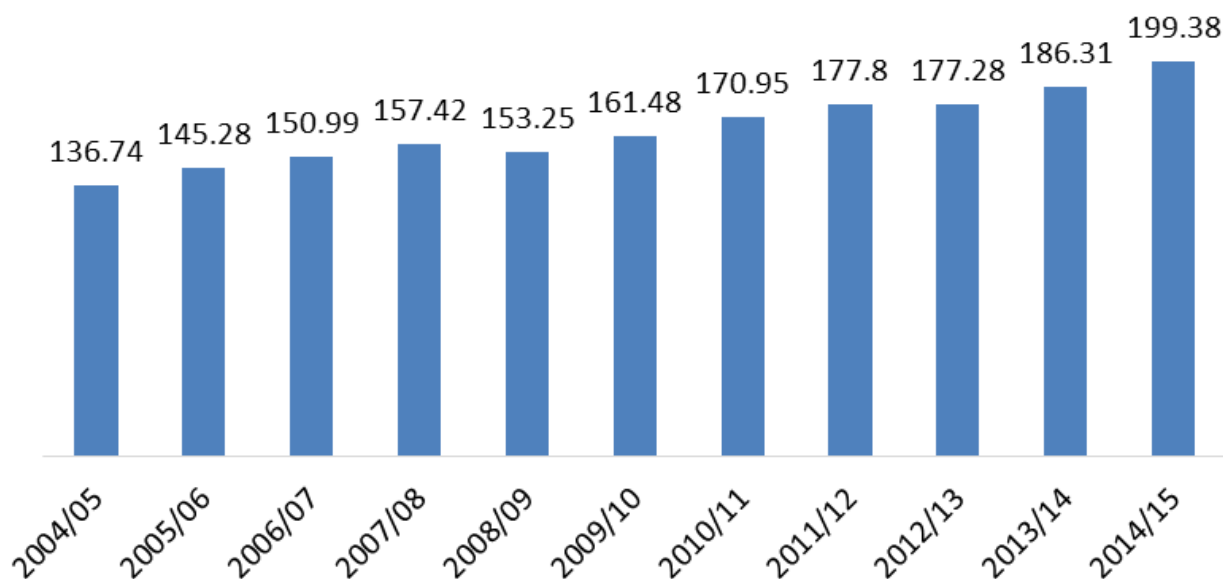
Source: USDFAS, US Foreign Agricultural Service's Production, Supply and Distribution (PSD) online database Soybeans: World supply and distribution, 2015

Soybean meal

Soybean meal is the most abundantly produced of all oilseed meals, the attractiveness of soybean meal as a feed ingredient is due to the high protein quality and nutritional value compared to alternatives.

Soybean meal in aquaculture feeds has been particularly notable, especially in growing Asian markets. It is broadly consumed and has penetrated markets in most regions, thanks to the progressive expansion of intensive livestock production methods (which are based on the use of high protein compound feed). In both developed and developing world, annual consumption growth in developing countries by far exceeds the expansion recorded in developed countries¹⁷.

¹⁷ Soybean International Commodity Profile, World Bank/FAO, P. Thoenes. 2007

Figure 7: Soybean meal Consumption, million tonnes, 2004-2014

Source: USDFAS, US Foreign Agricultural Service's Production, Supply and Distribution (PSD) online database Soybeans: World supply and distribution. 2015

3.2. Factors affecting demand

Factors affecting demand are the following:

Demography

The growth of China and India economies, with their combined populations means are an influential part of the global economy and can afford to purchase more protein, such as meat, milk and eggs, as well as whole soybean products and edible oils for cooking. This also led to an increase in global demand for poultry, pork and beef, which are fed typically with soybean meal, as it is a primary source of animal feed.

Consumer's preferences

Consumers realize the health benefits of soybeans in their diet. Dietary concerns over trans fats health issues, increase demand for soybeans specialty product. People shift to dairy and meat products to fulfill the requirement of proteins within their diet instead of cereal crops like rice and wheat.

Demand for non-GMO soybean products

Consumers also demand the origin of the production. Concerns over claims of health and environmental effects of genetically modified (GMO) varieties are a growing concern and demand for non-GMO soybeans is increasing. This trend is expected to continue as those products become available at local supermarkets in addition to specialty and health food stores.

Biofuels moral opposition

The use of biofuels has proven benefits. However, it has gained world controversy because of its perceived role in the world food crisis. Any legislation or international move to restrain biofuel development will lower the price of soybeans, because they would be less valuable as food than as a potentially viable substitute to gasoline.

Competing commodities, Alternatives

The alternative of soybean meal is corn. If there is excess production of corn, the farmers would prefer to use cheaper corn for farm feed rather than soybean, which

reduce the demand. Hence, substitute products keep a record on the increase in the price of soybean.

Demand for protein meal and higher protein content in soybean meal markets can be destabilized by sudden shifts in demand, for example as a result of food safety issues, as seen in recent years by the soymeal market through its link with the livestock industry.

Innovative technologies

Innovative seed technologies are developed to boost production yields, lower production costs, deliver nutritional profiles and value-added traits desired by consumers.

3.3. Outlook

Demand growth will be led by China, by far the biggest consumer. An increasing population, urbanisation, changing dietary habits and the expanding aquaculture sector should boost consumption of animal protein, leading to stronger demand for soybeans meal in large-scale industrialised feed production.

Outlook is conditional on China's strong demand for imported soybeans. Most of this further demand coming

mainly from Brazil, which has the most potential to expand his production. Should this demand falter, or should China's food security challenges push for increased diversification in import sources, Brazil may have to adjust production, given the size of alternative an competitive import markets.

An additional source of demand for vegetable oil is for the production of biodiesel, which expected to increase due to the domestic blending mandate.

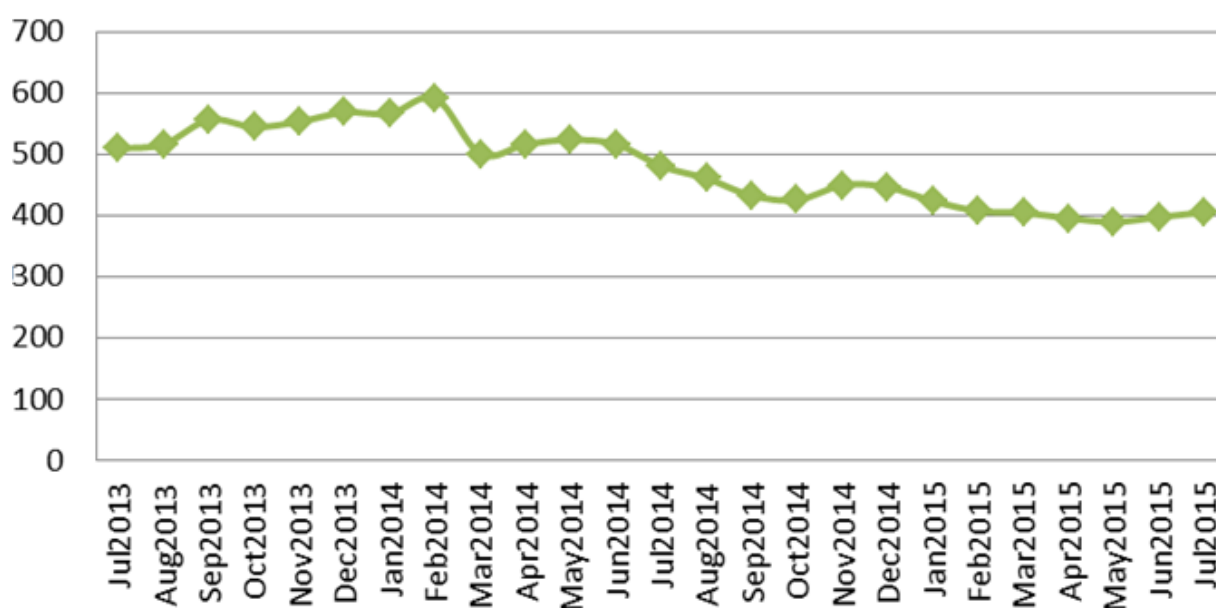
4. Prices

4.1. Price trends over the past two years

The Chicago Board of Trade is widely considered as the world's most important futures market for soybeans and products. North Western European ports, in particular Rotterdam, are the dominant import destination used to quote international prices of soybeans, soymeal and soybean oil.

A downward trend can be detected, mainly resulting from a gradual rise in yields and a marked decrease in the costs of production for soybean, soybean oil and soybean meal, as well as competing crops, in particular palm oil.

Figure 8: Monthly prices of soybeans 2013-2015



Source: UNCTADSTAT, 2015, Soybeans, in bulk, United States, n° 2 yellow, CIF Rotterdam

Soybean is highly traded on the international market, thus, value of the US dollar effects on soybean prices. High dollar value weakens export forecasts, as importers might have to pay higher prices. This, therefore, leads to weakened soybean prices.

Declining dollar value usually favours exports prospects, which in turn lead to higher soybean prices.

Crude oil prices also affect soybean prices. The link between crude oil and soybean is due to the growing importance of soybean use in the biofuel sector. Generally, high crude oil prices are positive for soybean prices, as it means that its use in this renewable energy sector could be profitable. Declining crude oil prices is considered negative for soybean prices because of the profitability of biofuel production.

Index commodity fund is another factor that affects soybean prices.

4.2. Price outlook

The production and processing of soybeans are seasonal activities, requiring storage facilities, such as grains elevators and processors, to acquire stocks that may be held in inventory for long periods of time. The futures market, by indicating the differences in the prices prevailing for spot and future sales, enables inventory holders to calculate the approximate return they will obtain by holding stocks¹⁸.

- USA production forecast is an indication of future soybean records. Therefore, a positive soybean production outlook is likely to send prices lower, as it indicates that inventories would be at high levels. Furthermore, if the production outlook is negative, prices are bound to go up, in response to fears over a coming decrease in inventories.

- Brazil has a meaningful effect on soybean prices. An incline in production from Brazil will send prices high, as it will create worries about a shortage in the market. Moreover, positive production from Brazil contributes to decrease prices.

- Chinese soybean import data is an indication of demand in the country. If China imports more soybeans, prices will go up.

- Global production outlook also affect soybean prices. When production forecast in other producing countries is positive, it is not positive for US exports, hence, sending prices low. However, other countries expect to produce fewer soybeans, the US exports prospects become positive, thus sending prices higher.

- Corn and soybean compete in the cooking oil, animal feed and biofuel industry. The production of one affects the other. In general, if the production of corn falls, soybean prices are expected to rise.

- The GMO controversy is also a factor that may influence soybean prices.

5. Markets

5.1. Market structure

Global soybean production, trade and processing, has many links in the commodity chain, characterized by a high level of concentration and specialization. The production is highly concentrated, with some 80 % originating in three countries alone: the United States, Brazil and Argentina. International business conglomerates control a highly competitive and mature market.

Many players are involved and are highly diversified and integrated both vertically and horizontally:

- Small numbers of big companies control large volumes of the soybean value chain, include crusher and traders, meat and dairy companies, retail and catering businesses. These are sophisticated, well-resourced players with wide international experience. Their decisions drive the development in the sector.

World's soybean production comes from medium to large-size farms that are characterized by a high level of mechanization and capital-intensive production method. The type of technological advances introduced in soybean cultivation and processing have been an important economy of scale and have become a key determinant for the industry's structure at the national and global level.

¹⁸ Soybean International Commodity Profile, World Bank/FAO, P. Thoenes. 2007

Leading producers have a considerable influence on soybean farmers, aided by high investment costs involved in soybean cultivation, storage, crushing and marketing. They benefit from a rich financial resource base, new technologies, program and national policies supported by government.

They provide seeds, fertilizer, and agrochemicals to the growers. Soybeans are transported and stored in their own facilities. At the global level, the bulk of soybean output is stored and shipped to large-scale industrial units for further processing into meal and oil. Transport of the commodities is complete in their own railway and maritime transport.

- Soybean economy has considerable value addition occurs at the downstream stages of the production and processing chain.

Strong price competitions, high levels of market concentration and private sector consolidation are driven by increased pressure from competing commodities, such as palm oil, and the prospect of further innovations in the area of biotechnology.

-Downstream transformation and subsequent export oriented marketing of the end products are distinct economic activities. It generates considerable value outside the agricultural sector itself, explaining the economic importance of soybean for the global food and feed industry.

- The Retail is characterized by few dominant supermarket chains and manufacturers in the food and cosmetics industries. They operate on an increasingly international scale and are improving their positions of power in the chain.

6. Pulic/private standards

Sustainability standards active in the sector and growing in popularity include the Danube Soya Initiative, Fairtrade, and the Round Table on Responsible Soy (RTRS), ProTerra and Organic. The International Sustainability and Carbon Certification (ISCC) and the

Roundtable on Sustainable Biomaterials (RSB) are other standards involved in the soybean industry.

6.1. Contractual arrangements

The Round Table Responsible Soy (RTRS) was founded in 2006 and promotes the use and growth of responsible production of soy, through the commitment of the leading stakeholders of the soybean value chain, and through a global standard for responsible production. It assures that soy, either as a raw material or as a by-product, was originated from a process that is environmentally and socially appropriate and economically viable. Therefore, there is evidence that products derive from responsible soy production management.

In December 2011, several Dutch companies agreed to achieve 100% use of “responsible soy” defined in the agreements as compliant with RTRS standard or equivalent¹⁹. The Round Table Responsible Soy and ProTerra are engaged in a mutual harmonization process that will result in ProTerra certified soy being recognized as “responsible soy” for the production of meat, dairy, eggs and other foods in the Netherlands in 2015. Such investments should allow growers in South America and other supply chain actors to implement the necessary improvements and achieve RTRS certification to reach the World Wide Fund’s (WWF) target of 25% of global production as “responsible soy” by 2020. Achieving this objective will almost certainly depend on RTRS’s ability to expand production and demand to other regions around the world²⁰.

6.2. Niche markets

Standard-compliant soybeans can be sourced from a large number of countries due to the wide coverage of organic schemes; however, the Round Table Responsible Soy (RTRS) and ProTerra standards have penetrated only a handful of countries, and the vast of all compliant production currently occurs in Brazil.

6.3. Non-genetically modified organism (GMO) soybeans

Non-GMO soybeans are varieties that have not been genetically improved through bioengineering technology. Genetically modified food controversies and consumer concern over the potential long-term health risks of

¹⁹ The State of Sustainability Initiatives review, Soybean Market, 2014.

²⁰ The State of Sustainability Initiatives review, Soybean Market, 2014.

consuming genetically modified foods has led to a greater demand for non-GMO soybeans and soybeans derived products.

The arrival of GMO soy has led to a radical transformation of the marketplace. Genetically modified soybean is now, in most countries, the dominant source of production. Soybeans had the highest absolute presence of biotech hectareage in the world²¹: 81 % of world plantings and 98 % of U.S. production in 2012²².

Organic and Fairtrade standards prohibit the use of GMOs, and the growing expansion of GMO soybean around the world has given initiatives. At the same time, with GMOs becoming increasingly omnipresent within the sector, non-GMO-based initiatives to address sustainability at the mainstream level face serious supply constraints and limits on total growth.

The Danube Soy Initiative was launched in 2012 as a mainstream vehicle for providing access to non-GMO soy for European U markets. The organization has shown signs of potential for significant growth and uptake, with significant support coming from stakeholders in Germany, Austria, France, Luxembourg and the United Kingdom.²³

7. Regional/International trade

7.1. Top 10 exporters and Importers (country)

The three world's leading soybean producers play a fundamental role in world trade because they provide annually about 90% of exports. The United States is the leading world supplier. By exporting more than a third of its production, they account for about 38% of world soybean exports. Brazil for which the export is a major outlet for its production and Argentina, are the two other major exporting countries.

Table 5: Top 10 Exporters in 2011, tonnes

	Exported quantity, Tons
World	91315863
1 United States of America	34394112
2 Brazil	32985560
3 Argentina	10820029
4 Paraguay	5093589
5 Canada	2650761
6 Uruguay	1700762
7 Ukraine	1096303
8 Netherlands	727035
9 United Arab Emirates	371182
10 Belgium	262606

Source: ITC Trade Map. 2015

Table 6: Top 10 importers in 2011, tonnes

	Imported quantity, Tons
World	91821424
China	52452848
Mexico	3340376
Germany	3188194
Spain	3176842
Netherlands	3034021
Japan	2830780
Taipei, Chinese	2349533
Indonesia	2088616
Thailand	1994378
Turkey	1297770

Source: ITC Trade Map. 2015

Changes in China's agricultural and trade policies have significantly influenced world oilseed markets. The growth of China's economy has encouraged food consumption, turning the country into the world's leading soybean

²¹ FAO, International Service for the Acquisition of Agri-Biotech Applications (ISAAA), 2013

²² The State of Sustainability Initiatives review, Soybean Market, 2014

²³ The State of Sustainability Initiatives review, Soybean Market, 2014

importer. China's World Trade Organization accession has reduced import tariffs and quantitative restrictions to its oilseed market.

7.2. Top biggest trading companies

Multinational companies play a big role in the soybean value chain and trade. They control a large part of the production and processing chains in the exporting and the importing countries. Major Players of Production (producer, grower) are named the « Big four » or « ABCD » after their initials. They are **A**rcher **D**aniels **M**idland Company (ADM), **B**unge Limited, **C**argill and **L**ouis **D**reyfus Group.

Other commodity trading firms are active in the global soybean trade, such as, Marubeni Corporation, Itochu Corporation, Mitsui & Co. Ltd., Noble Group and Sumitomo Corporation²⁴.

7.3. Fair trade initiatives

Fairtrade International

As of 2011, soybeans were being reported by Fairtrade International within the aggregated “Oilseeds and Oleaginous Fruit” category, which represented 8,800 farmers certified and 300 metric tons in sales volume in 2011 (FLO). With real soybean prices hovering at some of their highest levels since the mid-1980s, farmers may be less incentivized by the Fairtrade premium as they are in other agricultural sectors.

The Soybean and Pulses Standards for Small Farmer Organizations

It contains global Fairtrade minimum prices enabling producers from all regions to apply.

Fairtrade standards prohibit Fairtrade certified producer organisations from using genetically modified organisms (GMOs), including GM seeds and planting stock. Therefore, being Fairtrade certified will provide an incentive for small farmers to continue their commitment to produce GMO-free soybean.

The standard ensure greater transparency in the system, as well as to guarantee sustained trading relationships and enable producers to benefit from prefinance.

²⁴ Soya Tech (www.soyatech.com)

It gives to the small-scale farmers the opportunity to improve their position and secure their livelihoods. Standard is only available to small-scale producers. Fairtrade soybean volumes are still very small.

7.4. Trade issues (dispute; negotiation; agreements)

Policies to regulate trade in oilseeds (including soybean) have undergone gradual liberalization over the last 10-15 years under the influence of multilateral trade negotiations. The sector has benefited from increased transparency and progressive reductions in import tariffs²⁵.

Zero Tariff binding

This trade agreement specifies that no import tariffs have to be paid on soybean imports, as opposed to other products like sugar, which means that soybean is a cheap alternative to expensive European grains.

Blair House Agreement

The Blair house agreement is a memorandum of Understanding on Oilseeds. While allowing European Community support for the production of certain oilseeds to continue, it established a number of restrictions on this support. In particular, it placed a limitation on the supported area. A maximum oilseed production volume of fifteen million ton was instituted, which is much less than Europe uses.

²⁵ Soybean International Commodity Profile, World Bank/FAO, P. Thoenes. 2007

8. Useful links

8.1. Statistics

FAOSTAT	www.faostat3.fao.org
UNCTADSTAT	www.unctadstat.unctad.org
ITC Market analysis tools	www.trademap.org

8.2. International and national organisations and associations

Table 7: International and national soya association

OECD	www.oecd.org
International Standard Organization	www.iso.org
International Institute for Sustainable Development	www.iisd.org
Food Alimentation Organization	www.FAO.org
IDH	www.idhsustainabletrade.com
World Trade Organization	www.wto.org
World Health Organization	www.who.org
International Food and Agricultural Trade Policy Council	www.agritrade.org
Round Table on Responsible Soy Association	www.responsiblesoy.org
National Oilseed Processors Association	www.nopa.org
Brazilian Association of Vegetable Oil Industries	www.abiove.com.br
Canadian Oilseed Processors Association	www.copaonline.net
Cámara de la Industria Aceitera de la República Argentina	www.ciaracec.com
Federation of Oils, Seeds and Fats Associations	www.fosfa.org
The Grain and Feed Trade Association	www.gafta.com
Netherlands Oils, Fats and Oilseeds Trade Association	ww.nofota.nl
American Soybean Association	www.soygrowers.com
Argentine Oil Industry Chamber (CIARA):	www.ciaracec.com.ar
Brazilian Association of Vegetable Oil Industries (ABIOVE)	www.abiove.com.br
Canadian Soybean Exporters Association:	www.canadiansoybeans.com
EU Oil and Proteinmeal Industry (FEDIOL):	www.fediol.be
Qualisoy	www.qualisoy.com
United Soybean Board	www.soybean.org

8.3. Latest news

<http://www.oilseedandgrain.com>