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Soybean Production: A Versatile Pulse Crop for Farmers' Upliftment & Agro - Industrial Development

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Abstract

Soybean is one of the most widely planted and used legumes in the world due to its valuable seed composition. The many significant agronomic practices that are utilized in soybean production are highlighted with an emphasis on those used during the pregrowing season and growing season. The various pests of soybeans and the pest management strategies used to control them are described with special attention to insects, weeds, bacteria, fungi, and nematodes. The multitude of soybean uses for livestock and human consumption, and its industrial uses are discussed in this article. Additionally, the conventional breeding and genetic engineering attempts to improve soybean protein, oil, and sucrose content as well as eliminate the antinutritional factors, such as trypsin inhibitors, raffinose, stachylose, and phytate, are examined. In this article, industrial uses of soybean has been discussed.

Keywords: Legumes, soybean uses, industrial uses, human consumption.

Introduction

Soybean (*Glycine max*) is one of the most valuable, versatile, and nutritionally important legumes globally. It can be grown in a multitude of environments, using a variety of management practices, and for diverse end user purposes. In 2021, roughly 410 million tons of soybeans were produced worldwide which accounted for 68% of overall oilseed production and 6.5% of the world's arable land use. The United States, Brazil, and Argentina constituted approximately 81% of interna tional soybean production, producing 34, 32, and 15%, respectively. Soybean seed composition and its main components, meal and oil, are the driving forces behind crop production that has increased nearly 350% since 1987. In India, Madhya Pradesh, Maharashtra and Rajasthan together contribute to about 92-93% of area and production of soybean.

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World soyabean production in 2019-20 is estimated as 333.67 million tonnes from a total area of 120.50 million hectares. Brazil ranks first in soyabean production with 114.27 million tonnes followed by United States of America (96.79 million tonnes), Argentina (55.26 million tonnes), China (15.73million tonnes) and India (13.27 million tonnes) accounting for 34.25, 29.01, 16.56, 4.00 and 3.98 percent of world production (www.agricoop.gov.in).

India ranks fourth in area with 11.34 million hectares (28.02 million acres) accounting for 9.41% of the world area and fifth in production with 11.22 million tonnes in 2019-20. The major soyabean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Telangana. According to the first advance estimates 2021-22 of Ministry of Agriculture, Soybean production is estimated at 127.20 lakh tonnes as compared to 128.97 lakh tonnes in 2020-21 (www.agricoop.gov.in).

In India, area under soyabean during 2021-22 was 121.76 lakh hectares as against 121.20 lakh hectares during 2020-21. Among the states, Madhya Pradesh stood first with 55.84 lakh ha followed by Maharashtra (46.01 lakh ha), Rajasthan (10.62 lakh ha), Karnataka (3.82 lakh ha), Gujarat (2.24 lakh ha) and Telangana (1.51 lakh ha).

Soybean meal is intricately connected to the food supply through direct food consumption and indirect consumption as a large source of livestock feed. Soy oil provides great versatility with uses in food and beverage, wax, construction, cosmetics, plastics, and fuel. Soybean crop cultivation and Nutritional value of soybean crop shows in Fig.1 and 2.

The U.S and western countries mainly utilize soybean indirectly in the food supply as livestock feed and food ingredients such as textured vegetable protein and protein isolates. However, as more consumers are looking for plant-based protein in their diet, soy foods will become a globally viable alternative to animal protein. As the soybean appetite has increased and transformed, scientific developments have also improved soybean production through agronomic, management, and genetic methods to meet demand.

Utilization of Soybean and Their Products

Livestock feed

Soybean is a valuable crop worldwide mainly because of soybean meal's nutritional efficacy as a food and feed ingredient. A high protein content, balanced essential amino acid profile, and the presence of other beneficial nutrients all contribute to its economic and

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nutritional value. Soybean meal constitutes 70% of seed value while only being roughly 35% of seed dry weight. Furthermore, in the United States, 97% of soybean meal is used for livestock feed. This overwhelming usage rate as a livestock protein source is mainly due to the presence of essential amino acids. While some livestock require other amino acids, most livestock need nine essential amino acids: histidine, isoleucine, leucine, lysine, methionine, phenylanine, threonine, tryptophan, and valine. All nine of these amino acids are found in some quantity in soybean meal. For this reason, soybean meal can maximize livestock production in cattle, swine, poultry, and aquaculture. Generally, soybean meal and other soy byproducts use are limited to a supplementary or finishing role for cattle due to feed ration

Fig.1. Soybean crop cultivation

complications from other seed components.

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Soybean meal use is highly prevalent in monogastric livestock production such as swine and poultry and is increasing in popularity for aquaculture. However, soybean as feed has two main obstacles: methionine deficiency and trypsin inhibi tor proteins. Albeit present in soybean, methionine content is deficient for livestock needs, is considered the first limiting amino acid for soybean meal and requires producers to supplement with synthetic methionine. This has a variety of negative economic and environmental impacts, including increased cost and poor nitrogen-use efficiency. Trypsin inhibitor proteins are an antinutritional factor present in raw soybean that decreases feed efficiency and can harm the livestock. There are a variety of industrial processing methods used to overcome trypsin inhibitors in soybean such as thermal and infrared treatment. In the future, soybean methionine deficiencies and trypsin inhibitor levels may both be solved via breeding and transgenic efforts.

Human food

Soybean as human food exists to two different extents that are derived from geography and cultural tradition. Eastern hemisphere populations incorporate whole soybeans and processed soy foods into their lives on a daily basis, whereas Western hemisphere populations generally utilize processed soybeans as food ingredients. Eastern soy foods are divided into two main categories: fermented and non-fermented. Non-fermented soy foods include whole seed options such as whole dry soybeans, soy nuts, and edamame, processed items such as soy flour and soy milk, and vegetative soy sprouts.

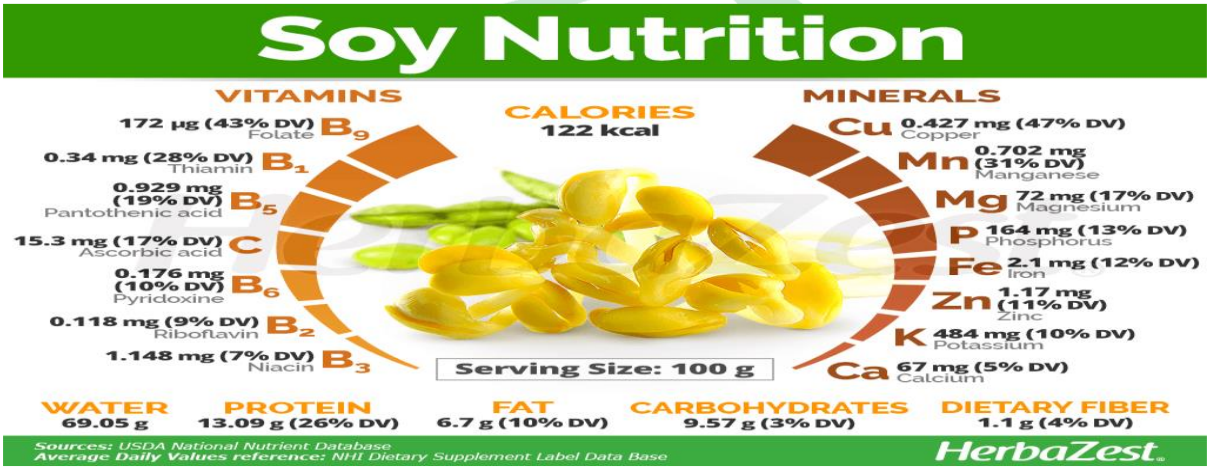

Fig. 2. Nutritional value of Soybean

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Soy milk in its simplest form is a water extract from soybean that when further processed can make tofu and tofu byproducts such as okra (soy pulp) and yuba (tofu skin). Fermented soy products include miso, soy sauce, tempeh, natto, and sufu, and each product has a specific bacterial species that enables proper fermentation. For example, natto is associated with Bacillus subtilis, and soy sauce is associated with *Aspergillus sp*.

Western cultures have assimilated many soy food products, and they are becoming more popular as consumers seek plant-based protein sources. However, the vast majority of soybeans in western diets consists of food ingredients made from soybean meal and soy oil. Soybean meal can be processed into ingredients such as soy flour, protein concentrates, and protein isolates that are used in bakery mixes, breakfast cereals, baby food, and exercise supplements. Soybean oil is widely used in vegetable oil and margarine mixes for a variety of cooking purposes. The importance of traditional and innovative soy food uses has perpetuated because of the potential health benefits from soy consumption. Soy foods have been shown to play a role in chronic human disease prevention for conditions such as heart disease, osteoporosis, and cancer. However, isoflavones, one of the most common seed components linked to disease prevention, is also negatively linked to hormonal health as a phytoestrogen. While large population subsets are concerned about isoflavones negatively impacting fertility, summarized data has shown inconsistent results. As consumers continue to seek plant-based protein, soybeans will be the premier source for historically and culturally significant recipes as well as healthy, novel animal meat alternatives.

Industrial uses

Even though soybean is classified as an oilseed, soybean oil has historically been an afterthought for soybean producers and processors. When markets for soybean meal would falter, researchers and other stakeholders would turn to soybean oil for added value or seek alternative uses for meal components. Modern sustainability and industrial goals have stimulated soy-based product usage in a variety of fields, as summarized in Table 1.

Current biodiesel production methods can create soy-based fuel that perform nearly equal or equivalent to standard diesel fuels and have the potential to become a truly renewable resource when coupled with sustainable farming practices. Constantly improving processing methods will continue to augment soybean seed component versatility and create new opportunities for soy-based products.

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Table 1. Soy-based product usage

Conclusion

Soybean is an essential crop that is grown globally due to its various and diverse uses. Given its importance, there are many pre-growing practices to prepare the field for the growing season, including tillage, pre-plant fertilization, and monitoring soil pH. Many agronomic aspects must be considered during growing season to ensure successful soybean growth including crop rotations, double cropping, cover crops, irrigation, row spacing, plant density, and post-emergence fertilization. While soybean is highly used in livestock feed due to its high protein content, it's methionine deficiency and presence of antinutritional factors still present problems that need to be solved. Soybean versatility is represented by the many uses in human consumption, biofuels, and other industrial uses. Traditional and conventional breeders have been working to increase protein and oil content, while eliminating antinutritional factors. Genetic engineering and gene editing show promise to help improve soybean by introducing genes to improve protein and oil quality and knocking out genes to remove antinutritional factors.

Soybean Oils		Soybean Lecithin	Soybean Powders
Anti-static agents	Lubricants	Alcohol	Adhesives
Candles	Metal casting	Concrete	Antibiotics
Caulks	Oiled fabrics	Inks	Asphalt
Concrete	Paints	Magnetic tapes	Fermentation aids
Crayons	Pesticides	Paint	Packing films
Dust control agents	Plastics	Paper	Firefighting foams
Electrical insulation	Printing inks	Pesticides	Inks
Epoxy	Putty	Pharmaceuticals	Leather substitutes
Fatty acids	Soaps and detergents	Synthetic rubber	Particle boards
Fatty alcohols	Solvents	Softening leather	Pesticides
Fuel	Vinyl	Yeast	Pharmaceuticals
Hydraulic fluids	Wallboard		Plastics
Pesticides			Polyester
Linoleum backing			Textiles

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