

Analytical Study on Soybean: a Protein, Fats and Carbohydrates rich food for Global Nutritional Security

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“This work was carried out in collaboration between all authors. Author A (**Mayur Gautam**) designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors B (**Shrestha Gautam**) and C (**Sneha Kumari**) managed the analyses of the study. Author D (**Dr Ranjay Kumar Singh**) and Dr R S Kureel managed the literature searches. All authors read and approved the final manuscript.”

Article Information

Abstracts:

The soybean (*Glycine max.*) cultivation has been expended in many countries because of its nutritive and economic importance and diverse domestic usage. India's share in the world's total area is about one percent and in production about 0.38 % at present, however, area expansion from 0.32 lakh ha in 1970 to 108.40 lakh ha in 2012-13 as well as production of Soybean from 0.2 lakh tonnes in 1970 to 146.7 lakh tonnes in 2012-13 in the country during the last 40 years is rated as one of the striking occurrences in the agricultural development process. It is a prime source of vegetable oil in the international market. Proximate composition of soybean whole seed contains 18-22% Oil, 39-42% Protein, 31-37% Carbohydrates, 4.9-5.0% Ashes.

Out of total oilseed production of 29.25 Million Tones, we produce 11.54 Million Tones soybean, which is 39 % of total production. Similarly, Soy oil is a primary source of edible oil and has 19% share in total consumption of vegetable oils in our country. Our domestic production of Soybean Oil is 1.66 M.T and consumption is 4.64 M.T. To meet our domestic requirement, country is importing around 3.00 Million Tones Soybean oil annually by incurring about 19000/- crores. The average globally, area, production and productivity of soybean is around 116.48 M hectares, 303.06 M T, 26.02 qtls/ha, respectively during 2013-16. The major five countries like USA, Brazil, Argentina, India and China account for more than 87% area and 90% production of soybean globally. The three major countries i.e USA, Brazil and Argentina alone comprises 71.13 % area 82% Production of Soybean globally.

Keywords: Unsaturated fatty acids, Cholesterol, Dementia, Alzheimer, Isoflavones, Tocopherol lecithin, Hemicellulose, Pectin, Soy protein, De-oiled cakes, Soy flour etc.

Date of Submission: 14-07-2020

Date of Acceptance: 29-07-2020

I. INTRODUCTION

Soybean is one among the major industrial and food crops grown in every continent. Soybean cultivation has been expended in many countries because of its nutritive and economic importance and diverse domestic usage. It is also a prime source of vegetable oil in the international market. Proximate composition of soybean whole seed contains 18-22% Oil, 39-42% Protein, 31-37% Carbohydrates, 4.9-5.0% Ashes. The fatty acid composition of soybean oil includes Palmitic (7-12%), Stearic (2-5.5%), Oleic (19-30%) and Linoleic (48-58%). The oil of Soybean has 85% unsaturated fatty acids, considered to be cholesterol-free[1]. Similarly, among the essential amino acids, it has lysine, Methionine, Cysteine, Tryptophan, Threonine, Isoleucine and Leucine, which are considered to be very good for human health. The soybean contain very little of starch (4.66-7%) and quite a lot of Hemicellulose and Pectin's. These Polysaccharides have several health benefits in human's life. Both play an important role in preventing certain type of cancer and helping in digestion and weight loss.

Protein of soybean products characterized much quantity of lysine, Tryptophan, Isoleucine, Valine and Threonine. Number of Nutraceutical compounds such as Isoflavones, Tocopherol and lecithin has made it one of

the most valuable agronomic crops in the world. Soybean has great potential as exceptionally nutritive and very rich protein food. Soybean oil has an important fatty acids, lecithin as well as vitamin A and D. Lecithin is used for reducing fatty build-up in the liver and treating memory disorders such as dementia and Alzheimer's disease. It is pertinent to mention that 90% of Indians are deficient of Vitamin –D. Soybean oil is very good for Vitamin –D deficient people. It can supply much needed protein to human diet, because, it contains 40 % protein of superior quality and all the essential amino acids similar to cow milk and animal proteins. In view of its nutritional values, it is a complete food for vegetarians [2].

Soybean can obtain between 50 to 70% of its nitrogen (N) requirements and improves soil fertility being leguminous crop. Soybean is capable of transforming nearly 60-100 kg atmospheric nitrogen in to 30-40 kg nitrogen per hectare in the soil through adequate populations of N-fixing bacteria *Bradyrhizobium japonicum*, in the genus *Rhizobium*. [3] It controls the *Strigahermonthica*, a parasitic weed and also provides protein rich fodder for the animals and soybean cake for egg layering birds. It is a nutrient rich food used in the form of Soy oils, nutri- nuggets, tofu, soy-milk, soy-cheese, soy-fish, soya-flour, Soya-chaap, Soya-noodles (Nutrala), soya paneer, soya protein, Soy Molasses, Soy Sauce, Soy Yogurt, Sweet Bean Sauce, Soya Extract, soya lecithin and so on. It has largest consumption among the vegetable oil in the world as well as in the Country [4].

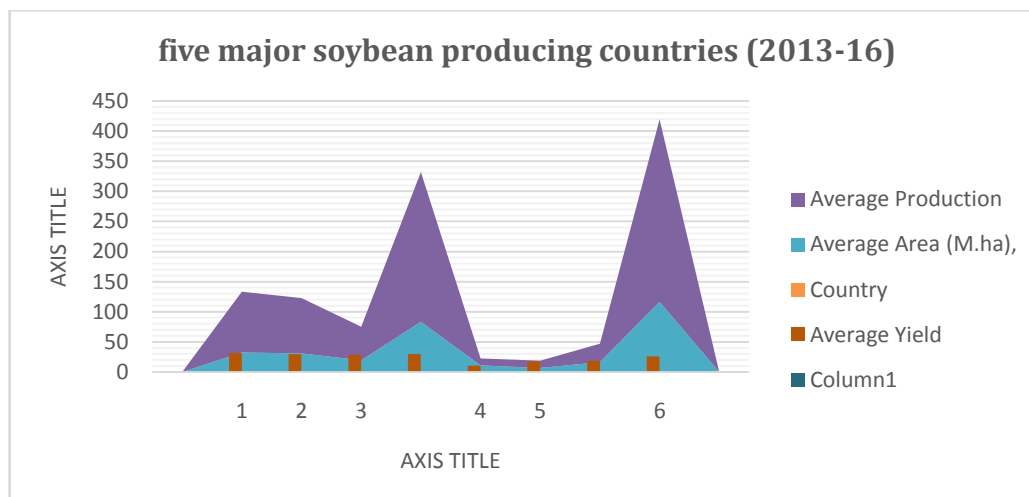
As per FAO's Agricultural Market Information System, global production of soybean during 2018-19 is estimated at 359.6 million tonnes, a new record, from an area of 129.27 million hectares. Production estimates for 2017-18 has been revised slightly upward to 337.9 million tonnes recently from 336.8 million tonnes projected during March, 2018 from an area of 124.25 million ha. [5]

Out of total oilseed production of 29.25 Million Tones (Avg. 2011-16), we produce 11.54 Million Tones soybean, which is 39 % of total production. Similarly, Soy oil is a primary source of edible oil and has 19% share in total consumption of vegetable oils in our country. Our domestic production of Soybean Oil is 1.66 M.T and consumption is 4.64 M.T. To meet our domestic requirement, country is importing around 3.00 Million Tones Soybean oil annually by incurring about 19000/- crores [6]

Global Scenario:

The average globally, area, production and productivity of soybean is around 116.48 M hectares, 303.06 M T, 26.02 qtls/ha. respectively during 2013-16. The major five countries like USA, Brazil, Argentina, India and China account for more than 87% area and 90% production of soybean globally. The record production of soybean was estimated during 2016-17 at 349 million tones. The three major countries i.e USA, Brazil and Argentina alone comprising 71.55 % area 82.08% Production of Soybean globally [7]. The average productivity of these three countries is 30 qtls per ha. as against the world average is 26.02 qtls/ha. and 10.45 qtls/ha in India. Estimated area, production and productivity of five major soybean producing countries (2013-16) are summarized as here under:

| | Country | Average Area (M.ha), | Average Production (M. T) | Average Yield Qtls/ha. |
|----|-----------------|----------------------|---------------------------|------------------------|
| 1. | USA | 32.40 | 101.07 | 31.19 |
| 2. | Brazil | 31.02 | 91.80 | 29.59 |
| 3. | Argentina | 19.43 | 55.84 | 28.74 |
| | Total (1 to 3) | 83.35 | 248.76 | 29.84 |
| 4. | India | 11.04 | 11.54 | 10.45 |
| 5. | China | 06.84 | 12.08 | 17.68 |
| | Other countries | 16.35 | 30.73 | 18.79 |
| 6 | World | 116.48 | 303.06 | 26.02 |



Keeping in to consideration, the nutritive value and importance of soybean in human diet and also vital role in world economy, Russia has offered to provide one million ha land to china or to any other country for production of soybeanrecently as published in Global Times on 25th, Oct, 2018 [8].

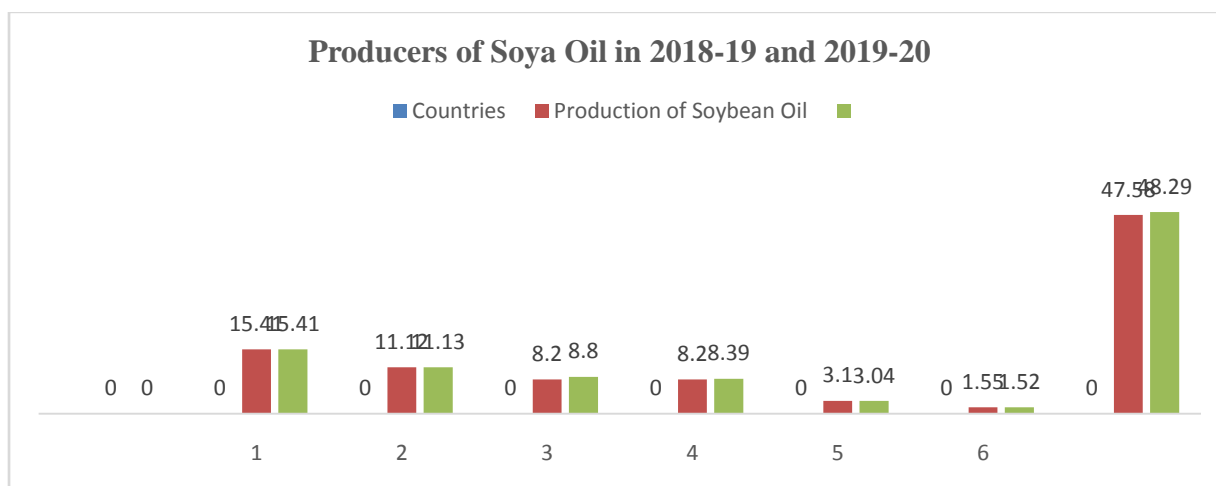
Global Production Trend of Soybean Oil:

China, United States, Argentina and Brazil were the key producers of Soya Oil in 2018-19 and 2019-20. India’s estimated share in global production of Soybean Oil in 2018 & 2019 was 3.25 % and 3.15 % respectively. The Production of Soya Oil by the major producing countries and their share in global production is enumerated as hereunder:

| Qty: Million Tonnes | | | | | |
|---------------------|---------------------|---------------------------|--------------|-------------------|------------|
| | Countries | Production of Soybean Oil | | % of Global share | |
| | | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| 1 | China | 15.41 | 15.41 | 32.39 | 31.91 |
| 2 | United States (USA) | 11.12 | 11.13 | 23.37 | 23.05 |
| 3 | Argentina | 8.20 | 8.80 | 17.24 | 18.22 |
| 4 | Brazil | 8.20 | 8.39 | 17.24 | 17.37 |
| 5 | European Union | 3.10 | 3.04 | 6.51 | 6.30 |
| 6 | India* | 1.55 | 1.52 | 3.25 | 3.15 |
| | World | 47.58 | 48.29 | 100 | 100 |

Source: United States Department of Agriculture

* Production of Soybean oil has been estimated considering crushing of 75% of total Soybean produce (10.33 MT in 2018-19 and 10, 13 MT in 2019-20) and 15 % recovery rate in oil extraction.



Global Soybean Oil exporting Countries:

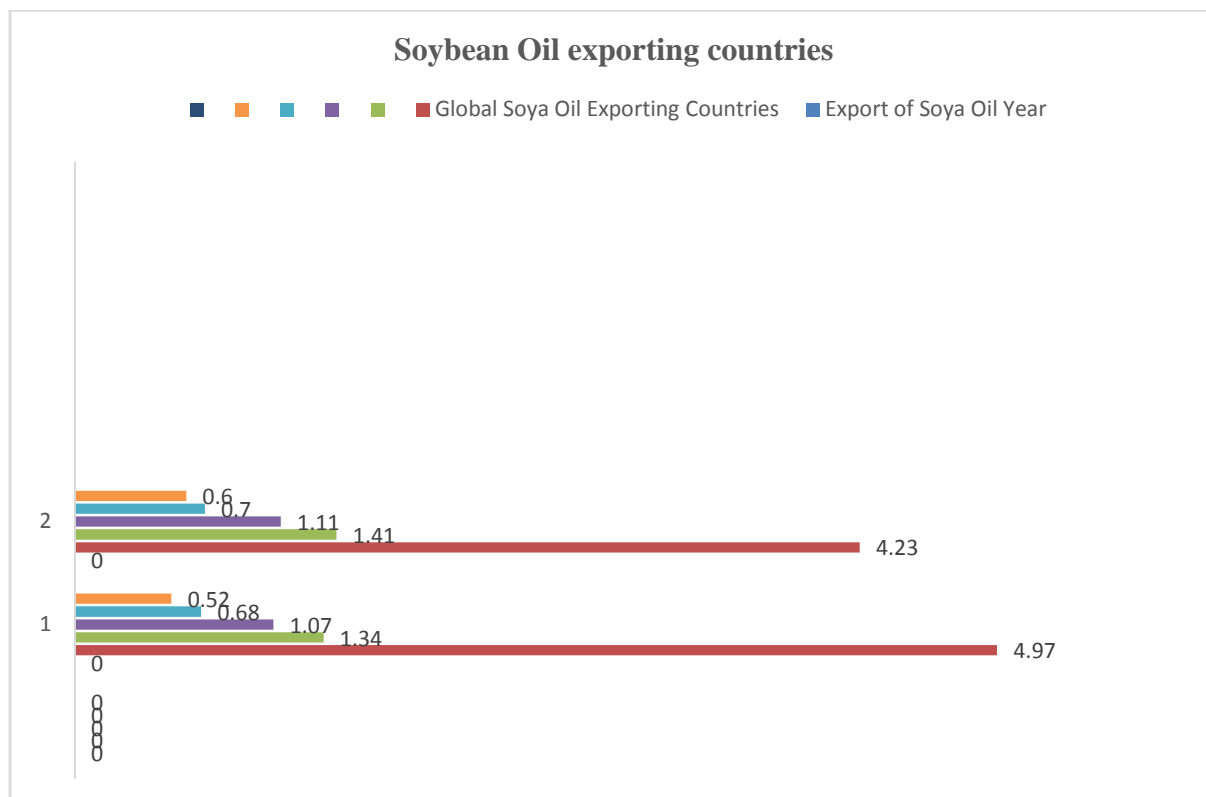
The main exporters of Soybean Oil were Argentina, Brazil, United States, Netherlands and Paraguay during 2018-19. Similarly, major Soybean Oil importing countries during the corresponding periods were India,

Bangladesh, Algeria, China and Morocco. The details of Soybean Oil exported by exporting countries are enumerated as here under:

Qty: Million Tonnes

| | Export of Soya Oil Year | Global Soya Oil Exporting Countries | | | | |
|----|-------------------------|-------------------------------------|--------|------|----------|-------------|
| | | Argentina | Brazil | USA | Paraguay | Netherlands |
| 1. | 2017-18 | 4.97 | 1.34 | 1.07 | 0.68 | 0.52 |
| 2. | 2018-19 | 4.23 | 1.41 | 1.11 | 0.70 | 0.60 |

Source: Comtrade



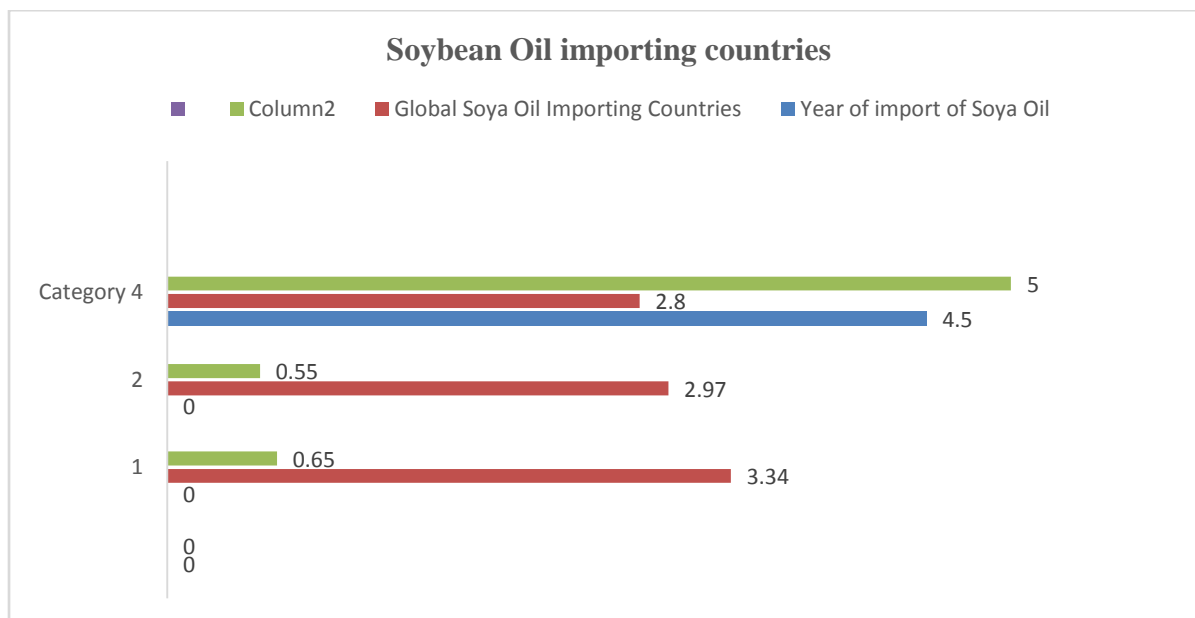
Global importing countries of Soybean Oil.

The major Soybean Oil importing countries during 2018-19 were India, Bangladesh, Algeria, China and Morocco. India was the largest importer of Soybean Oil that constituted 27.89 % of the global import in the year 2017-18. The details of Soybean Oil imported by these countries are enumerated as here under:

Qty: Million Tonnes

| | Year of import of Soya Oil | Global Soya Oil Importing Countries | | | | |
|----|----------------------------|-------------------------------------|-------|---------|------|----------|
| | | India | China | Morocco | Peru | Colombia |
| 1. | 2017-18 | 3.34 | 0.65 | 0.50 | 0.45 | 0.35 |
| 2. | 2018-19 | 2.97 | 0.55 | 0.53 | 0.50 | 0.34 |

Source: Comtrade



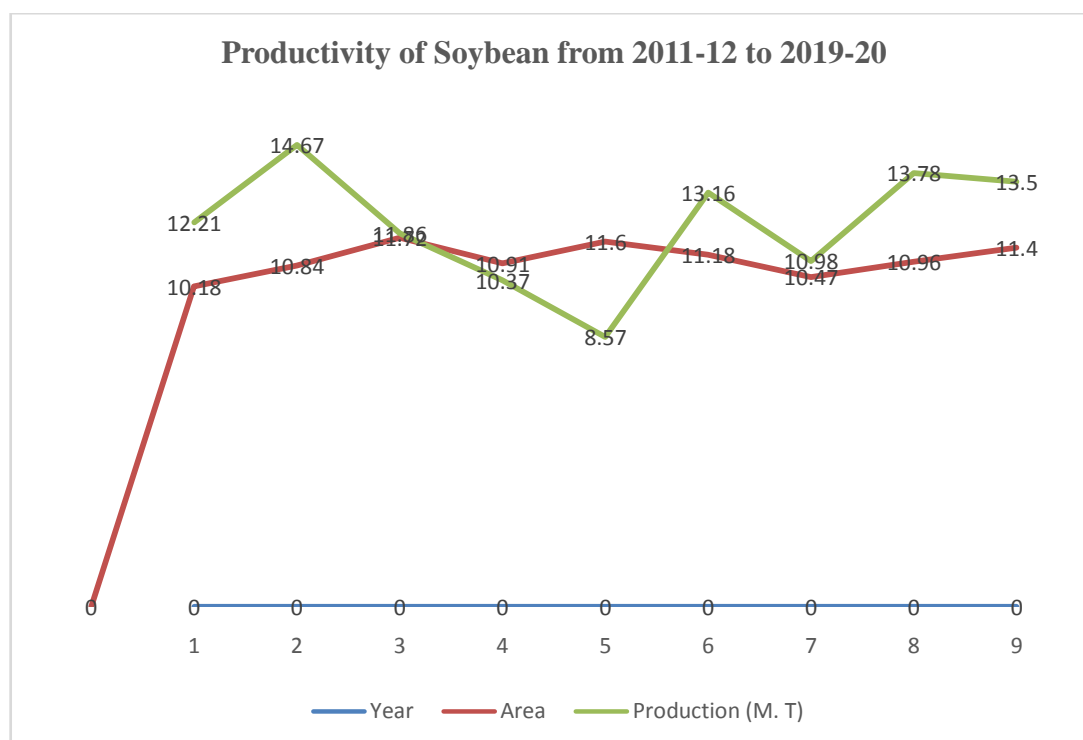
National Scenario:

India’s share in the world’s total area is about one percent and in production about 0.38 % at present, however, area expansion as well as production of Soybean in the country during the last 40 years is rated as one of the striking occurrences in the agricultural development process. The area under soybean was only 32000 hectares during 1070s. [9] It has been increased many folds up to 2013-14. Though still there is vast potential of area expansion and productivity enhancement, however, area and production of soybean is stagnating since last 10 years at around 10 to 11 million hectare and production at around 11 to 13 Million Tones

The estimates of area, production and productivity of Soybean from 2011-12 to 2019-20 is summarized as here under: -

| | Year | Area (M.ha) | Production (M. T) | Yield (Kg ha ⁻¹) |
|----|---------|-------------|-------------------|------------------------------|
| 1. | 2011-12 | 10.18 | 12.21 | 1200 |
| 2. | 2012-13 | 10.84 | 14.67 | 1353 |
| 3. | 2013-14 | 11.72 | 11.86 | 1012 |
| 4. | 2014-15 | 10.91 | 10.37 | 951 |
| 5. | 2015-16 | 11.60 | 8.57 | 739 |
| 6. | 2016-17 | 11.18 | 13.16 | 1177 |
| 7. | 2017-18 | 10.47 | 10.98 | 1049 |
| 8. | 2018-19 | 10.96 | 13.78 | 1257 |
| 9. | 2019-20 | 11.40 | 13.50 | 1104 |

Source: Directorate of Economics and Statistics, Min of Agriculture & Farmers Welfare, Govt of India.



The average area, production and productivity of soybean from 2011-12 to 2019-20 is 11.01 Million ha 12.12M T and 1104qtls/ha respectively. The soybean is contributing 39 % of total production of oilseeds i.e.29.25 M T from 26.51 M ha area in the country [10].

State and Year wise Area and Production of Soybean in India:

Area in 000ha. and Production in 000 tonnes

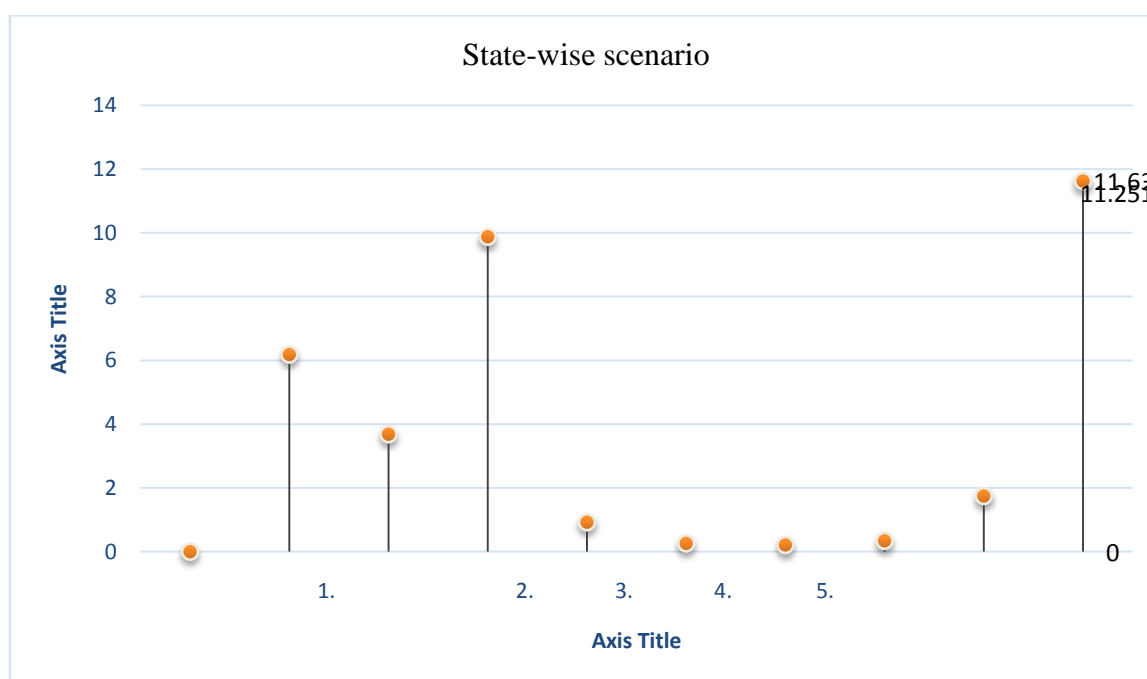
| STATES | Area | | | | | Production | | | | |
|-------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|----------------|
| | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 |
| Andhra Pradesh | 1.0 | 1.3 | 1.0 | 1.0 | 2.0 | 3.0 | 3.4 | 2.0 | 2.0 | 3.2 |
| Arunachal Pradesh | 3.0 | 2.8 | 2.8 | 2.8 | 3.1 | 4.5 | 3.5 | 2.6 | 2.8 | 4.4 |
| Chhattisgarh | 106.3 | 106.6 | 105.9 | 119.7 | 104.1 | 128.1 | 93.5 | 79.7 | 69.0 | 72.6 |
| Gujarat | 47.0 | 60.0 | 57.0 | 80.0 | 120.0 | 47.0 | 44.0 | 43.0 | 54.0 | 86.0 |
| Himachal Pradesh | 0.6 | 0.6 | 0.7 | 0.6 | 0.6 | 0.9 | 0.9 | 0.9 | 0.9 | 0.6 |
| Jharkhand | 0.7 | 0.5 | 1.0 | 0.5 | 1.0 | 0.9 | 0.6 | 0.8 | 0.5 | 0.6 |
| Karnataka | 170.0 | 219.0 | 256.0 | 258.0 | 318.0 | 178.0 | 270.0 | 189.0 | 140.0 | 237.0 |
| Madhya Pradesh | 6031.7 | 6308.6 | 5578.0 | 5906.0 | 5401.0 | 7800.1 | 5242.4 | 6353.0 | 4907.9 | 6649.0 |
| Maharashtra | 3219.0 | 3520.0 | 3640.0 | 3702.0 | 3840.8 | 4670.8 | 4754.9 | 2384.2 | 2061.1 | 4586.7 |
| Manipur | 7.5 | 5.2 | 5.3 | 5.1 | 5.1 | 0.8 | 4.6 | 4.6 | 4.3 | 4.4 |
| Meghalaya | 1.1 | 1.6 | 1.7 | 1.7 | 1.9 | 1.2 | 2.9 | 3.3 | 3.4 | 3.5 |
| Mizoram | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 |
| Nagaland | 24.7 | 24.8 | 24.8 | 24.9 | 25.0 | 30.9 | 31.1 | 31.1 | 31.2 | 31.4 |
| Odisha | 0.3 | 0.3 | 1.1 | 0.0 | 0.0 | 0.2 | 0.2 | 0.7 | 0.0 | 0.0 |
| Rajasthan | 1039.8 | 1175.1 | 923.1 | 1204.8 | 1055.6 | 1468.6 | 974.7 | 956.6 | 998.8 | 1131.8 |
| Sikkim | 3.9 | 3.9 | 4.1 | 3.3 | 3.3 | 3.6 | 3.7 | 3.9 | 3.2 | 3.2 |
| Telangana | 158.0 | 243.7 | 242.0 | 243.0 | 277.0 | 286.0 | 391.6 | 262.0 | 252.0 | 322.0 |
| Tripura | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Uttar Pradesh | 14.0 | 26.0 | 52.0 | 36.0 | 11.0 | 19.0 | 15.0 | 38.0 | 18.7 | 7.0 |
| Uttarakhand | 10.5 | 14.9 | 12.8 | 13.5 | 12.0 | 20.9 | 22.1 | 16.5 | 18.0 | 13.0 |
| West Bengal | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 |
| All India | 10840.7 | 11716.4 | 10910.8 | 11604.5 | 11183.4 | 14666.4 | 11860.8 | 10373.8 | 8569.8 | 13158.7 |

Sources: Directorate of Economics and Statistics, Ministry of Agriculture, Govt of India.

State-wise scenario:

Similar to international scenario i.e predominance of USA, Brazil & Argentina in Soybean, in India also Madhya Pradesh and Maharashtra alone covers 83.80 % area and 85 % production of soybean. i.e 9.43 M. ha. area and 9.88 M. tones production, out of total 11.251 Million hectares area and 11.63 M T production of soybean during 2012-13 to 2016-17 [11]. The estimated area, production and productivity of five major soybean producing states from 2012-13 to 2016 -17 is summarized as here under:

| | States | Avg. Area (M. ha) | Avg. Production (M. T) | Avg. Yield (Qtls/ha.) |
|----|-----------------------|-------------------|------------------------|-----------------------|
| | M.P | 5.845 | 6.190 | 10.59 |
| 1. | Maharashtra | 3.584 | 3.691 | 10.30 |
| | Total(1&2) | 9.429 | 9.881 | 10.45 |
| 2. | Rajasthan | 1.079 | 0.931 | 8.63 |
| 3. | Talengana | 0.233 | 0.265 | 11.37 |
| 4. | Karnataka | 0.244 | 0.212 | 8.68 |
| 5. | Others states | 0.266 | 0.341 | 12.81 |
| | Subtotal (2 to 5) | 1.822 | 1.749 | 10.21 |
| | All India | 11.251 | 11.63 | 10.38 |



Major Potential Districts of Soybean in India:

The major potential districts having more than 50,000 acreage of soybean in the country are 60 in 6 states [11]. The list of states and their 60 potential districts is enumerated as hereunder:

| Sl No. | State | List of Potential districts. |
|--------|---|--|
| 1. | Madhya Pradesh (30 Districts) | Ujjain, Sehore, Dewas, Dhar, Shajapur, Sagar, Vidisha, Harda, Indore, Rajgarh, Chhindwada, Betul, Mandasaur, Hosangabad, Guna, Ratlam, Raisen, Bhopal, Narsingpur, Shivpuri, Seoni, Neemuch, Khandwa, Ashok Nagar, Damoh, Tikamgarh, Jhabua, Khargone, Satna and Chhatarpur. |
| 2. | Maharashtra (20 Districts) | Amravati, Nagpur, Latur, Buldhana, Yavatmal, Nanded, Washim, Hingolui, Akola, Wardha, Kohlapur, Chandrapur, Sangli, Parbhani, Nasik, Satara, Ahmednagar, Jalna, Beed and Osmanabad. |
| 3. | Rajasthan (5 Districts.) | Jhalwar, Baran, Pratapgarh, Kota and Bundi |
| 4. | Talengana (2 Districts.) | Adilabad & Nizamabad |
| 5. | Karnataka (2 Districts) | Belgaon & Bidar |

| | | |
|----|---|-------------|
| 6. | Chhatisgarh (1. (1 District) | Rajnandgaon |
|----|---|-------------|

Crop-wise scenario of edible oil production in India:

The crop wise area and production (2011-16) also reveals that **soybean alone covers 42% area** and more than **39% production** followed by each **Rapeseed & Mustard (24%)** and **Groundnut (24%)** among the of oilseeds being grown in the in country [11]. The crop-wise area, production, yield and percentage share in production from 2011-16 is summarized as hereunder:-

| Crops | Area (lakh ha) | Production (lakh tones) | Yield (kg/ha) | % share in production. |
|----------------|----------------|-------------------------|---------------|------------------------|
| Soybean | 110.37 | 115.37 | 1045 | 39 |
| R &M | 60.85 | 71.18 | 1170 | 24 |
| Groundnut | 49.80 | 71.02 | 1426 | 24 |
| Sesame | 17.90 | 7.78 | 434 | 3 |
| Sunflower | 6.61 | 4.59 | 695 | <2 |
| Niger | 2.90 | 0.90 | 309 | <1 |
| Safflower | 1.80 | 1.02 | 567 | <1 |
| Castor | 12.00 | 19.21 | 1601 | 5 |
| Linseed | 2.92 | 1.45 | 496 | <1 |
| All India | 265.14 | 292.51 | 1103 | 100 |

Demand and availability of Vegetable oils:

India is a vegetable oil deficit country. The national consumption of vegetable oil was 4.5 kg per capita per annum during 1970-71, now it has been reached to 17.4 kg per capita per annum during 2013-14 against the recommendation of world health organization is 18.0 kg per capita per annum. However, the global consumption (2014-15) is 24.0 kg per capita per annum (Agriculture Statistics at a glance, 2015). [12]

Keeping in view the fast-growing population, it is becoming difficult day by day. The country is meeting out its requirement by importing vegetable oils. At present the domestic availability of vegetable oil is 8.64 Million Tonnes. i.e only 36.78% against the requirement of 23.50 Million Tonnes annually, therefore, the remaining 63.21% requirement of of vegetable oils is meeting out through import.

Import of edible oil:

India annually imports around 15 million tonnes of edible oils, including more than 9 million tonnes of palm oil and about 2.5 million tonnes each of soy oil and sunflower oil. It buys palm oil from Indonesia and Malaysia and other oils, such as soy and sunflower oil, from Argentina, Brazil, Ukraine and Russia [13]. According to Ministry of Consumer Affairs, Food & Public Distribution and Ministry of Commerce, Govt of India, theyear wise estimated domestic consumption, availability and import of edibleoils from 2013-14 to 2018-19is enumerated as hereunder:

Qty: Million Tones

| S. No | Year | Production of Oilseeds ¹ | Demand/ Consumption ³ | Domestic Availability | Import ² of major edible oils and its value | |
|-------|---------|-------------------------------------|----------------------------------|-----------------------|--|------------|
| | | | | | Both crude and refined | Rs. Crores |
| 1. | 2013-14 | 32.75 | 21.17 | 10.19 | 10.11 | 54,547 |
| 2. | 2014-15 | 27.51 | 23.05 | 9.20 | 12.19 | 61,355 |
| 3. | 2015-16 | 25.25 | 23.48 | 8.63 | 15.13 | 65,543 |
| 4. | 2016-17 | 31.27 | 25.41 | 10.09 | 13.49 | 69,589 |
| 5. | 2017-18 | 31.30 | 24.97 | 10.38 | 14.92 | 72,007 |
| 6. | 2018-19 | 31.52 | 24.98 | 10.06 | 15.01 | 66,680 |

1. Estimates of Ministry of Agriculture & Farmers Welfare, Govt of India.

2. Directorate General of Commercial Intelligence & Statistics, Ministry of Commerce, Govt of India.

3. Directorate of Vanaspati, Vegetable Oil & Fats and Ministry of Commerce, Govt of India

Consumption of Soybean Oil:

A large share of soy oil consumed in India is imported from Argentina, Brazil and US. In fact, soy oil is not permitted to export in bulk. About 1.5 million tons of soy oil is imported which makes the availability of oil in the country at 2.5 million tons. The rate of imports is still at a rising trend. The consumption of soybean oil is 4.643 Million Tonnes against 22.57 Million Tonnes (2013-16) average consumption of vegetable oil in our country annually. The domestic availability of soybean oil is only 1.660 M.T and remaining requirement is being met out by importing 2.983 M.T Soybean oil. It is pertinent to mention that among the primary sources of edible oil, consumption of soybean oil is highest i.e. 19% in comparison to other vegetable oils such as rapeseed & mustard 10%, Sunflower 7%, Groundnut 6%, Rice bran 4% etc [14].



Commodity wise estimated share of edible oil consumption during 2014-15:

(lakh qtls.)

| Source | Availability | Import | Total | % share |
|---------------------------|--------------|--------|--------|---------|
| Primary sources: | | | | |
| Soybean | 16.60 | 29.83 | 46.43 | 19 |
| R & M | 19.47 | 3.54 | 23.01 | 10 |
| Sunflower | 1.43 | 15.42 | 16.85 | 7 |
| Groundnut | 17.02 | 0 | 15.08 | 6 |
| Castor & Linseed | 7.95 | 0 | 7.39 | 3 |
| Sesame, Safflower & Niger | 3.07 | 0 | 3.02 | 1 |
| Secondary sources: | | | | |
| Palm oil | 1.71 | 97.09 | 98.80 | 41 |
| Cotton seed oil | 12.15 | 0 | 12.15 | 5 |
| Rice bran | 9.20 | 0 | 9.20 | 4 |
| Others | 9.40 | 0 | 9.40 | 4 |
| Total A+B | 98.00 | 145.88 | 241.63 | 100 |

Source: Department of Sugar & Vegetable Oils, Govt of India.

Import of soybean oil and other soy products in India:

Soy crude oil import in the country is declining since last 5 years after peaking at 3.96 Million Tonnes by spending Rs 19419 crores in the year 2015-16. India imported about 3.17 Million Tonnes of soybean crude oil and 0.3 M. T of refined oil valued Rs. 16390 Crores during 2018-19 [15]. Nearly 77 per cent of soybean crude oil is sourced from Argentina, 16.6 per cent from Brazil and 5.9 per cent from Paraguay. Import of soy

meal has declined in 2017-18 over previous years and so is the case for isolated soy protein, soy flour and soy milk drinks.



The import of Soybean crude and refined oil and its value is enumerated as hereunder:

Qty: Million Tonnes

| Sl No. | Year | Quantity | Rupees (Crores) |
|--------|---------|----------|-----------------|
| 1. | 2014-15 | 2.32 | 12908 |
| 2. | 2015-16 | 3.96 | 19419 |
| 3. | 2016-17 | 3.46 | 18708 |
| 4. | 2017-18 | 3.15 | 16493 |
| 5. | 2018-19 | 3.20 | 16390 |

Source: Department of Commerce, Govt of India

Export of soybean products from India:

The exports is approximately 65% of the total soy meal produced in India and has turned out to be one of the largest exporters of soy meal usually to the Asian countries. The soy meal is exported to South Korea, Thailand, Philippines and Japan. Indian soy meal is considered to be one of the premium soy meals and European and Asian countries prefer to use it other than any soy meal. [16]

Export of soybean meals/ de-oiled cakes during the year 2017-18 has increased by 48.45 percent in quantity and 37.48 per cent in value terms over 2016-17. More than 58% of soybean exported from India during 2017-18 was destined to USA, 25% to Canada, 5.6% to Belgium, 4.7% to Nepal and 4.2% to Spain. [17] Export of soybean from India reduces the domestic availability to crushers already struggling for capacity utilization. Even if the soybean is exported as organic, it would be better to process domestically and export organic branded edible oil and meals at premium. Whereas other soybean products such as soybean flour, soy sauce and soy milk drinks have declined during 2017-18, as compared to previous year figures, while that of isolated soy protein has increased. Bangladesh, Nepal, Germany, France, Japan, USA and Vietnam are the major export destinations for Indian soy meal export.

Export of Soybean Meal/ De-oiled cakes, Soy flour, Soy sauce, Soy Milk etc.

| Sl No. | Year | Quantity (M.T) | Rupees (Crores) |
|--------|---------|----------------|-----------------|
| 1. | 2014-15 | 1.631 | 5576 |
| 2. | 2016-17 | 1.276 | 3732 |
| 3. | 2017-18 | 1.894 | 5130 |

Source: Directorate General of Commercial Intelligence & Statistics, Ministry of Commerce, Govt of India.
www.quora.com/How-much-soya-does--India-export

Analysis and interpretations:

The area is almost constant to around 11 Million ha for the last 10 years, however, production is varying from 14.67 (2012-13) to 8.57 (2015-16) Million Tones and 13.50 M T in 2019-20 mainly because of variation in productivity [18]. The behavior of productivity of soybean is very erratic i.e 13.53 qtls/ha. in 2012-13 and 7.38 qtls/ha in 2015-16 and again 11.04 qtls/ha in 2019-20 may be because of variation in rainfall, high infestation by weeds, insect-pest and diseases being rainy season crop, availability of quality input support

services in time like seed, fertilizer, bio-ingredient, plant protection measures, agronomic practices, irrigation facilities at the time of sowing & grain filling stage, water logging, procurement/marketing of produce at remunerative price and so on.

The states like Andhra Pradesh, Meghalaya, Mizoram, Arunachal Pradesh, Nagaland, Telangana, Uttarakhand, Himachal Pradesh have very good productivity i.e more than 12 Quintal per hectare against the national average of 738 quintals per hectare (2015-16) have scope for area expansion.

The states having more acreage like Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, and Rajasthan, but productivity is less. In these states productivity enhancement programs need to be initiated.

The stagnation of area of soybean or even reduction may be because of diversion to other crops like urad, moong, maize, etc. in predominant soybean growing states like M.P, Maharashtra, Rajasthan etc due to better MSP of Green gram & Black gram i.e Rs 5600/-qtls and 6975/-qtls respectively as compare to Soybean Rs 3399/-qtls even during 2018-19. The less MSP and non-procurement as well as processing difficulties (Solvent extraction process) no local consumption etc are the major impediment for promotion of soybean [19]. The productivity enhancement of the crop and/or the reduction in cost of production seems to be the better policy option for the long term in order to improve the productivity.

Strategies for enhancing Production and productivity enhancement:

There are some agronomical management need to be adopted to enhance production and productivity of Soybean like Moist alluvial / vertisols are best soil, Deep ploughing in summer to expose insect/pests to sunlight and better water absorption in the rainy season, Use of well de-composed FYM - 5-10 tones/ha, Recommended doses of fertilizers @ 20: 40: 40:30 Kg N: P: K:,S / ha, Optimum sowing time is mid of June subject to availability of moisture/rainfall, Optimum seed rate of 75 Kg/ha for small seeded varieties and 100 Kg/ha for bold seeded varieties, Seed treatment with Rhizobium / PSB and Carbendazim/Thiram/Thiamethoxam, Application of pre-emergence weedicides like flumioxazin, sulfamethazin within three days of planting followed by inter-culture operations, Adoption of Broad-Bed-Furrow/Ridge-Furrow System for effective water management, Inter-cropping of soybean with pigeon pea for risk management., Use of Insect pest resistant varieties, Control of yellow Mosaic Virus/ foliar disease, soybean rust, harvesting and threshing facilities, marketing of produce at remunerative price etc [20].



Better Management:

Technology for safe storage and transport of soybean seed without loss of its viability, Availability of irrigation facilities at the time of sowing and grain filling stage as well as good drainage facility to avoid water logging, Better MSP and assured market/ procurement at remunerative price, Massive campaign for area expansion and productivity enhancement programme in identified states, Timely availability of input support services including quality seed, fertilizers, plant protection measures, post -harvest management, storage facilities etc, Oil extraction (Solvent Processing plants) units and infra-structure facilities for value addition and product development facilities at soybean.

Researchable areas:

- ❖ Dedicated research development programme for development of High Yielding Varieties in collaboration with potential networking of National Institutions of ICAR, SAUs, CSIR, Central & State Govt institutions for area expansion and productivity enhancement.
- ❖ Development of resistant varieties of Yellow Mosaic, short duration varieties for dry land areas, and varieties with bold pods/seeds for use as vegetable.

- ❖ Development of varieties with zero beany flavours and lipoxigenase (enzyme) lacking varieties for increasing domestic consumption of protein rich soyfoods.
- ❖ Bi-lateral programmeeither with USA, Brazil, and Argentina for Varietal and Technological exchange of Soybean as was done in early seventies for wheat.
- ❖ A joint research and development projects with the financial supportof international institutions like UNDP, FAO ICIMOD, European Commission can beinitiated and implemented in potential states for area expansion and productivity enhancement, value addition and product development etc.

II. CONCLUSION

Soybean has great potential as exceptionally nutritive and very rich protein food. Number of nutraceutical compounds such as Isoflavones, Tocopherol and lecithin has made it one of the most valuable agronomic crops in the world.Itcontains 20 to 22% oil,39 to 42% Protein, 31 to37% Carbohydrates and vitamins.Protein of soybean products characterized much quantity of lysine, Tryptophan, Isoleucine, Valine and Threonine. The fatty acid composition of soybean oil includes Palmitic (7-12%), Stearic (2-5.5%), Oleic (19-30%) and Linoleic (48-58%). The oil of Soybean has 85% unsaturated fatty acids, considered to be cholesterol-free. Similarly, among the essential amino acids, it has lysine, Methionine, Cysteine, Tryptophan, Threonine, Isoleucine and Leucine, which are considered to be very good for human health. The soybean contains very little of starch (4.66-7%) and quite a lot of Hemicellulose and Pectin's. Both these Polysaccharides have several health benefits in human's life. They play an important role in preventing certain type of cancerand helping in digestion and weight loss.Soybean oil has an important fatty acid, lecithin as well as vitamin A and D.Lecithin is used for reducing fatty build-up in the liver and treating memory disorders such as dementia and Alzheimer's disease.

Most of the population of our country is vegetarians and also nutrient deficit. Soybean is the best option for improving health of poor people particularly women and children. Soybean has vast potential in our country and need to be promoted through production and productivity enhancement, value addition andproduct development.

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Mayur Gautam, et. al. " Analytical Study on Soybean: a Protein, Fats and Carbohydrates rich food for Global Nutritional Security." *International Journal of Humanities and Social Science Invention (IJHSSI)*, vol. 09(7), 2020, pp 44-55. Journal DOI- 10.35629/7722