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NUTRITIONAL AND FOOD SECURITY THROUGH PULSES IN INDIA : A REVIEW

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ABSTRACT

Indian context, pulses plays a vital component of a human diet due to their positive physiological and nutritional benefits on human health. Pulse crops include redgram, chickpea, greengram, blackgram, horsegram, lentil and cowpea are rich in dietary fibre, protein and carbohydrates as well as other bioactive ingredients. Much of the Indian population considers protein-rich pulses to be a staple diet, meeting their needs for energy and protein. Climate change threatens the global food production and economic sustainability of the farmers. The inadequate availability of pulses, higher demand from the consumers and import of pulses highlight the firmness of increased pulses production in the country. India is the largest producer of pulses production, which accounts for 25% of total global production and highest consumer. Quick growth and short duration abilities of pulses makes an important character to fit in cropping systems. These crops also suitable to cultivate under high temperature and drought conditions. This habit of pulses more suitable to cultivate climate change conditions.

Key words : Climate smart agriculture, Pulses, Soil health, Nutritional value.

Introduction

In India, pulses crops are an important source of protein for vegetarians. It provides proteins, vital amino acids, vitamins and minerals to supplement the diets of people. Pulses are having a protein content of 22-24%, which is three times and two times more compared to rice and wheat, respectively. In addition to offering numerous nutritional and physiological advantages, pulses are also having several medicinal properties to lower the risk of a number of noncommunicable diseases, including heart disease and cancer (Shivare, 2016). Besides, they are also rich in complex carbohydrates, micro-nutrients, protein and B-vitamins and minerals like folate, iron, calcium, magnesium, zinc and potassium (OFUYA and AKHIDUE, 2005). Long shelf-life without loss of nutritional value, low prices coupled with wider availability make pulses an affordable source of protein and minerals and contribute to food security at all levels of society in India. Besides adding to the human nutrition, pulse crops serve as a source of fodder and fuel for the farm-families (Umadevi *et al*., 2022).

Pulses can be cultivated in a wide variety of climatic conditions, but it grows well in mild, cool and dry climate temperature ranging from 20-25 degrees Celsius and 40 to 50 centimetres of rainfall. Pulses play significant role in crop rotation, mixed and inter-cropping, maintaining soil fertility through nitrogen fixation, release of soil-bound phosphorus and thus contribute significantly to sustainability of the farming systems. There is less chance of soil and water pollution and greenhouse gas emissions when synthetic fertilizers are used less frequently. Pulses also support the microbial richness of the soil and enhancing its structure (soil aggregate stability, soil aeration and water-holding capacity), the symbiotic relationship between pulses and soil can enhance soil health and increase crop yields. Compared to other field crops, pulses are more suitable to grow under drought conditions. This habit of pulses more suitable to cultivate climate change conditions.

India is the largest producer of pulses production, which accounts for 25% of total global production. Furthermore, India is also the largest consumer (27% of world consumption) and importer (14%) of pulses in the world (NASS, 2022). In India, the highest area under pulses cultivation and production lies in Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, Bihar, Gujarat, Chhattisgarh, Tamil Nadu and Andhra Pradesh. There exists a huge gap between demand and supply of pulses in India and about 20 per cent of its total demand which is met by imports. Pulses contributes around 14% to agricultural imports basket (NASS, 2022). According to the Barik (2021), 52 g of pulses per capita day^{-1} must be consumed every day, however, because their production and consumption are consistently disregarded, the average per capita consumption has remained stagnant at about 19.5 g for the past thirty years (FAOSTAT, 2022).

Table 1 : Requirement for pulse production to provide per capita requirement of protein for current and future populations.

Year	Global population (10^6 Mg)	Required production (10^6 Mg)	Desired yield (t/ha)
2024	8.09	360	1.25
2030	8.50	392	1.50
2050	9.80	443	1.80
2100	11.20	511	2.15

(Source: Rattan Lal, 2017. *Advances in Agronomy*, Vol. **145**, 167-204).

Scenario of pulse production in India

The total world acreage under pulses is about 94.14 (Mha) with production of 89.74 (Mt) at 953 kg/ha yields level. India, with >35 Mha pulses cultivation area, is the largest pulses producing country in the world. It ranks first in area and production with 37 per cent and 29 per cent, respectively. During 2021-22 our productivity at 932 kg/ha has also increased significantly over last 05 years. The total acreage and production of pulses in India were 293 lakh ha and 247 lakh tones, respectively. Madhya Pradesh alone occupies more than 58 lakh ha of the total area, giving it a prime position in the production of pulses. It contributes an impressive 20% of the nation's pulse area and 24% of its production, placing it first in both area and production, followed by Rajasthan (16%), Maharashtra (16%) and Uttar Pradesh (10%). Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, Gujarat, Andhra Pradesh, Jharkhand, Tamilnadu and Telangana states have contributed more than 90% of the entire production of pulses in India (DPD/ Pub./TR/46/ Annual report, 2022-23).

Table 2 : Area, production and productivity of pulses from 2017-18 to 2021-22 in India.

State	Area (Lakh ha)	Production (Lakh tones)	Productivity (Kg/ha)
Madhya Pradesh	58.10	58.51	1007
Rajasthan	60.36	39.93	662
Maharashtra	44.05	38.22	868
Uttar Pradesh	23.46	24.30	1036
Karnataka	31.61	19.83	627
Gujarat	11.26	14.34	1273
Andhra Pradesh	12.91	10.55	817
Jharkhand	8.06	8.38	1040
Tamil Nadu	8.21	5.37	654
Telangana	5.57	5.34	958
Others	29.34	21.79	742
All India	**292.94**	**246.56**	**842**

Source: (DPD/Pub./TR/46/ Annual report, 2022-23).

Among the pulses, the highest contribution from Chickpea with 47 per cent production share to total pulses, which was followed by Redgram (15 per cent), greengram (12%), blackgram (10%) and Lentil (5%) (DPD/Pub./ TR/46/ Annual report, 2022-23).

Significant importance of pulses

Nutritional value

Pulses have several nutritional benefits and can be a good source of energy. It has been determined that the majority of pulses have an energy content of 300–540 Kcal/100g. Every physiological process requires energy, Protein, fat and carbohydrates are the nutrients that give energy. Pulses include significant amounts of the vitamins *viz.*, thiamin, riboflavin, pyridoxine, and folic acid, they also contain vitamin E and K (OFUYA and AKHIDUE, 2005). In biological activities, the B vitamins function as coenzymes. It is well known that vitamin E functions as an antioxidant, preventing the oxidation of polyunsaturates in the tissues and vitamin A in the gastrointestinal tract. Additionally, it is thought to preserve the integrity of cell membranes. The liver is where vitamin K predominantly works and is required for the production of blood clothing components (Davies and Stewart, 1987).

Pulses cultivated for Sustainable agriculture

Smallholder farmers in rainfed agroecosystems mainly rely on pulses on their food requirement and they store produce harvested from the field itself. Despite its many nutritional benefits, the area used for pulse farming only made up 3.0% [89.82 million tons] of grain output in

Table 3 : Proximate composition of pulse grain (per 100 g).

Pulses	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Total dietary fiber (%)
Redgram	342	21.7	1.5	62.0	15.5
Chickpea	368	21.0	5.7	61.0	22.7
Urdbean	347	24.0	1.6	63.4	16.2
Mungbean	345	25.0	1.1	62.6	16.3
Lentil	346	27.2	1.0	60.0	11.5
Field pea	345	25.1	0.8	61.8	13.4
Rajmash	345	23.0	1.3	63.4	18.2
Cowpea	346	28.0	1.3	63.4	18.2
Horsegram	321	23.6	2.3	59.1	15.0

(Source: E-pulses data book, IIPR, https://iipr.icar.gov.in/pulse-data-book/e-pulses-data-book-state-wise/)

Table 4 : Nitrogen fixation by different pulse crops.

Legume	% N fixed	Shoot dry matter (t/ha)	Total crop N (kg/ha)	Total N fixed (kg/ha)
Pea	66	4.8	162	105
Faba bean	65	4.3	172	110
Lentil	60	2.6	96	58
Soybean	48	10.8	373	180
Chickpea	41	5.0	170	70
Mungbean	31	3.5	109	34

Source: https://doi.org/10.1007/s11104-009-0136-5.

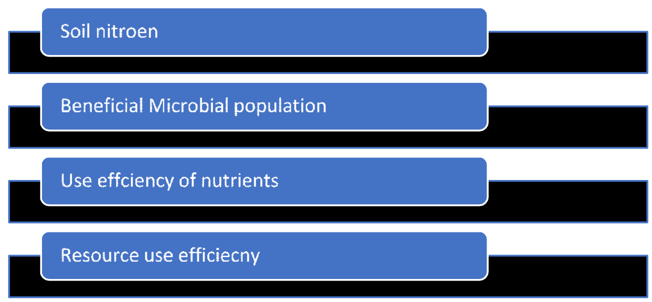

Fig. 1 : Role of pulses in soil health.

2020 and 12.7% (93.18 Mha) of cereals' (736 Mha) area (FAOSTAT, 2022). This statistic demonstrates how completely ignorant farmers and governments around the world are about pulse cultivation. In contrast to cereals, pulse output and productivity are low, highly variable, and unpredictable due to their primary cultivation in rainfed ecosystems, marginal soils and severe conditions (Shukla *et al*., 2022).

Pulses require very little water and they can withstand extreme temperatures and drought conditions naturally. Therefore, because of their deeper root structure, pulses can efficiently use the available water when grown as a monocrop, intercrop or sequential crop in rotation in a rainfed agroecosystem (Liu *et al*., 2019). Furthermore, these crops reduce the danger of water loss by evaporation, leaching, percolation, runoff, soil salinization, nutrient leaching and soil erosion while also effectively covering the land and conserving the scarce soil moisture. Furthermore, the nutrient-rich biomass produced by this crop group may raise SOC levels and support a robust soil biological community (Lehman *et al*., 2015). Because of their low nutrient requirements and BNF's ability to function as a companion crop in intercropping or mixed crops or as a follow-up crop in a rotation system, pulses are also a good fit for low-fertile rainfed locations (Sheoran *et al*., 2021).

Similarly, these low-fertile rainfed soil conditions are beneficial for lowering the N and C footprints of the agroecosystems, enhancing the concentration of micronutrients in the edible portions and restoring soil health (Lal, 2016). In the age of growing health crises like COVID-19, climate change, and depleting natural resources, it is further anticipated that rainfed pulse cultivation could bring about the second green revolution by ensuring food and nutritional security, strengthening ecosystem services and improving production sustainability. As a result, the potential of pulses has not yet been fully realized. This can be achieved by increasing the area that can be grown while adhering to the best management methods for site-specific soil and environmental circumstances and by concentrating more on sustainable pulse production under rainfed environments (Ghosh *et al*., 2019).

Pulses as intergraded nutrient management tool

Pulses root systems improve soil health by forming symbiotic relationships with soil bacteria like rhizobia and mycorrhizae. Pulses cultivation is essential to advancing the integrated nutrient management (INM) approach. According to Herridge *et al*. (2008), the pulses annual biological nitrogen fixation (BNF) inputs are predicted to be 2.95 Tg and the annual BNF by soybeans in the US, Brazil, and Argentina is predicted to be 5.7, 4.6 and 3.4

Tg, respectively. Faba beans can contribute up to 100–200 kgN/ha in the pulse cereal cropping system (Jensen *et al*., 2010).

In addition to enhancing N status of soil through BNF, soil under pulses has better P availability along with higher use efficiency of nutrients and water. Soil restoration and improvements in soil health under legumes is also attributed to enhanced aggregation, erosion control and water conservation, higher total productivity and more input of biomass-C into the agroecosystem.

Conclusion

The higher protein content of pulses is an important character making them a staple food in the Indian diet for everyone across the age groups. Regram, chickpea, greengram, blackgram, lentil, cowpea and horsegram were having higher protein content than cereals and numerous nutritional benefits. However, alarms increase of India's population and shortage of pulse output, which led to a growing disparity between supply and demand. Prices were high and unstable as a result of the extra demand. The primary cause of the surplus demand is the productivity stagnation, which is made worse by the shrinking area under cultivation. As a result, the nation's per capita net availability of pulses drastically decreased over time. To eradicate hunger and ensure food security, sustainable initiatives are required. They can withstand to a vagaries of adverse weather conditions. Through their ability to mitigate and adapt to climate change, reduce poverty and hunger, improve health by providing nutrition, and support economic stability, pulses contribute to sustainability. The ability to incorporate pulses into agricultural production and adapt to different cropping systems may be crucial for boosting climate change resilience.

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