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Pulses - Boon for Human and Soil Health

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Abstract

Pulses, the food legumes, are being grown by farmers since millennia and provide nutritionally balanced food to the people. Pigeonpea, blackgram, greengram, lablab bean, moth bean, and horsegram have originated and domesticated in the Indian subcontinent. These are rich source for vegetable proteins, fibre, iron, potassium, folate and antioxidants. Further, they are free from cholesterol and gluten. They have definite role in the prevention and management of chronic diseases such as diabetes, coronary conditions and cancer. They are grown as cover/inter crops and able to fix atmospheric nitrogen, sequester carbon into the soil, suppress the weeds and control soil erosion from the splash detachment thus protects soil health. Emissions of greenhouse gases soil and water pollution can be reduced through inclusion of pulses in cropping systems thus assures ecologically sustainable agriculture. Proper policy support to encourage the pulse production is the need of the hour.

1. Introduction

India was declared as one among the 17 megadiversity countries of the world by World Conservation Monitoring Centre (WCMC) of the United Nations Environment Program. It is also one of the prominent centers of origin and diversity of many crop plants. Pulses produce pods having one or more seeds of variable size, shape and color. They include chickpea, pigeon pea, green gram, black gram, horse gram, moth bean, cow pea and rice bean etc., (Nene, 2006). Pulses are contributing towards nutritionally balanced food to the people of India. They are second only to the cereals as human food and these are incredibly healthy, affordable, tasty and storable for long periods. They have definite role in the prevention and management of chronic diseases such as diabetes, coronary conditions, and cancer. Pulses are the most important sources of vegetable proteins, also rich in fibre, iron, potassium, folate and antioxidants. Furthermore, they are free from cholesterol and gluten (FAO, 2016).

Pulses help in improving soil fertility through leaf fall and restoration of soil N through biological nitrogen fixation. They also

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enhance the soil organic carbon and microbial population of rhizosphere zone, thus, Contribute for overall soil health. In view of significance of pulses, UN 68th General Assembly declared the year 2016 as the International Year of Pulses with an aim of amplifying the public awareness of the nutritional benefits of pulses as a part of sustainable food production for food security and nutrition. The year created a unique opportunity to encourage connections throughout the food chain that would better utilize pulse-based proteins, further global production of pulses, better utilize crop. Further, it has highlighted the nutritional benefits of pulses, recommended a paradigm shift for inclusion of pulses in the regular human diet all over the world. In 2019, the UN General Assembly proclaimed 10th February as the World Pulses Day. This year (2021) celebrated under the theme "Love Pulses for a healthy diet and planet will be an opportunity to raise awareness and recognize the contribution of pulses to sustainable food systems and healthy diets".

Figure 1: Love Pulses for healthy diet and planet (FAO, 2021)

2. Pulses in India

India is the largest cultivating, consuming and importer of pulses in the world. Pulse crops are cultivated in *Kharif*, *Rabi* and *Zaid* seasons of the Agricultural year. In India area under pulses over the last few years (2016 to 2019) has been around 29 million hectare and the production of pulses which was at 25.42 million tons in 2017-18 declined to 23.40 million tons in 2018-19. The imports of pulses were highest in 2016-17 and lowest in 2010-11, while the exports were maximum in year of 2013-14 and minimum in 2011-12 (Agricultural statistics at a glance, 2019). The main pulse growing states are Madhya Pradesh, Rajasthan, Uttar Pradesh, Maharashtra, Karnataka and Andhra Pradesh. Average yield of pulses increased from 655 kg ha^{-1} in 2010-11 to about 853 in 2017-18. It was below the world average of 910 kg ha^{-1} (Table 1).

2.1. Pulses and human health

Legume grains occupy an important place in human nutrition, especially in the pattern of low-income groups of people in developing countries. Several reports claim that inclusion of legumes in the daily diet has many beneficial physiological effects in controlling and

Table 1: Area, production, productivity, imports and exports of total pulses in India

Sl. No.	Year	Area (Million ha)	Production (Million ton)	Yield (kg ha^{-1})	Imports ('000 ton)	Value (Rs. crore)	Exports ('000 ton)	Value (Rs. crore)
1.	2010-11	26.4	18.24	691	2777.8	7512.5	209.02	870.0
2.	2011-12	24.46	17.09	699	3495.8	9448.4	173.50	1067.9
3.	2012-13	23.26	18.34	789	4013.2	13344.6	202.67	1284.99
4.	2013-14	25.21	19.25	764	3177.9	11036.8	345.55	1748.8
5.	2014-15	23.55	17.15	728	4584.9	17062.9	222.14	1218.3
6.	2015-16	24.91	16.32	655	5797.7	25619.1	255.72	1655.9
7.	2016-17	29.45	23.13	786	6609.5	28523.2	136.72	1277.7
8.	2017-18	29.81	25.42	853	5607.5	18748.6	179.6	1469.6
9.	2018-19	29.03	23.40	806	2527.9	8035.3	287.13	1801.5

(Directorate of Economics and Statistics, DAC&FW, 2019)

preventing various metabolic diseases such as diabetes mellitus, coronary heart disease and colon cancer. The role of legumes as therapeutic agents in the diets of persons suffering from metabolic disorders is gaining interest (Shehata et al., 1988). Legumes belong to a group that elicits the lowest blood glucose response. Legumes are considered as poor man's meat. They are generally good sources of slow release carbohydrates (*viz.*, dietary fibre) and are rich in proteins (18–25%). Soybean is unique, contains about 35–43% proteins. Legumes are the cheapest sources of supplementary proteins in Indian diets. They are also good sources of minerals and vitamins. Swaminathan (1988) has reported that germinated legumes are rich in vitamin C and in some there is an increase in the riboflavin as well as niacin contents upon germination. The activity of many enzymes such as amylase, protease, phytase and lipase will increase during germination. Processed legumes such as puffed bengal gram contains proteins of fairly high biological value and is a good supplement to the diets of children. There are many varieties of legumes such as redgram (pigeonpea, *Cajanus cajan*), blackgram (*Vigna mungo* L.), broad bean (*Vicia faba* L.), bengalgram (chickpea, *Cicer arietinum* L.), cowpea (*Vigna unguiculata* L.), field bean (*Dolichos lablab*), greengram (*Vigna radiata*), horsegram (*Dolichos biflorus*), etc. which are commonly used in India, especially by the weaker section of the population (Tharanathan and Mahadevamma, 2003).

2.2. Pulses as an alternative for meat in future world

Meat production increased and became more affordable leading to its increased consumption. The true costs of industrial agriculture, especially the livestock sector and "cheap meat" is emerging as one of the top two or three most significant contributors posing threat to global climate (Chandran, 2016). Chemical fertilizers used for produce the feed of livestock, as well as raising livestock results in the emission of methane from enteric fermentation and N_2O from excreted nitrogen. The total amount of meat produced increased from 70 million tonnes in 1961 to 278 million tonnes in 2009, an increase of 300% in 50 years. With a further increase of 65% the global meat consumption is likely to reach 450 million tonnes by 2050 (Alexandratos and Bruinsma, 2012). Today the largest share of GHG emissions is not from CO_2 but from two other gases: methane CH_4 and N_2O, mainly of livestock. Pulses and fish from natural sources are the only credible alternative for higher animal meat consumption, which is rising to alarming proportions in the world, unlike the slower increase in India. However, in India, urbanization has been causing a rise in demand for meat products. Despite the fact that per capita meat consumption is least in India (less than 5 kg $head^{-1}year^{-1}$), but, recent years witnessed India's growth as a great exporter of meat, and the world's second largest exporter of beef. Eating more of pulses along with fruits and vegetables can reduce GHG emissions (The Guardian, 3 Dec. 2014).

2.3. Pulses and soil health

Pulses cover 57.3 million hectares, one-tenth of the area dedicated to cereal crops. Pulses boost soil fertility and reduce the need for industrial nitrogen fertilizers because they fix nitrogen (N) from the atmosphere and provide organic matter to soils.

In crop rotation, legumes contribute to the diversification of cropping systems and act as free atmosphere N_2-fixing plants; it can reduce the synthetic N fertilizer demand. In the rotation of crops, leguminous crops like pulses, chickpea, beans, peas, groundnut, soybean, lentil, bengal gram and cluster bean are sown in between the seasons of cereal crops like rice, wheat, maize, sorghum and pearl millet and cash crop like cotton, sugarcane etc (Figure 2) (Luce et al., 2015).

Figure 2: Cotton (Non-legume) + Greengram (legume) cropping system in 1:2 row ratio for sustainable soil health

Pulses reduce the need for chemical fertilizers and that for pesticides because their cultivation improves soil health and creates disease-suppressive soils. Biological nitrogen fixation (BNF) to reduce emission of N_2O and leaching of NO_3^- N into the groundwater (Lal, 2017). The addition of crop residue into soils, with the objective of sustaining or improving productivity and soil fertility for the succeeding non-legumes, is known as green manuring. The introduction of green manure's biomass in crop rotation improves soil quality and their beneficial N effects (Jannink et al., 1996).

Legumes develop deep root systems which enable the acquisition of nutrients from deeper soil layers, and symbiotic N_2-fixing bacteria convert the environmental N into a form. This form is directly available for plant intake (Kakraliya et al., 2018). When, pulses grown as cover crops are able to fix atmospheric N, sequester C into the soil, suppress the weeds and control soil erosion from the splash detachment (Figure 3). Moller et al. (2008) estimated that leguminous cover crops (CCs) fix between 60 – 80 kg ha^{-1} of N into the soil compared with non-leguminous CCs. Pulses are known to improve the microbial environment in the soil by several ways. The rhizosphere of pulse crops is microbially more active than other field crops. The rhizosphere fungi produce a glycoprotein call Glomalin. It is insoluble in water and sticky nature entraps soil mineral, organic matter and debris and form stable soil aggregates. Hence microbial activity of pulse rhizosphere is directly responsible for the improved soil structure (Ganeshmurthy et al., 2006).

Figure 3: Redgram + Greengram (1:3) - a remunerative cropping system

GHGs emissions, soil and water pollution were minimized through cultivation of pulses by avoiding excessive application N chemical fertilizers and losses. Sridevi et al. (2018) reported about 12.9% reduction in GHG emissions with inclusion of legumes in cropping systems in a Crop + Livestock + Horticulture integrated farming system developed at Rajendranagar under irrigated dry conditions of Telangana, India. So, pulses had remarkable role in human health and ecologically sustainable agriculture (Table 2).

Despite their important role in improving the sustainability of agricultural cropping systems and mitigation of the effects of climate change, pulses have not received the same attention and production resources at the farm level compared to cereal crops.

Table 2: Nitrous oxide emissions in various cropping systems of IFS at Rajendranagar

Crop/ Cropping system	Area (sq.m)	N_2O emissions (kg $area^{-1}$)		
		Kharif	*Rabi*	Total
Rice- Groundnut	2000	0.384	0.071	0.455
Bt cotton + Greengram- fodder sorghum	1000	0.244	0.103	0.347
Maize- groundnut	1000	0.274	0.031	0.305
Pigeon pea + Sweet corn-sunhemp	1000	0.228	0.009	0.237
Pigeon pea + Maize -Bajra	1000	0.244	0.083	0.327
Orchard block Guava Hedge Lucerne & Stylo	1800	0.046 0.053		0.099
Fodder block (Hybrid bajra napier)	1200	0.378		0.378
Total	9000	1.950		2.148

3. Conclusion

Pulses offer remarkable nutritional benefits to human health and are also economically affordable. They reduce the application of nitrogenous fertilizers by 20-25% through fixation of atmospheric nitrogen, boost up the soil fertility and also minimize the greenhouse gas emissions. In view of their role in human nutrition and soil health, farmers should be encouraged to cultivate and to increase the area and production of pulses through proper policy support.

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