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ROLE OF DIVERSIFYING CONVENTIONAL CROPPING SYSTEMS WITH PULSES IN INDIA

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Agriculture has developed towards intensive but simplified production systems over the last decades, especially in the northern Hemisphere. While this trend significantly increased agricultural productivity, it also had detrimental effects on the cropping systems themselves and on the environment. Rainfed dry areas is often challenged by inadequate water and nutrient supplies. Summer fallowing has been used to conserve rainwater and promote the release of nitrogen via the N mineralization of soil organic matter. However, summer fallowing leaves land without any crops planted for one entire growing season, creating lost production opportunity. Additionally, summer fallowing has serious environmental consequences. It is unknown whether alternative systems can be developed to retain the beneficial features of summer fallowing with little or no environmental impact. Here, we show that diversifying cropping systems with pulse crops can enhance soil water conservation, improve soil N availability, and increase system productivity. A 3-yr cropping sequence study, repeated for five cycles in Saskatchewan from 2005 to 2011, shows that both pulse- and summer fallow-based systems enhances soil N availability, but the pulse system employs biological fixation of atmospheric N_2, whereas the summer fallow-system relies on 'mining' soil N with depleting soil organic matter. In a 3-yr cropping cycle, the pulse system increased total grain production by 35.5%, improved protein yield by 50.9%, and enhanced fertilizer-N use efficiency by 33.0% over the summer fallow system. Diversifying cropping systems with pulses can serve as an effective alternative to in rainfed dry areas. A multitude of driving forces led to lower diversity of cropping systems like, e.g. easy availability of mineral fertilisers and pesticides, concentration of breeding efforts on the economically most important crops and changes in agricultural policies that allow producers to respond more freely to market signals, incentives and technology change. These processes supported a higher genetic uniformity within crop species. Less crop species in rotations and higher uniformity within agricultural landscapes with large field sizes.

Diversification of cropping systems is central for reaching the goals of ensuring the availability of resources (e.g., nutrients, Water, land) for future generations, increasing the reliance on ecosystem services that replace external inputs, and promoting diverse diets, healthy agro ecosystems, and securing livelihoods (IPES-Food, 2016). The addition of functional biodiversity to cropping systems across multiple spatial and temporal scales,

through diversified crop rotations, integration of cover crops, green manures, and species mixtures (inter- and multi-cropping), can enhance resource use efficiency, promote the provision of ecosystem services and reduce negative environmental impacts (Kremen and Miles, 2012) without compromising crop yields in the production of food, feed, and raw materials (Tamburini*et al*., 2020). Simplification of farming system and growing environmental problems led to concerns about the future functionality of today's cropping systems with regard to resilience, adapt ability to climate change. Multi functionality of agricultural landscapes, provisioning of ecosystem services and biodiversity.

Importance of pulses

For developing such genotypes, wild relatives which are rich reservoir of useful alien genes can play an important role. Further improvement in pulses productivity is needed through conservation and diversification of agriculture so as to increase the productivity of the system and improve soil health. Our world faces climate change in a manner so intense than other years, which makes the planet unfit for life day by day. Globally more than 100 million people are suffering from severe hunger and malnutrition. Climate change, population explosion, food insecurity and associated risks directly influencing the economic systems of under developed and developing countries where agriculture contributes a considerable share to the economy. The world looks for a solution to this situation in a sustainable manner. The solution should be cheap, easy to access, requires minimum input, moisture, care and management practices and having a high nutritive content. Pulses are the best answer to all these requirements as it fulfils the criteria above mentioned. World Health Organisation recommends 80 g pulses. The Indian Council of Medical Research (ICMR) recommends 40 g pulses. However, actual availability ranges from 30-35 g pulses in 2016, the Food and Agriculture Organization (FAO) brought pulses into the spotlight that has immense potential to address the Issues of sustainability.

Needs for diversification:

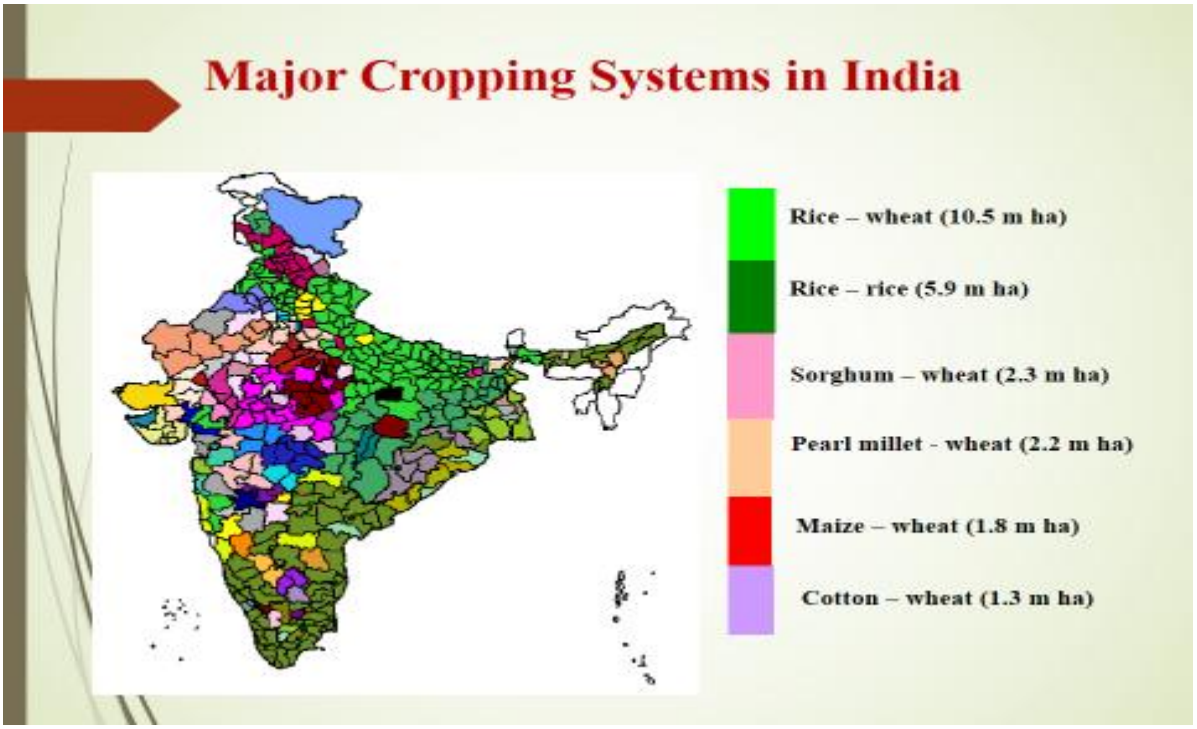
Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities. Pulses have very good opportunity to find place in different agro-ecosystems. Nowadays, soil organic carbon and crop productivity have become major concerns in sustainable agriculture. Since last six decades in our country, Improvement in productivity of most of the field crops has been obtained but much success could not be achieved in increasing area and productivity of pulse crops.

Type of crop diversification:

• Horizontal Diversification – This relates to multiple cropping or mix of crops instead of cultivating a single crop.

• Vertical Diversification – It refers to the incorporation of industrialisation along with multiple cropping.

Major cropping systems in India



Diversified cropping systems with pulses

Pulses are grown in different cropping systems such as sequential cropping, mixed and intercropping, relay cropping, catch cropping and ratoon cropping. It is a form of multiple cropping in which crops are grown in sequence on the same field, with the succeeding crop planted after harvest of the preceding crop. This system with relatively short growing season crops offers better total annual use of land than a single crop system. The prominent sequential cropping systems involving different pulses have been discussed crop wise.

• Rice-Chickpea/ Lentil/Fieldpea with the development of wheat varieties amenable for late-planting upto late December and January, the area under rice-wheat system has increased at a faster rate in the last two decades. The adverse effect of this system on soil health is being widely recognized in India, approximately 15 m ha area falls under rice Fallow. Studies on relative productivity of various pulse crops in rice fallows indicated that cowpea recorded highest productivity, followed by urdbean at Berhampur, but at Raipur, lathyrus, lentil and mungbean were more productive. At Kanpur, Kumar and Ali evaluated various pulses and oilseed crops after rice and found that lentil, lathyrus and linseed were more productive and remunerative than chickpea, fieldpea, and rajmash.

• Rice – Urdbean/Mungbean/ Lathyrus cultivation of rabiurdbean and mungbean in coastal regions of South India is being practiced since long but it could get momentum only after development of Powdery mildew resistant genotypes such as LBG 17, LBG 402, LBG 611 and LBG 22 having high yield potential. Development of these varieties in late Eighties has

revolutionized urdbean and mungbean cultivation in rice fallow especially in Andhra Pradesh. This system is highly productive and stable besides its benefits through improvement in soil health. This cropping system is now being practiced in other states like Orissa, Tamil Nadu and Karnataka.

Conclusion

There is an urgent need for diversification with pulses owing to the problems lying with continuous cropping cereal based CS. The alternative options are: Pigeonpea as a substitute crop in RWCS. Greengram&blackgram as catch crops in RWCS and as intercrops in wide spaced crops. Inclusion of pulses in intensive cereal based system itself is a component of INM. It is a viable alternative to improve the soil health, conserves the natural resources and improves agricultural productivity, profitability & sustainability.

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