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New Prediction Models of Innovative Technologies for Maximising the Production of Greengram and Blackgram in Coastal Areas of India

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Abstract

Pulse crops are having rich source of proteins and its plays major role in giving nutritionally balanced diet for vegetarian's humans. India is the major consumer, producer and highest importer of pulses. However, pulses yields are mostly affected input limits particularly fertilizers, quality seeds and lifesaving irrigation was not sufficient associated to cereal crops such as rice and wheat. In India green revolution was achieved only in rice and wheat with maximum yield, whereas yield and production of pulses is poorly increased and population is increased rapidly. In current situation, enhancing the pulse production with various new prediction models of innovative technologies for maximising the production of green gram and black gram in coastal areas is highly essential. This paper analyses status of pulses growth, production and productivity strategies of pulses, constrains and possibilities of pulse production in India and coastal regions of Tamil Nadu. Additionally, this paper also discusses maximizing the pulse production through system of pulse intensification (SPI), Ideotype concept and various innovative technologies. In future, using innovative technologies to develop the varieties with higher yield as well as biofortified micronutrients such as Iron and Zinc could be helps to prevent malnutrition deficiencies in peoples from India and South East Asia. Moreover, this paper also suggests that continuous and effective efforts are required to enhance the yield as well as costal area under cultivation of pulses.

Keywords: Black gram; Green gram; Ideotype concept; Innovative technologies; Pulses; Production

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Introduction

Pulses belong to the taxonomic family Fabaceae, containing over 18,000 species divided into three sub-families Mimosoideae, Caesalpinoideae and Papilionoideae.Pulses are commonly cultivated for several decades in all over the world because of the nutritional value of their seeds. Among different pluses, soybean, chickpea, common bean, cowpea, greengram, blackgram, and pigeonpea contribute significantly to serve the major protein source for the diets of large numbers of people living in Asia, Africa, and South America.In India, the production of pulses has not been able to keep pace with their domestic demand, resulting in imports of 4-5 million tonnes of pulses per annum, especially from the countries like Canada, Myanmar and Australia to meet its domestic requirement [1]. India is the largest producer of pulses and the production only met 27% of national requirement (Sing *et al*., 2016). The yield of pulses in India is quite low at 781 kg/ha which might be due to various factors. Pulse crops do not any significant increase in area and production during 1950-51 to 2009-10. However, significant growth in area and production has been recorded during the last five years (i.e. 2010-2011 to 2016-17). With the adoption of high yielding varieties, increase usage of agricultural inputs like fertilizers and manures etc. However, the pulses crops cultivatedunder irrigation are about 37% of the area whereas 63% of pulses are grown under rainfed conditions [2]. The productivity of pulses has increased about 77% at 779 kg/ha during 2016-17 from the level of 441 kg/ha during 1950-51. It is imperative to mention that the New Agriculture Technology (NAT) introduced during mid-sixties has increased the production of food-grains from 50.82 million tonnes during 1950-51 to 275.68 million tonnes during 2016-17 with the increase in area from 97.32 million hectares to 128 million hectares. In order to achieve self-sufficiency in pulses, the projected requirement by the year 2025 is estimated at 27.5 MT, to meet this requirement, the productivity needs to be enhanced to 1000 kg/ha [3].

Production and Productivity of Pulses in Tamil Nadu

Among the different legumes grown in India, the blackgram and greengram are most commonly cultivated in southern part of India, particularly Tamil Nadu for various food purposes. In India the area occupied by mungbean is about 3.0 million ha with total production of 1.1 million tonnes but average productivity is 3.20 (q/ha) and and in Tamil Nadu 1.1 million ha with total production 0.55 lakh tonnes. In India, an area of about 3.24 million hectares and producing 1.46 million tonnes. Productivity is only 526 Kg/ha.In Tamil Nadu, blackgram covers an area of about 3.06 lakh hectares with production of 1.70 million tonnes and productivity of 555 kg/ha [4]. The potential yield of blackgram and greengram is low due to several reasons *viz.*, cultivation of low yielding varieties, asynchronous maturity and extend the area of problem soils, cultivating in marginal lands mostly as rainfed crops and poor management practices [5]. Pulses are cultivated under rice fallow conditions in about 2.6 lakh hectares in Tamil Nadu and which occupy 30.75% of the total area under pulses in this state [6]. Rice fallow pulses contribute about 40.5% ofthe total pulse production.

Important of Pulses

Pulses foundavital part of the Indian diet for nutritional security and environmental sustainability [7]. Pulses are the cheapest source of proteins and Indians fulfil 20 to 30 per cent of their protein requirement from pulses, rich in calcium and iron also [8]. Per capita net availability of pulses in India, however, has reduced from 69.0gm/day to 47.2gm/day as against WHO recommendation of 80gm/day.

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Evolution of Pulses in India

The evolution of pulses in India classified into 5 categories *viz*. pre-green revolution period (1960-1970), green revolution (1970-1980), post-green revolution period (1980-1990), post liberalization period (1990-2000) and a period following the trade-spike from 2000-2010. During the green revolution period, the reduction in the variability of paddy and wheat yield coupled with unabated risks in pulses could have led to the substitution of area away from pulses. The post-liberalization period witnessed favourable terms of trade for agriculture over industry and this has potential to change and impact cropping pattern. Finally, the importance of post trade spike period is indicated by the fact that during this period pulses import increased by as much as 36 per cent.

Importance reasons for cultivation of pulses

Pulses in general are nutritionally enriched as they have high protein content, relative to staple cereals. In addition to their nutritional content, there are several reasons that strongly support legume cultivation and adoption. Important reasons for their cultivation include:

1. Pulses are rich in proteins and found to be main source of protein to vegetarian people of India.
2. It is second important constituent of Indian diet after cereals
3. They can be grown on all types of soil and climatic conditions.
4. They give ready cash to farmers
5. Pulses being legumes fix atmospheric nitrogen into the soil.
6. They play important role in crop rotation, mixed and intercropping, as they help maintaining the soil fertility.
7. They add organic matter into the soil in the form of leaf mould.
8. Pulses are generally not manured or require less manuring.
9. They are helpful for checking the soil erosion as they have more leafy growth and close spacing.
10. They supply additional fodder for cattle.
11. Some pulses are turned into soil as green manure crops
12. Majority pulses crops are short durational so that second crop may be taken on same land in a year.
13. They provide raw material to various industries.

Ex. Dal industry, Roasted grain industry, Papad industry etc.

Constraints in Pulse production in India

The pulses production has virtually stagnated over the last 40 years. There are mainly two reasons for this. Firstly, 87% of the area under pulses is rainfed. The second reason is that pulses are mainly grown as a residual crop on marginal lands, after diverting the better-irrigated lands for higher yield-higher input crops like cereals and oilseeds. The low priority accorded to pulse crops may be related to their relatively low status in the cropping system. As a crop of secondary importance, in many of these systems, pulse crops do not attract much of the farmer's crop management attention.

1. The non availability of high yielding varieties with desirable characters suitable for different condition
2. The non-availability of seeds of high-yielding varieties in the desired quantities is perhaps one of the major constraints in the expansion of pulses. Although more than 200 improved varieties of pulses have been released since 1970's, their impacts hardly get reflected in the yield. The rate of growth of yield of pulses was 0.03 percent over the past four decades.
3. In pulses there are a number of diseases and insect pests which cause heavy losses resulting in poor production. Though several resistant/tolerant varieties had been developed

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by research institutions the spread of such varieties in the farmers fields is very limited.
4. Lower production (as compared to demand) and lower stocks in both domestic and global markets have led to a steep rise in prices of pulses
5. Farmers are not motivated to grow pulses because of yield and price risk probably due to lack of effective procurement.
6. Lack of Technical knowledge of farmers
7. Grown as rainfed crop
8. Lack of incentives

Constraints of Pulse production coastal region of Tamil Nadu

The farmers in coastal areas are normally cultivate rice, groundnut, pulses (green gram and Blackgram), minor millets and vegetables for their livelihood purpose.

- Extension of salt affected and Drought affected areas
- Not aware about good pulse crops suitable for coastal region
- Not known about yield potential of black gram by farmers
- Frequent occurrence of flooding during rainy and cyclone
- Out breaking of pest and diseases
- Believe on zero tillage

System of Pulse intensification (SPI)

- Using suitable genotype with quality seeds (Higher seed rate)
- Line sowing should be taken in line planting rice field
- Timely weeding and irrigation if possible
- Population maintenance (Machine harvest field)
- Timely spraying nutrient solution to avoid flower dropping

(Single and uniform harvest and 1000 kg /ha)

Possibilities for pulse crops cultivation in Coastal region of Tamil Nadu

1. The Coastline of Tamil Nadu is located on the southeast coast of Indian Peninsula, and forms a part of Coromandel Coast of Bay of Bengal and Indian Ocean. It is 1,076 km long and is the second-longest coastline in the country after Gujarat. Inadequate rains and droughts have been leading to groundwater depletion in many coastal villages in Tamil Nadu. This has led to seawater seeping in and increasing the salinity levels in water and soil.
2. The cultivation of black gram and green gram in coastal area of Tamil Nadu is actually increase the acreages of pulse production and getting additional income for farmers from these pulse crops in short period of time. In general, most of the tropical grain legumes are highly sensitivity to Salinity and alkalinity problems, but green gram some extent to cultivate in inland and coastal salinity area. This is the situation arise to develop the genotypes for performing better in extreme condition of climate and soil conditions.
3. The evolution and development ideal genotypes are normally tedious and slow. Such plant type evolutes itself is. It is become viable with various morphological, physiological and biochemical characters involved or combined a single genotype from different sources exhibiting remarkable potential in future. In this case research priority should be given for development of ideal plant type through plant breeding can be useful method for crop improvement programme [9], which is used to enhance yield potential through genetic manipulation of individual plant characters are chosen in a such way that each character contributes towards increased economic yield. Ideotype variety is having their own limited capacity for economic yield (20-30 %) without any support, while other technologies used, the ideotype will be given more yield than our expectation.

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Factors and traits of importance for enhancement of pulse production

- Developed plant types should have shorter duration, more number of productive pods and seed weight, with increased level of per day productivity.
- Pulse Ideotype requirement for Irrigated Medium stature semi-erect and compact, responsive to high input and high harvest index (HI)

The following are characters essential for developing ideal plant types, varieties and or hybrids in pulses.

General plant ideotype concepts in pulses

- Determinate plant type
- Erect and upright plant
- Average plant height
- Early vigour, early flowering and synchronous maturity
- Pod bearing from well above the soil surface
- More pods/plant and more number of seeds/pods
- High harvest index
- Yield stability

Prediction model for enhancing the pulse production

- Developing efficient plant architecture

○ The important strategy for increasing productivity of pulse crops has to be achieved based on ideal plant architecture having high biological yield with optimum harvest index. The harvest index of many pulse species and varieties tends to be low because selection has been for some yield in all seasons. Extension of the harvest index concept to express the partitioning of mineral nutrients as well as dry matter (e.g. the nitrogen harvest index) has provided a range of responses whose implications for production and breeding remain to be explored [10] and in green gram derivatives [11] and green gram derivatives conformed through RAPDs [12]. The upright growth habit reduces foliar disease incidence in the canopy by allowing greater airflow and has improved harvest ease [13].

○ More number of leaves, small, erect, leaf lets are lanceolated with pale green colour

- Developing up right branched type (up right) and mono stem genotypes
- Developing genotypes with continuous multi blooming and elongated internodes length
- Exploitation of wild species for developing new plant types towards higher yield

e.g. Transfer of three peduncle/ axial character from *V. umbellata* to green gram and black gram genotypes [11].

- Evolving genotypes and arrangement of pods in top portion of the plant
- Development of long duration, perennial type genotypes
- Developing drought and salinity tolerant genotypes
- Possibilities of exploitation of heterosis through CMS and GMS
- Converting the lines into often cross-pollinated status
- Developing genotype with fast growing nature at early vegetative growth stage to surpassing the height of paddy stubbles to avoid etiolating and get light harvesting capacity more in rice follow condition
- Branches of plants started with top portion of the plant; Pod bearing started from 15 cm above the root surface of the plant
- Developing black gram genotype with 8-10 seeds/ pod and 15 seeds/ pod in green gram
- Developing genotypes with uniform vegetative growth
- Clear distinction between vegetative and reproductive phase like cereals
- Developing plants with reduced flower drops

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- Developing plants with halophyte root system and long tap root system to withstand salinity
- Inducing shallow anchoring side roots to uptake top soil nutrient
- Enriching bio-fortification genotypes in pulses Zn, iron, carotenoids and folates
- Increasing of carbohydrate level in green gram and black gram as same as equivalent quantity and quality of cereals carbohydrate
- Converting genotypes in pulse crops for single balanced food crops.
- Developing of seed priming methods to avoid early drought stress

❖ Seed priming, its simplicity and no requirement for expensive equipment and chemical could be used as a simple method for overcoming related to a poor germination and seedling establishment in saline condition.

❖ The development of suitable priming agents is highly helpful for pulse genotypes escape from seedling terminal stress when the genotypes are grown in in salt affected soils

- Change of Plant biochemical system similar to cereals

e.g: determination of vegetative and reproductive phase

- Erect and upright plant with average plant height
- Early vigour
- Determinate growth habit with synchronous and early maturity
- More pods/plant and more number of seeds /pods
- Resistance to shattering and sprouting.
- Developing different situation season, soil, drought, saline, frost
- Developing genotypes suitable for machine harvest

❖ Availability of cultivars suited to mechanical harvesting will reduce production cost and attract farmers towards increased pulses cultivation.

❖ Erect plant, upright, short stature with short duration adapted to machine paddy harvest field of green gram and black gram. Similarly, erect plant architecture was reported in dry bean (*Phaseolus vulgaris* L.) [14]. and also, in black gram Vamban 8 [15].

- More harvest indexes
- Pod formation in upright position, all the pods come only in the terminal parts of the plant even in monostem, the pod starts from 15 cm above the ground level to avoid pod damage during harvest.
- Lengthy pods contain more number of seeds
- Leaf shedding during harvest is better

Conclusion

India is the major producer, consumer, and importer of pulses. Most of the Indian consumers have low income and depended on pulses as vital source of protein. Comparing to population growth pulses production has very slow growth resulted, increasing demand and prices. Additionally, pulse production is still unattractive to Indian farmers from the coastal areas due to less productivity. Hence, enhancing the production and productivity of pulses through some new innovative and classical breeding techniques are essential. Currently, prediction models such as altering plant architectures, plant ideotype concepts, exploitation of heterosis, seed priming methods, developing genotypes with biotic and abiotic stress resistance, developing black gram and green gram varieties with increased yield along with bio-fortified nutrients such as iron, zinc, carotenoids and folates are highly required.

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