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REVIEW ARTICLE

Strategies for enhancing Pulse Production in Eastern Region of India –A review

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ABSTRACT
Pulses are considered as life blood of Indian agriculture because of their unique position in every known system of farming. Pulse are one among the important sources of proteins, vitamins, minerals and essential amino acids which complement the staple cereals as complete diet because of that it is also called popularly as "Poor man meat" . It is the major sources of proteins for Indians who all are hard core vegetarian. Pulse can be grown-up on series of soil and climatic circumstances and games eminent character in crop rotation, assorted cropping and inter-cropping, maintaining soil fruitfulness through nitrogen fixation, liberation of soil-bound phosphorus, and so be part of the cause extensively to sustainability of the farming systems.. The per capita availability of pulses in developing countries including India is gradually declining and one of the main reasons for this is the widening of gap between demand and supply due to mismatch in the growth of human population and production of protein-rich pulses. Their (pulses) green as well as dry plant parts serve as an important supply feed and fodder in many pulse based totally livestock manufacturing systems. Besides, they have been sustaining cereal based cropping systems through organic / biological nitrogen fixation and carbon sequestration due to the fact time immemorial .
Keywords: Poor man meat, Crop husbandry, Soil health , carbon sequestration ,pulses

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INTRODUCTION

Pulses are rich sources of protein and strength but in India, these are largely cultivated beneath power starved conditions, totally on marginal and sub-marginal land and more than three-fourth of the area below pulses continues to be rainfed ensuing in low crop productivity (1). Pulse are vital food crop due to their high protein and essential amino acid content (2). Being rich in protein and several essential amino acids like lycine, cystine and argentine, they are the ideal supplement to the cereal rich diet of predominantly vegetarian mass of the country. The long-term nature of biological nitrogen fixation and restoration of soil fertility, the ability to extract at least something from the environment and the least forgotten conditions with the least investment are additional benefits associated with pulses. India is a country of more than one billion people and about 70 % of its population lives in rural area where the main occupation is agriculture (3). In country continuously population increasing day by day to full fill the demand of food for increasing population is a big challenge for agriculturist and hence urgent need to increase the food production and crop diversification is the potential way to increase over existing land management and cropping system through horizontal and vertical utilization of resources (3). Food legumes are an integral part of the cropping system because it fits well in the crop rotation or crop mixture. Pulses are an integral part of many diets across the globe and are considered to have great potential for human health. On the other hand, legumes conserve soil, protect the environment and contribute to global food security. In 2018, about 56 grams of pulses was available per capita daily in India(4).

The important pulse crops in eastern region are chickpea, pigeonpea, mungbean, urdbean, lentil and fieldpea (5). pulse productiveness in India is much lower than different pulse producing countries. This is mainly because of unavailability of fine seed at favored time, cultivation on marginal and submarginal lands, injudicious use of fertilizers and non-adoption of crop control practices and poor marketing

infrastructure(1,6). Consequently per capita production and availability of pulses in the country have witnessed sharp decline which is further aggravated by farmers increasing preference for cultivation of cereal and cash crops. Due to failure in reducing the gap between demand and supply of the pulse in India, the nutritional security, especially of the poor are seriously compromised. In order to feed the estimated 1.68 billion population of the country by 2030, there is a need of about 32 million tons of pulses. This is a major challenge for Indian Agriculture(7).

PRESENT SCENARIO OF PULSE

India is the largest producer of pulses in the world with 25 per cent share in global production(8),consumer(27% of world consumption) and importer(14%) of pulse in the world. Madhya Pradesh, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka and Rajasthan are the major states growing pulses in India. These six states contribute 80% of total pulse production and area (9). According to ESI,2015,In India, production of pulses is around 19.3 million tons with a very low average productivity of 764 kg/ha. Currently, total area under pulses is 26.3 million ha (10)

Despite being the highest producer of pulses in the world, domestic demand of India is not fully met, and which necessitates for imports, India imports about 3.5 million tones of pulse every year from different countries (5).

The high dependence on the global market for essential source of protein for the vegetarian population in the country is a matter of serious concern in national perspective. The requirement of pulses will proceed to extend in future mostly due to ever growing population and choice for pulses as the cheapest supply of dietary proteins. Several centrally sponsored schemes like National Food Security Mission (NFSM)-pulses, built-in Scheme on Oilseeds, Pulses. Oil palm and Maize (ISOPOM) and built-in crop improvement programme (ICDP)- pulses under Macro Management Mode launched earlier for pulses development in the country- pulses under Macro Management Mode launched earlier for pulses development in the country(11).

IMPORTANCE OF PULSE CROP

The ability global effect of pulses for human nutrition and fitness is significant. Pulse grains have been mentioned for their role in nourishing youngstars prone to stunting all through the first one thousand days of life, in reducing continual diseases together with diabetes and coronary heart disease, in combacting obesity and in constructing a various microbiome. More central evidence collecting will make clear the importance of pulse consumption in decreasing malnutrition and obesity and will offer data to inform national dietry hints and the emerging medical area of “prescription food” and to support policies that higher incentivize farmers to develop pulses. Food legumes are the main source of protein for vegetarian and are traditionally recognized as an indispensible constituent of Indian diet. The protein content of food legumes are twice that of cereals (20-25%) and equal to that of animal protein (12). Food legumes are also rich source of energy, minerals, certain vitamins and also contain calories same as cereals. Pulses are “wonderful gift” of nature for all living being, natural resources and environment. Pulse crop can be said “mini nitrogen factory” as they fix atmospheric nitrogen with the help of Rhizobium in their root nodule. The intrinsic nitrogen fixing capability of pulse plants enables them to meet big proportion in their nitrogen requirement and also facilitates in economizing nitrogen in succeeding non-legume crops due to the residual impact. Different legumes have different capacity to leave behind varying amounts of N for use by way of the succeeding vegetation. In sequential cropping involving pulses, the preceding pulse might also contribute 18-70 kg N/ha to the soil and thereby sizeable quantity of nitrogen to succeeding crop . Food vegetation prosperous in vitamins ought to mitigate the deficiencies of micronutrients and consequently furnish a sustainable answer to international fitness troubles (13). Peas (*Pisum sativum* L.), chickpeas (*Cicer arietinum* L.), lentils (Lens culinaris Medik.), common beans (*Phaseolus vulgaris* L.), and mungbeans (Vigna radiate L.) are principal pulse crops grown worldwide (2). These meals legumes are amazing sources of dietary proteins, complex carbohydrates, vitamins, and minerals required for human nutrition (14-19). Pulse crops are used in common diets of humans in many components of the world considering the fact that they are prosperous in proteins and amino acid and are slowly digestible carbohydrates (20). They are without problems accessible to all agencies of people on a regular basis and supply the least pricey supply of proteins and micronutrients(21). Pulse consumption has been increasing owing to their health and environmental benefits (22).The beneficial impact of pulses was greater suggested in maize compared to sorghum after chickpea and pigeonpea whereas after lentil and peas the higher N equivalent gain was determined after pearlmillet (Table 1)(23). Pulse crop helps to promotes multiple cropping. Few pulse crops like rajmash, peas, chickpea and pigeonpea also used as green vegetables. Pulses add large amount of organic residues

to the soil in the form of root biomass and leaf litter. In a learn about performed over three years, mungbean, green manuring or incorporation of mungbean stover after picking of pods in rice wheat gadget drastically elevated /increased significantly. the available P status of soil, due to root exudates capable of mobilizing sparingly soluble P in soil (24). Study conducted at Pantnagar showed significant improvement in organic carbon and total N due to substitution of one cereal component with legumes (Table 2).

Pulses are known to enhance the microbial environment within the soils. In maize based system, maize-wheat-mungbean recorded highest soil microbial biomass carbon in comparison to maize-wheat (Table 3). Dehydrogenase enzyme activity, an index of soil microbial activity was also found to increase in soil after pulse crop. These increases in microbial activity in turn influence mineralization and immobilization of nutrients like N, P and S depending upon the environment. These consequences indicate the inclusion of pulses in crop rotation improve biomass and soil activity that could be imperative for long-term soil health and productivity. Similarly, when legume residues were incorporated into the soil, microbial activity and overall system productivity increased. In rice-chickpea system, incorporation of residues + irrigation + N @ 20 kg/ha resulted in highest yield (Table 4). The sole cropping of pulse in pre- and post-rainy seasons by fitting them into double and multiple cropping systems has opened out bright prospects in irrigated as well as rainfed area (25).

Pulse crop is also used as crop diversification. Crop diversification means the cultivation of number of different crops requiring different inputs at various points of time. Its helps to reduced potential pest and fungal invasion and also reduced need for chemicals to control this pest. Crop diversification also provide Stability of yields and conservation of natural resource base. Its (Crop diversification) also helps to suppress the weed population.

CONSTRAINTS OF FOOD LEGUME PRODUCTION

Major constraints of food legume production in eastern India are

a) Production constraints

The production of predominant pulses is limited by biological and abiotic loads (Table 5). For example, pod borer (Helicoverpa armigera), Fusarium wilting, root rot, Ascocetic disease, and Botrytis grey mildew are some of the main biological factors that reduce chickpeas productivity. The main constraints of productivit of pigeons are biological loads, including pod borer, pod fly, fusarium wilt and sterility mosaic diseases. In addition, pod boere, aphids, cut worms, Powdery mildew, rust, etc. are the principal pests and diseases affecting the production of lentils in India (26). Legumes rich in N and P are attractive for pests and diseases. (27). Insect-pests, diseases and weeds are the most important factors which might be proscribing productivity. Pests are one of the fundamental determinants for achieving better manufacturing in agriculture crops. It is envisioned that harboring insects consume approximately 26 % of the capability manufacturing. 30 % crop loss in India is recording every year because of insect-pests and sicknesses. This loss is as much as 40 % in vegetable production (28).

Most of the pulses in India are grown in low fertility, intricate soils and unpredictable environmental conditions.In arid ans semi arid regions seeed yield may reduced 50% due to drought and heat stress. (29). Another major trouble is salinity and alkalinity of soils which is high both in semi-arid tropics and in the Indo-Gangetic plains. Similarly uncertain rainfall patterns like heavy rainfall and few wet days, long dry spells, abrupt rise or drop of temperature etc are also known to limits production and productivity of pulse crops in eastern India. Since pulse crops are more photo-thermo-sensitive in comparison to cereals these crops suffer more in case of adverse condition. High yielding varieties requires masses of water similarly to fertilizers and pesticides support, which turns into more risky due to the absence of confident irrigation facility and unsure monsoons. The efficiency of inputs e.g. Fertilizers, insecticides and irrigation is in particular gritty with the aid of the pleasant of the seed used. Timely availability of satisfactory seeds at reasonable charges to farmers is necessary for achieving better productivity and production of pulse in eastern region (30).Imbalance use of fertilizers is one of the critical motives for low productivity and depleting soil fertility.

b) Socio-economic constraints

India imports more quantity of pulses from other countries. Pulse crops treated as a secondary vegetation in india. Until these days the authorities additionally gave less importance to pulses as compared to the staple cereals. Because of this situation, the farmers provide first precedence to staple cereals and cash plants for allocating inputs and the second one priority to pulses. Availability of quality seed of progressed varieties and different inputs is one of the fundamental constraints in growing the manufacturing of grain legumes (31). Indian agriculture is categorized through its subsistence nature, i.e., maximum of the produce is directly fed on by using producers and surplus, if any,

is commonly low. This is since maximum Indian farmers, being poor, and they are not able to afford expensive inputs. These effects in low returns and meager incomes, which in turn means much less financial savings and reinvestments. The social environment in terms of irrational attitude, illiteracy and impassive behaviors closer to the adoption of latest technologies is also a chief limiting element to the improvement within the agricultural productivity.

Strategies to mitigate constraints of Pulse productivity and production

There are a few available technologies that can increase the productiveness and manufacturing of pulses. Similar technologies are to be had for maximum major pulses grown in India. Abiotic stresses leading to sub-most fulfilling nutrient uptake, use of low doses of fertilizer /vitamins are the primary wrongdoer in pulse productivity. However, wide range of agroclimatic conditions, temperature appropriation in almost round the year for farming and availability of adequate rainfall indicates the fact that there is a immense capacity to improve productivity of pulses in India. Technologies could be potentially used for increasing pulses production and productivity in two ways

(A) Horizontal approach

(B) Vertical approach and

(A) Horizontal approach

Eastern region is the potential area of pulse production. About 25% of this area has potential for strengthening Rabi pulses next to paddy depending on soil conditions agreeing that additional 3 to 4 million ha area can be brought under Rabi pulses. through Use of zero tillage machines immediate after harvesting of rice for proper utilization of residual moisture.

Beside this, efficient water management is also important for dry areas. So supplemental

irrigation is beneficial for rain areas. Harvested rain water should be used for Rabi crop as life saving irrigation (32).

Replacement of low productivity crops with pulses is essential for dry areas. Wheat crop should be replaced by Rabi pulses such as chickpea whereas, barley and mustard should be replaced by lentil.

(B) Vertical approach

Potential techniques and methods should be discussed discussed to achieve more production without increasing in crop area, it is necessary to focus on improving crop productivity per area. By following the vertical approach, we can effectively and efficiently increase the pulse productivity.

a) Encourage pulse based sequential and inter cropping

Excellent number of promising sequential/ inter cropping systems for pulses have been developed by Agricultural Research Stations as shown in Table 6(22) whereas, promising high yielding pulse varieties for cultivation in eastern India are presented in Table 7(33).

b) Seed replacement rate / multiplication strategy

Productivity increment in pulses is feasible with incorporation of new HYVs to achieving maximize the yields. The major problem is well timed availability of high-quality seeds and its' popularization of promising view for the farmers in adequate quantities. t is not enough to Use good high-quality/ licensed seeds in pulses. Hence efforts need to be made in this direction through diverse Government backed programmes inclusive of National Food Security Mission, (NFSM), Integrated Scheme of Pulses, Seed Village Programme etc(11). These efforts have been a success so as to growth SRR of pulses to 22.5% by means of the year 2010-11(34).

c) Good Agronomic Practices

Good agronomic practice like Efficient and remunerative Cropping Systems , Balanced nutrition through INM, Raised bed planting and mulching, Seed Priming, Integrated weed management, Residue recycling and Tillage having impact on increase pulse productivity**(**35**).**

d) Input supply

Legumes restore atmospheric nitrogen. The availability of quality of rhizobium inoculum is limited. Phosphorus becomes a limited macronutrient that can capable to affect the production of pulses. A common problem in extracting P from the soil is that it cannot be available for vegetation because it reacts with aluminum and iron in P at pH 2 and calcium and magnesium in the soil at pH 6 at 10 p in the soil to shape complexes. The formation corresponds to the complex. These nutrients are mostly insoluble, so P migration is very little in soil solutions, and not in complex soil solutions may be taken up directly by roots (36). The use of phosphate solubilizing bacteria as inoculants simultaneously will increase P uptake of the plant and as a result crop yields increased.(37). Soils in many states in India are deficient in micro-nutrients such as boron, sulfur, zinc and magnesium (38). Application of small quantities (0.5 to 2 kg ha-1) has resulted in 40-120% boom in grain yield. Hence, making those micro-nutrient fertilizers easily available to small holder farmers in remote regions will cross a long way in enhancing productiveness and production of pulses.

e) Resource conservation technique for sustainable pulses crop production

Conservation agriculture in context of rainfed condition mainly includes integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained pulse production. In this technique mainly leaves crop residues on the surface which increases water infiltration, water retention and reduces soil compaction and soil erosion. Conservation tillage practices such as zero tillage, raised bed preparation can be transition steps towards conservation agriculture, its helps to biological tillage which improves networks of interconnected pores, nutrients recycle and physical and biological soil health. Crop residues management is an important renewable resource that can be used to conserve non-renewable soil and water resources and sustain pulse crop production. incorporation of legume crop residues helps as a soil binder and conserve the soil moisture besides this it builds up soil organic matter, soil nitrogen and increases the total available P and K content and micronutrients in the soil. Crop residues and their proper management reduced incidence of weeds flora through their physical presence on soil surface as mulch by restricting solar radiation reaching below the mulch layer. This process is highly remunerative and helps to fossil fuel and labour savings as well as long term benefits to the soil sustainability for higher production and productivity of pulses crop (39).

f) Efficient insects-pests and diseases management

In the existing era of climate change, it is critical that place unique advisories must be issued for steering pulse growers on ailment and pest control. Pulse plants are very touchy to many insect-pests and diseases, if insect pest are not control in initial stage it may demolish the complete crop. legumes grains are being extensively damaged via pests for the duration of storage. Similarly pod borer, aphids and wilt (*Fusarium lentis*) are foremost insects and diseases (26).

g) **Mechanizatio**n

Farm mechanization is the need of hour to improve the land and labour productivity. The rising wage rates and and non-availability of manpower in the course of height hours further beef up the case for mechanization. The timeliness of operations and increasing precision in input utility with minimum cost demand for more use of farm machinery(41). Agriculture mechanization is very capital intensive ,compared to other inputs. In advanced countries like Australia, Canada, USA pulse are harvested mechanically. But in India pulse are harvested by hand because the available varieties are not suitable for mechanical harvesting. For instance the modern chickpea cultivars are now not desirable to mechanical harvesting due to the fact the plant top is now not enough and the branches are close to ground due to semi –spreading growth habit. Development of chickpea cultivars with 30-40% greater height than the existing cultivars and semi-erect to erect growth dependency will make the cultivars proper to mechanical harvesting(42). The other production practice the place cost of cultivation can be decreased drastically is by using promoting use of post-emergence herbicides in controlling weeds by developing herbicide tolerant cultivars. Roller based herbicide applicator offer opportunity of controlling weeds through need-based applications of herbicide (41).

About more than 300 improved agricultural equipment/technologies have been developed countrywide for various pre and post harvest operations by human, animal, mechanical and electrical power, modernization of pulse milling industry to some extent, development of technology for value addition and for health and nutrition security.

Table1: Nitrogen economy due to inclusion of pulses in sequential cropping(42)

Preceding legume	Following cereal	Fertlizer N equivalent (kg N/ha)	Reference
Chickpea	Maize	60-70	Subbarao (1988); Lee and Wani (1989)
	Pearlmillet	40	
Pigeonpea	Wheat	40	
	Maize	20-49	
	pearlmillet	30	
Lentil	Pearlmillet	40	
	Maize	18-30	
Peas	Pearlmillet	40	
	Maize	20-32	
Greengram	Pearlmillet	30	
Pigeonpea	Sorghum	51	Ali (1984-87)
Chickpea	Rice	40	
Mungbean	Rice	40	

Modified table from Technical Bulletin, IIPR, Kanpur,2009, page-25

Table 2: Change in fertility status of soil under different cropping systems(42,43)

Crop sequences	Organic carbon (%)	Total N (kg/ha)	Available P (kg/ ha)
Rice-wheat	-0.004	-8.0	1.4
Rice-lentil	0.006	10.0	4.8
Rice-wheat- green manure	0.010	15.0	13.8

Modified table from Technical Bulletin, IIPR, Kanpur,2009,page-29 (sing et al.,1996)

Table 3: Microbial biomass carbon in maize based cropping system(42,44)

Cropping System	Microbial biomass carbon (µg/g)		
	Control	CRB + BF +FYM	NPKSZn B
Maize-Wheat	247	298	291
Maize –wheat –maize –chickpea	310	338	334
Pigeonpea-wheat	295	305	301

Modified table from Technical Bulletin, IIPR, Kanpur,2009,page-31(Kushwaha et al. 2007-08)

Table 4: Effect of residue incorporation on grain yield (kg/ha) of rice and chickpea in sequential cropping system(42,45)

Residue management	Yield (kg/ha)		
	Rice	Chickpea	Rice Equivalent
Removal	3273	2258	6848
Partial burning	3455	2323	7133
Incorporation + followed by irrigation	3313	2489	7253
Incorporation + Irrigation +20 kg N/ha	3828	2399	7626

Chickpea @ Rs1900/ q and Rice Rs 1200/q (modified table from IIPR,Technical Bulletin,2009,page-31) ,Singh et al. (2007-08)

Table 5: biotic and abiotic stresses limiting pulses production(33)

Stresses	Chickpea	Pigeonpea	Lentil	Mungbean	Urdbean
Biotic	*Fusarium wilt*,dry and wet root rot, collar rot,*Botrytis* gray mould	*Fusarium wilt*, sterility mosaic disease,*Phytopthora* stem blight,alternaria blight	*Stemphylium blight*,*Fusarium wilt*,rust	Mungbean yellow mosaic virus,*Cercospora* leaf blight	Mungbean yellow mosaic virus, *Cercospora* leaf blight
Abiotic	Drought and heat at reproductive stage,cold at early vegetative stage,fog during crop growth,soil salinity/acidity	Drought and cold at reproductive stage,frost at vegetative stage	Drought and heat for reproductive stage,fog during crop growth,soil salinity/acidity	Drought and heat for summer season crop,pre harvest,soil salinity/acidity sprouting	Intermittent drought,soil salinity/acidity,pre harvest sprouting

Table 6: Sequential / inter cropping system of pulses(11)

Pulse based sequential cropping	Inter cropping-mixed cropping
• Maize-wheat-greengram • Potato-wheat-greengram • Greengram-potato • Greengram-wheat • Arhar-chickpea • Arhar-greengram • Arhar-wheat-greengram • Pulse in rice fallow	• Greengram+maize/sorghum/pigeonpea during kharif season • Greengram+ spring planted sugarcane • Lentil + barley/linseed/rapeseed and mustard • Lentil + sugarcane(inter cropping)

Table 7: High yielding pulse varieties for cultivation in eastern India(33)

Crops	Varieties for rice fallow	High yielding varieties for normal sowing
Lentil	HUL57,Pant L 7,Moitree	HUL57,PantL7,Moitree,DPL62, Arun, KLS 218
Chickpea	Rajas,pusa 547,digvijay,dcp 92-3	GCP 105,Rajas,Birsa Chana 1,JG 14, Kbuli: HK2,HK05-169,Shubhra ,Ujjawal
Fieldpea	Adarsh,aman,vikash,prakash	Adarsh,dantiwada fieldpea1
Mungbean	Summer:HUM16,IPM 02-3,Pant moong 5,Meha,samrat	
	Kharif : MH 2-15, IPM 2-3, Pant Moong 5	
Rajmash	Amber (IIPR96-4),Utkarsh(IPR 98-5) and Arun(IPR 98-3-1)	
Lathyrus	Ratan(Bio L 212), Prateek	
Pigeon pea	IPA 203,NDA 1,Pusa 9,NDA2	

CONCLUSION

Pulse is one of the most important sources of dietary nutrition of the most Indian people. Pulse has lot of potential to improve soil health as well as farm income with less input. But Indian present production potential (19.90 mt.) is quite low to meet the per-capita consumption, thus Govt. of India have to import thousand tonnes of pulses (5.00 mt.). Indian pulse cultivation faces lot of abiotic and biotic constraints.We need to reform our future strategies by adopting vertical and horizontal expansion of production domain development of improved varieties fit for specific cropping sequence, development of abiotic and biotic stress tolerance varieties, ensuring availabilities of quality seeds by participatory approach as well as establishment of processing units under the control of Farmer's co-operate.

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