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Field Pea (*Pisum sativum L.*) yield gap analysis: A study from Assam, India

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ABSTRACT

A study was carried out to assess the performance of field pea under cluster frontline demonstrations in terms of grain yield, extension gap, technological gap and economics in field pea in different districts of Assam during four consecutive years i.e., 2016-17 to 2019-20 in *rabi* season. A total of 1285 cluster frontline demonstrations were conducted during 2016-17, 2017-18, 2018-19 and 2019-20 in an area of 465 ha by the Krishi Vigyan Kendras of Assam. The average yield of field pea achieved under cluster frontline demonstration through adoption of improved production technology was 1055 kg/ha compared to farmers' practices of 720 kg/ha which was 46.52 per cent higher than farmers' practices. The average extension gap, technological gap and technological index were 335 kg/ha, 645 kg/ha and 37.94 per cent, respectively. The net return was 28539.00 Rs./ha in demonstration plots whereas it was 13890 Rs./ha in farmer practices.

1. Introduction

Pulses played a crucial role in sustainable crop production system due to their natural biological fixation ability which subsequently enhance the soil fertility and as a rich source of proteins, vitamins and minerals which makes them the poor man's meat (Joshi,1998; Reddy, 2010; Gireesh *et. al.,* 2019; Singha *et. al.,* 2020; Singh and Singh, 2020; Smita and Satyasai, 2015). India is the largest producer (26%) and consumer (30%) of pulses in the world (Singha *et. al.,* 2020). In India, pulse consumption is far above the other source of protein (11% of entire intake of protein), which indicates the importance of pulses in daily food habits (Raj *et. al.,* 2013; Reddy, 2010). Every year, a variation in area, production and productivity of pulses have been observed, due to which the projected demand of pulses varies from 30.9 million tons to 42.5 million tones by different scholars in 2030 (Kumar, 1998; Mittal 2006; IIPR, 2011). Accordingly, to meet the growing demand the annual growth rate of the supply side has also varied from 3.35 to 6.5 (Mittal 2006; IIPR, 2011, Reddy *et. al., 2013).* The variation in estimates were impacted by the differences in yield observed over time and space (Dubey *et. al.,* 2022). Yield gaps are expressed as the difference between the potential yield and the average yield obtained by farmers over a given area or a given span of years (Evans, 1993; Van Ittersum *et al.,* 2013).

The major pulses grown in the country are green gram (*Vigna radiata*), black gram (*V. mungo*), pigeon pea (*Cajanuscajan*), cowpea (*V. unguiculata*), french bean (*Phaseolus vulgaris*), chickpea (*Cicer arietinum*), lentil (*L. culinaris)* and field pea (*Pisum sativum*). Out of all the pulses, field peas are grown extensively in the North Eastern region especially Assam. Field Pea (*Pisum sativum L.*) belongs to the family Leguminosae and is primarily used for human consumption or as a livestock feed. Field pea is the cheapest source of dietary protein (22.5%), carbohydrate (62.1%), fat (1.8%), vitamins (riboflavin, thiamin etc.), minerals (calcium, iron) and having amino acids *(*Nawab *et al., 2008,* Dahl *et al., 2012).* Field pea is cultivated mainly during the *rabi* season in the North East region (November-December) under rainfed conditions. In India, field pea covers an area of 0.498 million hectares with annual production of 4.81 million tones (Anonymous, 2017). Its area, production and productivity in the state of Assam are 28.33 thousand hectare 25.44 thousand tons and 898 kg/ ha respectively, (DES, 2018). Field pea

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crops has given vast importance by the government because of high yield gap between potential yield and yield under real farming. Therefore, it is recommended that the extension agencies engaged in the application of agricultural technologies on farmer's field should give priority to organize frontline demonstrations on a cluster basis for harnessing the productivity potential of pulse crops, reducing the technology gap, enhancing technology adoption and minimizing the disease and insect infestation. Cluster front line demonstrations (CFLDs) is a new way approach to provide a direct interface between researcher and farmer for the transfer of technologies and to get direct feedback from the farming community. The Centrally Sponsored Scheme 'National Food Security Mission (NFSM) is to operationalize the resolution of NDC and enhance the production of rice, wheat and pulses (Anonymous, 2011). The concept of Cluster front line demonstrations under this mission is a mission mode through a farmer centric approach. The scheme aims to target the selected areas by making available the improved technologies like promotion of Integrated Nutrient Management (INM), Integrated Pest Management (IPM), promotion of micronutrients/bio fertilizers, promotion of sprinkler irrigation, extension, training and mass media campaigns under the supervision of scientists of Krishi Vigyan Kendras, SAUs and their Regional Research Stations (Das, 2007). Keeping in view the above facts, the present investigation was undertaken to demonstrate the farm technology through Cluster Frontline Demonstration (CFLDs') in Field pea with the objectives to assess the performance of CFLDs on Field Pea in terms of grain yield, extension gaps, technological gap and economic gains by the farmers in the state of Assam.

2. Materials and Methods

The present study was carried out by the KVKs of Assam in *rabi* seasons at the farmers' fields during the period from 2016-17 to 2019-20. A total of 1285 CFLDs were conducted in 465 ha area in the field pea variety Prakash. All the technological interventions were taken as per the package of practices for selected variety (Table 1). The awareness programmes for the farmers were organized by the Scientists of KVKs as part of technological interventions with improved package of practices in demonstration plots at farmers' fields. The farmer's practice was considered as control plot/local check which was maintained by the farmers through traditional cultivation practices with mix varieties. The KVKs had provided critical inputs such as seeds, fertilizers, implements and bio-fertilizers etc.to the farmers for demonstration plots with technical support. The necessary steps for selection of site, selection of farmers, layout of demonstrations, etc. were followed as suggested by Choudhary (1999). The KVKs Scientists used to visit the demonstrations fields and farmer's fields (control) on regular basis for close supervision and data collection during the entire process of demonstration programmes.

% Yield increase over farmers' practice

$$= \frac{\text{Avg. yield in demonstration plots- average yield in farmers field}}{\text{Average yield in farmers field}} \times 100$$

Estimation of technology gap, extension gap, technology index: The estimation of technology gap, extension gap and technology index were done using following formulae (Kadian *et al.,* 1997; Samui *et al.,* 2000):

i) **Technology gap** = Potential yield-Demonstration plot average yield

ii) **Extension gap** = Demonstration plot average yield - Farmer's plot average yield

iii) **Technology Index** = $\frac{(Pi-Di)}{Pi} \times 100$

Where,

Pi = Potential yield of crop

Di =Demonstration plot yield of crop.

Economic analysis: Cost of cultivation includes cost of inputs like seeds, fertilizers, pesticides sowing charges of bullocks / tractor, labour etc. The net-return was worked out by taking into consideration the cost of cultivation and gross return. Similarly, the Benefit-Cost-Ratio (BCR) was worked out as a ratio of gross return corresponding to costs of cultivation as followed by Vedna, (2007); Ojha *et al.* (2020); Singha *et al.* (2020) and Singh *et al.* (2020).

Table 1. Details of technologies used for field pea cultivation

Technology	Demonstration plot	Farmers Practice
Variety	Prakash	Mix (local)
Sowing method	Line sowing @ 30cm × 10cm	Broadcasting
Time of sowing	November- December	November- December
Seed rate	70 kg/ha.	90 kg/ha
Seed treatment	Seed treatment with rhizobium culture @50 g/kg seed, Bavistin @ 2.0 g/kg seed and Trichoderma viride @ 4 g/kg seed.	Nil
Nutrient Management	Integrated nutrient management	Nil
Disease Management	Seed treatment with Carbendazim @ 2 g/kg against infestation of powdery mildew, other plant protection measures as per need	Nil

3. Results and Discussion

Grain yield: During the study, it was observed that demonstration plots had higher productivity than the respective farmer's practice. Data presented in Table 2 revealed that knowledge and transfer of improved farm technology under cluster frontline demonstrations in field pea resulted in increase in grain yield up to 32.07 to 57.35 per cent over farmers' local practices. The average yield of CFLD plots pooled over four consecutive years was 1055 kg/ha as compared to farmer's practice i.e. 720 kg/ha. The highest yield in demonstration plot was 1297 kg/ha during the year 2018 - 19 and the lowest yield (733 kg/ha) was recorded in the year 2016-17. Over the four consecutive years, increase in average yield of demonstration plots was 46.52 per cent over farmer's practice. The higher average yield in demonstration plots over the years compared to local check was mainly due to adoption of recommended package of practices. The above findings were in agreement with Singh *et al*. (2014); Dwivedi *et al.* (2014) and Tomar, (2010). The higher yield of field pea under improved technology was due to use of high yielding varieties, integrated nutrients management, integrated pest management etc. Similarly, yield enhancement in different crops in cluster frontline demonstrations were documented by Hiremath et al. (2007); Mishra *et al.* (2009); Kumar *et al.* (2010); Surywanshi and Prakash (1993); Dhaka *et al*. (2010); Dhaka *et al*. (2015); Kumar *et al*. (2017); Singha *et al*. (2020); Suresh *et al.* (2020) and Ojha *et al*. (2020).

Extension Gap: Extension gap means the difference between demonstration plot yield and farmers practice yield. A higher extension yield gap indicates that there is a strong need to educate and motivate the farmers through various extension means for adoption of improved farm technologies in oilseeds over existing local practices to reverse the existing trend (Kumar *et al.,* 2016). Extension gap ranges from 178 to 425 kg/ha during the study period and average extension gap was 335 kg/ha. The extension gap was lowest (178kg/ha) during *rabi* 2016-17 and highest (425 kg/ha) during *rabi* 2019-20 (Table 2, Fig. 1). Such gap could be attributed to the adoption of improved technology in demonstrations which resulted in higher grain yield than the traditional farmers' practices. Popularization of latest production technologies like high yielding varieties will subsequently change and fill the extension gap. This finding is in corroboration with the findings of Hiremath and Nagaraju (2010); Raju *et al*. (2017); Ojha *et al*. (2020); Singha *et al*. (2020) and Singh *et al*. (2020)

Technology gap: Technology gap is the difference between potential yield and demonstration plot yield. Wide technology gap was observed during different years and it was lowest (403 kg/ha) during *rabi* 2018-19 and highest (967 kg/ha) during *rabi* 2016-17. The average technology gap over the study period was 645.00 kg/ha (Table 2, Fig. 1). The observed technology gap may be attributed to dissimilarity in soil fertility status, rainfall distribution, disease and pest attacks as well as the change in the locations of demonstration plots etc. The technological yield gap of crops due to variation in the soil fertility and weather conditions was also reported by Raj *et al.,* (2013). Similar findings were also reported by Balail *et al*. (2013); Mukherjee (2003); Kumar *et al*. (2017); Saikia et al. (2018); Ojha *et al*. (2020); Singha *et al*. (2020) and Singh *et al*. (2020).

Technology index: The technology index for all the demonstrations during different years followed similar trend with technology gap. The technology index varied from 23.71 to 56.88 per cent (Table 2, Fig. 1). The highest technology index of 56.88 per cent was recorded in the year *rabi* 2016-17 and the lowest was observed in the year *rabi* 2018-19 which is 23.71 per cent. Technology index shows the feasibility of evolved technology at the farmer's field and lower the value of technology index more is the feasibility of the technology (Jeengar *et al*., 2006; Kumar *et al*., 2017; Ojha *et al*., 2020; Singha *et al*., 2020 and Singh *et al*., 2020).

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Table 2. Grain yield and gap analysis of CFLDs on field pea at farmers' fields

Year	No. of demo	Area (ha)	Potential yield (kg/ha)	Check yield (kg/ha)	Demo yield (kg/ha)	Yield Increase. (%)	Extn. Gap (kg/ha)	Tech. Gap (kg/ha)	Tech. index (%)
2016-17	297	100	1700	555	733	32.07	178	967	56.88
2017-18	481	175	1700	663	1024	54.44	361	676	39.76
2018-19	327	120	1700	921	1297	40.82	376	403	23.71
2019-20	180	70	1700	741	1166	57.35	425	534	31.41
Total	1285	465	-	-	-	-	-	-	-
Average	**-**	**-**	**-**	**720**	**1055**	**46.52**	**335**	**645**	**37.94**

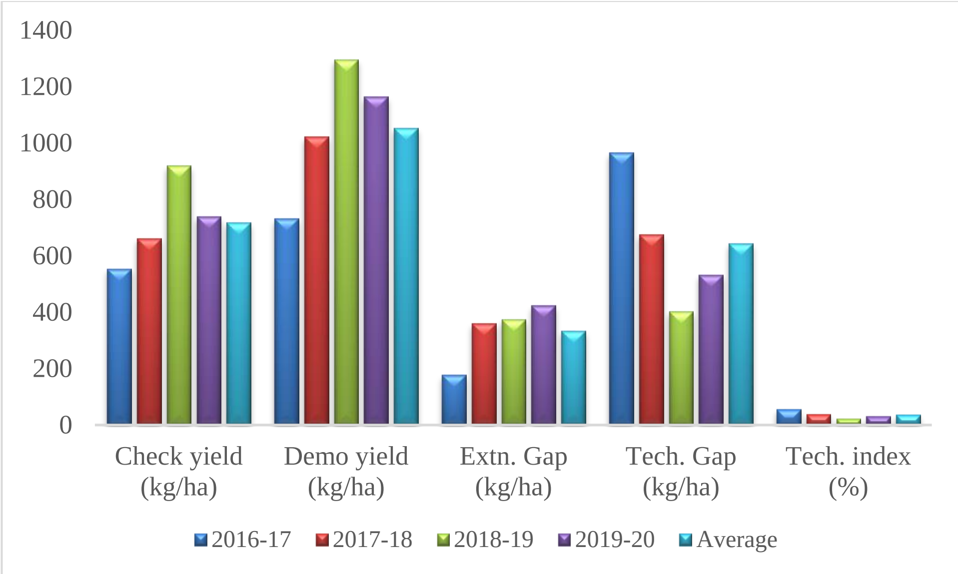

Figure 1. Yield, extension gap, technology gap and technology index of field pea cultivation under CFLD and farmer's field

Economic analysis: The economics of pulse crop production under cluster frontline demonstration were estimated and the results have been presented in Table 3. The economic analysis during the four years revealed that field pea under cluster front line demonstrations recorded higher gross returns. The cost involved in adoption of improved technology in field pea varies during different years. The input and output prices of commodities prevailed during the demonstrations were taken for calculating gross return, cost of cultivation, net return and benefit cost ratio. Use of pricey seeds for crop sowing, seed treatment, recommended dose of chemical fertilizers, proper pest management etc. all of these are the main reasons for high cost of cultivation in demonstration fields than local check. The average cost of cultivation pooled over the study period under demonstration was 23253.00 Rs/ha as compared to farmers' practices i.e. 20198.00 Rs/ha. The cultivation of field pea under improved technologies gave higher average net return of 28539.00 Rs/ha as compared to farmers' practices which was 13890.00 Rs/ha. The average benefit cost ratio of field pea under improved technologies was 2.17 as compared to 1.50 under farmers' practices. These results were in accordance with the earlier findings of Mauria *et al*. (2017). The benefit cost ratio of field pea cultivation under improved practices was higher than farmers' practices in all the years and this may be due to higher yield obtained under improved technologies compared to farmers' practices. This finding was in collaboration with the findings of Mokidue *et al*. (2011); Kumar *et al*. (2017); Ojha *et al*. (2020); Singha *et al*. (2020); Raghav *et al*. (2020) and Singh *et al*. (2020).

4. Conclusion

It is concluded from the study that there exists a wide gap between the potential and demonstration yield in field pea which may be due to variation in weather, soil health status, management practices, etc. The cultivation of field pea with improved technologies including suitable varieties, nutrients and pest management along with the active participation of farmers has a positive effect on the grain yield and economic return of field pea. Cluster Frontline Demonstrations produced a significant positive result and provided an opportunity to demonstrate the productivity potential and profitability of the latest technology under real farming situation. Technological and extension gaps can be bridged

Table 3. Economics of field pea cultivation under CFLD and Farmers practice

Year	Economics of Farmers' practice (Rs./ha)				Economics of Demonstration (Rs./ha)			
	Gross Cost	Gross return	Net return	BC ratio	Gross Cost	Gross return	Net Return	BC ratio
2016-17	19076	30679	11602	1.58	18959	39215	20256	2.04
2017-18	15524	26153	10420	1.24	20038	46477	26439	2.13
2018-19	24750	41883	17133	1.46	30325	63624	34908	2.21
2019-20	21440	37325	16405	1.71	23690	55343	32553	2.28
Average	**20198**	**34010**	**13890**	**1.50**	**23253**	**51165**	**28539**	**2.17**

by popularizing package of practices with emphasis on the seed of improved crop varieties, use of proper seed rate, balanced nutrient application, etc. hence it may be concluded that adoption of suitable variety along with improved agronomic practices resulted in higher productivity and better economic returns.

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