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Research Paper

Impact of pulses on technological gap and socio-economic status of farmers in North Eastern India

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ABSTRACT

The study was carried out to assess the performance of cluster frontline demonstrations (CFLDs) in terms of the Technological gap and Socio-economic status of farmers in fieldpea crop in three states of North East *i.e.* Assam, Arunachal Pradesh, and Sikkim. Krishi Vigyan Kendras of Assam, Arunachal Pradesh, and Sikkim conducted 1285 demonstrations in 465 ha area, 465 demonstrations in 270 ha area, and 126 demonstrations in 50 ha area, respectively in four years using improved production technology. The results revealed that the average yield of demonstration plots was highest in Arunachal Pradesh *i.e* 1,543 kg/ha during 2019-2020 as compared to farmers' practices 1008 kg/ha with 53.07 percent increase in yield followed by Assam 1297 kg/ha during 2018-2019 compared to farmers' practices (921 kg/ha). Results showed that net return in demonstration plots was Rs. 28,539/- per ha in Assam, Rs. 46,726/- per ha in Arunachal Pradesh, and Rs. 45,393/- per ha in Sikkim over farmer practices (Rs. 13,890, Rs. 24,108 and Rs. 24,056, respectively). The majority of farmers (62.66 percent) belong to medium level of knowledge in Assam and also it has adopted most of the improved technologies (53.02%), followed by Sikkim (48.99%) and Arunachal Pradesh (47.00%) which is highly encouraging and it is suggested to adopt these technologies for sustainable production of fieldpea in North East India.

Key words: Adoption, Cluster Frontline Demonstrations, Fieldpea, Knowledge, Technological gap

INTRODUCTION

Pulses are very important sources of proteins, vitamins, and minerals and are popularly known as "Poor man's meat" and "Rich man's vegetable", which contribute significantly to the nutritional security of the country. Besides, pulses possess several other qualities such as they improve soil fertility and physical structure, fit in mixed/ inter-cropping systems, crop rotations, and dry farming, and provide green pods for vegetables and nutritious fodder for cattle as well. India is the largest producer, importer, and consumer of pulses. Pulses contribute protein to a majority of the Indian population. In India, pulse consumption is far above the other sources of protein, which indicates the importance of pulses in daily food habits. Pulses contribute 11% of the entire intake of proteins in India (Reddy 2010). The average productivity of India is about 841 kg/ha against the average global productivity of 1023 kg/ha (DES 2018). The average productivity of pulses in the state of Assam was about 725 kg/ha in 2018-19 (Pocket Book of Agricultural Statistics 2018). 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, reduce the technology gap, and technology adoption, and minimizing the disease and insect infestation. Cluster front-line demonstrations (CFLDs) are 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) aims to operationalize the resolution of the National Development Council (NDC) and enhance the production of rice, wheat, and pulses (Annonymous 2011). The concept of Cluster front-line demonstrations under this mission is a mission mode through a farmer-centric approach. Demonstrations are conducted under the supervision of scientists of Krishi Vigyan Kendras, SAUs, and their Regional Research Stations.

Fieldpea (*Pisumsativum L.*) belongs to the family *Leguminosae* and is a very common crop cultivated throughout the world and also known as *Matar* in India. Fieldpea is primarily used for human consumption and as a livestock feed. Fieldpea consists of the cheapest source of dietary protein (22.5%), carbohydrates (62.1%), fat (1.8%), vitamins (riboflavin, thiamin etc.), minerals (calcium, iron), and have amino acids (Nawab *et al.* 2008, Dahl *et al.* 2012). Field pea is cultivated during the *Rabi* season in the North East region under rainfed conditions. In India field pea covers an area of 0.498 million hectares with an annual production of 4.81 million tonnes (Anonymous 2017). Its area, production, and productivity in the state of Assam are 28.33 thousand hectares, 25.44 thousand tonnes, and 898 kg/ha respectively, (DES 2019). Field pea crops have been given vast importance by the government because of the high yield gap that exists between potential yield and yield under real farming. Less or uncertain productivity mainly due to faulty sowing practices, avoiding the use of bio-fertilizers, other intercultural operations, and climatic variabilities are predominant reasons for limiting the potential yield. KVKs are grassroots level organizations for application of these technologies through assessment, refinement, and demonstration of proven produce under different micro-farming situations (Das 2007).

Keeping in view the above facts, the present investigation was undertaken to demonstrate the farm technology through CFLDs' in fieldpea a with the objectives to assess the performance of CFLD on fieldpea in terms of grain yield, extension gaps, technological gap, and economic gain, level of knowledge and extent of adoption in field pea crop by the farmers in the state of Assam, Arunachal Pradesh and Sikkim.

MATERIALS AND METHODS

The present study was carried out by the KVKs of Assam, Arunachal Pradesh and Sikkim in *Rabi* seasons at the farmers' fields during the period from 2016-17 to 2019-20. To assess the technological gap and socio-economic status of farmers, a total of 2058 cluster frontline demonstrations in a 785 ha area were conducted on IPFD 01-10 (Prakash), Aman (IPF 5-19) and Rachna varieties of fieldpea. Out of 2,058 farmers, 1,020 farmers were selected randomly to test their knowledge level and extent of adoption of improved practices using a well-structured schedule. All the technological interventions were taken as per the packages of practices for different varieties of fieldpea (Table 1) by the KVKs. The awareness programs for the farmers were organized by the scientists of KVKs as part of technological interventions with improved packages of practices in demonstration plots at farmers' fields. The farmer practice was considered as a control plot/ local check which was maintained by the farmers through traditional cultivation practices with mixed varieties. The KVKs provided critical inputs such as quality seeds, fertilizers, IPM, implements, and bio-fertilizers to the farmers for demonstration plots with technical support. The necessary steps for the selection of the site, selection of farmers, the layout of demonstrations etc. were followed as suggested by Choudhary (1999). The KVK scientists visited the demonstration fields and farmer's field (control) regularly for close supervision and data collection during the entire process of demonstration programs.

% Yield increase over farmers practice = Demonstration plot yield – Farmers' plot yield

The estimation of the technology gap, and extension gap technology index was done using the following formula (Kadian *et al*. 1997, Samui *et al*. 2000):

Technology Gap = Potential Yield – Demonstration yield

Extension gap = Demonstration plot yield - Farmer's plot yield

$$\text{Technology index (\%)} = \frac{\text{Potential yield} - \text{demonstration yield}}{\text{Potential yield}} \times 100$$

Economic analysis of CFLDs on fieldpea

The cost of pulses cultivation included the cost of inputs like seeds, fertilizers, pesticides purchased by the farmers in the control plot/supplied by the Krishi Vigyan Kendras as well as hired labour (if any), sowing charges of bullocks/tractor, and post-harvest operation charges. The gross net returns were worked out accordingly by taking the cost of cultivation and the price of grain yield. Similarly, the Benefit-Cost-Ratio (BCR) was worked out as a ratio of net-returns corresponding costs of cultivation as followed by Vedna (2007), Ojaha *et al.* (2020), Singha *et al.* (2020) and Singh *et al.* (2020).

Technology demonstration

Knowledge level and extent of adoption of improved technologies

Out of a total of 2085 farmers, the random

Table 1. Improved production technology and Farmer's practices of field pea under cluster frontline demonstrations.

Technology	Improved Technology	Farmers Practice
Variety	IPFD 01-10 (Prakash), IPF 5-19 (Aman) and Rachna	Mix (local)
Sowing method	Line sowing @ 30cm X 10cm	Broadcasting
Time of sowing	November- December	November- December
Seed rate	70kg/ha.	90kg/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	Application of vermicompost @ 1q/bigha, 65.5 kg/ha of lime as soil amendment, nutrient complex Tricontanol @ 0.75 l/ha and Borax @ 10kg/ha. Basal fertilizer application viz. 25 kg N, 50 kg P_2O_5 and 25 kg K_2O	Nil
Disease Management	Seed treatment with Carbendazim @ 2 g/kg against infestation of powdery mildew.	Nil

survey was conducted by selecting 600 farmers from Assam, 300 from Arunachal Pradesh, and 120 from Sikkim. This was done to test their level of knowledge and the extent of adoption of improved technologies for the fieldpea crop using a well-structured schedule.

RESULTS AND DISCUSSION

Grain yield

During the study, it was observed that cluster front-line demonstrations of improved technologies increased productivity over respective farmer's practices in Assam, Arunachal Pradesh, and Sikkim. Data presented in Table 2 revealed that knowledge and transfer of improved farm technology under cluster frontline demonstrations in field pea resulted in an increase in grain yield up to 40.79 to 64.62 percent than farmers' local practices. The average yield was recorded 1084 kg/ha in the demonstrated plots as compared to farmers' practice of 708 kg/ha. The highest yield of CFLD plot was recorded in Arunachal Pradesh *i.e*. 1543 kg/ha during the year 2019 – 20 as compared to farmers' practice i.e. 1008 kg/ha with a 53.07 per cent increase in yield followed by Assam 1297 kg/ha during 2018-2019. The results indicate that the higher average yield in demonstration plots over the years compared to local checks was due to knowledge and adoption of the full package of practices. The above findings were in agreement with Singh *et al.* (2014) and Tomar (2010). The higher yield of fieldpea under improved technology was due to the use of high-yielding varieties, integrated nutrients management, and integrated pest management. Similarly, yield enhancement in different crops in cluster frontline demonstrations was 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) and Ojaha *et al.* (2020).

Extension gap

The extension gap means the differences between demonstration plot yield and farmers' practice yield. An extension gap of 275 to 502 kg per hectare was found between demonstrated technology and farmers' practices during four consecutive years in Assam, Arunachal Pradesh and Sikkim and on an average basis the extension gap was 376 kg per hectare. The extension gap was lowest (275 kg/ha) during 2016-17 and it was highest (502 kg/ha) during 2019-20 (Table 2). Such a gap could be attributed to the adoption of improved technology in demonstrations which resulted in higher grain yield than the traditional farmers' practices. More and more use of the latest production technologies with high-yielding varieties will subsequently change and fill the extension gap. This finding is corroboration by the findings of Hiremath and Nagaraju (2010), Raju *et al.* (2017), Ojaha *et al.* (2020), Singha *et al.* (2020) and Singh *et al.* (2020).

Technology gap

The technology gap means the differences between potential yield and demonstration plot yield. Wide technology gaps were observed during different years and this was lowest (355 kg/ha) during *Rabi* 2019-20 and was highest (683 kg/ha) during *Rabi* 2016-17. On four consecutive years average basis the technology gap of a total of 2058 demonstrations was found as 550.00 kg per hectare (Table 2). 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 every year. The difference in technology gap during different years might be due to more feasibility of recommended technologies during different years. The technological yield gap of crops due to variation in the soil fertility and weather conditions is also reported by Raj *et al.* (2013). Similar findings were also reported by Balail *et al.* (2013), *Mukharjee* (2003), Kumar *et al.* (2017), Ojaha *et al.* (2020), Singha *et al.* (2020) and Singh *et al.* (2020).

Technology index (%)

The technology index for all the demonstrations in Assam, Arunachal Pradesh, and Sikkim during four consecutive years was in accordance with the technology gap. The technology index varied from 21.76 to 41.82 percent (Table 2). The highest technology index percent of 41.82 was recorded in the year *Rabi* 2016-17 and the lowest was observed in the year *Rabi* 2019-20 which is 21.76 percent. The technology index shows the feasibility of the evolved technology at the farmer's fields and the lower the value of the technology index more is the feasibility of the improved technology (Table 2). An average technology index was observed at 37.94 percent during the CFLD programme, which showed the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technical intervention to increase the yield performance of fieldpea. The technology index shows the feasibility of evolved technology at the farmer's field and the lower the value of technology index more is the feasibility of the technology (Jeengar *et al.* 2006, Kumar *et al.* 2017, Ojaha *et al.* 2020, Singha *et al.* 2020 *and* Singh *et al.* 2020).

Economic analysis

The economics of pulse crops production under cluster frontline demonstration in Assam,

Table 2. Grain yield and gap analysis of cluster front-line demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20

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	524	200	1633	675	950	40.79	275	683	41.82
2017-18	656	245	1633	636	1003	57.70	367	630	38.59
2018-19	552	210	1633	744	1104	48.39	360	529	32.41
2019-20	326	130	1633	776	1278	64.62	502	355	21.76
Total	2058	785	-	-	-	-	-	-	-
Average	-	-	-	708	1084	52.88	376	550	33.64

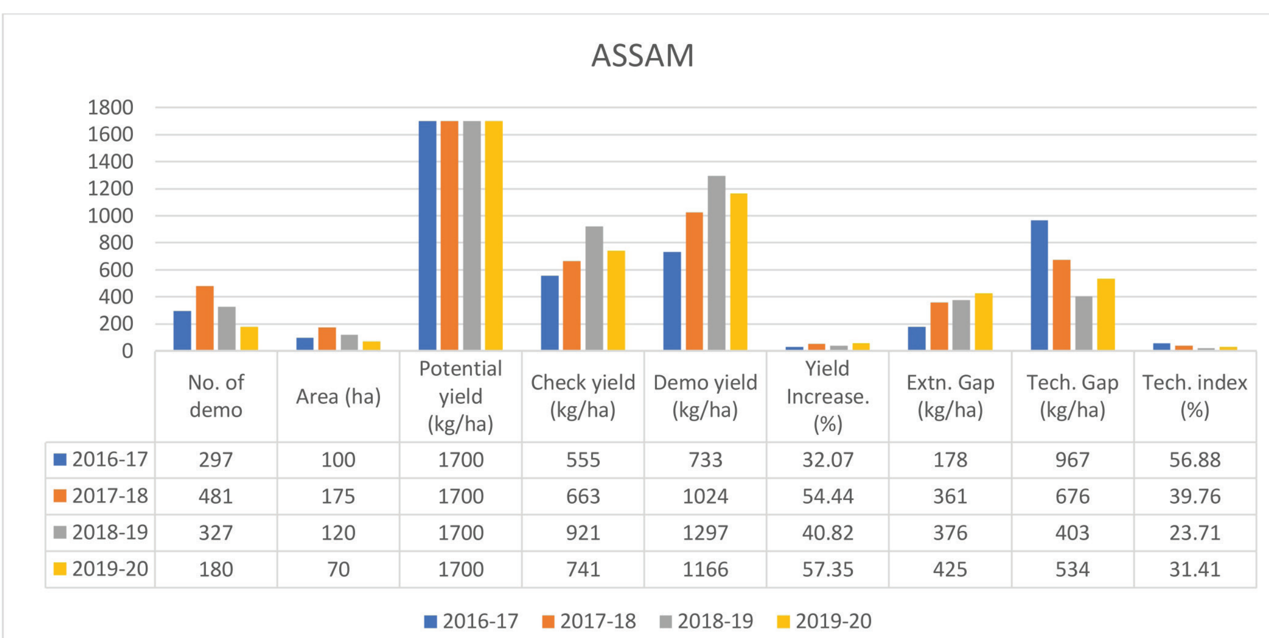
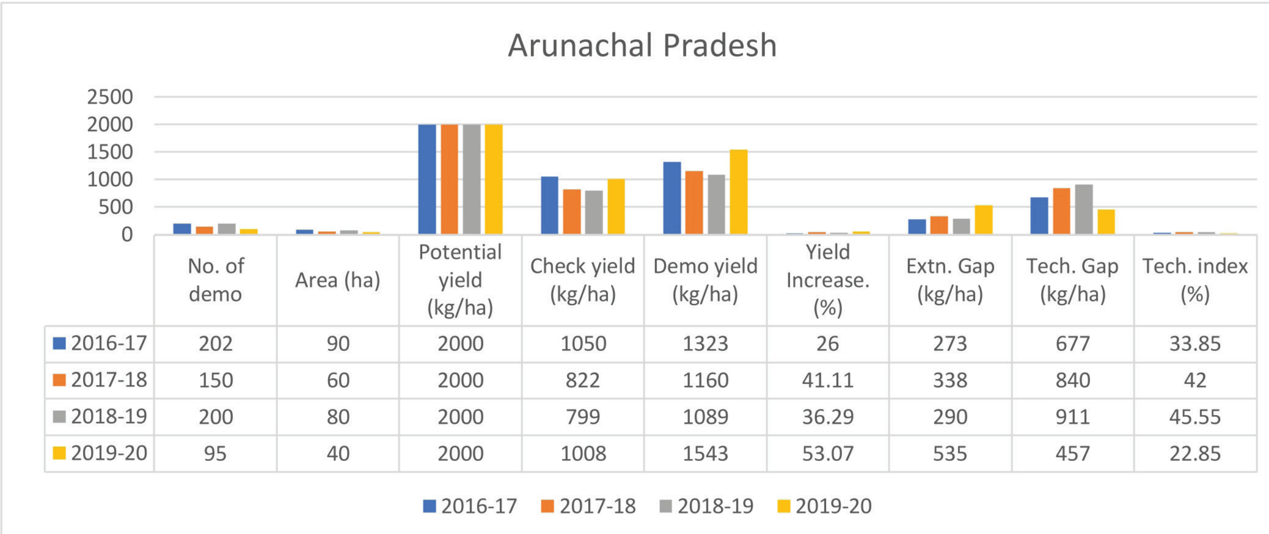
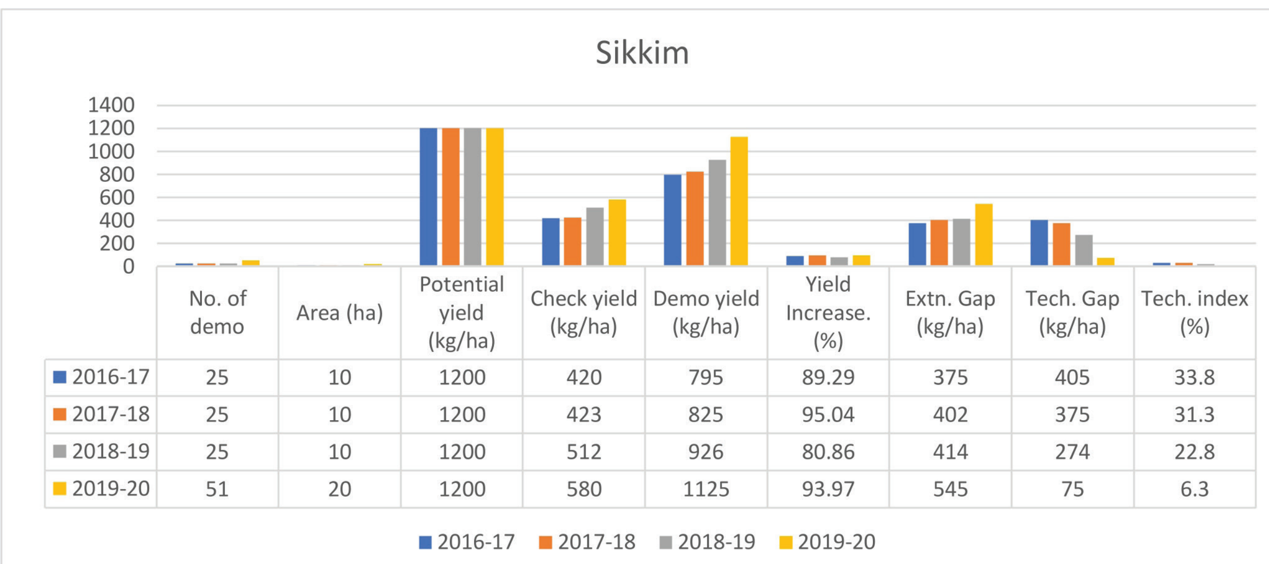


Fig 1. Grain yield and gap analysis of cluster front line demonstrations on Field pea at farmers' field from 2016-17 to 2019-20 in Assam



	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	202	90	2000	1050	1323	26	273	677	33.85
2017-18	150	60	2000	822	1160	41.11	338	840	42
2018-19	200	80	2000	799	1089	36.29	290	911	45.55
2019-20	95	40	2000	1008	1543	53.07	535	457	22.85

Fig 2. Grain yield and gap analysis of cluster frontline demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20 in Arunachal Pradesh



	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	25	10	1200	420	795	89.29	375	405	33.8
2017-18	25	10	1200	423	825	95.04	402	375	31.3
2018-19	25	10	1200	512	926	80.86	414	274	22.8
2019-20	51	20	1200	580	1125	93.97	545	75	6.3

Fig 3. Grain yield and gap analysis of cluster front-line demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20 in Sikkim

Arunachal Pradesh, and Sikkim were estimated and the results are presented in Table 3. The economic analysis during the period 2016 to 2019 revealed that fieldpea under cluster front-line demonstrations recorded higher gross returns. The cost involved in the adoption of improved technology in fieldpea varied and was more profitable. The input and output prices of commodities that 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 the high cost of cultivation in demonstration fields than local check. Therefore, the average cost of cultivation for four consecutive years in Assam, Arunachal Pradesh, and Sikkim increased in demonstration practice (Rs. 29,209 Rs/ha) as compared to farmers' practices (Rs. 26,122 Rs/ha). The cultivation of fieldpea under improved technologies gave a higher net return of Rs. 40,401/ha as compared to farmers' practices which was Rs. 20,685/ha. The benefit-cost ratio under improved technologies was 1.96 as compared to 1.35 under farmers' practices. These results were in accordance with the earlier findings of Mauria *et al.* (2017).

Table 3. Economic analysis of cluster front-line demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20

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	30859	55893	25034	0.82	28320	76461	48085	1.28
2017-18	23224	41163	17799	1.55	26603	63102	36499	2.24
2018-19	27146	52704	25666	1.55	30541	74518	44712	2.26
2019-20	23260	37327	14241	1.50	31372	63374	32309	2.06
Average	26122	46772	20685	1.35	29209	69364	40401	1.96

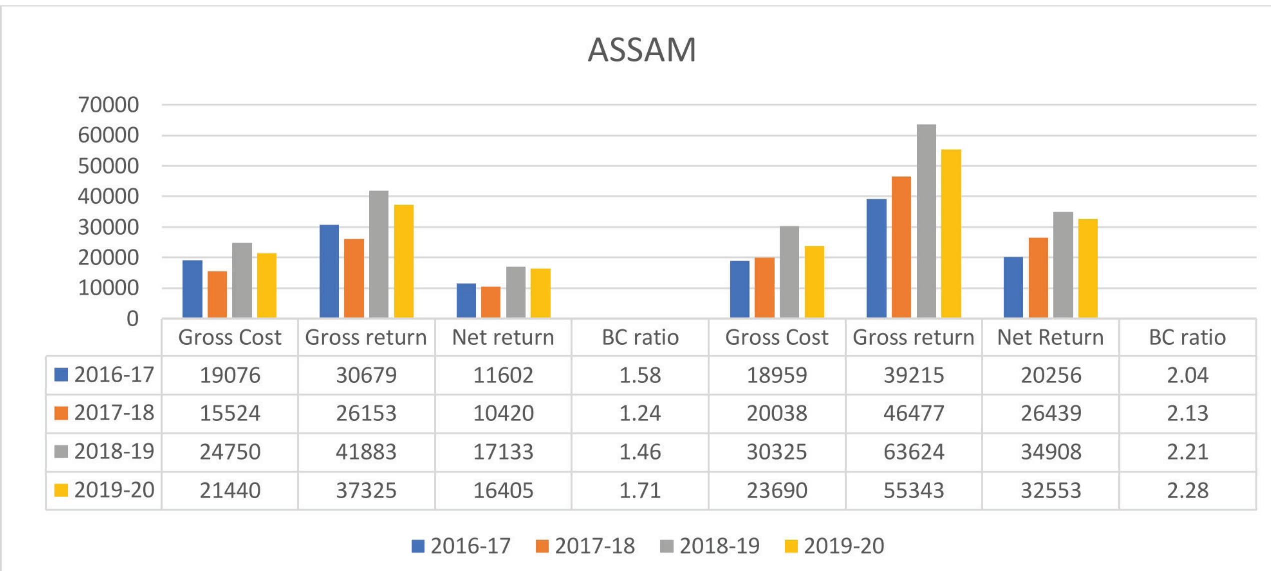


Fig 4. Economic analysis of cluster frontline demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20 in Assam

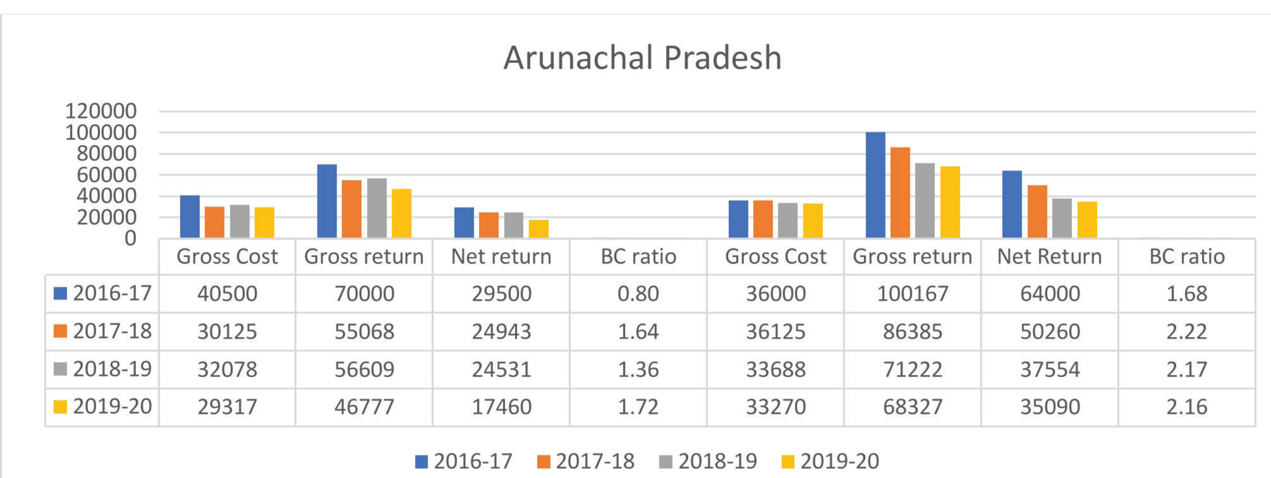


Fig 5. Economic analysis of cluster frontline demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20 in Arunachal Pradesh

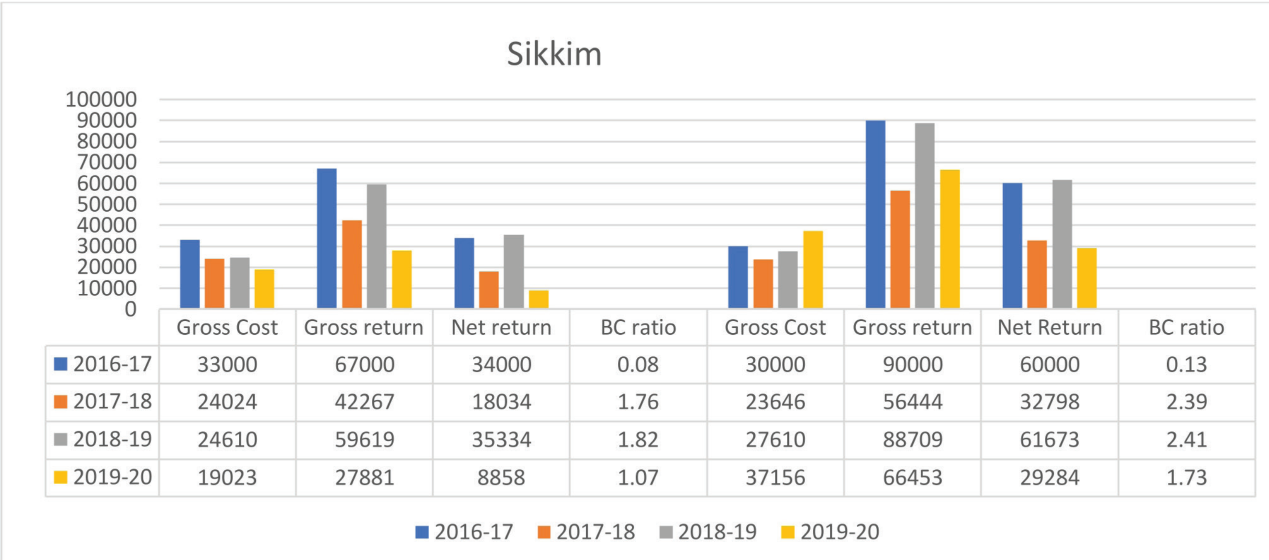


Fig 6. Economic analysis of cluster frontline demonstrations on fieldpea at farmers' field from 2016-17 to 2019-20 in Sikkim

The benefit-cost ratio of field pea cultivation under improved practices has been higher than farmers' practices in all the years and this may be due to higher yield obtained under improved technologies compared to farmers' practice. This finding was in collaboration with the findings of Mokidue *et al.* (2011), Kumar *et al.* (2017), Ojaha *et al.* (2020), Singha *et al.* (2020) and Singh *et al.* (2020).

Knowledge level of farmers

Results showed that in Assam, the majority of farmers (62.66%) had a medium level of knowledge, while 23.16% had a high level of knowledge and 14.16% had a low level (Table 4). In Arunachal Pradesh, 52% had a medium level of knowledge, 27.33% had a low level, and 20.66% had a high level. Similarly, in Sikkim, 50% of farmers had a medium level of knowledge, 29.16% had a high level, and 20.83% had a low level (Table 4).

Adoption of improved practices in fieldpea crop in Assam, Arunachal Pradesh and Sikkim

Table 5 showed that 87.67% of farmers in Assam were using quality seeds, compared to 81% in Arunachal Pradesh and 70.83% in Sikkim. Additionally, 59.33% of farmers in Assam used the

Table 4. Knowledge level of farmers in Assam, Arunachal Pradesh and Sikkim

Level	Assam (n=600)		Arunachal Pradesh (n=300)		Sikkim (n=120)	
	Frequency	%	Frequency	%	Frequency	%
Low	85	14.16	82	27.33	25	20.83
Medium	376	62.66	156	52.00	60	50.00
High	139	23.16	62	20.66	35	29.16

Table 5. Distribution of farmers of fieldpea crop in Assam, Arunachal Pradesh and Sikkim according to the extent of adoption of improved practices

Technology	Assam (n=600)		Arunachal Pradesh (n=300)		Sikkim (n=120)	
	Frequency	%	Frequency	%	Frequency	%
Use of Quality seed	526	87.67	243	81.00	85	70.83
Seed rate	356	59.33	142	47.33	65	54.16
Weed Management	262	43.67	126	42.00	50	41.66
Application of Fertilizer	226	37.67	110	36.67	42	35.00
Integrated Pest Management	220	36.67	85	28.33	52	43.33

optimum seed rate, followed by 54.16% in Sikkim and 47.33% in Arunachal Pradesh. In terms of weed management and fertilizer application, Assam had the highest adoption rates at 43.67% and 37.67%, respectively, followed by Arunachal Pradesh and Sikkim. For Integrated Pest Management, Assam led with a 43.33% adoption rate, followed by Sikkim at 36.67% and Arunachal Pradesh at 28.33%.

CONCLUSION

The present results showed that the integration of improved technology along with the active participation of farmers had a positive effect on increasing the grain yield, economic return, knowledge, and adoption of improved practices of field pea crop production in North East region. Thus, the cultivation of fieldpea crops with improved technologies including quality seeds, weed management, application of fertilizer, and integrated pest management has been found more productive. The productivity gain under the programme over existing practices of field pea cultivation created greater awareness and motivated the other farmers to adopt suitable production technology. It is concluded from the study that there exists a wide gap between the potential and demonstration yield in field pea mainly due to technology and extension gaps and also due to the lack of awareness about newer technology. Cluster Frontline Demonstrations (CFLDs) produced a significant positive impact and provided an opportunity to demonstrate the productivity potential and profitability of the latest technology under actual farming situations, which they have been advocating for a long time. Hence, it is suggested that farmers may follow the improved agronomic practices adopted under the CFLD programme both for higher production and better economic return for the sustainable cultivation of fieldpea in Assam, Arunachal Pradesh and Sikkim. Technological and extension gaps existed which can be bridged by popularizing a package of practices with emphasis on the seed of improved crop varieties, quality seeds, use of proper seed rate, weed management, application of fertilizer, integrated pest management, and proper use of plant protection measures.

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