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Yield Gap and Impact Analysis of Groundnut Cultivation Through Front Line in Chandel District, Manipur

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ABSTRACT

Background: One of the most important oil seed crops grown in India is Groundnut (*Arachis hypogaea* L.). It is abundant in energy, minerals and vitamins. It is a significant food legume and oilseed crop grown in tropical and subtropical regions of India that is used in various forms and aids in the reduction of malnutrition. Even if groundnut cultivation is not customary in the North Eastern Region of India, more groundnuts must be produced there to provide food security and nutrition. The crop has been newly introduced for cultivation in Manipur and found successful as rainfed crop during kharif season and has got very high yield potential. The technical gap is a major barrier to increasing groundnut output in Chandel district, Manipur State. Frontline demonstration (FLD), is one of the most significant and effective methods for technology transfer. By using the newest technologies, ICAR-Krishi Vigyan Kendra Chandel's interventions aim to boost productivity and production.

Methods: The present front-line demonstration was carried out by ICAR-Krishi Vigyan Kendra, Chandel, ICAR-Manipur Centre to find out yield gaps and it impact between demonstration practices under Front Line Demonstration and farmer's practice of kharif groundnut in 22 hectares of land with 54 numbers of demonstrations in different villages during 2018 to 2022, respectively. Prior to the demonstrations, a survey was conducted to collect the data on groundnut farming methods and based on survey data selection of farmers was done and improved technology for cultivation of groundnut was demonstrated.

Result: The results of the frontline demonstrations indicated that average seed yield of groundnut in Demonstration practices ranged between 18.10 q/ha to 24.45 q/ha whereas in Farmers practices it was 10.55 q/ha to 13.80 q/ha during demonstrated years. The per cent increased in yield with Demonstration practices over Farmer Practices was ranged between 41.71% to 43.56 %. The technological or Yield Gap ranges from 5.55 q/ha to 11.90 q/ha and extension gap were from 7.55 q/ha to 10.65 q/ha respectively. Similarly, technological index decreased from 39.67% to 18.50% during the study period. The benefit cost ratio was in the range of 2.81:1 to 3.94:1 under demonstrations, while it was 1.67:1 to 2.30:1 under farmer practices. By conducting front line demonstration on improved practices with High Yielding Verities of proven technologies in farmer's field can reduce the yield/technology Gap to a considerable extent and thus yield potential of groundnut enhanced to a great extent which increased in the income level of farmers and improved livelihood of farming community in the region by reducing the technology gaps.

Key words: Extension gap, Frontline demonstration, Impact, Technology gap, Technology index, Yield gap.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), one of the most significant oilseed crops farmed in India is sometimes referred to as the ″king of oilseeds.″ The self-pollinating edible oilseed crop, also referred to as the "wonder nut" and the ″poor man's cashew nut,″ is a key source of necessary nutrients and is widely used as a staple food and income crop in our nation. It is a great source of many vitamins B and E, with 570 calories per 100 g serving (Rai *et al.,* 2020). About 37% of all oilseeds produced in India are from groundnuts, however, due to a lack of awareness and the slow adoption of better techniques, groundnut productivity is much lower than potential yield (Singh *et al.,* 2019). India is the world's second largest producer of groundnuts, with 101 lakh tons of production and 1863 kg/ha of productivity in 2021-2022 and the country with the largest groundnut area (54.20 lakh ha) (agricoop.nic.in). Smallholder farmers depend primarily on groundnuts for their subsistence. It can be found in tropical and subtropical areas of the world. Due to the seed's ability to produce oil, the crop is classified as an oil seed crop, it is occasionally regarded as a grain

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legume. The seed is estimated to contain between 40-50 percent oil. The crop's usable portion or economically significant portion develops underground as pods. It is a significant food legume and oilseed crop grown in tropical and subtropical regions of India that is used in various forms and aids in the reduction of malnutrition. However, because of variations, the acidic pH (4.5 to 6.0) of the soil, Al and Fe toxicity and Ca and P deficiencies, its cultivation is quite poor in remote areas of northeastern India (Singh *et al.,* 2003, 2006). Since traditional cereals like rice and maize were originally grown on these acidic, steep, upland and low-yielding soils, groundnuts have become a popular food crop in India's Eastern Himalayan Region (EHR) (Singh *et al.,* 2003).

Due to its high yield potential, capacity to thrive in marginal soils with little input or management and reduced susceptibility to pests and diseases, groundnut is becoming more and more important in Chandel district, Manipur. Depending on the monsoon rain, groundnut is mostly grown as a rainfed kharif crop, with seeds sown in May to June. Farmers' fields yield less groundnuts mostly because they do not have access to modern technology. Due to inadequate alternative farming patterns and a lack of irrigation facilities in rain-fed regions like the Chandel districts, farmers mostly rely on rainfall to cultivate their crops. Adopting a suitable package of practices can significantly raise groundnut productivity in the area. The farmers have adopted to cultivating groundnut crop after the interventions by KVK Chandel, ICAR-Manipur Centre.

Although a sizable portion of the Chandel district, Manipur is under groundnut cultivation, it is possible to bridge the yield gap and enhance productivity to the potential level (25.0 q/ha to 35 q/ha) by adopting the improved technologies available. Low productivity can be attributed to farmers' lack of understanding of newly developed crop protection and production technology and how to manage them in the field. The high yielding groundnut variety ICGS-76 has been the focus of various field trials (FLDs) by ICAR-KVK, Chandel, with the aim of demonstrating the production potential of innovative production technologies in actual farming situations. The current study was conducted with all of these factors in mind in order to determine how FLDs influence in bridging the yield gap in terms of technology gap, extension gap and technology index.

MATERIALS AND METHODS

The study was carried out for five consecutive years (2018 to 2022) at framers' field of Chandel district in an area of 22 hectares covering 54 farmers during Kharif seasons under Front Line Demonstrations (FLD) by ICAR-KVK Chandel. The demonstrations were conducted in eight different villages of Chandel and Chakpikarong blocks of Chandel district, Manipur State in cluster approach and the special location map of the study area is shown in Fig 1. The geographic location of the areas is 24°40' N Latitude and 93°50' E Longitude and 966 m above MSL altitude. Monthly average temperature varied from 21.54°C to 29.89°C while average relative humidity varied from 66 to 89%. The details are shown in the Fig 2. In general, soils of the area under study were clay loam and medium to low in fertility status.

Before conducting demonstration, a total of fifty-four farmers were trained by conducting group meeting and specific skill training was imparted to the selected farmers regarding improved crop management aspects. All the participating farmers were trained on various aspects of ground nut production technologies with scientific package of practices and certified seeds of groundnut variety ICGS-76 was used for demonstration. The seeds of groundnut were sown to ensure recommended plant spacing within a row because excess population adversely affects growth and yield of crop. Sowing was done in the first week of May to first week of June with a seed rate of 100 kg/ha. The observations were recorded for various parameters of the

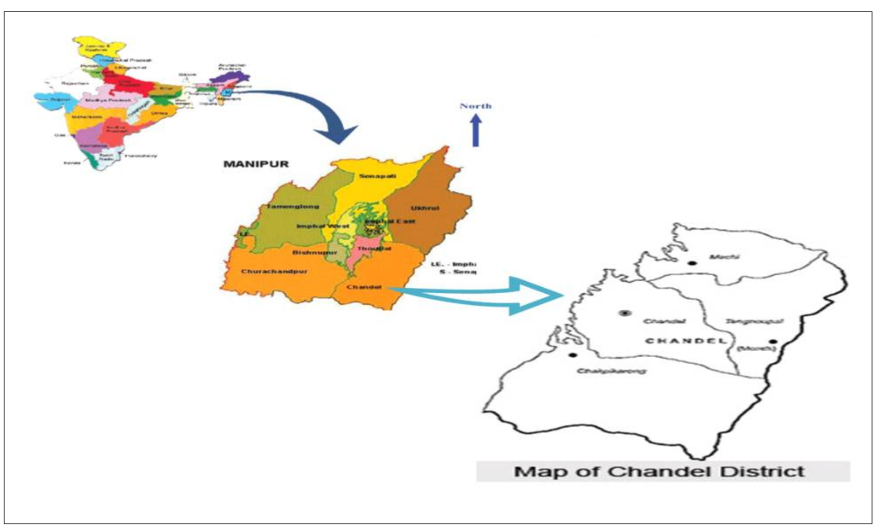

Fig 1: Spatial location of the study area.

crop. The field observations were taken from demonstration plot and farmers plot as well. Parameters like, plant height (cm) number of pods per plant, Test weight (gm) and seed yield (q/ha) were recorded at maturity stage and the gross returns (Rs per ha) was calculated on the basis of prevailing market price of the produce. The extension gap, technology gap, technology index along with B: C ratio was calculated and the data were statistically analysed applying the statistical techniques. To estimate the technology gap, extension gap and technology index following formulae have been used according to Samui *et al.* (2000) as given below.

$$\text{Tech gap} = \text{Potential yield} - \text{Demo. Plot yield} \quad \text{...(1)}$$

$$\text{Ext. gap} = \text{Demo. Plot yield} - \text{Farmer's plot yield} \quad \text{...(2)}$$

$$\text{Technology index} = \frac{\text{Pi - Di}}{\text{Pi}} \times 100 \quad \text{...(3)}$$

Where
Pi = Potential yield.
Di = Demonstration yield.

Yield gap analysis

The Yield gap has been computed using basic statistical procedures based on the actual and potential farm yields per hectare. Singh and Feroze (2017).

The production efficiency was also estimated by using the following equations:

$$\text{Production efficiency (kg/ha/day)} = \frac{\text{Grain yield (Kg/ha)}}{\text{Crop duration (days)}} \quad \text{...(4)}$$

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads.

Differences between farmer's practices and Technology demonstrated

The major differences observed between technology demonstrated and farmers practices were regarding recommended varieties, seed treatment, soil test-based fertilizer application, method of weed management and plant protection measures. The data of Table 1 showed that under the Demonstrated plot only recommended high yielding variety, seed treatment and need based plant protection chemicals, herbicides along with all other scientific package and practices were followed. But in case of Farmers practice, it was also observed that farmers were unaware about balanced fertilizer application, seed treatment and other scientific techniques of cultivation.

Performance growth characters of groundnut in Demonstration field and Farmers' field

In the demonstration field (groundnut var. ICGS-76), the average plant height at maturity for the five years of the study was 48.44 cm, while in the farmers field (groundnut var. local), the average plant height was only 43.33 cm. Similarly, over the course of the five-year study, the average number of pods per plant was found to be greater in the improved variety of groundnut (Demonstration field) compared to the local cultivar (Farmers field) averaging 26.24 and 21.66, respectively (Table 2). It was also observed that, throughout the course of the study period during 2018 to 2022, the average test weight of the demonstration field was higher than that of the farmers field, weighing 200.08 gm and 198.11 gm, respectively. This may be attributed to adoption of enhanced scientific cultivation practices coupled with high yielding groundnut var. ICGS-76 in the demonstration field whereas in the farmers field local cultivar groundnut was grown with no

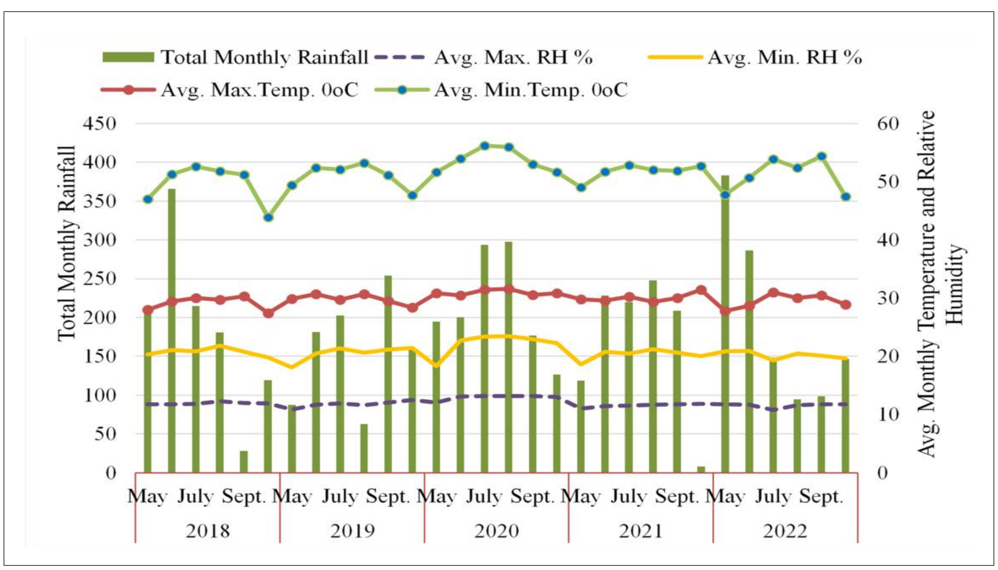

Fig 2: Monthly weather parameters observations (rainfall, maximum and minimum temperature and Relative humidity) at study area during the experimental period of 2018 to 2022.

suitable cultivation techniques. Therefore, in the demonstration field, a higher number of pods per plant and test weight were the influencing factors for a higher pod yield, these results are in close agreement with those of Kumari and Reddy (2019) and Dash *et al.* (2021).

Seed yield

The performance of groundnut var. ICGS-76 in the demonstration field over the period of the five years of front-line demonstrations revealed that the mean seed yield of 22.14 q/ha was recorded in all five years under demonstrated plots, which was higher than the local check of 11.98 q/ha. The maximum seed yield of 24.45 q/ha was recorded during 2022 and the minimum grain yield of 18.10 q/ha during 2018, respectively. On an average there was increased in the yield by 45.79% over local check (Table 3). This clearly indicates the positive impact of front-line demonstration with improved technology. The studies conducted by Chongloi *et al.* (2024) and Natarajan *et al.* (2024) revealed results that were consistent with the findings of this study.

Yield gaps

Yield of Groundnut var. ICGS-76 under demonstration and farmers' var. Local was compared to estimate the yield difference for the years of demonstrations (2018 to 2022). Throughout the years of research, it has been noted that the yield gap/technology gap ranges from 5.55 to 11.90 q/ha. The highest yield/technological gap was attained during 2018 (11.90 q/ha) while lowest gap was observed during 2022 (5.55 kg/ha) (Table 3). Groundnut yield potential can be greatly increased by implementing front-line demonstrations using proven technology in farmer's fields. The higher technology gap may be attributed to uneven rainfall distribution, variations in soil fertility, unfavourable weather patterns and localised crop management issues that arise when trying to maximise the yield potential of particular crop cultivars. Similar findings were also documented by Ahmad *et al.* (2013). By adopting a package of techniques and emphasising improved varieties, appropriate seed rate, balanced nutrient application and appropriate use of plant protection measures, the technology and extension gap can be narrowed. The results have similarities to those of Nikulsinh. (2012) and Chongloi *et al.* (2024).

Extension gaps

The extension gap showed increasing trends in each consecutive year of study (Table 3). The extension gap ranging between 7.55 - 10.65 q/ha during the study period 2018 to 2022 respectively. It emphasizes the need to educate the farmers through various means for adoption of improved agricultural production technologies to reverse the trend. Using the most recent production technologies and high-yielding varieties will thereby reverse the alarming pattern of the increasing extension gap. The new technologies will eventually lead the farmers to discontinue the old technology and to adopt new technology. This finding is in corroboration with the findings of Chongloi and Singh, 2022 and Garud *et al.* (2023).

Technology Index

The technology index data (Table 3) demonstrated the viability of advanced technologies in agriculture. In terms of the technological index, the more feasible a technology

Table 1: Comparison of demonstration package and farmers practices under FLD on groundnut.

Particulars	Demonstration	Farmers practice
Variety	ICGS-76	Local
Time of sowing	1st week of May to 1st week of June	2nd week of June to 1st week of Aug.
Seed rate	100 kg	150 kg
Seed treatment	Seed treatment with thiram @ 3g/kg of seed	No seed treatment
Fertilizer dose (NPK)	20:60:40 kg N:P:K per ha.	Irrational use of Nitrogenous fertilizers only and no others fertilizers are used.
Plant protection	Need based application	No plant protection
Intercultural operations	Two weeding at 30-35 DAS	One weeding

Table 2: Agronomic attributes of groundnut under demonstration (averaged of 5 years).

Year	Plant height at maturity (cm)		No. of pods /plant		Test weight (g)		Production efficiency (kg/ha/day)	
	D	FP	D	FP	D	FP	D	FP
2018	46.50	39.45	24.65	19.50	199.45	197.50	15.08	8.79
2019	47.00	41.10	25.20	21.15	199.65	197.80	17.67	9.00
2020	48.80	43.65	26.00	21.95	200.15	198.10	19.29	9.63
2021	49.40	45.55	26.85	22.50	200.45	198.35	19.83	11.00
2022	50.50	46.90	28.50	23.20	200.70	198.80	20.38	11.50
Mean	48.44	43.33	26.24	21.66	200.08	198.11	18.45	9.98

D= Demonstration, FP= Farmers' practice.

Table 3: Productivity, technology gap, extension gap and technology index in groundnut var. ICGS-76 under FLDs.

Year	Area (ha)	No. of farmers	No. of demonstration	Seed yield (q/ha)			% increase over control	Yield gap/Tech gap (q/ha)	Ext. gap (q/ha)	Tech. index %	B:C ratio	
				P	D	FP					D	FP
2018	2	8	8	25-35	18.10	10.55	41.71	11.90	7.55	39.67	2.81	1.67
2019	4	10	10	25-35	21.20	10.80	49.06	8.80	10.40	29.33	3.23	1.70
2020	5	10	10	25-35	23.15	11.55	50.11	6.85	11.60	22.83	3.68	1.90
2021	5	12	12	25-35	23.80	13.20	44.54	6.20	10.60	20.67	3.75	2.15
2022	6	14	14	25-35	24.45	13.80	43.56	5.55	10.65	18.50	3.94	2.30
Total	22	54	54	-	-	-	-	-	-	-	-	-
Mean					22.14	11.98	45.79	7.86	10.16	26.20	3.48	1.94

P= Potential; D= Demonstration; FP= Farmers' practice.

is, the lower its value. The technology index reached its maximum of 39.67% in 2018 and its lowest of 18.50% in 2022. This suggests that there is a significant gap between the technology developed at research institutions and the technology applied by farmers. The viability of the improved technology in the farmer's field has been shown by the technology index. This variation in the technology index over the course of the study can be linked to differences in soil fertility, weather patterns, unavailability of irrigation water during crucial periods and insect and pest infestations. The present results corroborated earlier investigations by Singh and Chaudhury (1995) and Arunkumar *et al.* (2023). However, the acceptance of developed technology by district farmers would eventually lead to the increase of production and productivity enhancement in groundnut farming. This will happen through the introduction of High Yielding Varieties and the demonstration of better technology, followed by an intense awareness campaign.

Economic analysis

For the purpose of calculating the economics, the commodity prices that were in effect during the demonstration study were used. The benefit:cost ratios were higher in frontline demonstrations, when scientific package of practices was followed, as compared to farmers' practices showing higher profitability, according to an economic analysis of the data (Table 3) for groundnut over the study period. During the study period from 2018 to 2022, the benefit cost ratios under demonstration plots (2.81, 3.23, 3.68, 3.75 and 3.94) were higher than the farmers practice (1.67, 1.70, 1.90, 2.15 and 2.30), respectively. This might be because farmers are using the high-yielding groundnut variety ICGS-76, which produces better yields than the local cultivar and new technologies are producing higher yields overall. Similar findings were also reported by Dash *et.al*. (2021) and Natarajan *et al.* (2024). Also, the production efficiency (Table 2) of groundnut ranged from 15.08 to 20.38 kg/ha/day with a mean efficiency of 18.45 kg/ha/day.

CONCLUSION

From the above findings, it can be concluded that by conducting frontline demonstrations of improved variety with intervention practices of proven technologies in farmer's field, groundnut productivity enhanced to a great extent which increased in the income level of farmers and improved livelihood of farming community and also reduced the yield/technology gap to a considerable extent. Hence, to increase the horizontal spread of the technology to a greater number of farmers in the district, there is a need to disseminate the improved technologies among the farmers with effective extension methods like training and demonstrations.

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Conflict of interest

All authors declared that there is no conflict of interest.

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