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Productivity, Profitability and Yield Gap Analysis in Chickpea under Front Line Demonstration in Tungabhadra Command Area of Koppal District

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ABSTRACT

Background: Front line demonstration in chickpea is to demonstrate and popularize the improved agro-technology on farmers' fields of Koppal District under varied existing farming situations for effective transfer of generated technology and fill the gap between improved technology and adopted/indigenous technology to enhance the productivity. The average productivity of chickpea is low due to lack of improved agrotechnology, mostly grown under rainfed conditions and vulnerable attack of pests and diseases causing huge production losses. Therefore, in order to conduct/create awareness of front-line demonstration with improved agrotechnology's for higher productivity and profitability in *rabi* chickpea.

Methods: ICAR-Krishi Vigyan Kendra, Koppal (Karnataka) was conducted frontline demonstrations (FLD) for two consecutive years during *Rabi* seasons of 2021-22 and 2022-23 at farmer's fields of Koppal district of Karnataka state. The data on productivity, yield gap analysis, per cent disease index and economics in demonstrated plots (DP) were compared with existing farmer's practice (FP).

Result: Two-year results concluded that 19.13 per cent yield increment was observed in the demonstration plot as compared to existing farmers practices. Use of improved methods of chickpea cultivation can reduce the technology gap to a considerable extent thus leading to increased productivity and profitability of farmers in the Koppal district under Northern Dry Zone of Karnataka.

Key words: Chickpea, FLD, Productivity, Profitability, Yield gap.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important pulse crop in India has first ranks in production and consumption in the world. Although, chickpea is predominantly consumed as a pulse, dry chickpea is also used in preparing a variety of foods, processed foods, sweets and condiments and green fresh chickpeas are commonly consumed as a vegetable (Wallace *et al.,* 2016). Legume crops are the gift of nature which play very important role in nitrogen fixation, soil fertility management, biomass enhancement, soil conservation and also helpful in improving the organic matter of soils grown as sole crop or intercrop by (Singh *et al.*, 2016). In India it is cultivated in an area of about 149.66 lakh hectares with an annual production of 162.25 lakh tonnes and the productivity of 1252 kg ha^{-1} (Anonymous, 2023).

In India, the average productivity of chickpea is low as compared to world average due to lack of improved agronomic practices, most vulnerable crops to the attack of pests and diseases causing huge production losses. Among the diseases, chickpea wilt and rust pose a severe problem in rainfed areas. Therefore, adaption of frontline demonstration with improved agrotechnologies plays a crucial role in crop production.

The main objective of front-line demonstration in pulses is to demonstrate and popularize the improved agro-technology on farmers' fields under varied existing farming situations for effective transfer of generated technology and fill the gap between improved technology and adopted/indigenous technology to enhance the pulse productivity (Singh *et al.,* 2019).

In Koppal district, farmers usually cultivate the chickpea in medium black soils under rainfed condition during *rabi* season. Farmers realizing the lower productivity in chickpea due to use of local variety, reuse of their own seeds, no seed treatment, occurrence of moisture stress, poor management practices especially no use of fertilizers and pesticides for managing pod borer and *Fusarium* wilt and rust disease incidence. Chickpea is one of the most vulnerable crops to the attack of pests and diseases causing huge production losses. Insect pests are the main constraints which limit the production of chickpea. Pod borer, *H. armigera* (Hubner) (Lepidoptera: Noctuidae) is the most

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prominent insect species that causes major economic damage to this crop. It is highly polyphagous pest attacks over 182 plants species including both widely grown and economically important crops as cotton, maize, tobacco, pigeon pea, chickpea and tomato (Gowad, 2020). The yield loss in chickpea due to pod borer was reported as 10-60 per cent in normal weather conditions while it was 50-100 per cent in favorable weather conditions, particularly in the states where frequent rains and cloudy weather are prevailing during the crop season (Srivastava, 2003).

By adoption of improved package of practices (integrated crop management practices) increased yield levels up to 25 to 35 per cent and lower pest and disease incidence in green gram and chickpea (Malve *et al.,* 2018). The further highest yield (1743 kg ha^{-1}) was recorded in front line demonstrations plots of chickpea by adopting integrated crop management technology as compared to farmers practice (1330 kg ha^{-1}). By the adoption of improved production technology of chickpea, the yield was found in increasing trend *i.e,* 31.05% over farmer practices (Gathiye *et al.,* 2022).

By considering the above facts, present front-line demonstration was conducted over two year to know the impact of improved agrotechnology in chickpea under front line demonstration were compared with existing farmers practices in Koppal district of Northern Dry Zone of Karnataka.

MATERIALS AND METHODS

Area of survey

Eighty-five front line demonstrations on chickpea were conducted at farmers' field to assess the improved agrotechnology in chickpea during *rabi* seasons of 2021-22 and 2022-23 at covering entire district of Koppal.

Soil physico-chemical properties of Koppal District (Table 1)

Demonstration of Improved agrotechnology

Demonstration of improved agrotechnology and existing farmers practices are presented in Table 2. The regular visits by respective scientists to FLDs plots were also made to ensure timely application of critical inputs and crop management guidance. The extension activities like field days and group discussion were organized at the demonstration sites as to motivate and make awareness about demonstrated technology around the different demo locations among farmers of the locality (Plate 1, 2 and 3). The yield data were collected from all demonstration units and along with the farmers feedback and opinion for further improvement facilitating technology adoption.

Meteorological data of Koppal district

Koppal district is located in Northern Dry Zone (Zone III) of Karnataka state. This zone receives the rainfall from both South West and North East monsoons which is well distributed from June to November with lower co-efficient of variation. The monthly mean meteorological data of rainfall, temperature and relative humidity for the experimental years from January to December for the period of 2021-22 and 2022 (Table 3).

Details of frontline demonstration plots of Koppal District

The details of frontline demonstration data were presented in Table 4.

Collection of yield, per cent disease index and yield gap analysis

The data on yield, per cent disease index and economics was workout.

Table 1: Soil physico-chemical properties of Koppal District.

Chemical properties of soil	Soil depth (0-15 cm)
Soil pH	6.85
Organic carbon (%)	0.42
Available nitrogen (kg/ha)	195
Available phosphorus (kg/ha)	30
Available potassium (kg/ha)	295

Plate 1: Distribution of high yielding variety (BGD-103) to farmers by KVK scientists.

Plate 2: Field visit and distribution of inputs to farmers by KVK scientists.

Plate 3: Demonstration of installation of pheromone traps to farmers by KVK scientists.

Table 2: Details of improved agrotechnology and existing farmers practices under front line demonstrations.

Particulars	Improved agrotechnology	Existing farmers practices
Variety	BGD-103	Annigeri-1
Seed rate	50 kg ha^{-1}	Higher seed rate
Sowing method	Seed cum fertilizer	Broadcast
Seed treatments with biofertilizers	Seed treatment with Rhizobium and PSB	No seed treatments
Fertilizer application	25 kg Nitrogen and 50 kg P_2O_5	Imbalance application
Weed management	Pre-emergent application of Pendimethalin + One intercultivation at 30 DAS	No chemical weed management
Pest and Disease management	1. Seed treatment with Carbendazim + Mancozeb @ 2.5 g/kg seeds 2. Soil application of *T.viridae* enrich (1 kg/100 kg) FYM in furrow application at 30-45 DAS, 3. Installation of pheromone traps and Propiconazole 25 EC @ 1.0 ml/lit for rust management, 4. Spraying of chickpea special at flowering stage and Chlorantraniliprole @ 0.25 ml/liter of water at pod development stage.	Improper management

Table 3: Monthly meteorological data during the year 2021 and 2022 (Jan-Dec).

Months	Rainfall (mm)		Maximum temperature (°C)		Minimum temperature (°C)		Maximum relative humidity (%)		Minimum relative humidity (%)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
January	16.80	0	29.90	29.97	17.64	18.15	57.09	77.06	15.17	41.93
February	0.5	0	30.96	31.68	15.89	18.17	40.42	79.89	12.45	46.75
March	0	9	34.35	34.09	15.65	21.08	30.38	72.06	8.13	47.17
April	4.0	17.5	38.27	37.41	23.84	24.27	85.83	70.9	25.94	47.5
May	70	65.5	37.17	36.24	24.7	25.07	87.03	71.0	35.32	37.53
June	65	58.5	33.67	34.45	23.98	24.27	90.60	77.4	47.80	55.63
July	2.5	84.5	31.91	30.93	24.12	23.68	91.39	87.33	57.94	73.6
August	49.5	146	31.92	30.75	23.71	23.45	93.61	87.83	57.83	74.52
September	104.5	122	30.79	30.77	23.29	22.86	96.87	88.76	66.43	76.07
October	40.5	109.5	32.06	31.09	22.51	21.22	99.58	89.84	57.48	79.39
November	115.5	5.5	29.7	30.31	21.28	18.27	99.67	86.33	63.53	65.3
December	4.5	40	30.37	30.43	17.9	18.21	99.81	87.45	45.71	55.29

Source: ICAR-KVK, Gangavathi.

Table 4: Details of frontline demonstration plots of Koppal district.

Details of frontline demonstration plots of Koppal district	
Agroclimatic Zone	Northern dry zone of Karnataka (III)
State and District	Karnataka and Koppal
Coordinates of the site	15.350708 Latitude and 76.155434 Longitude
Mean annual rainfall (mm)	611 mm
Major soil type	Black cotton soil (*Vertisol*)
Available nutrient status (kg ha^{-1})	N-195, P_2O_5 - 30 and K_2O-295
Major crops grown	Maize, sorghum, cotton, pigeon pea, chickpea, grape and pomogranate
Growing period temperature (°C)	November (29.7 and 30.31) December (30.37 and 30.43) January (29.97 and 29.89) (Table 2)
Date of sowing	05.11.2021 and 16.11.2022

Yield gap analysis (Samui *et al.,* 2000) were calculated by using formulae as given below:

Extension gap: It means the differences between demonstration plot yield and farmer's yield.

Extension gap = Demonstration yield - Farmers yield

Technology gap: It means the differences between potential yield and demonstration yield:

Technology gap = Potential yield - Demonstration yield

Technology index: It indicates the feasibility of the evolved technology in the farmers' fields. Lower the value of technology index, higher is the feasibility of the improved technology.

Technology index (%)=

$$\frac{\text{Potential yield - Demonstration yield}}{\text{Potential yield}} \times 100$$

RESULTS AND DISCUSSION

Growth parameters of chickpea

The results of front line demonstration of growth parameters in chickpea were presented in (Table 5). The higher growth parameters *such as.,* plant height (33.1 cm), number of branches per plant (6.75) and dry matter production (19.5 g/plant) were observed in demonstrated plot as compared to existing farmers practices (31.5 cm, 4.95 and 16.70, respectively). The higher growth parameters which might be due adoption of improved technology like high yielding variety, seed treatment with biofertilizers, balanced use of fertilizer, properly management of pest and diseases which ultimately higher growth attributes under demonstrated plot. The similar results were close conformity with the findings of (Rajpoot, 2020 and Jyothi and Lahari, 2022).

Yield parameters of chickpea

The graphical representation of yield parameters in chickpea (Fig 1). The higher yield parameters *such as.,* number of pods per plant (38.0) and test weight (23.5 g) were noticed in demonstrated plot. Whereas, lower yield parameters *viz.,* number of pods per plant (25.0) and test weight (20.0 g) observed in existing farmers practices. The higher yield parameters which might be due to higher growth attributes under adoption of improved agrotechnology. The similar results are in line with the findings of (Singh *et al.,* 2016 and Kantwa *et al.,* 2022 and Gathiye *et al.,* 2022).

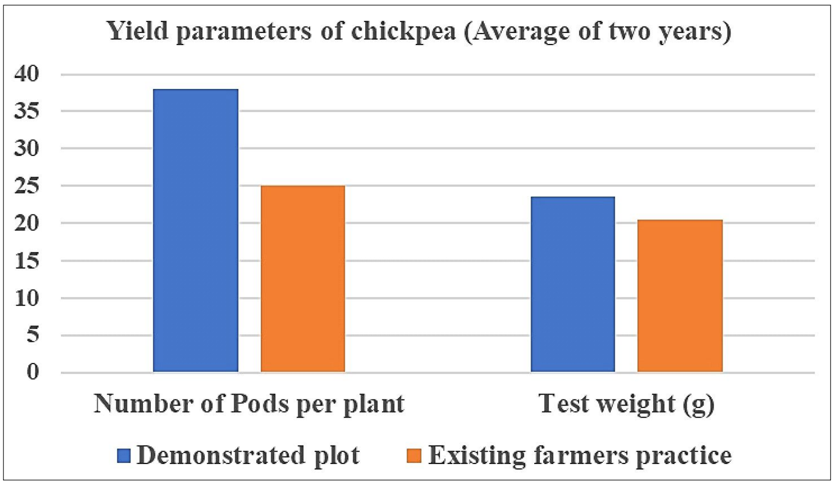

Fig 1: Yield parameters of chickpea under demonstrated plot and existing farmers practices under front line demonstration.

Table 5: Growth parameters at harvest of chickpea under demonstrated plot and existing farmers practices under front line demonstration.

Years	Plant height (cm)		Number of branches		Dry matter production (g/plant)	
	DP	FP	DP	FP	DP	FP
2021-22	32.5	29.8	6.5	4.7	18.5	15.8
2022-23	33.7	30.5	7.0	5.2	20.4	17.6
Average	33.1	31.5	6.75	4.95	19.45	16.70

Note: DP: Demonstrated plot. FP: Farmers practices.

Table: 6: Seed yield and percent disease index in demonstrated plot and existing farmer practices under front line demonstration.

Years	Yield (q ha^{-1})		% increase	Wilt PDI		Rust PDI %		Pod damage	
	DP	FP	yield	DP	FP	DP	FP	DP	FP
2021-22	13.40	11.20	19.64	14.35	21.40	8.15	16.30	4.25	8.56
2022-23	14.25	12.02	18.75	12.30	15.30	6.60	11.30	4.12	7.50
Average	13.82	11.61	19.13	13.32	18.35	7.07	13.80	4.18	8.03

Note: DP: Demonstrated plot. FP: Farmers practices, PDI: Per cent disease index.

Seed yield of chickpea

The results of front line demonstration indicated that, seed yield of chickpea from both the plots *i.e,* demonstrated and existing farmers practice were compared in Table 6. The supervision of the respective KVK scientists monitored the crop yield. The performance of demonstration plot was found better fetched good yield in comparison to existing farmer practices. The seed yield under demonstrated plots were 13.40 and 14.25 q ha^{-1} with an average of 13.82 q ha^{-1} from the year 2021-22 and 2022-23. However, it was 11.20 and 12.02 q ha^{-1} with an average of 11.61 q ha^{-1} under existing farmer practices. About 19.13 per cent yield increment was observed in the demonstration plot as compared to existing farmer practices. The yield enhancement under the technology demonstration was due to the need based use of improved and disease resistant varieties, balanced use of nutrients with biofertilizers, efficient weed and insect pest management practices. The results were in conformity with the findings of (Narwale *et al.,* 2009) who reported higher yield under FLD as compared to farmers practice in demonstration studies. Further also similar results were reported by (Kantwa *et al.,* 2022 in chickpea, Gathiye *et al.,* 2022 in chickpea, Jat *et al.,* 2022 in pulses, Kumar *et al.,* 2023 in black gram and Tiwari *et al.,* 2023 in soybean).

Per cent disease index of chickpea

Per cent disease index of chickpea are presented in Table 6. Under demonstrated plots were observed lower per cent disease index of wilt (13.32) and rust (7.07) and less pod damage (4.18%) were compared with existing farmers practices, 18.35, 13.80 and 8.03 per cent of wilt, rust and pod damage respectively. The lower pest and disease incidences were noticed in demonstrated plot due to adoption of seed treatment with Carbendazim + Mancozeb @ 2.5 g/kg seeds along with soil application of T.viridae enrich (1 kg/100 kg) FYM in furrow application at 30-45 DAS, Installation of pheromone traps and Propiconazole 25 EC @ 1.0 ml/lit for rust management and Chlorantraniliprole @ 0.25 ml/liter of water at pod development stage which resulted in lesser incidence of pest and disease. The present results are in line with the findings of (Kumar *et al.,* 2018).

Table: 7: Yield gap analysis in demonstrated plots and existing farmer practices under front line demonstration.

Years	Yield (q ha^{-1})		% Increase yield	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
	DP	FP				
2021-22	13.40	11.20	19.64	2.20	2.60	16.25
2022-23	14.25	12.02	18.75	2.23	1.75	10.93
Average	13.82	11.61	19.13	2.21	2.17	13.59

Note: DP: Demonstrated plot. FP: Farmers practices.

Table: 8: Economic analysis in demonstrated plots and existing farmer practices under front line demonstration in chickpea.

Year	Gross returns (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		B:C ratio	
	DP	FP	DP	FP	DP	FP
2021-22	67,000	56,000	44,500	35,950	2.97	2.79
2022-23	74,812	63,105	52,312	43,055	3.32	3.14
Average	70,906	59,552	48,406	39,502	3.14	2.96

Note: DP= Demonstrated plot. FP: Farmers practices.

Yield gap analysis

Yield gap analysis in demonstrated plots and existing farmers practices under chickpea are presented in Table 7.

Extension gap

An extension gap between demonstrated plot and existing farmers practices was calculated and average of extension gap of 2.21 q ha^{-1} (Table 6). This gap might be attributed to the adoption of improved technology in demonstrated plots which resulted in higher seed yield than the existing farmers practices. This emphasized the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. The similar results were reported by (Raju *et al.,* 2012; Kumar *et al.,* 2014; Singh *et al.,* 2017; Gathiye *et al.,* 2022; Rajpoot, 2020 and Jyothi and Lahari, 2022).

Technology gap

The technology gap, the difference between potential yield and yield of demonstration plots was 2.60 and 1.75 q/ha in 2021-22 and 2022-23, respectively. The technology gap observed may be attributed to dissimilarity in the soil fertility status, agricultural practices and local climatic situation. Hence, location-specific recommendations are necessary to fulfill the gap (Singh *et al.,* 2007; Singh *et al.,* 2019; Rajpoot, 2020 and Jyothi and Lahari, 2022).

Technology index

The technology index was observed 16.25 per cent during 2021-22 and 10.93 per cent during 2022-23. On an average technology index was 13.59 per cent. The technology index shows the feasibility of the evolved technology at the farmers' field. The lower value of technology index shows the efficacy of good performance of technological interventions. This variation indicates that the result differ according to soil fertility status, weather condition and mismanagement of crop. Similar findings were reported by (Joshi *et al.,* 2014; Kumar *et al.,* 2014, Rajpoot, 2020 and Jyothi and Lahari, 2022) and Siva *et al.,* 2023).

Economics of chickpea

The demonstrated technology was observed higher gross return (Rs. 70,906 ha^{-1}), net return (Rs. 48406 ha^{-1}) and benefit cost ratio (3.14) on overage of both the years as compared to existing farmers practices (Table 8). Higher net returns which might be due to adoption of improved technologies resulted in higher yield and which leads to higher profit. The present results are in line with the findings of (Kumar *et al.,* 2018, Rajpoot, 2020 and Jyothi and Lahari, 2022).

CONCLUSION

Two-year results concluded that 19.13 per cent yield increment was observed in the demonstration plot as compared to existing farmer practices. The farmers are convinced with the technological interventions demonstrated under frontline demonstration programme and motivated the other farmers of the district to adopt the improved technology in chickpea for getting higher productivity and profitability.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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