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RESEARCH ARTICLE

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# Improving Productivity and Profitability of Chickpea (*Cicer arietinum* L.) Through Front Line Demonstrations in Bihar, India

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## ABSTRACT

**Background:** In order to know about the yield gap, economic return, level of farmer satisfaction and challenges faced by the farmers, ICAR-Indian Agricultural Research Institute-conducted on-farm front-line demonstrations (FLDs) on the chickpea crop in various villages of Muzaffarpur and Vaishali districts of Bihar in 2020-21 and 2021-22.

**Methods:** Every year, twenty farmers' fields were used for front-line demonstrations (FLDs) to show how improved agro-techniques affect output and financial gains. The chickpea variety Pusa 3043 (BG 3043) was demonstrated with the use of improved production technologies.

**Result:** The technologies under FLDs that were demonstrated produced an augmented mean yield of 19.10 q/ha, which was 35.95% higher than the yield of 14.05 q/ha obtained from the farmer's practice known as local check. The FLDs recorded an additional return of 20378.00 `/ha and 22975.00 `/ha with a B: C ratio of 2.21 and 2.44 for demonstration and 1.70 and 1.88 for local check during 2020-21 and 2021-22, respectively. Therefore, the introduction of new chickpea varieties, along with the suggested improved package of practices and technologies, could lead to an increase in chickpea productivity.


**Key words:** Chickpea, Economics, Extension gap, FLDs, Technology gap, Technology index.

## INTRODUCTION

In India, pulses play a significant role in food and nutritional security. With 25% of the world's total production, India is the leading producer of pulses. In regions where pulses are the primary source of protein for vegetarian populations, they are also the most affordable and concentrated source of amino acids for diet. After common bean and field pea, chickpea (*Cicer arietinum* L.) is the largest produced food legume in South Asia and the third largest produced food legume globally. India is the world's leading producer of chickpeas, accounting for more than 75% of global production. It is being cultivated on an area of 10.91 mha with 13.75 mt of production and an average productivity of 1.26 t/ha in India (Anonymous, 2022).Still, there is gap between the requirement and production of pulses in the country (DES, 2021-22). Since India is the world's largest importer of pulses, the production of pulse crops has remained constant over the past 20 years, ranging from 11 to 14 million tonnes. Consequent upon this there is widening gap between demand and supply. India still lags far behind in the production of pulses. About 20% of the total pulse demands are met by imports only (Mousumi and Jayita, 2020). The low productivity of pulse crops at farmers' field is one of the reasons for this gap. The production of chickpea is decreasing day by day because farmers unaware of new technology. Inadequate implementation of improved agronomic practices is the primary cause of low productivity of chickpea in India, especially in Bihar. Moreover, poor agronomic practices such as higher seed rate, unsuitable varieties for the specific area, faulty nutrient management practices as well as weed control measures *etc* are responsible for low productivity of chickpea in Bihar.

The main factors limiting chickpea production in Bihar are declining factor productivity, macro- and micronutrient deficiencies, salinity and alkalinity of the soiland wild animals (Maji *et al.,* 2019). Sowing of the chickpea was delayed due to water logging in *Kharif* season, as fields are not ready for timely sowing, resulting in substantial

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yield loss (Singh, 2016). Because of the delayed sowing, the crop experiences low temperatures at sowing, which delays germination, slows growth and developmentand ultimately results in a low yield (Richards *et al.,* 2020). Further, delayed sowing causes high thermal stress at the reproductive stage of the crop, resulting in enforced maturity (Devasirvatham *et al.,* 2015). Other significant factors that have a negative impact on chickpea productivity in the state include the adoption of low-yielding, locally available varieties (Wani *et al.,* 2021), uneven fertilizer use (Gupta *et al.,* 2011; Maji *et al.,*2019, outdated weed control techniques (Kumar *et al.,*2016), inadequate plant protection measures against pests and wild animals (Chandrashekar *et al.,* 2014)and a lack of irrigation facilities (Singh, 2018). Due to these limiting factors, farmers in the Muzaffarpur and Vaishali districts often fail to achieve the desired yield of chickpeas. By adopting appropriate high-yielding varieties and recommended scientific and sustainable production practices, chickpea productivity and net monetary returns could both be increased.

Keeping in mind the importance of FLDs, the ICAR-Indian Agricultural Research Institute, Regional Station, Bihar, laid out demonstrations of chickpea crops in a systematic manner on farmers' fields during the *rabi* season of 2020-21 and 2021-22 at different villages in Muzaffarpur and Vaishali districts of Bihar under the IARI-ICARDA Collaborative Project.

## MATERIALS AND METHODS

On-farm front-line demonstrations of chickpea were conducted by the ICAR-Indian Agricultural Research Institute, Regional Station Pusa, Samastipur, Bihar, under the IARI-ICARDA Collaborative Project during the *rabi* season of 2020-21 and 2021-22. A total of 40 demonstrations (20 demonstrations per year) were conducted in different villages of Muzaffarpur (Dwarkanathpur and Mahmadpur Khaje of Marwan block; Sakri Kothi Man and Patsara of Bandra block) and Vaishali (Mukundpur of Rajapakar block) districts of Bihar, India, with the aim of demonstrating the production potential and economic feasibility of improved technologies in the farmer's field. The site under demonstration has an average annual rainfall of 1100-1200 mm and is characterized by a subtropical humid climate with hot summers and cold winters. The total rainfall received during 2020-21 was 0.80 mm however; in 2021-22 total 41.90 mm rainfall was received. Before the demonstrations, a survey was conducted to get information on chickpea cultivation practices. The data from the survey was used to select farmers and improve farming methods for the demonstrations.

The chickpea demonstrations were conducted under the strict supervision of the scientists and technical personnel of the institute. The improved chickpea variety Pusa-3043 (BG 3043), along with an improved package of practices, includes seed treatment with a fungicide (2.0 gm carbendazim) and inoculation with bio-fertilizers (*Rhizobium* and PSB). The biofertilizers, including *rhizobium* and PSB, were purchased from Agriculture College, Dholi Muzaffarpur, Bihar. Seed and other inputs were provided to FLD farmers by IARI, R.S. Pusa Bihar, along with extra technical support concerning the recommended set of practices. The scientists and technical staff of our institute regularly monitor the farmer field demonstrations, from sowing to harvesting. The farmers' plot (FP) was maintained as a local check for comparison studies. Relevant data was collected from FLD farmers as well as from non-FLD farmers for the comparison. The sowing was done during the first week of November and harvested during the last week of March to the first week of April, depending on the crop condition. Mean values for yield, cultivation costs, gross returns, net returns and the B: C ratio was calculated using the collected data (Suppl. Table 1). Finally, conclusions were drawn through the use of the technology index, technology gapand extension gap analyses (Samui *et al.,* 2000).

$$\text{Yield gap (\%)} = \frac{\text{Demonstration yield - Control yield}}{\text{Control yield}} \times 100$$

Technology gap (q/ha) = Potential yield - Demonstration yield

Extension gap (q/ha) = Demonstration yield-Farmers yield

Technology index (%)=

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

Additional cost (`) =

Demonstration cost (`/ha) - Farmers' practice cost (`/ha)

Additional returns (`) =

Demonstration returns (`/ha) - Farmers practice returns (`/ha)

Effective gain (`) =

Additional returns (`/ha) - Additional cost (`/ha)

$$\text{Incremental B: C ratio} = \frac{\text{Additional returns (`/ha)}}{\text{Additional cost (`/ha)}}$$

## RESULTS AND DISCUSSION

The technology gap between frontline demonstrations (FLDs) and existing farmers' practices (FP) of chickpea crop in Muzaffarpur and Vaishali districts of Bihar is presented in Table 1. The use of variety, seed rate, sowing methods, seed treatment, fertilizer application, use of bio-fertilizers, weed management, water managementand harvesting and threshing all showed full gaps. On the other hand, there was a partial gap in the sowing timeand no gap was observed in the field preparation. Unavailability of seed of high-yielding varieties at the right time and lack of awareness about improved production technologies were the main reasons for low yields. Farmers used the broadcast method of sowing, applying a higher seed rate than recommended and failing to maintain the appropriate spacing against the recommended line sowing.

### Yield analysis

Table 2 shows the chickpea yield data collected over the course of two years of FLD. There was a quantum leap in demonstration yield of chickpea (18.50 q/ha and 19.70 q/ ha) against the local check control (13.60 q/ha and 14.50 q/ha) by a margin of 4.90 q/ha and 5.20 q/ha with a percentage increment of 36.03% and 35.86% over the local check (farmer's practice) during 2020-21 and 2021-22, respectively. For the demonstration and local check, the results show a mean yield (mean of two years) of 19.10 q/ha and 14.05 q/ha, respectively. Furthermore, a 35.95% increase in yield over local check was observed with the technologies that were demonstrated under FLD (Table 3). The results were found to be in close conformity with the findings of Amuthaselvi *et al.* (2023); Hashim *et al.* (2022); Hashim *et al.* (2023); Kantwa *et al.* (2022); Meena *et al.* (2021); Prajapati *et al.* (2019) and Bamboriya *et al.* (2023) who reported FLD farmers had more benefit as compared to existing practices in different crops and in different areas.

### Technology gap

The findings of the technology gap between farmer's practice (FP) and the improved technologies demonstrated (FLDs) showed a full gap in the variety used in the FLDs (Table 1). Wherein the demonstrated technology resorted

**Supplementary Table 1:** Minimum support price of chickpea and rates used for calculating costs of key inputs in economic analysis.

| Particular | Input cost |
|---|---|
| Minimum support price for chickpea (`/q) | 4875 (2020-21); 5100 (2021-22) |
| Labor wage (`person/day/) | 362 (01.07.2020); 368 (01.01.2021); 372 (01.07.2021); 377 (01.01.2022); 382 (01.07.2022);Average- 365(2020-21); 372.5 (2021-22)* |
| Seed (`/kg) | 125 |
| Ploughing and harrowing rental charges (`/operation) | 2000 |
| Sowing | 2000 |
| Urea (`/kg) | 5 |
| DAP (`/kg) | 25 |
| MOP (`/kg) | 20 |
| Irrigation-Diesel pump rental charges (`/hr) | 100 |

* The labor cost was estimated by multiplying labor used in all operations (person-days $ha^{-1}$) with the minimum wage rate as per India's labor law (Minimum Wage Act, 1948) adopted at ICAR- IARI, Regional Station, Pusa Bihar.

**Table 1:** Comparison of technology gap between frontline demonstrations (FLDs) and existing farmer's practice (FP).

| Particulars | FLDs | Farmers practice (FP) | Technology Gap |
|---|---|---|---|
| Field preparation | Timely | Timely | No gap |
| Variety | Improved variety *i.e.* Pusa-3043 (BG 3043) | Local | Full |
| Sowing time | Timely | Late sowing (Up to December) | Partial |
| Seed rate | 75 kg/ha | High seed rate (100-120 kg/ha) | Full |
| Sowing method | Line sowing and maintaining row t o row spacing of 30 cm and plant to plant 10 cm (30 × 10) | Broadcasting and not maintaining proper spacing | Full |
| Seed treatment | Seed treatment with Carbendazim 12%+Mancozeb 63% WP (Saaf)@ 2.0 g/kg seed before sowing | No seed treatment | Full |
| Fertilizer application | Fertilizer application @ 20 kg N, 60 kg P2O5 and 40 kg K2O per hectare. | Imbalance fertilizer application without considering the recommended rate of application | Full |
| Use of bio-fertilizers | Use of *Rhizobium* culture and PSB | No use of Biofertilizers | Full |
| Weed management | Pre-emergence application of Pendimethaline and one hand weeding | No weed control measures followed | Full |
| Water management | 1 irrigations | No irrigation | Full |
| Harvesting and threshing | Harvesting and threshing at the right time | No timely harvesting and threshing was done | Full |

to the use of an improved variety of chickpea (BG 3043), while farmers' practices adopted local varieties or old varieties. As opposed to timely sowing (first week of November) in FLDs, the farmers had sown the chickpea seed until December. Additionally, farmers used a higher seed rate of 100-120 kg/ha as against 75 kg/ha in FLD sand there was a full gap in the seed rate used. A full gap was also observed between demonstration fields and farmers' practices in the cases of variety, seed rate, sowing methods, seed treatment, fertilizer application, use of bio-fertilizers, weed management, water managementand harvesting and threshing. In respect of sowing time, a partial gap between the demonstration fields and farmers' practices was noticed. According to factual data on the technology gap, the highest technological gap was registered during 2020-21 (6.50 q/ha) and during 2021-22 it was 5.30 q/ha, while the overall mean technological gap was 5.90 q/ha (Table 2). Overall, from the study, the lower technological gap was evident in 2021-22, where the highest yield was obtainedand this indicates that the lower technological gap has an inverse relationship with crop yield, as a narrower gap resulted in more adoption of the demonstrated technology. Kantwa *et al.* (2022), Meena *et al.* (2021); Amuthaselvi *et al.* (2023) and Bamboriya *et al.* (2023) also reported the same results.

It is important to stress that in order to reduce the trend of a large extension gap, farmers must be persuaded and educated to adopt improved agricultural technologies during both FLD years. More adoption of recent production technologies with high-yielding varieties will subsequently change this alarming trend and will help to improve the farmer's income. The variation in the technology gap may be attributed to dissimilarities in soil fertility status, agricultural practicesand local climatic conditions (Thakur *et al.,* 2019).

**Extension gap**

The data revealed a significant extension gap between farmers' practices and the technology that was demonstrated (Table 2 and 3). Results of two years showed that the highest extension gap (5.20 q/ha) was recorded during 2021-22, whereas during 2020-21, an extension gap of 4.90 q/ha was reported, while the mean extension gap during both years was 5.05 q/ha. There is a need to impart training and awareness programs to the farmers for the early adoption of improved agricultural production technologies for chickpea and varieties to narrow down the wide extension gap between the demonstrated technology and farmers practices. This new technology will eventually encourage farmers to discard their existing practices and adopt new one. This finding is in corroboration with the findings of Yadav *et al.* (2023), Rupesh *et al.* (2017), Raghav *et al.* (2021) and Rachhoya *et al.* (2018) and Hashim *et al.* (2022) which showcased the efficacy of good performance of technical interventions.

**Technology Index**

The feasibility of the evolved technology in the farmer's field is indicated by the technology index (Table 2). The lower the value of the technology index, the more the feasibility of the technology. The highest technology index (26.00%) was recorded during 2020-21, whereas during 2021-22, a technology index of 21.20% was reported, while the mean technology index during both years was 23.60%. It may be due to variations in the fertility status of the soil, erratic and uneven rainfalland regional weather patterns. Our results are in conformity with the results of Rupesh *et al.* (2017), Raghav *et al.* (2021) and Rachhoya *et al.* (2018) and Hashim *et al.* (2022).

**Economic analysis**

Based on current input and output costs, the economic performance of the demonstrated technologies over farmer practices was calculated (Table 4 and 5). It is revealed that a higher cost of cultivation of 29245 `/ha of demonstrated technology was recorded in 2021-22, while it was 28100 `/ha in 2020-21, as against the cost involved in the local check of 25700 `/ha and 24590 `/ha during 2021-22 and 2020-21, respectively. In both years, the cost of cultivation was lowest in the local check and higher in the demonstrated technologies. The demonstration plots fetched higher gross returns of 100470.00 `/ha and 90188.00 `/ha and net returns of 71225.00 `/ha and 62088.00 `/ha with a higher benefit: cost ratio of 2.44 and 2.21 as compared to gross returns of 73950.00 `/ha and 66300.00 `/ha, net returns of 48250.00 `/ha and 41710.00 `/ha and benefit: cost ratio of 1.88 and 1.70 during 2021-22 and 2020-21, respectively of local check.This finding is in concordance with the findings of Singh *et al.* (2014); Singh *et al.* (2020); Thakur *et al.* (2019); Yadav *et al.* (2023); Hashim *et al.* (2022) and Hashim *et al.* (2023).

The average net returns of 66656.50 `/ha was obtained in the demonstration, which was 21676.50 `/ha (48.20%) higher than the farmer's practice (44980.00 `/ha) and the B: C ratio of improved technologies (2.33) was also higher than the farmer's practice (1.79) and presented in table 5. The incremental benefit-cost ratio (6.15) is sufficiently high to motivate the farmers to adopt the technology.

The highest additional cost generated from the demonstrated field was reported during 2021-22 (3545.00 `/ha) and the lowest was observed in 2020-21 (3510.00 `/ha). Regarding additional returns and effective gains, the same patterns were also observed. The highest additional returns of 22975.00 `/ha, an effective monetary gain of 19430.00 `/haand an incremental B: C ratio of 6.48 were recorded during 2021-22 and the lowest additional returns of 20378.00 `/ha, an effective monetary gain of 16868.00 ` /ha and the highest incremental B:C ratio of 5.81 were recorded in 2020-21.

**Feedback of the farmers and extent of farmer's satisfaction**

It was possible to convince the farmers in the adopted village to use the specific new technologies and varieties.

**Table 2:** Performance of improved chickpea variety (BG 3043) against local variety on farmer's field.

| Year | Name of variety | Potential yield (q/ha) | No. of demonstrations | Seed yield (q/ha) Improved technology (FLDs) Max. | Seed yield (q/ha) Improved technology (FLDs) Avg. | Farmer's practice (Average yield q/ha) | Extension gap (q/ha) | Increase in yield over farmer's practice (%) | Technology gap (q/ha) | Technology Index (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2020-21 | BG 3043 | 25.0 | 20 | 20.00 | 18.50 | 13.60 | 4.90 | 36.03 | 6.50 | 26.00 |

**Table 3:** Yield of chickpea crop in improved and farmer's practices through frontline demonstration under real farm situation.

| Year | No. of demonstrations | Seed yield (q/ha) Improved technology (FLDs) (mean) | Seed yield (q/ha) Farmer's practice (mean) | Extension gap (q/ha) | Yield gap (%) |
|---|---|---|---|---|---|
| 2020-21 | 20 | 18.50 | 13.60 | 4.90 | 36.03 |
| 2021-22 | 20 | 19.70 | 14.50 | 5.20 | 35.86 |
| Mean | 20 | 19.10 | 14.05 | 5.05 | 35.95 |

**Table 4:** Detailed comparative analysis of the demonstrated technology and farmers practice on economic performance of chickpea under front line demonstration.

| Year of demonstration | Cost of cultivation (`/ha) | | Gross returns (`/ha) | | Net returns (`/ha) | | B: C ratio | | Additional cost (`/ha) | Additional return (`/ha) | Effective gain (`/ha) | Incremental B: C ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Demo | Control | Demo | Control | Demo | Control | Demo | Control | | | | |
| 2020-21 | 28100 | 24590 | 90188 | 66300 | 62088 | 41710 | 2.21 | 1.70 | 3510 | 20378 | 16868 | 5.81 |
| 2021-22 | 29245 | 25700 | 100470 | 73950 | 71225 | 48250 | 2.44 | 1.88 | 3545 | 22975 | 19430 | 6.48 |
| Average | 28672.5 | 25145 | 95329 | 70125 | 66656.5 | 44980 | 2.33 | 1.79 | 3527.5 | 21676.5 | 18149 | 6.15 |

The new high-yielding variety had an advantage over the check varieties. The technology that was demonstrated and the degree of yield satisfaction received positive feedback from the nearby farmers. Most farmers think they will adopt proven technologies if input support is discontinued. The level of satisfaction with the support provided was also satisfactory (Table 6). The extent of farmer satisfaction with front-line demonstrations showed that the majority of the respondent farmers expressed a high (80%) and medium (15%) level of satisfaction regarding the performance of FLDs (Table 7). In contrast, only a small percentage of respondents (5%) indicated a lower level of satisfaction, indicating a stronger conviction and active participation in both the physical and mental aspects of the front-line demonstrations, which would then result in higher adoption.

Table 8 presents a preferential ranking given in descending order to identify problems or limitations faced by the farmers in the cultivation of chickpea. The awareness and lack of suitable high-yielding varieties were the very serious constraints that ranked first (I) both by FLD farmers and non-FLD farmers. Unavailability of disease resistance varieties (rank II), unavailability of efficient manpower (rank III), inadequate infrastructure (rank IV), lack of proficiency in using insecticides and others (rank V), low level of technical expertise in chickpea cultivation (rank VI), inadequate supply of inputs (rank VII) and higher cost of input (rank VIII) were the constraints of FLD farmers. However, non-FLD farmers' constraints in descending order were: lack of proficiency in using insecticides and other pesticides (rank II), unavailability of disease resistance varieties (III),

**Table 5:** Comparative economics of chickpea improved technology and farmer's practices.

| Particulars | Farmer's practice | Improved technology | Actual increase over farmer's practice | Increase over farmer's practice (%) |
|---|---|---|---|---|
| Average yield (q/ha) | 14.05 | 19.10 | 5.05 | 35.95 |
| Cost of cultivation (`/ha) | 25145 | 28672.5 | 3527.5 | 14.03 |
| Net return (`/ha) | 44980 | 66656.5 | 21676.5 | 48.20 |
| B: C ratio | 1.79 | 2.33 | 0.54 | 30.17 |

**Table 6:** Feedback of the farmers.

| Particulars | Feedback |
|---|---|
| Benefits of the demonstrated variety in comparison to local check | Beneficial |
| Response of the neighbouring farmers to the demonstrated technology | Positive |
| Level of satisfaction with yield obtained | Very high |
| Will the farmer adopt the demonstrated technologies if input support is discontinued | Yes |
| Level of satisfaction with the support provided under the FLDs programme | Satisfactory |

**Table 7:** Extent of farmer's satisfaction about front line demonstration (N= 40).

| Satisfaction Level | Frequency | Percentage |
|---|---|---|
| Low | 2 | 5 |
| Medium | 6 | 15 |
| High | 32 | 80 |

**Table 8:** Distribution of FLDs farmers and non-FLDs farmer's constraints faced in chickpea cultivation.

| FLDs farmers (N=40) | | | | Non-FLDs farmers (N=40) | | |
|---|---|---|---|---|---|---|
| Constraints | Frequency | Percent | Rank | Frequency | Per cent | Rank |
| Low level of technical expertise in chickpea cultivation | 32 | 80.0 | VI | 33 | 82.5 | VIII |
| Inadequate infrastructure | 35 | 87.5 | IV | 36 | 90 | V |
| Awareness and lack of suitable high yielding variety | 39 | 97.5 | I | 40 | 100 | I |
| Unavailability of disease resistance variety | 37 | 92.5 | II | 38 | 95 | III |
| In adequate supply of inputs | 31 | 77.5 | VII | 34 | 85 | VII |
| lack of proficiency in using insecticides and other | 34 | 85.0 | V | 39 | 97.5 | II |
| Higher cost of input | 30 | 75.0 | VIII | 35 | 87.5 | VI |
| Unavailability of efficient manpower | 36 | 90.0 | III | 37 | 92.5 | IV |

unavailability of efficient manpower (IV), inadequate infrastructure (V), higher cost of input (VI), adequate supply of inputs (VII)and low level of technical expertise in chickpea cultivation (VIII).

## CONCLUSION

Based on the current study, it can be inferred that farmers' perceptions have shifted due to the FLD programand enhanced technologies used by farmers are more profitable and productive than their previous methods. Furthermore, this enhanced and strengthened the bond between farmers and scientists. Improved suggested varieties were substituted for local ones with the assistance of front-line demonstration. Improved production technologies significantly increased the yield and economic returns of the chickpea crop compared to farmers' practicesand these improved technologies are also more profitable and productive than farmers' traditional methods. The FLDs significantly reduced the extension and yield gap, which will help the farmers' financial issues as well as their living standards.

Therefore, in order to improve the farmers' standard of living and financial situation, it is necessary to disseminate the improved production technologies among the farmers with effective extension methods.

### Conflict of interest

The authors declare no conflicts of interest.

## REFERENCES

Amuthaselvi, G., Anand, G., Vijayalakshmi, R., Kanif, N.A.K., Dhanushkodi, V., Gayathri, M., Ravi, M. (2023). Yield gap analysis through cluster front line demonstration in blackgram at Tiruchirapalli district. Legume Research. 46(7): 898-901. doi:10.18805/LR-5119.

Anonymous (2022). Directorate of Economics and Statistics, DAC and FW. www.agricoop.nic.inandhttp://desagri.gov.in.

Bamboriya, S.D., Jat, A.S., Bamboriya, S.D. (2023). Impact of cluster front line demonstrations on performance of chickpea crop in western rajasthan. Annals of Agricultural Research. New Series. 44(1): 136-139.

Chandrashekar, K., Gupta, O., Yelshetty, S., Sharma, O.P., Bhagat, S., Chattopadhyay, C., Sehgal, M., Kumari, A., Amaresan, N., Sushil, S.N., Sinha, A.K., Asre, R., Kapoor, K.S., Satyagopal, K. and Jeyakumar, P. (2014). Integrated pest management for chickpea. National Centre for Integrated Pest Management, New Delhi, India, 43.

DES (2021-22). State-wise area, production and yield of important food and non food crops in India. Directorate of Economics and Statistics, New Delhi.

Devasirvatham, V., Gaur, P.M., Raju, T.N., Trethowan, R. M., Tan, D.K.Y. (2015). Field response of chickpea (*Cicer arietinum* L.) to high temperature. Field Crops Research. 172: 59-71.

Gupta, S.C., Kumar, S., Khandwe, R. (2011). Effect of bio-fertilizers and foliar spray of urea on symbiotic traits, nitrogen uptake and productivity of chickpea. Journal of Food Legumes. 24(2): 155-157.

Hashim, M., Singh, K.K., Dhar, S. (2022). Impact of front line demonstration on performance of wheat (*Triticum aestivum* L.) in Muzaffarpur, Bihar. Annals of Agricultural Research. New Series. 43 (2): 142-147.

Hashim, M., Singh, K.K., Kumar, N., Deo, M.M., Singh, D., Kumar, M. (2023) Impact of front line demonstrations in improving rice productivity and profitability in Jaunpur district of Uttar Pradesh, India. Journal of Experimental Agriculture International. 45(11): 74-82.

Kantwa, C.R., Tripathy, S., Bhadauria, R.S., Sharma, B., Jakhar, S.R., Kumar, S., Singh, S.R.K. (2022). Front line demonstration on performance of chickpea in malwa Region of Madhya Pradesh. Legume Research. doi: 10.18805/LR-4890.

Kumar, N., Hazra, K.K., Nath, C.P. and Sharma, A.R. (2016). Efficient weed management in pulses for higher productivity and profitability. Indian Journal of Agronomy. 61: 93-105.

Maji, S., Das, A., Nath, R., Bandopadhyay, P., Das, R., Gupta, S. (2019). Cool season food legumes in rice fallows: An Indian perspective. Agronomic Crops*:* 1: 561-605.

Meena, R.K., Singh, B., Chawla, S., Meena, R.K., Shinde, K.P. (2021). Evaluation of frontline demonstrations of chickpea under irrigated North Western Plain Zone-1b of Rajasthan. Journal of Pharmacognosy and Phytochemistry. 10(1): 1240-1244.

Mousumi Malo, Jayita Hore, (2020). Pulse production in India: Major constraints and way forward. Research Trends in Multidisciplinary Research and Development. 5: 35-63.

Prajapati, P.J., Joshi, N.S., Patel, M.L.,Parmar, V.S.,Gadhiya, K.K., Hadiya. N.J. (2019). Impact of frontline demonstrations on yield of chickpea (*Cicer arietinum* L.) in Amreli district of Gujarat state. Journal of Pharmacognosy and Phytochemistry. 8(2): 1431-1433.

Rachhoya, H.K., Sharma, M., Saini, V.K. (2018). Impact of cluster front line demonstrations on productivity and profitability of chickpea in desert of Rajasthan, India. International Journal of Current Microbiology and Applied Sciences. 7 (6): 1860-1864.

Raghav, D.K., Indrajeet, Kherwar, D., Kumar, A., Singh, A.K., Chauhan, J.K. (2021). Role of frontline demonstration on chickpea for enhancing the production in district Ramgarh of Jharkhand. Indian Research Journal of Extension Education. 21(1): 30-34.

Richards, M.F., Preston, A.L., Napier, T., Jenkins, L., Maphosa, L. (2020). Sowing date affects the timing and duration of key chickpea (*Cicer arietinum* L.) growth phases. Plants. 9(10): 1257.

Rupesh, K., Shinde, V., Chaudhari, P. (2017). Role of cluster frontline demonstrations in enhancement of chickpea production. Journal of Krishi Vigyan. 6(1): 172-174.

Samui, S.K., Maitra, S., Roy, D.K., Mandal, A.K., Saha, D. (2000). Evaluation of front line demonstration on groundnut. Journal of Indian Society of Coastal Agricultural Research. 18(2): 180-183.

Singh, B.D. (2018). Constraints and shifting of area of chickpea cultivation in tal area of Patna district in Bihar. Journal of Krishi Vigyan. 6(2): 17-21.

Singh, D., Patel, A.K., Baghel, S.K., Singh, M.S., Singh, A., Singh, A.K. (2014). Impact of front line demonstration on the yield and economics of chickpea (*Cicer arietinum* L.) in Sidhi district of Madhya Pradesh. Journal of Agriculture Research. 1(1): 22-25.

Singh, R. P. (2016). Increased yield and crop diversification through adoption of climate resilient varieties among pulse crops in India: An appraisal. Climate Change and Environmental Sustainability. 4(1): 47-59.

Singh, R.P., Singh, A.K., Singh, R.P., Singh, R.K., Singh, M. (2020). Impact of cluster frontline demonstrations on pulses productivity and profitability in farmer's field. Indian Journal of Extension Education. 56(1): 134-141.

Thakur, C.L., Sahu, B., Markam, S., Nag, U. (2019). Impact of front line demonstration on yield and economics of chickpea (*Cicer arietinum*) in Uttar-Bastar Kanker District of Chhattisgarh. International Journal of Current Microbiology and Applied Sciences. 8(06): 2337- 2341.

Wani, S.P., Chander, G., Patil, M.D., Sawargavkar, G., Kumar, S. (2021). Scaling up food legume production through genetic gain and improved management. In: Genetic Enhancement in Major Food Legumes (TSI). Springer, Switzerland, pp. 303-338.

Yadav, B.L., Khan, I., Rathore, S.S. (2023). Role of cluster front line demonstration for enhancing the productivity of chickpea in Jaipur district of Rajasthan. Annals of Agricultural Research. New Series. 44 (2): 266-269.