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Impact of frontline demonstration on the knowledge and adoption level of farmers during kharif onion production in North Alluvial plains of Bihar

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Abstract

The objective of this study was to demonstrate the technology of kharif onion production with the use of improved kharif onion variety Bhima Super during kharif seasons of the years 2020–2021 and 2022–2023 at farmer's field of various locations under the guidance of Krishi Vigyan Kendra, Birauli, Samastipur, Bihar. The investigation included measures like yield and economic performance, technology gap, extension gap, frontline demonstration technology index, and respondent farmer's degree of adoption of the demonstration. Over the course of the study's two years, it was found that there was a 19.74% enhancement in bulb yield above local check and that the average B:C ratio under the demonstration plot was 3.98 which was higher than that of control plots 2.19. When enhanced quality seed was adopted, the extent of adoption increased to 47.12 percent. The study displays the technology index (22.64%), the average technical gap (81.22 q/ha), and the extension gap (62.98 q/ha). Current research highlights the potentiality of frontline demonstration for dissemination of technology at the grassroots level.

Key words: Kharif onion, *Allium cepa* L. Bhima Super, technology index, extension gap, yield, adoption

Introduction

Onion (*Allium cepa* L.) is a major vegetable crop globally, valued for its nutritional, medicinal, therapeutic, and culinary uses. In India, onion is harvested in three main seasons: rabi (April-May, 60%), late rabi (Feb-March, 20%), and kharif (Oct-Nov, 20%) (Murkute, 2012). The rabi season yields the bulk of the crop, often causing a market glut. Some of this quantity is exported, while the rest is preserved for domestic use (Sharma *et al*., 2022). Stored onions are depleted by August-September, leading to price increases from October to March (Sharma and Dogra, 2017). Although states like Maharashtra, Karnataka, and Madhya Pradesh produce kharif onions, the supply is insufficient to meet national demand during price hikes, necessitating imports and further driving up prices (Mohanta *et al*., 2017).

The shortage of high-quality seeds for high-yielding kharif onion varieties, along with limited technical knowledge, continues to hinder kharif onion production (Hirave *et al*., 2015). Additionally, kharif onion cultivation is highly susceptible to unpredictable monsoons, overcast skies, and persistent drizzle, exacerbating foliar and soil-borne diseases (Kale *et al*., 2022). However, following scientific methods such as using high-yielding varieties, planting on raised beds, ensuring proper drainage, and employing integrated pest and disease management can result in successful kharif onion production (Yoo *et al*., 2019).

Kharif onion production is crucial for stabilizing onion prices and ensuring year-round supply to consumers (Sharma and Jarial, 2017). Bihar primarily grows onions as a rabi crop, constituting 60% of the total production. However, due to a lack of awareness, kharif onion cultivation in Bihar, particularly in Samastipur district, is limited and yields are low. Introducing kharif onion cultivation in northern, eastern, and central India could meet the demand for fresh bulbs during the off-season and help stabilize prices.

Front Line Demonstrations (FLDs) effectively encourage farmers to adopt new technologies and practices. Established by ICAR in 1991–1992 as part of the First Line Transfer of Technology program, FLDs operate on the principle of "seeing is believing," providing tangible proof of the recommended technology in the farmer's actual farming environment. The ICAR-DOGR has developed ten onion varieties through genetic enhancement, with the Bhima Super variety recommended for kharif and late kharif seasons.

To address these challenges, Krishi Vigyan Kendra, Birauli, Samastipur, conducted the 'Front Line Demonstration of Kharif onion cv. Bhima Super' in Samastipur district, Bihar, to assess the impact of FLD on kharif onion cultivation.

Materials and method

The demonstration was laid out in Samastipur district of Bihar during kharif seasons of 2020-2021 and 2022-2023. Three C.D. blocks namely, Pusa, Kalyanpur and Tajpur were selected for this study. Twelve communities from three blocks (four villages per block) were selected for the study. Seeds of High Yielding variety (HYV) of kharif onion cv. Bhima Super and required agrochemical were provided to the farmers as critical inputs under the demonstration programme. A thorough roster of FLD farmers was compiled. Four beneficiaries were chosen at random from each village that was considered. As a result, throughout two years, a total of 48 respondents were recruited under the study. FLD was carried out on farmers' fields in compliance with the guidelines suggested by Pune's ICAR-DOGR. The farmers kept these check plots as per their customary farming methods. The scientists from KVK periodically monitored the FLD plots. After harvesting, the average yield from both control and demonstration fields were recorded to evaluate the effect of FLDs on onion yield. In 2020, a planned and pre-tested interview schedule was used to conduct in-person interviews with recipient farmers to gather information regarding the acceptance, varietal replacement, and horizontal spread of onion crop technology in adopted villages. In light of the study's objectives, the collected data were analyzed using appropriate statistical tools like mean percent score, ranks, etc. Samui *et al*. (2000) provided the formula to compute the extension, technology, and technology index gap.

$$\text{Yield Increase (\%)} = \frac{\text{DPY-FPPY}}{\text{FPY}} \times 100$$

DPY=Demonstration plot yield (kg ha^{-1})

FPPY=Farmer's practice plot yield (kg ha^{-1})

FPY= Farmer's practice yield (kg ha^{-1})

Extension yield gap = Demonstration yield (kg ha^{-1}) - Farmer's practice yield (kg ha^{-1})

$$\text{Technology Index (\%)} = \frac{\text{PY-DY}}{\text{PY}} \times 100$$

PY= Potenital yield (kg ha^{-1})

DY= Demonstration yield (kg ha^{-1})

Technology yield gap (kg ha^{-1}) = [Potential yield (kg ha^{-1}) – Demonstration yield (kg ha^{-1})]

Results

Yield performance: The data clearly indicates that the use of the improved Bhima Super variety significantly enhanced onion yield compared to traditional farming methods. (Table 1) The research trial over two years showed a consistent increase in onion bulb yield when using the improved Bhima Super variety. The average yield for the Bhima Super variety was 285.0 q/ha, compared to the local check yield of 238.5 q/ha. This represents an average yield increase of 17.95% over traditional farmer practices.

Table 1. Yield and related parameters of frontline demonstrations on Bhima Super during 2020-2021 and 2022-2023

Parameter	Year		
	2020-2021	2022-2023	Average
Number of demonstration	48	48	48
Area (ha)	1	1	1
Average yield (q/ha), Demo	315.29	322.27	318.78
Average yield (q/ha), Check	254.13	257.46	255.79
Increase in yield over check plot (%)	19.39	20.10	19.74
Extension Gap	61.16	64.81	62.98
Technology Gap (q/ha)	84.71	77.73	81.22
Technology Index (%)	21.17	24.11	22.64

Technological gap: The technological gap between farmers' practices and the demonstration plot highlights several areas of disparity. There is a partial gap in selecting suitable variety, fertilizer management, weed management, and adopting plant protection measures. However, there is a full gap concerning seed treatment practices. The data in Table 1 shows that the average technical gap during the two study years was 81.22 q/ha. The average extension gap was 62.98 q/ha. The technology index value, as shown in Table 2, was 22.64%. The improved practices, especially using the Bhima Super variety, demonstrate a marked increase in yield and productivity, showcasing the potential benefits of adopting these technologies.

Economic performance: The economic analysis of the frontline demonstrations for the Kharif onion variety Bhima Super shows a clear advantage of improved practices (IP) over farmers' practices (FP). In 2020-2021, the cost of cultivation for IP was Rs. 76,500/ha compared to Rs. 78,200/ha for FP. The gross return for IP was Rs. 378,348/ha, significantly higher than Rs. 244,130/ha for FP, resulting in net returns of Rs. 301,848/ha and Rs. 166,930/ha, respectively. The BC ratio was 3.94 for IP versus 2.13 for FP (Table 3).

Table 2. Technological gap between improved production technology under FLD and farmer's practices

Practices	Improved technology	Farmer's practices	Gap
Preparation of field (Tillage)	Thorough ploughing through mould board plough during summer month and 2-3 ploughing with cultivator and Rotavator.	Same as that of improved technology	Nil
Variety	Improved variety Bhima super	Local Varieties	Partial gap
Seed rate	7 kg/ha	10-12kg/ha	Partial gap
Seed treatment	Thiram/ captan/ carbendazim at the rate of 2-3 g/kg of seed.	Without treatment of seed	Full gap
Application of Fertilizer	NPKS/ha = 75:40:40:30 kg. While the remaining two thirds of the necessary N are applied in two equal splits at 30 and 45 days following planting, one third of the recommended N is applied at the time of planting together with the full doses of P_2O_5, K_2O, and S.	Imbalance use of fertilizer and no use of sulphatic fertilizer	Partial gap
Weed management	Application of Oxyflurofen @ 23.5% EC (2.0 ml/L) or Pendimethalin @ 30% EC (3.5ml/L) followed by 1 hand weeding at 40 DAT	Three weeding manually at 20,40 and 60 DAT	Partial gap
Plant protection	Application of fungicides based on need to control onion diseases and pests. Wet the nursery beds must be treated with with 0.2% Captan or Thiram, 0.1% Carbendazim (do not use Carbendazim if using Trichoderma), 0.3% Copper oxychloride, or 0.2% Metalaxyl. For the treatment of fungal foliar disease, fungicides like tricyclazole (0.1 g/L) and hexaconazole (1 g/L) are advised. IPM techniques are used to manage pests like as green loopers, cutworms, and thrips.	Injudicious use of fungicides and Insecticides without following proper dosage.	Partial gap

Source: e-book on Good Agricultural Practices in Onion and Garlic Production, by Kale *et al.,* 2022.

In 2022-2023, the cost of cultivation for IP was Rs. 77,154/ha compared to Rs. 79,120/ha for FP. The gross return for IP was Rs. 386,724/ha, compared to Rs. 257,460/ha for FP, leading to net returns of Rs. 309,570/ha and Rs. 178,140/ha, respectively. The BC ratio improved to 4.01 for IP compared to 2.25 for FP.

Averaged over two years, the cost of cultivation for IP was Rs. 76,827/ha compared to Rs. 78,660/ha for FP. The average gross return for IP was Rs. 382,536/ha, significantly higher than Rs. 250,795/ha for FP, resulting in average net returns of Rs. 305,709/ha and Rs. 172,535/ha, respectively. The average BC ratio was 3.98 for IP compared to 2.19 for FP.

Table 3. Economic parameters of frontline demonstrations of Kharif onion variety Bhima Super

Year (Kharif)		2020-2021	2022-2023	Average
Cost of cultivation (Rs./ha)	IP	76500	77154	76827
	FP	78200	79120	78660
Gross return (Rs./ha)	IP	378348	386724	382536
	FP	244130	257460	250795
Net Return (Rs./ha)	IP	301848	309570	305709
	FP	166930	178140	172535
BC ratio	IP	3.94	4.01	3.98
	FP	2.13	2.25	2.19

IP- Improved practice; FP-Farmer's practice

The magnitude of adoption's extent: The data on the adoption of enhanced technologies for producing Kharif onions was documented in two categories: adoption prior to frontline demonstrations (FLDs) and adoption after FLDs. Table 4 reveals that before FLDs, farmers used the following methods: improved and quality seed (41.22%), fertilizer application (38.15%), plant protection (43.16%), harvesting (68.22%), seed treatment (37.13%), scientific weed management (55.10%), storage (57.13%), land preparation (77.56%), irrigation scheduling (62.67%), and sowing time (68.13%). Following the introduction of the Kharif onion variety Bhima Super, Table 4 clearly illustrates an increase in the adoption of various practices. Post-FLD adoption rates were as follows: seed treatment (78.34%), plant protection measures (70.39%), improved and quality seed (88.23%), irrigation scheduling (83.56%), storage (72.54%), harvesting (77.34%), fertilizer application (73.37%), weed management practices (76.68%), and sowing time and method (80.24%). However, a lower degree of acceptance was observed in areas such as sowing time, method, and storage, due to practices like using high seed rates with close spacing, late planting, and excessive fertilizer dosages. The findings also showed that adoption rates increased to 47.12% for enhanced and high-quality seeds after implementing training and field-level demonstration programs and to 09.12% for harvesting time and method.

Table 4. The extent to which the respondents had adopted onion production technologies

Onion production technology	Before FLD (%)	After FLDs (%)	Increase in Adoption level (%)
Land preparation	77.56	87.12	9.56
Improved and quality seed	41.22	88.34	47.12
Seed treatment	37.13	78.23	41.10
Seed rate and spacing	45.71	74.11	28.40
Sowing time	68.13	80.24	12.11
Irrigation scheduling	62.67	83.56	20.89
Scientific weed management	55.10	76.68	21.58
Plant protection measures	43.16	70.39	27.23
Fertilizer application	38.15	73.37	35.22
Harvesting time and method	68.22	77.34	09.12
Storage	57.13	72.54	15.41

FLD-Front Line Demonstration

Discussion

In the present study, it was found that the average yield performance was higher in demonstration plot as compared to farmer's field. The reason might be because of the choice of the high-yielding onion cultivar Bhima Super, accurate fertilizer dosages, suitable plant protection techniques, and other recommendations made by scientists in the demonstration plot that may have contributed to the higher bulb production than farmer practices. The study is in accordance with the results of Chigadolli *et al.* (2020), Meena *et al.* (2021) and Srivastava *et al.* (2022). Therefore, it can be said that the adoption of better variety and the demonstration of proven techniques led to enhanced yield. When 70% of the plants exhibited neck fall or yellowing symptoms, the bulbs were harvested at physiological maturity. The harvested bulbs were then utilized to determine the morphological properties of the plants (predominant bulb color, shape, and uniformity), yield attributes and yield.

The technology gap indicates the gap in the demonstration yield over the potential yield which has to be reduced by conducting FLD/s. Different soil fertility statuses, varying weather patterns and a scarcity of knowledge about the improved variety and seed availability might be reasons for the technological gap. In order to narrow down the technology gap, location-specific guidance and precise technology deployment in the fields are required, as proposed by Gaharwar and Jayashri (2018). The extension gap depicts the gap in the demonstration yield over farmers' yield. The existence of the extension gap is known to be due to lacuna in adoption of advanced production technologies and high-yielding varieties. The greater gap suggests that farmers need to be strongly encouraged to adopt new technology in place of their traditional methods. The present findings support the findings of researcher Mukherjee (2003), who claimed that targeted interventions based on problem identification and location may have a significant impact on increasing agricultural output. The results of this investigation are consistent with findings of various authors. (Hiremath and Hill, 2012; Meena *et al.,* 2021; Meena *et al.*, 2016; Singh *et al.,*2011). The viability of any improved variety in the field of farmer's is indicated by the technological index. There are findings that lesser the value of technological index the high is the feasibility of the improved variety (Hiremath and Hill, 2012; Hiremath and Nagaraju, 2010).

As far as economic performance is concerned, the higher benefit cost ratio of demonstration plot might be due to better yield with enhanced quality of the bulb which resulted in better market price. Due to an increase in input prices, the cost of cultivation in local and demonstration plots went up gradually. The aforementioned results are reported by Meena *et al.* (2021), Kaur *et al.* (2020) and Kumari *et al.* (2023). The findings of the investigation also showed that implementation of training and field-level demonstration programs resulted in enhanced adoption rates of high-quality seed, seed treatment, harvesting time and other important agricultural practices. This may be because training programs on various Kharif onion production technologies, such as choosing a high-yielding variety, treating seeds, spacing and timing of seeds, testing the soil, treating soil, controlling weeds, protecting plants, scheduling irrigation, applying fertilizer, and harvesting, have increased farmers' knowledge, expertise, and confidence. These results are consistent with those of Bishnoi *et al.* (2020), Meena *et al.* (2021), Morwal *et al.* (2018) and Chaitanya *et al.* (2020). The farmers believed that the Bhima Super variety produced bulbs with good size, an appealing form, a pleasing skin color, a higher yield, good keeping quality (longer shelf life), and strong consumer preference.

Front Line Demonstration is one of the important extension tools to demonstrate the improved/potential technology at field level. This study shows, that adopting improved variety Bhima super along with the complete package of practices enhanced the yield to the extent of 19.74% over the check variety. Although increase in yield was significant, still there exist huge technology gap and extension gap which can only be minimized through more awareness programme, trainings, field visits etc. In order to increase the adoption rate and undoubtedly improve farmers' livelihoods in a sustainable way, sincere extension activities are needed to educate the agricultural community about the advantages of new technologies as well as their drawbacks and downsides.

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