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Impact of Frontline Demonstrations on Yield of Wheat (*Triticum aestivum* L) in Kurukshetra District of Haryana State, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

FLD is a unique approach to provide a direct interface between scientists and farmers resulting in bridging the yield gap that exists between a validated technology and existing farmer practices. Krishi Vigyan Kendra, Kurukshetra has conducted 40 front line demonstration on wheat Var. WH

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1105 during two consecutive year from 2022-23 to 2023-24 under 16 ha area to demonstrate technological and extension yield gaps of improved technologies. Study revealed that improved cultivation practices comprised under FLDs viz., recommended variety, seed treatment with bio fertilizer, seed rate, timely sowing resulted in increase in yield in wheat crop over the check plots. The improved technologies gave higher yields and recorded a mean yield of 52.0 and 53.9 q/ha during the year 2022-23 and 2023-24, respectively which was 5.69 and 6.94 percent higher compared to prevailing farmers practice. The technology gap was 19.0 and 17.1 q/ha and extension gap was 2.80 and 3.50 q/ha during the year 2022-23 and 2023-24, respectively.

Keywords: Front Line Demonstrations (FLDs); wheat; WH 1105; economic analysis.

1. INTRODUCTION

"Wheat is a staple crop worldwide and second most important cereal crop in India followed closely by rice. It is one of the most widely grown and consumed cereal grains contribute significantly to the overall food grain production and play a vital role in ensuring food security in India. India is the second-largest producer of wheat globally, following China, and consistently ranks among the top three wheat-producing countries in the world. The country diverse agro-climatic conditions enable cultivation of wheat throughout the year, with the Rabi season contributing the majority of the wheat yield. Systematic research in the crop has started in India way back in 1960s through the coordinated system of multi-location research to cater the needs of diverse population. The country achieved rapid strides in wheat production during the last four decades resulting in self-sufficiency and surplus production. The country as per the national policy on agriculture has set a target of 4 per cent growth rate for which high growth in wheat production becomes a mandate owing to its importance in food basket. The growth rate can be achieved by increasing the production and bridging the existing yield gap. Regional surveys reveal large variation in yield across research farm, farmers and yields attributed to management, site and season differences. Punjab and Haryana recorded 4.3 and 4.2 t ha-1 respectively in wheat production and the yield gap between farm and potential yield was about 45 and 35 per cent respectively in those states" (Fischer *et al*., 2009). Bhattacharya (2011) estimated "28.22 per cent yield gap I (difference between potential yield and national average yield) in India and 57.01 per cent yield gap II (difference between potential yield and state average yield) and 0.98 per cent yield gap III (difference between potential yield and on-farm yield) in Uttar Pradesh". Aggarwal *et al.* (2008) found that "wheat registered a yield gap of 70 kg ha^{-1} between research farm and farmers yield. Frontline demonstrations are essential components of agricultural extension programs, serving as practical platforms for showcasing improved agricultural technologies to farmers" (Rai *et al*., 2020 and Desai *et al*., 2021). In Kurukshetra district, wheat is an important Rabi season crop, and enhancing its yield is of paramount importance to ensure food security and improve the livelihoods of local farmers. Keeping in view these facts, the present investigation was undertaken to demonstrate standardized and validated technology of wheat cultivation at farmer,s field with the objectives of enhancing productivity, farmer profitability and narrowing extension yield gaps. This study analyses the effectiveness of FLDs in improving wheat yield and the adoption of improved practices by farmers. Besides this, the study also holds significant importance for the scientific community as it provides empirical evidence on the effectiveness of technology transfer through frontline demonstrations (FLDs). By quantifying yield improvements and identifying gaps between potential and realized productivity, the study offers insights into the role of extension services in enhancing agricultural productivity. Furthermore, the findings can guide policymakers, researchers, and extension workers in refining intervention strategies to maximize wheat yields, particularly in agriculturally intensive regions like Haryana.

2. MATERIALS AND METHODS

2.1 Climatic Characteristics

The study was conducted in the Kurukshetra area of eastern Haryana, India, between the latitudes of 29° 522 and 30° 122 and the longitudes of 76° 262 and 77° 042 in the north-eastern part of the state. It lies in the eastern plain zone of Haryana. The district has a variable climate with temperature as high as 47^{o}C in summers to as low as 1^{o}C in winters. Annually, the district receives 582 millimetres of rainfall, primarily during July and august which is distributed unevenly around the region. The soils composition ranges from fertile clay loam to sandy loam in texture.

2.2 Identification and Ranking of Major Constraints

The demonstration locations were selected on the basis of agro-socio-economic survey and farmer beneficiaries were interviewed to prepare the list of major common constraints in the cultivation and adoption of wheat crop. Based upon the assessment of constraints, ten most common constraints were shortlisted. A performa with the list of ten constraints was prepared and distributed individually to the selected farmers for ranking of these constraints from 1 to 10, where 1 signified the most important constraint and 10 as the least important constraint. The frequency of farmers for each constraint under a particular rank was recorded. The quantification of this data was done by calculating Rank Based Quotient (RBQ) as given by Sabarathanam (1988), using the following formula:

$$RBQ = \frac{\Sigma fi\ (n+1Q=)}{N \times n} x100$$

Where, fi= number of farmers reporting a particular problem under ith rank,

N = number of farmers (40)

n= number of problems identified (09)

2.3 Technology Demonstrations

FLDs on improved farm technology were conducted by Chaudhary Charan Singh Haryana Agricultural University Krishi Vigyan kendra, Kurukshetra on Wheat in the last week of October each year during rabi 2022-23 and 2023-24 on an area of 16 ha at 40 locations. In the FLD plot, full package of agronomic practices was adopted with special emphasis on improved cultivars (WH 1105), line sowing, nutrient-management, seed treatment which are major production constraints in Kurukshetra, Haryana (Table 2). The performance of the demonstrated technology was compared with the farmers' practice (check). The crop yield from the demonstration plots as well as check plots was recorded and the cost of cultivation, gross returns, net returns and B:C ratio were also computed.

Appraisal of crop productivity and yield enhancements: The primary data on grain yield was recorded and the yield increase in frontline demonstrations over farmers' practice was calculated using the following formula (Choudhary *et al.,* 2009):

$$\%YIOFP = \frac{\text{Average demonstration plot yield} - \text{Farmer's average plot yield}}{\text{Farmer's average plot yield}} \times 100$$

Where, %YIOFP = per cent yield increase over farmer's practice

Data Analysis: The data output from both demonstrated plot as well as farmers practices was collected and finally the extension gap, technology gap, technology index were calculated (Samui *et al.*, 2000) as given below:

Technology gap = Pi (Potential yield) – Di (Demonstration yield)

Extension gap = Di (Demonstration yield) – Fi (Farmers Yield)

Technology index (%) = (Technology gap / Potential yield) × 100

Economic performance of FLDs on Wheat: The cost of cultivation of wheat include cost of inputs such as seed, fertilizers and pesticides purchased by the farmers (in farmers' practice) and input supplied by the Krishi Vigyan Kendra, Kurukshetra (in demonstration plots) as well as hired labour, sowing charges, hoeing, pesticide sprays and post-harvest operation charges (if any) paid by the farmers. The farmer's family labour was not taken into consideration in the present study. The gross and net returns were worked out accordingly by taking cost of cultivation and price of grain yield of wheat. The data output were collected from both the improved practice and farmers practice were analysed and cost of cultivation, net income and benefit cost ratio were also worked out (Samui *et al.*, 2000).

3. RESULTS AND DISCUSSION

The constraints in wheat cultivation were identified using the preferential ranking technique. The ranks given by the individual farmers to each constraint were used to calculate Rank Based Quotient (Table 1). The major crop rotation of the district was Rice- wheat and RBQ revealed that short time window available for timely sowing of wheat due to late harvesting of paddy crop was the major constraints faced in wheat cultivation with RBQ value of 93. Other major constraints included management of previous crop (paddy) stubbles, lack of awareness of improved varieties seed, Non adoption of seed treatment/seed inoculation among the farmers regarding wheat, incidence of weed infestation mainly Phalaris minor (Canary grass) and lack of technical guidance with RBQ of 90, 78.4, 76.1, 75.2 and 70, respectively.

Measures taken by the farmers in respect of soil health rank VI with RBQ of 68% as farmers did not adopt soil testing/ soil test based fertilizer application or balanced use of fertilizer. The Lack of availability of latest farm machinery used for wheat cultivation (field preparation and sowing) and damaged by wild animals was ranked as V and VII with RBQ of 68 and 51, respectively. Similar findings were observed by Antil *et al.* (2025) and have also reported similar type of constraints such as short sowing time window, previous crop stubbles management, weed infestation and wild animal damage etc. in wheat production and the results of the present study also indicated similar constraints in wheat production.

Table 1. Ranking of technical constraints and problem facing by the farmers in wheat cultivation

S. No.	Constraints	Rank based quotient (RBQ)	Overall Rank
1	Short time window between the rice harvest and the subsequent wheat sowing	93	I
2.	Management of previous crop (paddy) residue	90	II
3.	Lack of awareness of improved variety seed	78.4	III
4.	Non adoption of seed treatment/seed inoculation	76.1	IV
5.	Weed infestation	75.2	V
6.	Lack of technical guidance	70	VI
7.	Soil health measure (Soil testing)	68	VII
8.	Lack of availability of latest farm machinery	51	VIII
9.	Damage by wild animal	46	IX

Table 2. Technology interventions vis-à-vis farmers' practices

S. No.	Technological intervention	FLD	Farmer practice
1.	Wheat variety	WH 1105	Local Seed
2.	Seed rate	100 kg/ha	100-125 kg/ha
3.	Seed treatment	Carbendazim/Tubeconazole/Bavistin(2g/kg seed)	No seed treatment
4.	Time of sowing	Last week of October to Ist fortnight of November	Mid of November to end of November
5.	Fertilizer (N:P:K and Zink in kg/ha and biofertilizers)	150:60:30:25 (Drilling of DAP fertilizer during sowing below the seed, split applications of urea & azotobactor+ PSB culture	Imbalance use of NPK fertilizers and no use of bio-fertilizer (DAP fertilizer mixed with seed and broadcast, Improper use of urea)
6.	Sowing method	Line sowing	Broadcasting
7.	Weed management	Sulfosulfuran @33gm/ha at 30 DAS	Tank mixing of weedicides, application between 40-45 DAS
8.	Insect-pest management	Aphid-1 litre malathion/ha	Non recommended insecticides
9.	Disease mangemnt	Yellow rust- 500 ml propiconazole as and when disease appear	Delayed application

Table 3. Yield performance of the wheat under front line demonstrations in the district

S. No.	Year	No. of demonstration	Variety demonstrated	Area (ha)	Average Yield (q/ha)			% increase over control/ %YIOFP	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
					Potential yield	Demo	Check				
1	Rabi-2022-23	20	WH-1105	8	71	52.0	49.2	5.69	19.8	0.90	27.9
2	Rabi-2023-24	20	WH-1105	8	71	53.9	50.4	6.94	17.1	2.70	24.1

Table 4. Economic analysis of FLDs on Wheat in Kurukshetra district

S. No.	Year	Gross cost (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B:C ratio		Additional return (Rs/ha)
		Demo	Check	Demo	Check	Demo	Check	Demo	Check	
1	**Rabi-2022-23**	39870	39810	117000	110700	77130	70890	2.93	2.78	6240
2	**Rabi-2023-24**	39280	39210	121275	113400	81995	74190	3.09	2.89	7805
Mean		39575	39510	119137.5	112050	79562.5	72540	3.01	2.84	7022.5

3.1 Yield of Crop

Table 2 depicted the data on average yield of wheat during the year 2022-23 and 2023-24 for FLD plots as well as in farmers practice. Data revealed that the average yield obtained from demonstration plot was varied from 52.0 to 53.9 q/ha and there was a increase in yield obtained from the technology demonstrated as compared to the farmers' practice where the average yield of wheat ranged from 49.2 to 50.4 q/ha during both the year 2022-23 and 2023-24, respectively. It is clearly evident from the recorded data that yield received under the frontline demonstrations plots was higher than the yield observed under the farmer practice during both years. The highest yield was recorded in year 2023-24 in FLD plot as well as the farmer practice and also the percentage increase in FLD over farmer practice. This increased in yield in the demonstration plot might be due to use of improved agronomic practices i.e. in-situ residue incorporation, optimum seed rate, optimised line sowing, timely sowing of crop, use of bio-fertilizer, recommended integrated nutrient and insect pest management over the farmers practices. Similar trends in yield performance in wheat crop due to adoption of improved technologies were also observed at different locations by Verma *et al.* (2014), Meena & Singh (2017) and Antil *et al.* (2025). The another possible reason for the higher yield in both the plot is might be the good weather condition for rabi crop and overall good yield was received in the district. The behavioural variability in average yield and production of the wheat crop was also observed in Haryana state during the last five years from 2018-19 to 2022-23 (Anonymous, 2022-23).

3.2 Technology Yield Gap

The yield gap for the present study were categorised into two i.e. technology gap and extension gap. The average yield of the demonstration plots and potential yield of the crop was compared to estimate the yield gaps. The technological yield gap in wheat was higher (819.0q/ha) during rabi 2022-23 as depicted in the table 3. It is found that technological gaps appear even in the FLDs that was might be attributed mainly to variations in soil fertility status, uneven rainfall distribution, specific crop management problems, field operations adopted in order to harness the yield potential of crop under demonstration plots and menace of crop damage by wild animals which is highly prevalent in the district. Wider gap in technological index could be influenced by many factors like soil fertility status, weather conditions, non-availability of irrigation water and insect-pests attack in the crop (Tiwari, 2014). The similar results were observed by Mukherjee (2019) and Singh (2020), Singh (2022) and Antil *et al.* (2025). This suggests that location specific crop management recommendations are needed to bridge the gap in potential and demonstration yields (Vedna *et al.,* 2007), besides disseminating the technical know-how on minimizing the local problems and strengthening of farm infrastructure.

3.3 Extension Gap

The basic and major concern for the successful development, dissemination, adoption and performance of improved technologies, depends upon the careful planning of research, selection of site, site specific refinement and the use of appropriate methodologies in extension. Extension yield gaps in the present study ranging from 2.80 q/ha to 3.50 q/ha (Table 3) over the years emphasized that there is a strong need to educate and motivate the resource poor farmers through various mean to adopt improved farm technology that mitigation this extension gap.

3.4 Technology Index

"The technology index indicates the feasibility of generated farm technology in the farmers' fields under existing agroclimatic situations" (Vedna *et al.,* 2007; Choudhary *et al.,* 2009). Technology index for the present study was 26.8% for the year 2022-23 and 24.1% for the year 2023-24, respectively (Table 3). As the technology index decreases, the feasibility of generated farm technology under farmers' fields increases, and vice versa. The present studies revealed that the technology index varied from 24.1 to 26.8 per cent in wheat over the years which indicated that there exists a wide gap between the generated technology in wheat and technology disseminated at the farmers' fields (Dayanand *et al.,* 2012) but the lower average value of technology index (25.45 %) suggested the greater feasibility of the demonstrated technology in the district Kurukshetra.

3.5 Cost-Benefit Analysis

The prevailing input and output prices of commodities during the time of demonstrations were used to calculate the gross return, cost of cultivation, net return, and benefit-cost ratio in each year and are presented in Table 4. It was found that gross cost of cultivation for wheat crop under improved agricultural practice ranged from Rs/ha 39280 to 39870 Rs/ha with a mean value of Rs/ha 39575 against farmers practice where it was ranged from Rs/ha 39210 to 39810 Rs/ha with an average of Rs/ha 39510. The gross returns under the demonstration was ranged from Rs/ha 117000 to Rs/ha 121275 with a mean value of Rs/ha 112050 while the farmers practice gross return ranged from Rs/ha 110700 to Rs/ha 113400 with mean value of Rs/ha 112050 during the two years commodity sales. The net returns from the frontline demonstration ranged from Rs/ha 77130o Rs/ha 81995 with a mean net returns of Rs/ha 70890 while net returns in farmers practice was ranged from Rs/ha 70890 to Rs/ha 74190 having mean net returns as Rs/ha 72540 in during both the years. The BCR of FLD was ranged from 2.93 to 3.09 with an average BCR ratio of 3.01 while BCR of farmers practice ranged from 2.78 to 2.89 with a mean value of 2.84 in during both years. The cost benefit variation during different years might be due to variation in yield performance and fluctuation in sale price of wheat and other input output costs in that particular year. The additional returns due to improved practices was ranged from Rs/ha 6240 to Rs/ha 7805 with mean value of Rs/ha 7022.5. Additional returns clearly showed that demonstration was feasible for yield enhancement of wheat crop at farmer field and was cost effective. The farmers were convinced with the technological interventions and good management practices. Similar results were reported by Bisen *et al.,* (2019), Tiwari *et al.,* (2015), Sharma *et al.,* (2020) and Antil *et al.* (2025).

4. CONCLUSION

The results revealed that FLD received higher yield over the farmer practice. The higher value of technological gap indicated that the varieties have potential of higher yield and could be achieved. The improved agricultural practices could enhance the yield and economic benefits in wheat cultivation. Such demonstrations help in improving the skills of farmers and also aware extension worker about current issues faced by the farmers. FLD programme is an appropriate tool in skill and knowledge up gradation and providing scientific information to the farmer through on farm experimental approach. It can be concluded from the findings that use of improved technologies can reduce the technology gap to a considerable extent resulting in increased productivity of wheat crop in the district. It needs the efforts of both extension workers and farmers to enhance adoption level of location and crop specific technologies among farmers for bridging these gaps. Therefore, the farmers need to provide proper technical support and guidance through various improved agronomic practices for better production and productivity in the district.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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