Original Research Article

Impact of Frontline Demonstrations on Productivity and Economics of Wheat (Triticum Aestivum L.) in Sonipat District of Haryana, India

ABSTRACT

The Krishi Vigyan Kendra Sonipat has conducted the 205 frontline demonstrations on wheat crop during the year 2020-21, 2021-22 and 2022-23 in 73 villages at farmers' field in district Sonipat and demonstrated the improved agricultural practices and analysed the received economic benefits over the farmers' practices. The recommended agronomic and engineering practices like in-situ residue incorporation, optimum seed rate, optimised line sowing, use of bio-fertilizer, recommended integrated nutrient and insect pest management over the farmers practice were followed to evaluate the yield and economic performance of wheat varieties HD 2967, HD 3086 and DBW 222 during the rabi season in each year. The three years data revealed that the frontline demonstrations of improved technologies gave mean yield of 46.26 qha^{-1} while the mean yield of farmers practice was observed as 42.25 qha^{-1} with overall increased in yield over the farmers practice as 9.81 percent. The extension and technological gap showed a variable trend in each year which indicated that problem centric approach to educate the farmers should be emphasized in the district so as to obtain a stable and reversible trend in gaps. The mean extension gap was observed as 4.06 qha^{-1} while the mean technological gap was observed as 26.73 qha^{-1}. The benefit cost ratio under frontline demonstrations was 2.66 and under farmers practice was 2.28. The farm operations under improved practices saved gross expenditure of Rs. 2644 $Rsha^{-1}$ and additional returns due to demonstration of improved technologies were received as 9773 $Rsha^{-1}$. The major constraint faced by the farmer (95%) was shortage of time for sowing of wheat due to late harvesting of paddy crop followed by inconvenience in paddy crop residue management (92%) although farmers were satisfied with availability of latest farm machinery in the district.

Key words: *Front line demonstration, wheat, BC ratio, frontline demonstration, yield gap technology gap, extension gap, yield*

1. INTRODUCTION

Wheat (Triticum aestivum) has a major role in ensuring food security and nutrition to the large population of globe. In India, wheat is the second most important cereal grain after rice, and being cultivated on 31.40 Mha and has production of 110.55 mtons with the average productivity of 35.21 q/ha (Anonymous, 2024). In past few years more than 50% of wheat crop was sown late sown till December and early January due to late harvesting of preceding paddy crop in India (Tiwari et al., 2014). Irrigation water scarcity at critical stage of growth of wheat could influence the productivity of wheat. In Haryana, last five years area sown, average yield and production data (2018-19 to 2022-23) showed variability in production of the wheat crop (Anonymous, 2022-23). The sowing of wheat also gets delayed due to late harvesting of paddy and thereafter due to difficulties encountered in residue management of paddy crop. Availability of shortage of time span for sowing of wheat crop leads to poor agronomic practices such as higher seed rate, faulty nutrient, weed and pest management and use of unsuitable wheat varieties. The utilization of fertilizers that are rich in phosphorus (P) and nitrogen (N) may increase the wheat yield although the excessive use may have negative impact on yield. (Akhila and Pandey, 2024). Such challenges are being addressed by Indian Council of Agricultural Research (ICAR) through adoption of the strategic research programme and frontline demonstration (FLDs) to showcase the improved agricultural technologies directly on farmers' fields through KVKs and its other institutes. Keeping this in view, the frontline demonstrations on wheat crop were conducted at farmers' fields in the district and improved production technologies for enhancing the productivity of wheat were demonstrated and farmers were convinced to adopt such improved technologies.

2. MATERIAL AND METHODS

The Krishi Vigyan Kendra Sonipat (Haryana) had identified the constraints in achieving the higher production of wheat through participatory approach like farmers' meetings and diagnostic field visits during previous seasons of wheat crop. The major constraints were less time available for wheat sowing, crop residue management of previous crop, selection of suitable variety, imbalance use of agrochemicals and fertilizer, improper use of plant protection measures, uncontrolled weed and short of knowledge about other latest information. The list of willing farmers for FLDs was prepared through these farmers meetings, considering the suitability of site and attitude of farmers towards advance techniques. Then the Krishi Vigyan Kendra, Sonipat (Haryana), India had laid out frontline demonstrations on improved crop production technologies of wheat during rabi season of 2020-21, 2021-22 and 2022-23 (Three consecutive years) in the farmer's field wide spread in 73 adopted villages in the district Sonipat of Haryana, India. An area of 82.4 ha was covered with plot size 0.40 ha (1 acre) under each front line demonstration with active participation of 205 farmers in different villages in consecutive years. The necessary steps for selection of site and farmers, layout of demonstration etc. were followed as suggested by Choudhary, (1999). The main technological intervention demonstrated at farmers field under

FLDs are listed in Table1. The 40 kg seed of wheat variety HD 2967, HD 3086 and DBW 222, Azotobacter+PSB and other required need based diagnostic agrochemicals was given as input under FLD to each farmer during different years. The wheat varieties HD 2967 was widely accepted and dominating variety in North Western Plain Zones (NWPZ) having the average yield is 5.0 tha^{-1} and it matures in 143 days in this zone. Brown and yellow rust resistant variety HD 3086 was also recommended as timely sown variety for NWPZ with an average yield of 5.4 tha^{-1} and matures in 145 days and found suitable choice for the farmers of NWPZ. The DBW 222 variety was also recommended as timely sown for irrigated areas and released in the year 2020.

Table 1. Details of technological intervention under FLD and farmer practice

Sr. No.	Technological intervention	FLDs	Farmer Practice
1	Wheat variety	HD 2967, HD 3086, DBW 222	Local seed
2	Seed rate	1.0 q ha^{-1}	0.87-1.25 q ha^{-1}
3	Seed treatment	Vitavax/Tubeconazole/Bavistin (2g/kg seed)	No treatment
4	Fertilizer used (N:P:K and Zink in kg/ha)	150:60:30:25 (Drilling of DAP fertilizer during sowing below the seed, split applications of urea) & azotobactor + PSB culture	Improper of use of NP fertilizers (N 130 kg & P 50 kg ha^{-1}) (DAP fertilizer mixed with seed and broadcast, Improper use of urea)
5	Sowing method	Line Sowing	Broadcasting
6	Weed management	Pinoxaden 5% EC @1000 ml/ha at 30-35 DAS later by one week Algrip @ 20 gm/ha	Improper weed management. Over/under use of ready mixed herbicides either at early or at late stage
7	Disease management & Plant protection measures	Need based spray of insect and fungicide (problem based)	Either not used/Un-recommended use of agrochemical

The other technological intervention like optimum seed rate of 1.0 qha^{-1}, seed treatment with Vitavax/Tubeconazole/Bavistin @ 2g kg^{-1} seed, use of Azotobactor + PSB culture, fertilizer used (N:P:K and zink in kgha^{-1}) 150:60:30:25, Drilling of DAP fertilizer during sowing below the seed, split applications of urea, line sowing of wheat and proper weed and insect pest management was maintained by farmers and KVK scientists continuously monitored and provided other support to the FLD farmers like arrangement of farm machinery from the other farmers or from custom hiring centres in case non availability etc. The visits of non FLD other farmers and the extension functionaries were organized at demonstration plots to disseminate the message at large scale (Tiwari et al., 2014). The line sowing was done by drilling in 22.5 cm rows apart in between 28th Oct to 15 Nov in all years and harvesting of crop was done during first fortnight of April each year. At the time of crop maturity field days were organised each year in demonstrated plots to show the outcomes and to popularise and increase the acceptance of improved technologies among other farmers (Sharma, et al., 2020).The data related yield and economics of FLDs and farmers practices was collected and the extension gap, technology gap, technology index along with the benefit cost ratio were worked out (Samui et al., 2000) as given below:

Increase over farmers practices (%) = ((Improved practices –Farmers practices) / farmers practices) x 100

Extension gap = Demonstration yield – Farmer's yield

Technology gap = Potential yield - Demonstration yield

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

3. RESULTS AND DISCUSSION

The results on performance of the frontline demonstrations conducted during the year 2020-21 to 2022-23 are presented in Table 2, 3 & 4. The numbers of FLDs were 100, 25 and 80 having the area of 40, 10 and 32 ha in the year 2020-21, 2021-22 and 2022-23 with random coverage in 73 villages in the district Sonipat. The Variety HD 2967, HD 3086 and DBW 222 were demonstrated. The area under one frontline demonstration was taken as 0.4 ha sand compared with the same area of farmers practice.

Yield Performance

The data on average yield was recorded over the said years in both FLD plots as well as in farmers practice and shown in Table 2. 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 all the three years. The average yield under demonstration plots varied from 43.65 qha^{-1} to 48.80 qha^{-1}. While the yield under farmers practice was varied from 39.05 qha^{-1} to 46.20 qha^{-1}. The increased in yield over farmer practice was ranged from 5.60 qha^{-1} to 12.05 qha^{-1} over the years. The highest yield was recorded in year 2020-21 in

FLD plot as 48.80 qha^{-1} and simultaneously the farmer practice has also received highest yield in the same year (2020-21) but the percentage increase in FLD over farmer practice in year 2020-21 was minimum as 5.60 among all the years. It showed that year 2020-21 has good weather condition for rabi crop and overall good yield was received in the district. Thereafter in the successive years, the decrease in yield was observed in both FLD plots and as well as in farmers practice. 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). The three years pooled data on yield showed that the frontline demonstrations of improved technologies gave mean yield of 46.26 qha^{-1} while the pooled mean yield of farmers practice was observed as 42.25 qha^{-1}. The overall increase in pooled yield over the farmers practice was observed as 9.81 percent. This increased in yield in the demonstration plot could be use of improved agronomic and engineering practices i.e. in-situ residue incorporation, optimum seed rate, optimised line sowing, 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) and Meena & Singh (2017).

Table 2. Yield performance of the wheat varieties under front line demonstrations in the district

Crop Season & Year	Variety	No. of FLD	Area under FLD (ha)	Avg. Yield (qha^{-1})		Increase over farmer Practice (%)
				Demo Plot	Farmer Practice	
Rabi 2020-21	HD 2967	100	40.0	48.80	46.20	5.60
Rabi 2021-22	HD 3086	25	10.4	46.50	41.50	12.05
Rabi 2022-23	DBW 222	80	32.0	43.65	39.05	11.78
Total/Mean		**205**	**82.4**	**46.26**	**42.25**	**9.81**

Extension Gap and Technology Gap

The extension gap ranged from 2.6 to 5.0 qha^{-1}. The extension gap showed a variable trend in each year which indicated that problem centric approach to educate the farmers should be emphasized so as to obtain a stable and reversible extension gap trend in the district. The averaged extension gap was observed as 4.06 qha^{-1}. Technological gap ranged from 17.2 – 38.4 qha^{-1} and the average technological gap was observed as 26.73 qha^{-1}. 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). The variability noticed in the technological gap might be due to adoption of different varieties in successive years and their response with soil fertility, irrigation water quality, difference in potential yield and weather conditions in each year. Hence the location specific varietal selection and their management could minimised the technological gap in the district. Many researchers have studied the genetic characterization and noticed that harvest index has a positive and significant association with grain yield (Yadav et al., 2023)

Table 3: Gap and technology index under Front Line Demonstrations of wheat crop

Crop Season & Year	**Variety**	Potential Yield (qha^{-1})	Extension Gap (qha^{-1})	Technology Gap (qha^{-1})	Technology Index (%)
Rabi 2020-21	HD 2967	66.0	2.6	17.2	26.0
Rabi 2021-22	HD 3086	71.1	5.0	24.6	34.6
Rabi 2022-23	DBW 222	82.1	4.6	38.4	46.7
MEAN		**73.06**	**4.06**	**26.73**	**35.76**

Economic Analysis

The prevailing input and output prices of commodities during the demonstrations as well as farmers practice 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 35250 to 40468 Rs/ha with a mean value of Rs/ha 38076 against farmers practice where it was ranged from Rs/ha 36862 to 42698 Rs/ha with an average of Rs/ha 40720. The increased in cost of cultivation over the years indicated the increase in cost of input and labour etc. The gross returns under the demonstration was ranged from Rs/ha 96380 to Rs/ha 108092 with a mean value of Rs/ha 101409 while the farmers practice gross return ranged from Rs/ha 89937 to Rs/ha 96854 with mean value of Rs/ha 92678 during the three years commodity sales. The gross returns include the price earned from wheat straw also. The net returns from the frontline demonstration ranged from Rs/ha 59288 to Rs/ha 65394 with a mean net returns of Rs/ha 61937 while net returns in farmers practice was ranged from Rs/ha 47336 to Rs/ha 55000 having mean net returns as Rs/ha 52164 in all the three years. Economic analysis further showed that the improved practices demonstration has incurred less expenditure than farmers practice and ranged from Rs/ha 1612 to Rs/ha 4188 and with mean value of Rs/ha 2644 due to introduction of zero tillage and super seeder machine for sowing by some of farmers (Chourasiya et al., 2022). The BCR of FLD was ranged from 2.46 to 2.80 with an average BCR ratio of 2.66 while BCR of farmers practice ranged from 2.11 to 2.47 with a mean value of 2.28 in all three years. The cost benefit variation during different years might be due to variation in yield performance and fluctuation in sold value of wheat straw and other input output costs in that particular year. The additional returns due to improved practices was ranged from Rs/ha 6130 to Rs/ha 11952 with mean value of Rs/ha 9773. 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) and Sharma et al., (2020). Involvement of small, marginal and large category farmers in frontline demonstration activities actively and speedy disseminate the recommended agricultural practices to other remaining farmers in the society (Guruprem et al., 2018)

Table 4: Economics analysis of selected wheat varieties in respective years under frontline demonstrations (FLDs) vs framers practice (FP)

Year	Gross Cost (Rs. ha^{-1})		Gross Return (Rs. ha^{-1})		Net Return (Rs. ha^{-1})		B:C ratio		Saving in gross cost due to recomm. Production technologies in Demo. (Rs. ha^{-1})	Add. Return due to Improved Technologies (Rs. ha^{-1})
	Demo.	FP	Demo.	FP	Demo.	FP	Demo.	FP		
2020-21	35250	36862	96380	91245	61130	55000	2.73	2.47	1612	6130
2021-22	38510	42698	108092	96854	65394	54156	2.80	2.26	4188	11238
2022-23	40468	42601	99756	89937	59288	47336	2.46	2.11	2133	11952
Average	**38076**	**40720**	**101409**	**92678**	**61937**	**52164**	**2.66**	**2.28**	**2644**	**9773**

Technical Constraints and problems

It was observed in the study area that almost all farmers were following rice-wheat cropping system. Mostly basmati varieties were cultivated by the farmers and which were being harvested in mid of October to first week of November every year. During the field visits and group meetings the technical constraints and problem influenced the farmers were also studied. The shortage of time span was noticed between harvesting of paddy and timely sowing of wheat which ultimately shrinks the available days for proper and timely sowing wheat crop. All the adopted farmers ranked this issue as I (95%). Preparation of land and management of paddy residue for sowing of wheat crop in such a short span was noticed another major constraint and farmers reported and ranked this issue as II (92%). The aggravated problems of weeds majorly annual grasses weed like *Phalaris minor* was reported by the farmers and ranked it as III (78%). In the past years occurrence of excess rainfall event at the time of maturity of wheat crop were observed in the district which impacted the yield of wheat crop so famers ranked this happening as IV (61%). The damage of wild animal and non-availability of latest wheat sowing equipment were ranked as V (54%) and VII (35%). Similar findidings were observed by Dhruw et al. (2012) and have also reported similar type of constraints such as lack of suitable varieties, low technical knowledge etc. in maize production and the results of the present study also indicated similar constraints in wheat production.

Table 5. Technical constraints and problem influencing the farmers in the study area

S. N.	Constraints	Percentage	Rank
1	Less time window available for timely sowing of wheat due to late harvesting of paddy crop.	95	I
2	Management of crop residue of previous crop (paddy)	92	II
3	Aggravated problems of weeds	78	III
4	Excess rainfall at the time of crop maturity	61	IV
5	Damage by wild animals (especially Blue cow).	54	V
6	Lack of availability of latest farm machinery	35	VI

CONCLUSION

The results showed that frontline demonstrations received higher yield over the farmer practice. The large value of technological gap indicated that the varieties has potential of higher yield and could be achieved with area specific management practice. The improved agricultural practices could enhanced the yield and economic benefits in wheat cultivation. Such demonstrations improves the skills of farmers and the aware the KVK scientists about current issues faced by the farmers. The beneficiary farmers helps in dissemination of right information to other farmers. Hence frontline demonstration programme is an appropriate tool in skill and knowledge upgradation and providing scientific information to the farmer through on farm experimental approach.

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 the writing or editing of this manuscript.

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COMPETING INTERESTS

"Authors have declared that no competing interests exist.".