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Impact of climate smart production technologies and practices in wheat (*Triticum aestivum* L.) through front line demonstrations in Dhar district of Madhya Pradesh

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Abstract
The present study was carried out by Krishi Vigyan Kendra, Dhar, Madhya Pradesh to study the impact of climate smart production technologies and practices in wheat (*Triticum aestivum* L.) through frontline demonstrations in Dhar district of Madhya Pradesh. The results revealed that an average highest yield (4295 kg/ha) was recorded in front line demonstrations plots of wheat by adopting climate smart production technologies and practices as compared to farmers practice (3278 kg/ha). By the adoption of improved production technology of wheat, the yield was found in increasing trend *i.e.* 31.21% over farmer practice. The average technological gap (505 kg/ha), extension gap (1017 kg/ha) and technological index (10.52%) were noticed during the year 2021-22. The maximum gross monetary returns (Rs. 90203/ha), net profit (Rs. 62403/ha) and benefit cost ratio (3.24) was recorded under demonstration while minimum gross monetary returns (Rs. 68832/ha), net profit (Rs 42982/ha) and benefit cost ratio (2.67) was recorded, respectively under farmer's practice during the year of study. Thus, the yield and profitability was increased in demonstration plots over local check due to adoption of knowledge and climate smart production technologies and practices. The present study resulted to convincing the tribal farming community for higher productivity and returns.

Keywords: Front line demonstrations, technological gap, extension gap, technology index, yield and economics

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop of India fulfilling food as well as nutritional security of millions. It is one of the most imperative and consumed principal foods at global level. Wheat has a surfeit of uses nowadays including making different types of bread, biscuits, cakes, pasta, noodles and grain alcohols. It is second most important staple food crop after rice in India and generally provides about 50 percent of the calories and proteins requirement to a vast majority of India's population. The major wheat producing states are Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Rajasthan, Bihar, Gujarat and Maharashtra in India. These states contribute about 99.5% of total wheat production in the country. Remaining states contributes only 0.5% of total wheat production in the country (Directorate of Wheat Development). In India, it is cultivated on an area of about 31.61 million hectares, which is likely to produce more than 109.52 million tonnes with productivity 3464 kg/ha during the year 2020-21 (Anonymous, 2021) [1]. Uttar Pradesh (9.85 million hectare), Madhya Pradesh (6.35 million hectare), Punjab (3.53 million hectare), Haryana (2.56 million hectare) and Rajasthan (3.00 million hectare) constitute the major niche for the cultivation of wheat crop. Madhya Pradesh is the second leading wheat producing state after Uttar Pradesh contributing about 20.20% wheat area and productivity 2758 kg/ha of the country (Anonymous 2021) [1].

However, wheat production and yield need improvement to feed the continually increasing world population. Various biotic and abiotic stresses are major limiting factors for wheat production as they decrease the crop yield considerably. Therefore, finding ways to improve crop tolerance to abiotic stresses will be essential to improve agricultural production further and achieve the food security. There are several constraints of low productivity of wheat in India, out of which poor extension of improved agronomic practices is on the top (Singh, 2017) [7]. Moreover, poor agronomic practices such as higher seed rate, unsuitable varieties, faulty nutrient and irrigation management as well as weed control etc.

Are responsible for low productivity of wheat in India (Tiwari *et al.*, 2014) [9]. Frontline demonstration is the recent perception with the aim to prove recently released crop production and protection technologies and its management practices at farmer's fields. FLD on wheat has played a significant role in acreage expansion through variety percolation as well as yield enhancement. The FLD is a planned programme, executed and evaluated with the people and they are taught and motivated to act. Under the programme, the extension workers act as a catalyst, a change agent who set up the learning situation (demonstration) for the farmers and use them for horizontal dissemination of technology through farmers' day, print and electronic media. Farmers from the neighbouring villages are invited to interact with the FLD farmers. The programme not only aims at developing the individual but leadership qualities as well so that the users are also benefited. Finally, the findings/impact of the programme is given wide coverage through mass media.

Wheat is an important *rabi* cereal crop for livelihood and nutritional security of tribal farmers in Dhar district of Madhya Pradesh and it is mostly sown in October-November and harvested in March. The productivity (3200 kg/ha) of wheat in the Dhar district is far below as compared to the potential yield (5000 kg/ha) due to non-availability of quality seed, poor irrigation management, deterioration in soil health and poor adoption of improved agronomical practices. For the sustainable production of wheat, numbers of technologies are available but farmers' perception towards adoption of good agricultural practices is very poor and they are still practicing the unscientific methodologies. To sustain production of wheat, several steps were taken. In this regard, to sustain the potential production and consumption system, ICAR-Indian Grassland and Fodder Research Institute, Jhansi had sanctioned the project "Crop, fodder and livestock based technological modules for upliftment of tribal's under Tribal sub Plan'' to Krishi Vigyan Kendra, Dhar. The basic strategy of the Mission is to promote and extend improved technologies along with capacity building of farmers.

Materials and Methods

Front line demonstrations (FLDs) are one of the most powerful tools of extension because farmers, in general, are driven by the perception that "Seeing is believing". The main objective of frontline demonstrations is to demonstrate newly released crop production and protection technologies and its management practices at the farmer's fields under the micro-farming situation. Frontline demonstrations is an adaptive research on the improved varieties and technologies, which is demonstrated by Krishi Vigyan Kendra, Dhar at selected tribal farmers' fields who were the beneficiaries of the programme.

Krishi Vigyan Kendra, Dhar conducted the 13 front line demonstrations on wheat crop during rabi season 2021-22 in Nalcha block of Dhar district. Each frontline demonstration was conducted on 1.0 acre area and adjacent 1.0 acre was considered as control for comparison (farmer's practice). The total area of 5.2 ha was covered for wheat demonstrations. A list of farmers was prepared from group meeting and specific skill training was imparted to the selected farmers regarding different aspects of recommended production and protection technologies. The technological interventions on wheat crop was comprised of climate suitable improved variety HI-1605 (Pusa ujala) and demonstrated with full package of practices like soil testing, line sowing, seed treatment with fungicide and inoculation with bio-fertilizer, fertilizer application, weed management, irrigation management, integrated pest management practices etc. for cultivation as recommended by the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) and need based inputs were provided to the beneficiaries (Table 1). Climate resilient improved variety HI-1605 (Pusa ujala) is a widely adapted high yielding bread wheat genotype, suitable for timely sown under limited irrigation (two irrigations) condition and matures in 120 days was selected. Critical inputs like seed, fungicide, culture, weedicide and insecticide were facilitated to the beneficiaries under the programme by KVK scientists during the course of training and visits (Table 2). In case of local check, the traditional practices were followed by using existing variety (Lok-1). The yield data were collected from both the demonstration and farmers practice by random crop cutting method. Qualitative data was converted into quantitative form and expressed in terms of per cent increase in yield. The data was further analyzed by using simple statistical tools. Finally the extension gap, technology gap, technology index along with the benefit cost ratio were worked out with the help of formula as given by Samui *et al.*, (2000) [6] as described below:

Technology gap

It means the differences between potential yield and yield of demonstration plot.

Technology gap = Potential yield - Demonstration yield

The Extension gap

It means the differences between demonstration plot yield and farmers yield.

Extension gap = Demonstration yield - Farmer's 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.

$$\text{Technology index (\%)} = \frac{\text{Potential yield} - \text{Demo. yield}}{\text{Potential yield}} \times 100$$

Table 1: Comparison between demonstration package and existing practices under FLD

Particulars	Wheat		
Technology	Demonstration	Farmers Practice	GAP (%)
Farming situation	Irrigated	Irrigated	-
Variety	HI-1605 (Pusa ujala)	Lok-1	100
Time of sowing	October to November	October to November	No gap
Method of sowing	Line sowing	Line sowing	No gap
Seed rate	100 kg/ha	140 kg/ha	Higher seed rate
Fertilizer as per STV	NPK 80:40:20 kg/ha	NPK 64:46:00 kg/ha	Full gap
Seed treatment and inoculation	With Carboxin 17.5 + Thiram 17.5 @ 2.5 ml/kg of seed and inoculation with Azotobactor and PSB @ 5 g/kg of seed	Nil	Full gap

Weed management	Post-emergence herbicide (Clodinafop propargyl 15% + metsulfuron methyl 1% WP)	No herbicide (only hand weeding)	Full gap
Plant protection	IPM	No use	Full gap
Grading & processing	Grading followed	Not followed	Full gap

Table 2: Details of need based critical inputs/technological packages distributed in front line demonstrations of wheat

Year	Village covered	No. of demo.	Variety	Technology demonstrated	Need based input distributed
2021-22	Bhilbarkheda	13	HI-1605	Improved variety, seed treatment, inoculation, nutrient management, weed management and integrated pest management	Improved seed (100 kg/ha), soil testing, seed treatment with Carboxin 17.5 + Thiram 17.5 @ 2.5 ml/kg of seed and inoculation with azotobactor and PSB @ 5 g/kg of seed, clodinafop propargyl 15% + metsulfuron methyl 1% WP, on and off campus trainings, exposure visits and field days

Results and Discussion

Frontline demonstrations are effective educational tools in introducing various new technologies to the farmers to boost the farmer's confidence level by comparison of productivity levels between good agricultural practices in demonstration trials. The performance of wheat crop owing to the adoption of improved technologies is assessed during 2021-22.

Yield attributing parameters

The maximum number of tillers (5.62), number of kernels/ear (45.2) and test weight (44.36 g) was recorded in front line demonstration while minimum number of tillers (3.55), number of kernels/ear (41.4) and test weight (41.65 g) was recorded in local check. The average highest yield (4295 kg/ha) was recorded in demonstrations when adopted full package of practices over the lowest yield (3278 kg/ha) in farmer's practice. Whereas, the integrated crop management practice in wheat recorded average 31.21% increase in the yield as compared to local practices (Table 3 & 4). Similar results were reported by Nainwal *et al.* (2019) [4]; Prajapati *et al*. (2019) [5]; Shabir *et al.* (2017) [8]; Tripathi *et al*. (2018) [10] and Verma *et al.* (2016) [11].

Technology Gap

The technology gap of demonstration plots was recorded 505 kg/ha during 2021-22 (Table-4). On The technology gap observed during study may be attributed due to dissimilarity in the soil fertility status, production, protection practices and local climatic situation (Table 5).

Extension Gap

Extension gap of 1017 kg/ha was noticed during 2021-22 (Table-4). On an average extension gap under FLD programme was emphasized the need to educate the farmers through various extension programs *i.e.* front line demonstration for adoption of improved production and protection technologies, to revert the trend of wide extension gap. Timely use of latest production technologies with high yielding varieties will subsequently change this alarming trend of galloping extension gap (Table 5).

Technology Index

The technology index 10.52% was recorded (Table-4) which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technical intervention to increase the yield performance of wheat (Table 5). Similar results were reported by Dhakad *et al.* (2018) [2]; Gathiye *et al.* (2022) [3] and Yadav *et al.* (2020) [12].

Economic Returns

Results revealed that the cost involved in the adoption of improved technology in wheat production varied and was more profitable. The cultivation of wheat under improved technologies gave higher net returns of Rs. 62403/ha over farmer's practice (Rs 42982/ha) during 2021-22. The highest B:C (3.24) was recorded under improved package of practices (FLDs) during assessment year as compared to farmers practice (2.67). This may be due to higher yield obtained under improved technologies compared to local check (Table 6). Similar results were reported by Prajapati *et al.* (2019) [5]; Shabir *et al.* (2017) [8] and Verma *et al.* (2016) [11].

Table 3: Data on yield attributes in wheat

S. No.	Crop	Yield attributing characters					
		Av. no of tillers /hill		No of kernels/ear		Test weight (g) (1000 grain wt.)	
		Demo.	FP	Demo.	FP	Demo	FP
1	Wheat (HI-1605)	5.62	3.55	45.2	41.4	44.36	41.65

Table 4: Impact of demonstrations on the yield of wheat.

Year	No. of Demonstrations	Area (ha)	Yield kg/ha			% increase in yield over FP
			Potential yield	Demonstration Yield	Farmers practice	
2021-22	13	5.2	4800	4295	3278	31.21

Table 5: Technology gap, extension gap and technology index in wheat production.

Year	Area (ha)	No. of farmers	Technology gap (kg/ha)	Extension gap (kg/ha)	Technical index (%)
					FLD
2021-22	5.2	13	505	1017	10.52

Table 6: Economics of demonstrations under wheat demonstration

S. No	Year	Cost of Cultivation (Rs./ha)		Gross Monetary Return (Rs./ha)		Net Return (Rs.)		B:C ratio	
		Demo.	FP	Demo.	FP	Demo.	FP	Demo.	FP
1	2021-22	27800	25850	90203	68832	62403	42982	3.24	2.67

* Rate of wheat during 2021-22 in the Mandi of Dhar was Rs 2100/q

Conclusion

It is concluded from the study that there exists a wide gap between the potential and demonstration yields in wheat mainly due to lack of climate smart technology, extension gaps and lacking of awareness about new technology in wheat cultivation in Dhar district of Madhya Pradesh. The above findings of FLDs on wheat *var.* HI-1605 revealed that the technology gap can be reduced to a considerable extent by adopting climate smart production technologies and practices of wheat cultivation and it may lead to increase productivity, sustainability and profitability. The FLD showed a significant positive result and provided the researcher an opportunity to demonstrate the productivity potential and profitability of the latest technology at the farmers' fields, which have been advocating for long time. The productivity gain under FLD over existing practices of wheat cultivation created greater awareness and motivated the other farmers to adopt suitable climate resilient production technology in the district. It was also observed that potential yield can be achieved by imparting scientific knowledge to the farmers, providing the quality inputs and their proper utilization. Horizontal expansion of improved technologies may be achieved by implementation of various extension activities like field days, exposure visit, training programme *etc.* organized during course of study at the farmer's fields.

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