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Research Article

Dissemination of salt tolerant wheat varieties through frontline demonstrations approach for sustainable wheat production in Pali district of Rajasthan

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Abstract

Front line demonstrations (FLDs) on wheat were laid down at 465 farmers' fields to demonstrate production potential and economic benefits of improved production technologies comprising salinity tolerance varieties namely KRL 210, KRL 213, KRL 19 and KRL 1-4 in Pali district of arid zone of Rajasthan state during *Rabi* seasons from 2012-13 to 2017-18 in irrigated farming situation. The findings of the study revealed that the improved production technologies recorded an additional yield ranging from 7.1 to 16.0 qha^{-1} with a mean of 11.1 qha^{-1}. The per cent increase yield under improved production technologies ranged from 22.5 to 52.9 (KRL 210), 25.6 to 45.2 (KRL 213), 26.6 to 47.7 (KRL 19) and 33.8 to 45.5 (KRL 1-4) in respective years. The average extension gap, technology gap and technology index were 11.1qha^{-1}, 11.3qha^{-1} and 24.4 per cent, respectively in different salt tolerance varieties of wheat. The improved production technologies gave higher benefit cost ratio ranging from 2.0 to 3.0 with a mean of 2.4 as compared to local checks (1.8) being grown by farmers under locality. The results revealed that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended wheat production technology. The study reported lack of suitable salt tolerance HYV as major constraints by beneficiaries at rank first followed by low technical knowledge. Thus the productivity of wheat per unit area could be increased by adopting feasible scientific and sustainable management practices with a suitable salt tolerance variety.

Keywords: Adoption, constraints, impact, FLD, salt affected soils, technology, wheat

1. Introduction

Wheat (*Triticum aestivum* L.) is the second most important food crop in India after rice, both in terms of area and production. India is the second largest wheat producer and produces 12 per cent of the world production. In India wheat is grown between 11^0N to 55^0 N Latitude and 72^0E to 92^0E Longitude and at altitude of more than 3000 m above mean sea level. Soil and water salinity and lack of irrigation are the principal constraints affecting crop planning in narrow arid zone of western Rajasthan. The physical, soil characteristics of the well developed soils are good and do not constitute any restriction for food crop production. If efforts are made to evolve and introduce a scientific crop planning in the saline affected areas, it should be possible to increase wheat productivity sustainability. Higher salinity delayed and reduced germination percentage (Ramden *et al.* 2012). Salinity decreased germination per cent, root length, callus size, coleoptiles length and seedling growth (Lallu and Dixit 2005; Ghannadha *et al.* 2005; Bera *et al.* 2006 and Agnihotri *et al.* 2006). Plant height, stem diameter, dry weight decreased with increasing levels of salinity. For increasing wheat productivity in salt affected area, it is necessary to make more intensive efforts for evolving suitable salt tolerant varieties of wheat like KRL 210, KRL 213, KRL 19 and KRL 2-4 which was tolerant saline (EC 5-7 ds m^{-1}) as well as alkaline soil (pH 8.7-9.3). Wheat is one of the important cereals crop grown in *Rabi* season grown in all over the Rajasthan. Area, production and productivity of wheat crop during 2017-18 in Pali district was 46550 ha, 14725 metric tons and 3152 kg per ha, respectively (GOR 2017-18). The productivity of wheat (2017-18) is comparatively low in Rajasthan (3112 kg/ha) than other wheat cultivated states such as Haryana (5030kg/ha) and Punjab (4898 kg/ha).

Frontline demonstration is the new concept of field demonstration evolved by the Indian Council of Agriculture Research (ICAR) with main objective to demonstrate newly released crop production and protection technologies and its management practices in the farmers' field under different agro-climatic regions of the country under different farming situations. While demonstrating the technologies in the farmers' field the scientists are required to study the factors contributing higher crop production, field constraints of production and thereby generate production data and feedback information. Taking into account the above considerations FLDs were carried out in a systematic manner on farmer's field to show the worth of a new variety and convincing farmers to adopt improved production management practices of wheat for enhancing productivity of wheat. The low productivity of this crop is due to poor adoption of improved technologies of wheat by the farmers. Hence, the Krishi Vigyan Kendra, Pali has organized frontline demonstrations (FLD's) with improved salt tolerant variety along with recommended package of practices. The main purpose of these demonstrations was to enhance the productivity levels of wheat which in turn will increase the income levels of farmers and to transfer the latest production technologies to farmers in the district. Pali district is located between 24.45 to 26.75 degree N latitude and 72.48 to 74.20 degree E longitude at an altitude ranging between 212 m to about 220 m above mean sea level with a total geographical area of 12,387 square kilometers. In Pali district wheat traditionally grown as a *Rabi* crop. The regions are biotic, abiotic, and socio-economic constraints causing low productivity in pulses in this region. In addition, lack of improved varieties is reported as most serious constraints among all biophysical constraints in pulses production. While demonstrating the technologies in the farmer's fields, the scientists are required to study the factors contributing higher crop production, field constraints of production and thereby generate production data and feedback information. Taking into account the above considerations, frontline demonstrations (FLDs) were carried out in a systematic manner on farmer's field to show the worth of a new variety and convincing farmers to adopt improved production management practices of wheat for enhancing productivity.

2 Materials and methods

The study was conducted in farmers' fields to demonstrate production potential and economic benefits of improved technologies in Pali district arid zone of Rajasthan state during *Rabi* seasons from 2012-13 to 2017-18 in irrigated farming situation. To popularize the improved wheat production practices, constrains in wheat production were identified though participatory approach. Preferential ranking technique was utilized to identify the constraints faced by the respondent farmers in wheat production. Farmers were also asked to rank the constraints they perceive as limiting production factor for wheat cultivation in order of preference. Based on top rank farmers problems identified, front line demonstrations were planned and conducted at the farmer's fields. In all, 464 full package frontline demonstrations were conducted to convince them about potentialities of salt tolerant varieties of wheat *viz.,* KRL 210, KRL 213, KRL 19 and KRL 1-4 during *Rabi* seasons from 2012 to 2018 under irrigated farming condition, in light to medium soils with low to medium fertility status under wheat-mungbean cropping systems. Each demonstration was conducted in an area of 0.4 ha and adjacent to the farmer's fields in which the crop was cultivated with farmer's practice/ local variety. The package of practices included were improved varieties, seed treatment, maintenance of optimum plant stand, recommended fertilizers dose, plant protection measures especially termite management. The spacing followed was at 15 m x 10 cm sown between first week of November during the five years with the seed rate of 100 kg/ha. All the participating farmers were trained on all aspects of wheat production management. To study the impact of front line demonstrations, out of 464 participating farmers, a total of 160 farmers were selected as respondent through proportionate sampling. Production and economic data for FLDs and local practices were collected and analyzed. The Extension gap, technology gap and technology index were calculated using the formula as suggested by Samui *et al.* (2000).

Extension gap (qha^{-1}) =

Demonstration yield (qha^{-1}) –Yield of local check (qha^{-1})

Technology gap (qha^{-1}) =

Potential yield (qha^{-1}) – Demonstration yield (qha^{-1}).

Technology index (%) =

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

Knowledge level of the farmers about improved production practices of wheat before frontline demonstration implementation and after implementation was measured and compared by applying paired t-test at 5% level of significance. Further, the satisfaction level of respondent farmers about extension services provided was also measured based on various dimensions like training of participating farmers, timeliness of services, supply of inputs, solving field problems and advisory services rendered, fairness of scientists, performance of variety demonstrated and overall impact of FLDs. The selected respondents were interviewed personally with the help of a pre-tested and well structured interview schedule. Client Satisfaction Index was calculated as developed by Kumaran and Vijayaragavan (2005). The individual obtained scores were calculated by the formula as:

Client Satisfaction Index =

$$\frac{\text{(Totale individual obtained score)}}{\text{(Maximum score possible)}}$$

The data thus collected were tabulated and statistically analyzed to interpret the FLDs results.

3 Results and discussion

3.1 Increase in knowledge

Knowledge level of respondent farmers on various aspects of improved wheat production technologies before conducting the frontline demonstration and after implementation was measured and compared by applying paired'-test. It could be seen from the Table 1 that farmers mean knowledge score had increased by 33.2 after implementation of frontline demonstrations. The increase in mean knowledge score of farmers was observed significantly higher. As the computed value of 't-test' (8.63) was statistically were significant at 5% probability level. The results are at par with Meena and Singh (2017) on wheat crops, Singh and Sharma (2004) on mustard crop, Singh *et al.* (2007) on different crops like soybean, pigeon pea, black gram, Dhaka *et al.* (2010) on mothbean crop, Meena *et al.* (2016) on wheat crop and Rathod *et al.* (2016). It means there was significant increase in knowledge level of the farmers due to frontline demonstration. This shows positive impact of frontline demonstration on knowledge of the farmers that have resulted in higher adoption of improved farm practices. The results so arrived might be due to the concentrated educational efforts made by the scientists. The findings confirm with the finding of Ashiwal and Hussain (2008).

Table 1: Compression between knowledge levels of the respondents farmers about improved farming practices of wheat (N=160)

Mean score			Calculated "t" value
Before FLD implementation	After FLD implementation	Mean difference	
36.3	69.5	33.2	8.63*

*Significant at 5 % probability level

Table 2: Extent of farmers satisfaction of extension services rendered (N=160)

Satisfaction level	Number	Percent
Low	21	13.13
Medium	108	67.50
High	31	19.38

3.2 Farmer's satisfaction

The extent of satisfaction level of respondent farmers over extension services and performance of demonstrated variety was measured by Client Satisfaction Index (CSI) and results presented in Table 2. It is observed that majority of the respondent farmers expressed medium (67.50%) to the high (19.38%) level of satisfaction for extension services and performance of technology under demonstrations whereas, very few 13.13 per cent of respondents expressed lower level of satisfaction. The results are in close conformity with the results of Raj *et al.* (2013) on pulses crops, Meena and Singh (2014) on gram crops and Dhaka *et al.* (2010) on mothbean crop. The medium to higher level of satisfaction with respect to services rendered, linkage with farmer's and technologies demonstrated *etc.* indicate stronger conviction, physical and mental involvement in the frontline demonstration which in turn would lead to higher adoption. This shows that the relevance of frontline demonstrations. It indicates that wheat grown with low yield are identified by low knowledge, un-favorable attitude towards high yielding varieties, low risk bearers with negative perception of wheat production technology. In other wards it may also due to then socio-economic status, lower holdings and unavailability of inputs and credit facilities and to some extent supply and marketing problems. This is a point of concern for research and extension functionaries to disseminate improved wheat production technologies for raising the productivity of wheat at all the levels.

3.3 Constraints in wheat production

Farmer's wheat production problems were documented in this study. Preferential ranking technique was utilized to identify the constraints faced by the respondent farmers in wheat production. The ranking given by the different farmers are given in Table 3. A perusal of table indicates that lack of suitable salt tolerance high yielding variety (HYV) (88.3%) was given the top most rank followed by low technical knowledge (78.9%), termite infestation (77.8%), vagaries of weather (73.3%). Based on the ranks given by the respondent farmers for the different constraints revealed that lack of suitable salt tolerance HYV, low technical knowledge, termite infestation are the major constraints to wheat production and followed by wild animals. Other constraints such low or erratic rainfall, low soil fertility post, rust disease infestation, stem rot, weed infestation, water lodging, marketing and were found to reduce wheat production. Among all the constraints, harvest management got least concerns. Other studies Dhaka *et al.,* (2010) and Ranawat *et al.* (2011) have reported similar problems in wheat production.

3.4 Performance of FLD

A comparison of productivity levels between demonstrated varieties and local checks is shown in Table 4. During the period under study, it was observed that the productivity of wheat in Pali district under improved production technologies ranged between 33.9 to 46.2 qha^{-1} with a mean yield of 40.3 qha^{-1}. The productivity under improved technologies varied from 38.7 to 46.2, 39.4 to 44.7, 34.8 to 41.1 and 36.0 to 38.9qha^{-1} for the varieties KRL 210, KRL 213, KRL 19 and KRL 1-4, respectively as against the yield range between 23.3 to 33.1 with a mean of 29.0 qha^{-1} under farmers local practices and varieties during study period. The additional yield of different varieties under improved production technologies over local practices ranged from 7.1 to 16.0 qha^{-1} with a mean of 11.1 qha^{-1} in comparison to local practice and varieties. The per cent increase yield under improved production technologies ranged from 22.5 to 52.9 (KRL 210), 25.6 to 45.2 (KRL 213), 26.6 to 47.7 (KRL 19) and 33.8 to 45.5 (KRL 1-4) in respective years. This increased grain yield with improved production technologies was mainly because of high potential yielding varieties.

The variation in the productivity was also caused unusual delay in sowing in some of the farmer's fields. In fields where delayed sowing was done because of prolonged dry hot spell in the month of November and unavailable of irrigation, the crop growth was restricted. The late sowing crop was subjected to relatively less time span available for plant growth and development. Similar yield enhancement in different crops in front line demonstration has amply been documented by Dhaka *et al.* (2010), Kumar *et al.* (2010), Prushottam e*t al.* (2012), Kumar *et al.* (2014), Tolessa *et al.* (2017) and Hussain *et al.* (2018). From these results it is evident that performance of improved salt varieties was found better than the local check under local conditions. Farmers were motivated by results of agro technologies applied in the FLDs trials and it is expected that they would adopt these technologies in the coming years also. Yield of the frontline demonstration trials and potential yield of the different varieties of crop was

Table 3: Ranking given by farmers for different constraints (N=160)

S. No.	Constraints	Percentage	Ranks
1	Lack of suitable salt tolerance variety	88.3	I
2	Stem rot diseases	29.4	VII
3	Aphid infestation	47.1	VI
4	Low soil fertility	26.7	X
5	Low technical knowledge	78.9	II
6	Wild animals (Blue bulls and wild pigs)	52.6	V
7	Vagaries of weather (mid season high temperature)	73.3	IV
8	Weed infestation	27.1	VIII
9	Termite infestations	77.8	III
10	Water lodging	31.5	IX
11	Marketing	25.7	XI
12	Post harvest management	21.4	XII

compared to estimate the yield gaps which were further categorized into technology index. The technology gap shows the gap in the demonstration yield over potential yield and it was 11.3 qha^{-1}. The observed technology gap may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other vagaries of weather conditions in the area. Hence, to narrow down the gap between the yields of different varieties, location specific recommendation appears to be necessary. Technology index shows the feasibility of the variety at the farmer's field. The lower the value of technology index more is the feasibility. Table 4 revealed that the technology index value was 24.4. The findings of the present study are in line with the findings of Sawardekar *et al.* (2003), Dhaka *et al.* (2010), Kumari *et al.* (2017), Verma *et al.* (2016), Singh and Kumar (2017) and Singh 2017.

The economic feasibility of improved technologies over traditional farmer's practices was calculated depending on the prevailing prices of inputs and output costs (Table 5). It was found that cost of production of wheat under improved technologies varied from Rs.23550 to Rs. 25500 ha^{-1} in case of KRL 210, Rs. 23900 to Rs. 24900 ha^{-1} for KRL 213, Rs. 22790 to Rs. 24180 ha^{-1} for KRL 19 and Rs.23700 to 25300 ha^{-1} in case of KRL 1-4 with an average of Rs. 24246 ha^{-1} of improved technologies and with an average of Rs. 22836 ha^{-1} in local practice. The additional cost incurred in the improved technologies was mainly due to more costs involved in the cost of improved seed only. Front line demonstrations recorded higher mean gross returns (Rs. 59267 ha^{-1}) and mean net return (Rs.35021 ha^{-1}) with higher benefit ratio (2.4) under improved technologies of different improved varieties of wheat as compared to local checks. These results are in line with the findings of Yadav *et al.* (2007), Narwale *et al.* (2009), Meena and Dudi (2012), Poonia and Pithia (2011), Rajni *et al.*(2014), Raj *et al.* (2013), Dhaka *et al.* (2016) and Pathak (2018). Further, additional cost of Rs. 1421 ha^{-1} in demonstration has yielded additional net returns of Rs. 16242 ha^{-1} with incremental benefit cost ratio 3.8 suggesting its higher profitability and economic viability of the demonstration. Similar results were also reported

Table 4: Yield of wheat as influenced by improved production technologies and drought tolerance varieties over local practices in farmer's fields (2012-2018)

Year	Variety	Area (ha)	No. of Demo.	Yield (qha^{-1})		Add. Yield over local check (qha^{-1})	% increase over local check	EG (qha^{-1})	TG qha^{-1})	TI (%)
				IP	FP					
2012	KRL 210	12	30	44.5	32.1	12.4	32.6	12.4	08.0	15.2
	KRL 213	12	30	39.4	30.8	08.1	25.6	08.1	11.1	21.9
2013	KRL 210	10	25	38.7	31.6	07.1	22.5	07.1	13.8	26.3
	KRL 19	10	25	35.2	27.8	07.4	26.6	07.4	19.8	36.0
2014	KRL 210	08	20	42.1	28.9	13.2	45.6	13.2	10.4	24.7
	KRL 213	12	30	44.9	31.3	13.6	43.5	13.6	05.1	11.4
	KRL 1-4	10	25	36.6	26.0	10.6	40.8	10.6	16.9	46.2
	KRL 19	12	30	37.0	25.4	11.6	45.7	11.6	13.0	35.1
2015	KRL 19	08	20	38.7	27.7	11.0	39.7	11.0	11.3	29.2
	KRL 210	12	30	44.8	33.1	11.7	35.3	11.7	07.7	17.2
2016	KRL 210	12	30	45.2	31.6	13.6	43.0	13.6	07.3	16.2
	KRL 213	10	25	40.1	29.5	10.6	35.9	10.6	10.4	25.9
	KRL 19	12	30	34.8	26.8	08.0	29.9	08.0	15.2	30.4
2017	KRL 210	12	30	46.2	30.2	16.0	52.9	16.0	06.3	12.0
	KRL 213	08	20	41.1	28.3	12.8	45.2	12.8	09.4	18.6
	KRL 1-4	08	20	36.0	26.9	09.1	33.8	09.1	14.0	28.0
2018	KRL 210	10	25	45.7	31.4	14.3	45.5	14.3	06.8	12.9
	KRL 1-4	08	20	33.9	23.3	10.6	45.5	10.6	16.1	32.2
	Average	**10.3**	**25.8**	**40.3**	**29.0**	**11.1**	**38.3**	**11.1**	**11.3**	**24.4**

Table 5 Cost of cultivation (Rs. ha^{-1}) net return and benefit cost ratio of wheat as affected by improved production technologies over local practices

Year	Variety	Total cost of cultivation		Gross return (Rs ha^{-1})		Net return (Rs ha^{-1})		B:C ratio		Add. Cost of cultivation	Add. Net returns (Rs.ha^{-1})
		IP	FP	IP	FP	IP	FP	IP	FP		
2012	KRL 210	23550	22100	55625	40125	32075	18025	2.4	1.8	1450	14050
	KRL 213	23960	22400	53190	38500	29230	16100	2.2	1.7	1560	13130
2013	KRL 210	24970	23600	52245	39500	27275	15900	2.0	1.5	1370	11375
	KRL 19	22790	21350	47520	34750	24730	13400	2.1	1.5	1440	11330
2014	KRL 210	25890	24200	56835	36125	30945	11925	2.2	1.4	1690	19020
	KRL 213	24080	23300	61400	45385	37320	22085	2.5	1.9	780	15235
	KRL 1-4	23700	22400	53070	37700	29370	15300	2.2	1.6	1300	14070
	KRL 19	23690	22100	53650	36830	29960	14730	2.3	1.7	1590	21865
2015	KRL 19	24252	23200	56115	40165	31865	16965	2.3	1.7	1052	14900
	KRL 210	23970	22300	67200	49650	43230	27350	2.8	2.2	1670	15880
2016	KRL 210	23780	21400	67800	47400	44020	26000	2.9	2.1	2380	18020
	KRL 213	22650	21400	62155	44250	39505	22850	2.7	2.0	1250	16655
	KRL 19	24180	23600	53940	40200	29760	15400	2.2	1.7	580	14360
2017	KRL 210	24870	23200	71610	46810	46740	23610	2.9	2.0	1670	23130
	KRL 213	24900	23700	63705	43865	38805	20165	2.6	1.9	1400	18640
	KRL 1-4	24400	23500	59400	44385	35000	20885	2.4	1.8	900	14115
2018	KRL 210	25500	23100	75405	51810	49905	28710	3.0	2.2	2400	21195
	KRL 1-4	25300	24200	55935	39445	30635	15245	2.2	1.6	1100	15390
Average		**24246**	**22836**	**59267**	**42050**	**35021**	**19147**	**2.4**	**1.8**	**1421**	**16642**

by Singh and Singh (2009), Dhaka *et al.* (2010), Mahadik and Talathi (2016), Rathore *et al.* (2016), Lothwal (2010), Meena and Singh (2017) and Morwal *et al.* (2018) in wheat crops. The results from the present study clearly brought out the potential of improved production technologies in enhancing wheat production and economic gains in rainfed farming situations conditions of this region of Rajasthan. Hence, wheat production technologies have broad scope for increasing the area and productivity at each and every level.

4. Conclusion

It may be concluded that the introduction of salt tolerant wheat varieties on salt affected soil with proper agronomic practices are followed then wheat yield increased by 22.5 to 52.9 per cent. Full adoption of salt tolerant wheat production technology was reported by 67.5 per cent and partially adopted by 13.1 per cent. The major constraints perceived by farmers were salt affected soils followed by lack of suitable salt tolerance variety. If these constraints are managed somehow then farmers can harvest more yield with the same level of input which would definitely improve their socio-economic status through frontline demonstration at real farming situation in Pali district. On the basis of the result obtained in present study that the yield gap between conventional practices and improved production technologies was perceptibly higher, there is urgent need to make stronger extension services for educating the cultivators in the implementation of improved production technology. However, the yield level under FLD was better than the local varieties and performance of these varieties could be further improved by adopting recommended production technologies. Hence, it can be observed that increased yield was due to adoption of high yielding varieties and conducting front line demonstration of proven technologies. Yield potentials of crop can be increased to greater extent. This will subsequently increase the income as well as the livelihood of the farming community. From the above research findings it can be also concluded that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended wheat production technology. The study reported lack of suitable salt tolerance HYV as major constraint by the beneficiaries and is ranked first followed by low technical knowledge.

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