International Scholars Journals

International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 3 (7), pp.566-570, September, 2013. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Economic impact of front line demonstrations on cereal crops in Tribal Belt of Rajasthan

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Accepted 05 May, 2013

Dungarpur is one of the most backward districts of Rajasthan (India) having 69.5% of area as rainfed. *Maize (Zea mays), Paddy (Oryzae sativa)* and Wheat (*Triticum aestivum)* are the three major cereal crops grown in the district. Farm Science Centre known as Krishi Vigyan Kendra laid down Front Line Demonstrations on these three cereal crops under NAIP project by introducing some new varieties and applying scientific package of practices in their cultivation. The productivity and economic returns of maize, paddy and wheat in improved technologies were calculated and compared with the corresponding farmer's practices (local checks). All the three cereal crops recorded higher gross returns, net return and benefit cost ratio in improved technologies as compared to the plots where farmers were using traditional practices in their cultivation. It is suggested that location-specific integrated approaches would be needed to bridge the productivity gap of the cereal crops grown in the district.

Key words: Cereal crops**,** front line demonstrations, technology and extension gaps, technology index, improved technologies, rainfed.

INTRODUCTION

Krishi Vigyan Kendra (Farm Science Centre) an innovative science–based institution, plays an important role in bringing the research scientists face to face with farmers. The main aim of Krishi Vigyan Kendra is to reduce the time lag between generation of technology at the research institution and its transfer to the farmers for increasing productivity and income from the agriculture and allied sectors on sustained basis. KVKs are grass root level organizations meant for application of technology through assessment, refinement and demonstration of proven technologies under different ‘micro farming’ situations in a district (Das, 2007). Front line demonstration (FLD) is a long term educational activity conducted in a systematic manner in farmers fields to worth of a new practice/technology. Farmers in India are still producing crops based on the knowledge transmitted to them by their forefathers leading to a grossly unscientific agronomic, nutrient management and pest management practices. As a result of these, they often fail to achieve the desired potential yield of various crops and new varieties. Potential yield is determined by solar radiation, temperature, photoperiod, atmospheric concentration of carbon dioxide and genotype characteristics assuming water, nutrients, pests, and diseases are not limiting the crop growth. Under rainfed situation, where the water supply for crop production is not fully under the control of the grower, water-limiting yield may be considered as the maximum attainable yield for yield gap analysis assuming other factors are not limiting crop production. However, there may be season-to-season variability in potential yield caused by weather variability, particularly rainfall. Water-limiting potential yield for a site could be determined by growing crops without any growth constraints, except water availability (Singh *et al*. 2001).The baseline survey was conducted by Krishi Vigyan Kendra, Dungarpur during 2006-07 under National Agricultural Innovation Project entitled “Livelihood and Nutritional Security of Tribal Dominated Area through Integrated Farming System and Technology Models” and the aim of project was to research a replicable model for sustainable rural livelihood security. In the project, a bouquet of 25 techno-

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Table 1. Area, Production and Productivity of major crops cultivated in the District (2010-11).

Crop	Area (ha)	Production (Quintals)	Productivity (Qha^{-1})
Kharif season			
Maize	89065	1304802	14.65
Paddy	13727	135897	9.90
Black gram	11609	67332	5.80
Other crops	17116		
Rabi season			
Wheat	37334	580917	15.56
Gram	13566	125892	9.28
Other crops	1760		

logies were tested in Faloj cluster consisting of 5 villages and involving 1142 households in Faloj, Dhani, Ghatau, Dabela and Futi talai villages. It was found that farmers were using old varieties of cereal crops without proper use of chemical fertilizers, herbicides and pesticides. Keeping in view the constraints, Krishi Vigyan Kendra Dungarpur conducted front line demonstrations on major cereal crops which would ensure livelihood, nutritional security and economic empowerment of tribal households at faster pace.

MATERIALS AND METHODS

Profile of the study area

Krishi Vigyan Kendra, Dungarpur (situated at 23.83°N latitude, 73.72°E longitude and an altitude of 579.5 m above msl) belonging to Humid Southern Plain of Rajasthan. In the Eastern and Northern borders of Banswara and Udaipur districts, respectively while it adjoins the State of Gujarat in Southern and Western part. Dungarpur district is the smallest district of the state covering an area of 385592 hectares only, which is 1.13 percent of the total area of Rajasthan. Average land holding is 1.67 hectare per capita, which is lowest in the state. Most parts of the district is covered by hills. Agriculture is the main source of the livelihood in the Dungarpur district of Rajasthan with a gross cropped area of 131517 hectare (Govt. of Rajasthan, 2010-11). The district has a semi-humid climate with average temperature of the district varies from 21.8-46^{0}C in summer and 11-26^{0}C in winter and annual rainfall is about 729mm.Maize – Wheat is the major cropping sequence being followed in the district. There are three major cereal crops being cultivated in Dungarpur which includes maize and paddy during *Kharif* season (summer) and wheat during *Rabi* season (winter). Table 1 shows the area, total production and productivity of major crops cultivated in the district during 2010-11 (Govt. of Rajasthan, 2010-11). It is evident that 72.1 per cent of the total cultivated area during *Kharif* season (summer) has been covered under maize *and* paddy *whereas wheat* alone covered about 59 per cent during *Rabi* season (winter). The present investigation was carried out in the adopted villages located in the operational area of Krishi Vigyan Kendra Dungarpur with the objective to identify the yield gaps as well as to work out the difference in input cost and monetary returns under front line demonstrations and farmers' practices (local checks). Soil of the study area is sandy loam in texture with alkaline in reaction (pH 8.3), low organic carbon (0.47 g kg^{-1} soil), low nitrogen (247 kg ha^{-1}), medium phosphorus (18.7 kg ha^{-1}) and high in available potassium (267 kg ha^{-1}). The critical inputs were applied as per the scientific package of practices recommended by the research wing of Maharana Pratap University of Agriculture and Technology, Udaipur (Anonymous, 2007a and Anonymous, 2007b). The data on production cost and monetary returns was collected for two years (2008-09 and 2009-10) from Front Line Demonstration plots to workout the economic feasibility of improved and scientific cultivation of cereals. Besides, the data from local checks, data was also collected where farmers were using their own practices for cultivation of cereal crops. The technology & extension gaps and technology index were calculated as given by Samui *et al*. (2000) as:

1. Technology gap = Potential yield – Demonstration yield
2. Extension gap = Demonstration yield – Yield from farmers practice (Local check)
3. Technology index = $\frac{\text{Potential yield – Demonstration yield}}{\text{Potential yield}} \times 100$

RESULTS AND DISCUSSIONS

Description of Front Line Demonstrations

The details of demonstrations conducted by Krishi Vigyan Kendra, Dungarpur are presented in Table 2. In each front line demonstration, the improved variety suitable to local condition was selected and the recommended package of practices was adopted. Some of the major differences between the improved tec-

Table 2. Particulars showing the details of cereal crops grown under Front Line Demonstrations and farmers practices.

Crop	Particulars	Farmers Practices (Local checks)	Front Line Demonstrations (Improved technologies)	2008-09		2009-10		Total	
				Area (ha)	No. of farmers	Area (ha)	No. of farmers	Area (ha)	No. of farmers
Maize									
	Variety	Mixed/local	Hybrid (MRM 3838, MRM 3765)	59.6	270	93.40	467	153	737
	Seed rate	30kgha^{-1}	25 kg ha^{-1}						
	Seed treatment	no seed treatment	Seed treatment with *Trichoderma viride* @ 6 g kg^{-1} seed+ *Azotobector* + PSB @ 20 g kg^{-1} seed						
	Sowing	Line sowing, crop geometry(30×20cm)	Line sowing, crop geometry (60×25cm)						
	Weed Management	no use of herbicide	Atrazin a. i. @ 0.5kg ha^{-1} at pre emergence						
	Nutrient Management (N:P:K)	60:30:0	90:40:30						
	Pest Management	no use of plant protection measures	Methyl Parathion 2%dust @ 25 kg ha^{-1}& Carbofuran 3G @ 7.5 kg ha^{-1}						
Paddy									
	Variety	Vagad dhan	Pusa Sugandha 5/Pusa Sugandha 4	7	21	5	14	12	35
	Seed Rate for nursery	40 kgha^{-1}	25 kg ha^{-1}						
	Weed Management	no use of herbicide	Banthiocarb @1.5 Lit. ha^{-1}						
	Nutrient Management (N:P:K:Zn)	60:30:0:0	90:40:30:25						
Wheat									
	Variety	Mixed/local	Raj 3077/Raj 4037	85	425	90	217	175	642
	Seed rate	150 kgha^{-1}	125 kg ha^{-1}						
	Seed treatment	no seed treatment	Seed treatment with thiram @ 2.0 g kg^{-1} seed+ *Azotobector* + PSB @ 20 g kg^{-1} seed						
	Weed Management	no use of herbicide	2-4D amine salt a.i. @750 g ha^{-1}						
	Nutrient Management (N:P:K)	60:30:0	90:40:30						

hnologies adopted in front line demonstrations and farmers practices (local checks) adopted by farmers in different crops are summarized as below.

Maize: The improved technologies included improved varieties (cv. MRM 3838 and MRM 3765), integrated nutrient management (90:40:30 NPK kg ha^{-1} + *Azotobector*+ Phospho- Solubilising Bacteria (PSB) @ 20 g kg^{-1} seed) and integrated pest management (deep ploughing+ seed treatment with *Trichoderma viride* @ 6 g kg^{-1} seed + Methyl Parathion 2% dust @ 25 kg ha^{-1} + Carbofuran 3% G @ 7.5 kg ha^{-1}) were tested under demonstrations. Deep ploughing was done during the month of (also mentioned the year). Crop was sown by using seed @ 25 kg ha^{-1} with crop geometry 60X25 cm after receiving sufficient rainfall. The whole of Phosphorus and Potash in the form of Diammonium Phosphorus (DAP) and Murat of Potash were applied as basal dose and Nitrogen in the form of Urea was top dressed in two equal splits at 25 and 45 days after sowing. The seed was treated with *Trichoderma viride*

Table 3. Productivity of Cereal crops, yield gaps and technology index (average over years).

Crop	No. of Demonstrations	Area (ha)	Productivity (qha^{-1})			Per cent increase over local	Technology gap (qha^{-1})	Extension gap (qha^{-1})	Technology Index (%)
			Potential	Improved technologies	Local Check				
Maize	737	153	40	29.25	15.08	94.03	10.75	14.18	26.88
Paddy	35	12	45	26.56	17.25	53.94	18.45	9.31	40.99
Wheat	642	175	50	34.13	21.50	58.72	15.88	12.63	31.75

Table 4. Economics of cereal crops production under Front Line Demonstrations and Farmers Practices (local checks).

Particulars		Year and crop								
		2008-09			2009-10			Overall		
		Maize	Paddy	Wheat	Maize	Paddy	Wheat	Maize	Paddy	Wheat
Yield (qha^{-1})	**Improved technologies**	28.50	26.50	35.00	30.00	26.61	33.25	29.25	26.56	34.13
	Local check	14.75	16.50	21.00	15.40	18.00	22.00	15.08	17.25	21.50
Cost of cultivation (Rs.ha^{-1})	**Improved technologies**	16620	24050	19970	17515	25020	20223	17068	24535	20097
	Local check	10840	21090	18430	12730	22340	18930	11785	21715	18680
Additional cost of cultivation over local (Rs.ha^{-1})		5780	2960	1540	4785	2680	1293	5283	2820	1417
Gross returns (Rs.ha^{-1})	**Improved technologies**	29213	58300	52500	33375	63864	52369	31294	61082	52434
	Local check	15119	36300	31500	17133	43200	34650	16126	39750	33075
Net Returns (Rs.ha^{-1})	**Improved technologies**	12593	34250	32530	15860	38844	32146	14226	36547	32338
	Local check	4279	15210	13070	4403	20860	15720	4341	18035	14395
Additional Net Returns over local (Rs.ha^{-1})		8314	19040	19460	11458	17984	16426	9886	18512	17943
B:C Ratio	**Improved technologies**	1.76	2.42	2.63	1.91	2.55	2.59	1.83	2.49	2.61
	Local check	1.39	1.72	1.71	1.35	1.93	1.83	1.37	1.83	1.77

@ 6 g kg^{-1} seed and then seed was inoculated with *Azotobector* and Phospho-solubilizing bacteria as bio fertilizers each @ 20 g kg^{-1} seeds. Herbicide Atrazin a. i. @ 0.5 kg $ha^{-1}$was applied pre emergence of maize. The Methyl Parathion 2% dust @ 25 kg ha^{-1} was top dressed at the time of incidence of grasshopper (*Hieroglyphus nigroripletus*) and Carbofuran 3% G @ 7.5 kg $ha^{-1}$was applied in the shoots for the control of maize stem borer (*Chilo partillus*).

Paddy: Farmers were using 'Vagad dhan' local course variety of paddy. The seed rate used by the farmers was very high and during transplanting 3-4 seedlings per hill were used by the farmers. Chemical fertilizers i.e. Urea and DAP were used by the farmers. In improved technologies includes improved varieties (cv. Pusa sugandha 4 and Pusa sugandha 5), Nutrient Management (90:40:30:25 N P K Zn kg ha^{-1}) and Weed Management (Banthiocarb @1.5 Lit. ha^{-1} after 3-5 days of transplanting) were tested. Crop was sown between 2nd week of July to last week of July. The single seedling per hill was transplanted with crop geometry of 25×25 cm. The whole of the Phosphorus, Potash and Zinc were applied in the form of Diammonium Phosphorus, Murat of Potash and Zinc Sulphate as basal dose and Nitrogen in the form of Urea was top dressed in two equal splits at 25 and 45 days after sowing. For the control of weeds, Banthiocarb @1.5 Lit. ha^{-1} was applied after 3-5 days of transplanting was used.

Wheat: In case of wheat (Table 2), farmers were using local or mixed seed retained by them over the years. The farmers were using broadcast method of sowing without the use of any herbicides. In improved technologies, included improved varieties (cv. Raj 3077 and Raj 4037), Nutrient Management (90:40:30 N P K kg ha^{-1}+ *Azotobector* + Phospho-Solubilising Bacteria (PSB) @ 20 g kg^{-1} seed) and Weed Management (2-4D amine salt a.i. @750gha^{-1}) were tested. Crop was sown between Ist week to 3rd week of November by using seed @ 125 kg ha^{-1} with crop geometry of 22.5×10 cm. Whole of the Phosphorus and Potash were applied in the form of DAP and MOP as basal dose and Nitrogen in the form of Urea was top dressed in two equal splits at 25 and 45 days after sowing. The seed was treated with

Thirum @ 2.0 g kg^{-1} seed and then the seed was inoculated with *Azotobector* and Phospho-solubilizing bacteria as bio fertilizers each @ 20 g kg^{-1} seeds. For the control of weeds, 2-4D amine salt a.i. @ 750 g ha^{-1} was applied 30-35 days after sowing the crop.

Economic impact of Front Line Demonstrations

During the period of study, it was observed that in front line demonstrations of improved technologies increased productivity over respective local checks (Table 3). The improved technologies recorded higher productivity of maize and paddy 29.25 q ha^{-1}, 26.56 q ha^{-1}as compared to farmers practices (local checks) 15.08 q ha^{-1}, 17.25 q ha^{-1}, respectively. The increase in productivity of maize and paddy over respective local checks were 94.03 % and 53.94 %. The higher productivity of maize and paddy under improved technologies were due to the sowing of latest high yielding crop varieties and adoption of improved Nutrient and Pest Management techniques. Similar results have been reported earlier by Haque (2000), Jeengar *et al.* (2006) and Dhaka *et al.* (2010). The year wise fluctuation in yields was observed mainly on the account of variations in soil fertility status and moisture availability due to untimely rainfall every year (Table 4). Maize and paddy also recorded higher productivity in the year 2009-10 which might be due to rainfall received on the critical stages of crop growth. Similarly, Wheat recorded higher productivity of 34.13 qha^{-1}in improved technologies compared to local check (21.50 q ha^{-1}). The increase in the productivity of wheat over local check was 58.72 %. The yield improvement in wheat might be due to combined effect of high yielding, moderate disease resistant varieties & adoption of improved Weed and Nutritional Management. Similar yield enhancement in different crops in front line demonstration has amply been documented by Haque (2000), Tiwari *et al*. (2003), Mishra *et al*. (2009) and Kumar *et al*. (2010).Yield of the front line demonstration trials and potential yield of the crop was compared to estimate the yield gaps which were further categorized into technology and extension gaps (Hiremath and Nagaraju, 2009). The technology gap shows the gap in the demonstration yield over potential yield and it was highest in paddy (18.45 q ha^{-1}) in comparison to wheat (15.88 q ha^{-1}) and maize (10.75 q ha^{-1}). The observed technology gap was mainly attributed to rainfed conditions prevailing in the district. The other reasons include dissimilarity in soil fertility status, marginal land holdings and hilly terrain. Further the higher extension gap of 14.18 q ha^{-1} was recorded in Maize after wheat (12.63 q ha^{-1}) and paddy (9.31q ha^{-1}). This emphasized the need to educate the farmers through various extension means for the adoption of scientific practices in cultivation of all the cereal crops. Mukharjee (2003) has also opined that depending on identification and use of farming situation, specific interventions may have greater implications in enhancing system productivity. The data presented in Table 3 revealed that, the technology index was minimum for maize (26.88%) compared to wheat (31.75%) and paddy (40.99%). Technology index shows the feasibility of evolved technology at the farmer's field and lower the value of technology index more is the feasibility of the technology (Jeengar *et al*. 2006).The inputs and outputs prices of commodities prevailed during each year of demonstrations were taken for calculating cost of cultivation, net return and benefit cost ratio (Table 4). The economic analysis of the data over two years revealed that paddy under front line demonstrations recorded higher gross returns (Rs.61082 ha^{-1}.), net return (Rs. 36547 ha^{-1}) and B:C. ratio (2.49) as compared to the local check where farmers got gross returns, net returns and B:C ratio of Rs. 39750 ha^{-1}, Rs. 18035 ha^{-1} and1.83 respectively. Maize also recorded higher gross returns of Rs. 31294 ha^{-1}, net return of Rs. 14226 ha^{-1} and B:C ratio of 1.83 in improved technologies as compared to the local check where farmers got gross returns, net returns and B:C ratio of Rs. 16126ha^{-1}, Rs. 4341ha^{-1} &1.37, respectively. Similarly, wheat recorded gross returns of Rs. 52434 ha^{-1}, net return Rs. 32338 ha^{-1} and B:C ratio of 2.61 as compared to the local check where farmers got gross returns, net returns and B:C ratio of Rs. 33075 ha^{-1}, Rs. 14395 ha^{-1}& 1.77, respectively. These are in corroboration with the finding of Tomar (2010) and Mokidue et al. (2011).

CONCLUSION

Thus, the cultivation of cereal crops with improved technologies including suitable varieties, Weed Management, Nutrients and Pest Management has been found more productive and grain yield in maize, paddy and wheat was increased up to 94.03, 53.94, and 58.72 per cent, respectively. Technological and extension gaps existed which can be bridged by popularizing package of practices with emphasis on the seed of improved crop varieties, use of proper seed rate, balanced nutrient application and proper use of plant protection measures. Replacement of local varieties with the released varieties of maize, paddy and wheat would increase the production and net income of these crops.

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