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Research Article

Enhancing marketable yield of vegetables through front line demonstrations in Dungarpur district of Rajasthan

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SUMMARY : Dungarpur is one of the most backward districts of Rajasthan (India) having 70.8 per cent of populations are tribal. Chilli (*Capsicum annuum*), bottle gourd (*Lagenaria sineraria*) and tomato (*Lycopersicon esculentum*) are the three major vegetable crops grown in the district. Farm Science Centre known as Krishi Vigyan Kendra laid down front line demonstrations on these three vegetable crops under NAIP project by introducing hybrid varieties and applying scientific package of practices in their cultivation. The productivity and economic returns of chilli, bottle gourd and tomato in improved technologies were calculated and compared with the corresponding farmer's practices (local checks). All the three vegetable 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 vegetable crops grown in the district.

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KEY WORDS :
Front line demonstrations, Technology, Extension gaps, Technology index, Improved technologies, Economics

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BACKGROUND AND OBJECTIVES

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 technologies 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 vegetable crops without proper use of recommended scientific package of practices. Keeping in view the constraints, Krishi Vigyan Kendra Dungarpur conducted front line demonstrations on major vegetable crops which would ensure livelihood, nutritional security and economic empowerment of tribal households at faster pace.

RESOURCES 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 (Agro climatic Zone IV b). 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 per cent of the total area of Rajasthan. Average land holding is 0.67 hectare per capita, which is lowest in the state. Most parts of the district are 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. Dungarpur is one of the most backward districts of Rajasthan (India) having 70.8 per cent of populations are tribal (Population Census, 2011). There are three major vegetable crops being cultivated in Dungarpur which includes chilli, bottle gourd and tomato. Table A shows the area, total production and productivity of major vegetable crops cultivated in the India during 2010-11 (Indian Horticulture Database, 2011). It is evident that 58.5 per cent of the total vegetables cultivated area has been covered under okra, onion, brinjal, potato and tomato crops in India and 62.7 per cent of total vegetable production is covered by these vegetables. In Rajasthan, the total area under vegetable production is 143.92 thousand hectares with the production of 620.11 thousand metric tons (Govt. of Rajasthan, 2010-11). 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) of chilli, bottle gourd and tomato vegetable crops. 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, 2007). The data on production cost and monetary returns was collected for five years (2007-08 to 2011-12) from front line demonstration plots to workout the economic feasibility of improved and scientific cultivation of vegetables. Besides, the data from local checks, data were also collected where farmers were using their own practices for cultivation of vegetable crops. The technology gaps, extension gaps and technology index were calculated as given by Samui *et al*. (2000) as:

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – Yield from farmers practice (Local check)

$$\textbf{Technology index} = \frac{\textbf{Potential yield - Demonstration yield}}{\textbf{Potential yield}} \textbf{x100}$$

Table A: Area, production and productivity of major vegetable crops cultivated in the India (2010-11)

Vegetable	Area (in 000'ha)	% of total vegetable area	Production (in 000'MT)	% of total vegetable production	Productivity (in MT/ha)
Okra	498.0	5.9	5784.0	3.9	11.6
Onion	1064.0	12.5	15118.0	10.3	14.2
Brinjal	680.0	8.0	11896.0	8.1	17.5
Potato	1863.0	21.9	42339.0	28.9	22.7
Tomato	865.0	10.2	16526.0	11.5	19.5
Other vegetables	3525.0		54891.0		
Total	8495.0		146554.0		

OBSERVATIONS AND ANALYSIS

The experimental findings obtained from the present study have been discussed in following heads:

Description of front line demonstrations:

The details of demonstrations conducted by Krishi Vigyan Kendra, Dungarpur are presented in Table 1. In each

Table 1: Particulars showing the details of vegetables growing under front line demonstrations and farmers practices

Crop	Particulars	Farmers practices (Local checks)	Front line demonstrations (Improved technologies)	2007-08		2008-09		2009-10		2010-11		2011-12		Total	
				Area (ha)	No. of farmers	Area (ha)	No. of farmers	Area (ha)	No. of farmers	Area (ha)	No. of farmers	Area (ha)	No. of farmers	Area (ha)	No. of farmers
Chilli															
	Variety	Local/ improved	Vaishnavi, (hybrid)	2.0	12	3.5	18	3.5	17	2.5	13	2.5	14	14.0	74
	Seed rate for nursery	700-800 gha^{-1}	500 gha^{-1}												
	Sowing	Crop geometry (40×30 cm)	Crop geometry (50×45cm)												
	Weed management	no use of herbicide	Basalin (Fluclorolin 45%EC)@1.6 lha^{-1} pre sowing												
	Nutrient management (N:P:K)	50:30:0	80:50:30												
	Pest management	No use of plant protection measures	Dimethoate 30EC @1.2lha^{-1} or Imidacloprid @250$mlha^{-1}$												
Bottle gourd															
	Variety	Local	Pusa Sankar3, Varad (hybrid)	2.0	10	2.5	12	2.5	12	1.5	7	1.5	8	10.0	49
	Seed rate	6-7 $kgha^{-1}$	5 $kgha^{-1}$												
	Sowing	Crop geometry (2-3m row spacing ×40-50cm plant spacing)	Crop geometry (3.5m row spacing ×60cm plant spacing)												
	Weed management	No use of herbicide	Butaclor 50EC @4.0lha^{-1} pre emergence												
	Nutrient management (N:P:K)	40:40:0	80:50:30												
	Pest management	No. use of plant protection measures	Dimethoate 30EC @1.2lha^{-1}												
Tomato															
	Variety	Local/improved	Dev (hybrid)	3.0	15	3.5	17	4.0	20	3.5	17	3.0	15	17.0	84
	Seed rate for nursery	500-600gha^{-1}	400gha^{-1}												
	Sowing	Crop geometry (50×40 cm)	Crop geometry (60×45cm)												
	Weed management	No use of herbicide	Basalin (fluclorolin)@1.6lha^{-1} pre transplanting												
	Nutrient management (N:P:K)	60:30:0	80:60:30												
	Pest management	No use of plant protection measures	Dimethoate 30EC @1.2lha^{-1}												

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

Chilli (Capsicum annuum):

The improved technologies included improved hybrid variety (Vaishnavi), nutrient management (80:50:30 NPK kgha^{-1}) and integrated pest management (Pheromone trap @5/ha + Dimethoate 30EC @1.2lha^{-1} or Imidacloprid @250mlha^{-1}) were tested under demonstrations. The seeds of chilli were sown in the raise bed nursery. The size of 15-20cm height, 45cm width and length as needed raise bed nursery were prepared, the seeds were sown in 5-7cm row distance and 1-2cm deep. After sowing of seeds in the raise bed, watering was done by water cane or sprinkler. The seed were sown between 2nd to last week of April. After 35-40 days, single seedling per hill was transplanted from nursery to field with crop geometry of 50×45cm. The whole of phosphorus and potash in the form of diammonium phosphate (DAP) and murat of potash (MOP) were applied as basal dose and nitrogen in the form of urea was top dressed in two equal splits at 15 days and 35 days after transplanting. The herbicide, basalin (fluclorolin 45%EC) @ 1.6lha^{-1} was applied at pre sowing of chilli crop. The dimethoate 30EC @1.2lha^{-1} or Imidacloprid @250mlha^{-1} was applied at the time of incidence of yellow mosaic virus.

Bottle gourd (*Lagenaria sineraria*):

Farmers were using local or improved variety of bottle gourd. The seed rate used by the farmers was very high (6-7 kgha^{-1}). Chemical fertilizers *i.e.* urea and DAP were used by the farmers. Improved technologies included improved hybrid varieties (Pusa Sankar 3, and Varad), nutrient management (80:50:30 NPK kgha^{-1}) and weed management (Butaclor 50EC @4.0lha^{-1} pre emergence) were tested. The seeds were sown with crop geometry of 3.5m row to row spacing and 60cm plant to plant spacing following the ridge and furrow method in the month of February. The whole of the phosphorus and potash were applied in the form of diammonium phosphate and murat of potash as basal dose and nitrogen in the form of urea was top dressed in two equal splits at Ist and IIIrd irrigation. For the control of weeds, butaclor 50EC @4.0lha^{-1} was applied at pre emergence of the crop. Dimethoate 30EC @1.2lha^{-1} was used for the control of mosaic.

Tomato (*Lycopersicon esculentum*):

In case of tomato (Table 1), farmers were using local or improved varieties of tomato. The farmers were sowing the seeds in flat bed using broadcast method without the use of any herbicides. In improved technologies, included hybrid variety (Dev), nutrient management (80:60:30 NPK kgha^{-1}) and weed management basalin (fluclorolin)@1.6lha^{-1} at pre transplanting) were tested. Tomato crop was sown between Ist to 3rd week of July by using seed @ 400g ha^{-1}.The seeds of tomato were sown in the raise bed nursery. The size of 15-20cm height, 45cm width and length as needed raise bed nursery were prepared, the seeds were sown in 5-7cm row distance and 1-2cm deep. After sowing of seeds in the raise bed, watering was done by water cane or sprinkler. After 35-40 days, seedling of tomato were transplanted in the field with crop geometry of 60×45cm. 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 15 and 35 days after transplanting of crop. For the control of weeds, Basalin (fluclorolin) @1.6lha^{-1} was applied before transplanting of the crop. At the incidence of mosaic, dimethoate 30EC @1.2lha^{-1} was applied.

Economic impact of front line demonstrations:

During the period of study, it was observed that in front line demonstrations of improved technologies increased productivity of all the vegetables over respective local checks (Table 2). The improved technologies recorded higher productivity of chilli and tomato 68.33q ha^{-1}, 238.20q ha^{-1} as compared to farmers practices (local checks) 40.32q ha^{-1}, 152.96q ha^{-1}, respectively. The increase in productivity of chilli and tomato over respective local checks were 69.47 per cent and 55.73 per cent. The higher productivity of chilli and tomato under improved technologies were due to the sowing of latest high yielding varieties and adoption of improved nutrient and pest management techniques. Similar results have been reported earlier by Hiremath and Nagaraju (2009) and Dhaka *et al*. (2010). The year wise fluctuation in

Table 2: Productivity of vegetables, 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				
Chilli (Green)	74	14	85	68.33	40.32	69.47	16.67	28.01	19.61
Bottle gourd	49	10	200	173.80	124.60	39.49	26.20	49.20	13.10
Tomato	84	17	300	238.20	152.96	55.73	61.80	85.24	20.60

Table 3: Economics of vegetables production under front line demonstrations and farmers practices (local checks)

Particulars		Yield (q/ha)		Cost of cultivation ($Rs.ha^{-1}$)		Additional cost of cultivation over local (Rs./ha	Gross returns ($Rs.ha^{-1}$)		Net Returns (Rs/ha)		Additional Net returns over local ($Rs.ha^{-1}$)	B:C Ratio	
		Improved technologies	Local check	Improved technologies	Local check		Improved technologies	Local check	Improved technologies	Local check		Improved technologies	Local check
2007-08	Chilli (Green)	65.75	40.60	34813	28310	6503	69038	42630	34225	14320	19905	1.98	1.51
	Bottle gourd	173.00	123.00	32169	27450	4719	64010	45510	31841	18060	13781	1.99	1.66
	tomato	249.00	161.80	44934	35268	9666	174300	113260	129366	77992	51374	3.88	3.21
2008-09	Chilli (Green)	73.00	42.50	36413	28870	7543	81760	47600	45347	18730	26617	2.25	1.65
	Bottle gourd	164.00	120.00	33069	27890	5179	72160	52800	39091	24910	14181	2.18	1.89
	tomato	235.00	153.00	46400	35830	10570	164500	107100	118100	71270	46830	3.55	2.99
2009-10	Chilli (Green)	70.50	41.25	40613	32970	7643	83190	48675	42577	15705	26872	2.05	1.48
	Bottle gourd	175.00	124.00	36269	31090	5179	87500	62000	51231	30910	20321	2.41	1.99
	tomato	229.00	156.00	48800	38030	10770	183200	124800	134400	86770	47630	3.75	3.28
2010-11	Chilli (Green)	68.40	39.50	42313	34970	7343	85500	49375	43187	14405	28782	2.02	1.41
	Bottle gourd	180.00	126.00	37169	31890	5279	117000	70560	79831	38670	41161	3.15	2.21
	tomato	238.00	158.00	49790	39130	10660	226100	142200	176310	103070	73240	4.54	3.63
2011-12	Chilli (Green)	64.00	37.75	43613	35720	7893	85120	50208	41507	14488	27020	1.95	1.41
	Bottle gourd	177.00	130.00	38869	32790	6079	115050	84500	76181	51710	24471	2.96	2.58
	tomato	240.00	136.00	50700	41080	9620	228000	129200	177300	88120	89180	4.50	3.15
Overall	Chilli (Green)	68.33	40.32	39553	32168	7385	80922	47698	41369	15530	25839	2.05	1.48
	Bottle gourd	173.80	124.60	35509	30222	5287	91144	63074	55635	32852	22783	2.57	2.09
	tomato	238.20	152.96	48125	37868	10257	195220	123312	147095	85444	61651	4.06	3.26

yields was observed mainly on the account of variations in soil fertility status and moisture availability due to untimely rainfall every year (Table 3). Similarly, bottle gourd recorded higher productivity of 173.80qha^{-1} in improved technologies as compared to local check (124.60q ha^{-1}). The increase in the productivity of bottle gourd over local check was 39.49 per cent. The yield improvement in bottle gourd might be due to combined effect of high yielding, moderate disease resistant hybrid varieties and adoption of improved weed and nutritional management. Similar yield enhancement in different crops in front line demonstration has amply been documented by 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 showed the gap in the demonstration yield over potential yield and it was highest in tomato (61.80q ha^{-1}) in comparison to bottle gourd (26.20q ha^{-1}) and chilli (16.67q ha^{-1}). The observed technology gap was mainly attributed to rainfed conditions prevailing in the district. The other reasons included dissimilarity in soil fertility status, marginal land holdings and hilly terrain. Further the higher extension gap of 85.24q ha^{-1} was recorded in tomato after bottle gourd (49.20q ha^{-1}) and chilli (28.01q 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 vegetable 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 bottle gourd (13.10%) compared to chilli (19.61%) and tomato (20.60%). 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 five years revealed that tomato under front line demonstrations recorded higher gross returns (Rs. 195220 ha^{-1}), higher net return (Rs. 147095 ha^{-1}) and height B:C. ratio (4.06) as compared to their local checks of tomato crops where farmers got gross returns, net returns and B:C ratio of Rs. 123312 ha^{-1}, Rs. 85444 ha^{-1} and 3.26, respectively. Bottle gourd also recorded higher gross returns of Rs. 91144 ha^{-1} and B:C ratio 2.57 in improved technologies as compared to their local checks *i.e.* 63074

ha^{-1} and 2.09, respectively. The chilli crop under improved technologies recorded higher additional net returns of Rs. 25839 ha^{-1} which was higher than its local check and bottle gourd improved technologies and their local check. The tomato crop recorded highest B:C ratio of 4.06 as compared to its local check and bottle gourd, chilli improved technologies and their local checks. The highest net returns of Rs. 147095 ha^{-1} was recorded under improved technologies of tomato crop as compared to all the improved technologies of vegetable crop and their local checks. These are in corroboration with the finding of Mishra *et al.* (2009), Tomar (2010) and Mokidue *et al.* (2011).

Conclusion:

Thus, the cultivation of vegetable crops with improved technologies including suitable varieties, weed management, nutrients and pest management has been found more productive and yield of chilli, bottle gourd and tomato was increased up to 69.47, 39.49, and 55.73 per cent, respectively. Technological and extension gaps existed which can be bridged by popularizing package of practices with emphasis on the seed of improved vegetable hybrid varieties, use of proper seed rate, balanced nutrient application and proper use of plant protection measures. Replacement of local varieties with the released hybrid varieties of chilli, bottle gourd and tomato would increase the production and net income of these vegetable crops.

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