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Research Article

Economic Impact of Front Line Demonstrations on Vegetables in Tiap District of Arunachal Pradesh

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ABSTRACT

Tirap is one of the most backward districts of Arunachal Pradesh (India) having 88.2 % of populations are tribal. Okra (Abelmoschus esculentus), Onion (Allium cepa L.) and Brinjal (Solanum melongena L.) 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; by introducing improved and hybrid varieties and applying scientific package of practices in their cultivation. The productivity and economic returns of okra, onion and brinjal 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.

Key words: *Vegetable crops, Front line demonstrations, Technology and extension gaps, Technology index, Improved technologies, Economics.*

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[2].

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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[15]. The baseline survey was conducted by Krishi Vigyan Kendra, Tirap during 2012-13. In the trial, a bouquet of 15 technologies were tested in Deomali cluster consisting of 5 villages and involving 354 households in Noitong, Otonkhowa, Deomali , Namsang and Nutan basti 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 Tirap conducted front line demonstrations on major vegetable crops which would ensure livelihood, nutritional security and economic empowerment of tribal households at faster pace.

MATERIAL AND METHODS

Profile of the study area

Krishi Vigyan Kendra, Tirap (situated at 26.91°N latitude, 95.50°E longitude and an altitude of 1215 m above msl) belonging to Hot and Humid Eastern district of Arunachal Pradesh. Tirap district is the second smallest district of the state covering an area of 236200 hectares only, which is 2.82 percent of the total area of Arunachal Pradesh. Average land holding is 2.17 hectare per capita, which is lowest in the state. Most parts of the district are covered by hills and foot hills. Agriculture is the main source of the livelihood in the Tirap district of Arunachal Praesh with a gross cropped area of 81517 hectare[4]. The district has a semi humid climate with average temperature of the district varies from 18.8-35^{0}C in summer and 6.5-24^{0}C in winter and annual rainfall is about 3457 mm. Tirap is one of the most backward districts of Arunachal Pradesh (India) having 88.2 % of populations are tribal[13]. There are three major vegetable crops being cultivated in Tirap which includes okra, onion and brinjal.

Table 1: Area, production and productivity of Okra, Onion and Brinjal crops cultivated in the India (2015-16)

Vegetable	Area (in 000' ha)	% of total vegetable area	Production (in 000' MT)	% of total vegetable production	Productivity (in MT/ha)
Okra	511	5.02	5849	3.45	11.00
Onion	1320	13.06	20931	12.34	16.00
Brinjal	663	6.56	12515	7.40	19.00
Other Veg.	1625	22707			
Total	10106	169064			

Table 1 shows the area, total production and productivity of okra, onion and brinjal vegetable crops cultivated in the India during 2015-16[7]. It is evident that 24.6 per cent of the total vegetables cultivated area has been covered under okra, onion and brinjal in India. The 13.06 area of total vegetables comes under onion crop and per cent of total vegetable

production 12.34 is covered by onion crop. In Arunachal Pradeh, the total area under vegetable production is 10106 thousand hectares with the production of 169064 thousand metric tons[4]. The present investigation was carried out in the adopted villages (Noitong, Otonkhowa, Deomali, Namsang and Nutan basti) located in the operational area of Krishi Vigyan Kendra Tirap 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 okra, onion and brinjal vegetable crops. Soil of the study area is sandy in texture with acidic in reaction (pH 5.3), high organic carbon (2.47 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 Asam Agricultural University, Jorhat[1]. The data on production cost and monetary returns was collected for five years (2012-13 to 2016-17) from front line demonstration plots to work out 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.*[14] as:

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension gap} = \text{Demonstration yield} - \text{Yield from farmers practice (Local check)}$$

$$\text{Technology index} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential Yield}} \times 100$$

Table 2: Particulars showing the details of vegetables under Front line demonstrations and farmers practices

Crop Particulars	Farmers Practices (Local checks)	FLD (improved technologies)	2012 - 13		2013 - 14		2014 - 15		2015 - 16		2016 – 17		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
Okra														
Variety	Local/improved	VRO-6, Arka Anamika	2	28	3	46	3	46	4	52	4	58	16	230
Seed rate	25 kgha^{-1}	20 kgha^{-1}												
Sowing	Crop geometry (15 x 15 cm)	Crop geometry (15 x 15 cm)												
Weed Management	no use of herbicide	Basalin @1.6 l ha^{-1} pre sowing												
Nutrient Management (NPK)	20:40:30	80:40:40												
Onion														
Variety	Local	N-53	1.5	10	1.5	12	2	16	2	18	2	23	9	79
Seed treatment	no seed treatment	Thiram @ 2.5 g kg^{-1}												
Seed rate for nursery	12-15 kg ha^{-1}	8-10 kgha^{-1}												
weed management	no use of herbicide	Pendimethaline 30% EC @ 3 l ha^{-1} pre transplanting												
Nutrient Management (N:P:K)	20:40:0	40:50:70												
Pest management	no use of plant protection measures	Dithane M 45 @ 1.0 l ha^{-1}												
Brinjal														
Variety	local	Pusa purple long	2	18	2	21	3	34	3	30	4	42	14	145
Seed rate for Nursery	600 gm ha^{-1}	400 gm $^{-1}$												
Sowing	Crop geometry (50 x 40 cm)	Crop geometry (70 x 60 cm)												

Weed management	no use of herbicide	Basalin 1.6 l ha^{-1} pre transplanting
Nutrient management (N:P:K)	15: 30:0	50: 60: 30
Pest management	no use of plant protection measures	Profenophos @ 1.2 l ha $^{-1}$

Table 3: Productivity of vegetables, yield gaps and technology index (average over years)

Crop	No. of Demons-trations	Area (ha)	Productivity (qha^{-1}) Potential	Improved technologies	Local check	Percent increase over	Technology gap (qha^{-1})	Extension gap (qha^{-1})	Technology index (%)
Okra	230	16	120	94	76	23	26	18	21.66
Onion	79	9	210	178	116	53	32	62	15.24
Brinjal	145	14	290	227	183	24	63	44	21.72

Table 4: Economics of vegetables production under front line demonstrations and farmers practices (local checks)

Particulars	Yield (qha^{-1}) T	Yield (qha^{-1}) C	Cost of cult. (Rs.ha^{-1}) T	Cost of cult. (Rs.ha^{-1}) C	Additional cost of cult. Over local (Rs. ha^{-1})	Gross returns (Rs. ha^{-1}) T	Gross returns (Rs. ha^{-1}) C	Net Returns (Rs. ha^{-1}) T	Net Returns (Rs. ha^{-1}) C	Additional net return over local (Rs. ha^{-1})	B:C Ratio T	B:C Ratio C
2012-13 Okra	95	64	56749	43730		172841	108376	97825	64646	33179	3.04	2.48
Onion	167	106	36042	31042		117379	81830	76987	50788	26199	3.25	2.63
Brinjal	221	187	69340	56218		183480	123047	105809	66829	38980	2.65	1.18
2013-14 Okra	93	89	56982	44620		152027	102402	76071	57782	18289	2.67	2.30
Onion	187	117	37379	32876		134248	96256	96869	63380	33489	3.59	2.92
Brinjal	214	194	70821	57263		170278	129314	90705	49741	40964	2.40	2.25
2014-15 Okra	91	81	57914	45286		178000	113026	100354	67740	32614	3.07	2.49
Onion	174	115	38627	33685		153238	104927	109111	71242	37869	3.96	3.11
Brinjal	226	176	71638	59856		192375	109271	112237	49415	62822	3.11	2.68
2015-16 Okra	92	79	59326	46218		192378	123487	111789	77269	34520	3.24	2.67
Onion	168	119	39824	35624		121205	81926	75381	46302	29079	3.04	2.30
Brinjal	233	177	72654	61382		199072	110842	117097	49460	67637	2.74	1.80
2016-17 Okra	99	67	60621	48195		187290	102367	104997	62600	42397	3.08	2.12
Onion	194	123	40628	37831		192821	118283	130521	75455	55066	4.74	3.12
Brinjal	241	181	73638	63129		203567	113928	120340	50799	69541	2.76	1.80
Overall Okra	94	74	58318	45609	9981	176507	109931	98207	66007	32200	3.02	2.41
Onion	178	116	38500	34212	5005	143778	96644	110433	61465	48968	3.73	1.80
Brinjal	230	183	71618	59569	8898	189754	117280	119237	84357	34880	2.65	1.97

Note - T indicates Trials of Demonstrations and C indicates Local Checks

RESULTS AND DISCUSSION

Description of Front Line Demonstrations

The details of demonstrations conducted by Krishi Vigyan Kendra, Tirap 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 technologies adopted in front line demonstrations and farmers practices (local checks) adopted by farmers in different vegetable crops are summarized as below.

Okra

The improved technologies included improved hybrid varieties (cv. Bhindi VRO-6 and Cylinder), nutrient management 80:40:40 NPK kgha^{-1}) and pest management (Dimethoate 30EC @1.2 l ha^{-1} and Malathion 35EC@ 1.2 l ha-1) were tested under demonstrations. Crop was sown by using seed @ 20 kg ha-1 with crop geometry 30×15cm.

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 30 and 60 days after sowing. The herbicide, Basalin (fluclorolin 45 %EC) @ 1.6lha^{-1} was appllied at pre sowing of okra crop. The Dimethoate 30EC @1.2lha^{-1} was applied at the time of incidence of yellow mosaic virus and Malathion 35EC@1.2 lha-1 was applied for the control of fruit borer.

Onion

Farmers were using local variety of onion. The seed rate used by the farmers was very high (12-15 kg ha^{-1}). Chemical fertilizers i.e. Urea and DAP were used by the farmers. In improved technologies includes improved varieties (cv. N 53 and AFDR and seeds was treated with Thiram @ 2.5g kg-1seed), nutrient management (40:40:30 NPK kgha-1) and weed management (Pendamethalin 30%EC @3.0lha-1 pre transplanting) were tested. The seeds of onion 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 3rd week of October to 1st week of November. After 35-40 days, single seedling per hill was transplanted from nursery to field with crop geometry of 15×10 cm. 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 30 and 45 days after transplanting. For the control of weeds, Pendamethalin 30% EC @3.0lha^{-1} was applied before transplanting of the crop. Dithane M-45 @1.0lha-1 was use for the control of purple blotch in onion (*Alternaria porri*).

Brinjal

In case of brinjal (Table 2), farmers were using local or improved varieties of brinjal. The farmers were owing the seeds in flat bed using broadcast method without the use of any herbicides. In improved technologies, included Improved variety- Pusa Purple Long, nutrient management (90:60:50 NPK kgha-1) and weed management (Fluclorolin 45%EC @1.6lha-1 at pre transplanting) were tested. Brinjal crop was sown between Ist week to 3rd week of November by using seed @ 400g ha-^{1}. The seeds of brinjal 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 30-35 days, seedling of brinjal were transplanted in the field with crop geometry of 70×60cm. 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 transplanting of crop. For the control of weeds, Basalin (fluclorolin) @1.6lha-1 was applied before transplanting of the crop. At the incidence of shoot borer (*Leucinodes orbonalis*), Profenophos @ 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 3). The improved technologies recorded higher productivity of brinjal and onion 230 q ha^{-1} 178 q ha^{-1} as compared to farmers practices (local checks) 183 q ha^{-1}, 116 q ha^{-1}, respectively. The increase in productivity of brinjal and onion over respective local checks were 24 % and 53 %. The higher productivity of brinjal and onion 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 Haque[5], Hiremath and Nagaraju[6] and Dhaka *et al.*[3]. 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). Similarly, okra recorded higher productivity of 94 qha^{-1} in improved technologies as compared to local check (76 q ha^{-1}). The increase in the productivity of okra over local check was 23 %. The yield improvement in okra 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 Haque[5], Tiwari *et al.*[16], Mishra *et al.*[10] and Kumar *et al.*[9]. 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[6]. The technology gap shows the gap in the demonstration yield over potential yield and it was highest in brinjal (63 q ha^{-1}) in comparison to onion (32 q ha^{-1}) and okra (26 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 62 q ha^{-1} was recorded in onion after brinjal (44 q ha^{-1}) and okra (18 q 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[12] 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 onion (15.24%) compared to okra (21.66 %) and brinjal (21.72 %).

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[8]. 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 brinjal under front line demonstrations recorded higher gross returns (Rs. 189754 ha^{-1}) and net return (Rs. 119237 ha^{-1}) while onion recorded height B: C ratio (3.73) as compared to their local checks of respective vegetable crops where farmers got gross returns, net returns and B: C ratio of Rs. 117280 ha^{-1}, Rs. 84357 ha^{-1} and 1.80, respectively. Onion recorded maximum additional ret return (Rs. 48968) fallowed by Brinjal (Rs.34880) while Okra recorded minimum (Rs. 32200). These are in corroboration with the finding of Mishra *et al.*[10], Tomar[17] and Mokidue *et al.*

CONCLUSIONS

Thus, the cultivation of vegetable crops with improved technologies including suitable varieties, weed management, nutrients and pest management has been found more productive and fruit yield in okra, onion and brinjal was increased up to 23, 53, and 24 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 okra, onion and brinjal would increase the production and net income of these vegetable crops.

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