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Yield gap analysis through Front Line Demonstration in Castor (*Ricinus communis* L.) crop in Chitradurga districts of Karnataka

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Abstract: *Chitradurga is one of the most backward districts of Karnataka (India). Castor (*Ricinus communis *L.) crop is the major oilseeds crop grown in the district. Zonal Agricultural and Horticultural Research Station (ZAHRS) Hiriyur laid down front line demonstrations on castor crop under AICRP on Castor project by introducing improved and hybrid varieties and applying scientific package of practices in their cultivation. The productivity and economic returns of castor crop in improved technologies were calculated and compared with the corresponding farmer's practices (local checks). The castor crop 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 approaches would be needed to bridge the productivity gap of the castor crop grown in the district.*

Keywords: *Yield gap, castor, frontline demonstration technology, technology index, economics*

INTRODUCTION

Zonal Agricultural and Horticultural Research Station (ZAHRS), an innovative science–based institution, plays an important role in bringing the research scientists face to face with farmers. The main aim of Research Station 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. Research station and 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. Front line demonstration (FLD) is a long term educational activity conducted in a systematic manner in farmer's 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 rain fed 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 Zonal Agricultural and Horticultural Research Station, Chitradurga during 2012-13 to 2014-15 under All India Coordinated Research Project on Castor, the aim of project was to research a replicable model for sustainable rural livelihood security. In the project, a bouquet of eight technologies were tested in three villages and involving 75 households in Iddilanagenahalli Vanivilasa sagar and Kurubarhalli villages. It was found that farmers were using traditional old varieties

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of castor crop without proper use of recommended scientific package of practices. Keeping in view the constraints, ZAHRS Chitradurga conducted front line demonstrations on major castor crop which would ensure livelihood and economic empowerment of tribal households at faster pace.

MATERIALS AND METHODS

The present investigation was carried out in the adopted villages located in the operational area of Zonal Agricultural and Horticultural Research Station, Hiriyur, during the year 2012 to 2015 in three villages viz. Iddilanagenahalli, Vanivilas sagar and Kurubarahalli of district Chitradurga. Seventy five numbers of demonstrations was conducted in three villages with an 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 castor crop.

Castor in Karnataka is mainly grown as rain fed crop, in some pockets as irrigated crop and sporadically as border crop/ inter crop in the fields of groundnut, finger millet. The districts namely Chitradurga, Davangere, Hasan, Shivamogga, Tumkur, Bangalore rural and Chikkamangalore are important in their contribution to the increase in the area and production of castor in Karnataka. Table 1 shows the area, total production and productivity of castor crop cultivated in the Karnataka during 2014-15 (Anonymous, 2015). Chitradurga belonging to Deccan plateau, hot semi arid eco region (Central Dry Zone IV of Karnataka). Chitradurga district covering an area of 7,70,700 hectares, agriculture is the main source of the livelihood in the Chitradurga district with a gross cropped area of 4,81,430 hectare (Source:, *www.raitamithra.kar.nic.in* 2008-09). Soil of the study area is clay loam in texture with alkaline in reaction (pH 8.3- 8.7), low organic carbon (0.54 g kg^{-1} soil), low nitrogen (200 -250 kg ha^{-1}), medium phosphorus (10-15 kg ha^{-1}) and high in available potassium (225 kg ha^{-1}).

The critical inputs were applied as per the scientific package of practices recommended by the research wing of University of Agriculture Sciences, Bangalore (Table 2). The component demonstration of front line technology in castor was comprised of improved hybrids DCH-177, proper tillage, proper seed rate and sowing method, balance dose of fertilizer (40 kg Nitrogen + 40 kg P_2O_5 /ha + 20 kg K_2O), use of Trichoderma @ 5-10 g/kg of seed as seed treatment, proper irrigation, weed management and protection measure (Table 2). The data on production cost and monetary returns were collected for three years (2012-13 to 2014-15) from front line demonstration plots to work out the economic feasibility of improved and scientific cultivation of castor. Besides, the data from local checks, data were also collected where farmers were using their own practices for cultivation of castor crops. The technology gaps, extension gaps and technology index were calculated as given by Samui *et al.,* (2000) as:

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

RESULTS AND DISCUSSION

Description of Front Line Demonstrations

The details of demonstrations conducted by Zonal Agricultural and Horticultural Research Station, Chitradurga are presented in Table 2,3 and 4. 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 villages of castor crops are summarized as below.

In improved technologies, included hybrid variety (DCH-177), nutrient management (40:40:20 NPK kg ha^{-1}) 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 30 and 45 days after sowing of crop. For the control of weeds, Pendimethalin 1.0 kg ha^{-1} was applied two to three days after sowing of the crop. At the incidence of semilooper, methomyl @1.5 kg ha^{-1} was applied. The crop was sown between 1^{st} week to 3^{rd} week of June by using seed @ 5 kg ha^{-1}. The seeds of castor were sown in the line. The seeds were sown in 5-7 cm deep with crop geometry of 60×90cm.

Technology intervention and farmers practice under FLD on castor

The gap between the existing and recommended technologies of castor in district Chitradurga

Table 1
Castor area, production and productivity in Chitradurga and Karnataka.

Year	*Area (ha)*		*Production (tonnes)*		*Productivity (kg/ha)*	
	Chitradurga	*Karnataka*	*Chitradurga*	*Karnataka*	*Chitradurga*	*Karnataka*
2011-12	4275	12000	1978	12000	1183	1000
2012-13	3417	11000	3840	7000	1026	836
2013-14	5970	19000	6709	16000	1183	842

Table 2
Difference between technology intervention and farmers practice under FLD on castor

Particulars	*Technology intervention*	*Existing practice*	*Gap*
Hybrid	DCH-177	Old& degenerated	Full gap
Land preperation	Three ploughing	Three ploughing	Nil
Seed rate	8-10kg/ha	15-20kg/ha	Higher seed rate
Sowing method	Line sowing (PXP 60cm) (RXR 90 cm) and 6 cm depth	Line sowing (PXP 45cm) (RXR 90 cm) and 8 cm depth	Partial gap
Seed treatment	Trichoderma powder @ 5-10 g/kg of seeds	No seed treatment	Full gap
Fertilizer dose	40:40:20 kg NPK/ha	No use of fertiliser	Full gap
Weed management	Pre-emergence application of Pendimethalin @1.0 kg a.i./ha along with intercultivation at 45DAS	One hand weeding	Partial gap
Plant protection	Need based plant protection measure	No plant protection	Full gap

Table 3
Economics of castor production under frontline demonstrations and farmers practice in Chitradurga district

Year	*Village*	*Mean seed yield (q/ha)*		*% increase in yield*	*Cost of cultivation (Rs/ha)*		*Gross returns (Rs/ha)*		*Additional net returns (Rs/ha)*	*B:C ratio*	
		IT	*LC*		*IT*	*LC*	*IT*	*LC*		*IT*	*LC*
2012-13	Iddilanagenahalli	12.3	8.5	45.1	11000	8200	43225	29785	10640	3.9	3.6
2013-14	Vanivilasasagar	9.9	6.6	50.1	11300	7537	35568	23688	8117	3.1	3.1
2014-15	Kurubarhalli	10.8	7.0	55.3	14250	9320	38880	25020	8930	2.7	2.6
	Overall	11.0	7.3	50.1	12183	8352	39195	26130	9234	3.2	3.1

Table 4
Productivity of castor, yield gaps and technology index.

Year	*Village*	*No.of Demonstrations*	*Productivity (q/ha)*			*% increase over local*	*Technology gap (q/ha)*	*Extension gap (q/ha)*	*Technology index (%)*
			Potential	*IT*	*LC*				
2012-13	Iddilanagenahalli	25	20	12.3	8.5	45.1	7.7	3.8	38.5
2013-14	Vanivilasasagar	25	20	9.9	6.6	50.1	10.1	3.3	50.5
2014-15	Kurubarhalli	25	20	10.8	7.0	55.3	9.2	3.8	46
	Overall	75	20	11.0	7.3	50.6	9.0	3.6	45

presented in table 2. Full gap was observed in case of use of high yielding hybrids, seed treatment, fertilizer dose and plant protection and partial gap was observed in sowing method and weed management, which definitely was the reason of not achieving potential yield. Farmers were not aware about recommended technologies. Farmers in general used local or old-age varieties instead of the high yielding resistant varieties. Unavailability of seed in time and lack of awareness were the main reasons. Farmers followed closer method of line sowing against the recommended line sowing and using local or improved varieties of castor, because of this they applied higher seed rate than the recommended.

Economic Impact of Front Line Demonstrations:

During the period of study, 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 3). The economic analysis of the data over three years revealed that Iddilanagenahalli under front line demonstrations in improved technologies (IT) recorded higher productivity of seed yield (11.0 q/ ha), The increase in the productivity of castor crop over local check (LC) in Iddilanagenahalli village was 45.1% and higher gross returns (Rs. 43225 ha^{-1}), net return (Rs. 10640 ha^{-1}) and B:C. ratio (3.9) as compared to the local checks. Contrastingly, in Vanivilas sagar village also, the seed yield increase obtained from improved technologies to the tune of 50.1%, with a meager additional net returns of Rs 8117/ha. and B:C ratio was 3.1 for both situation. Similarly, In Kurubarahalli village, recorded higher productivity over local check was 55. 3%, with additional net returns of Rs 8930/ha. and the B:C ratio was 2.7 and 2.6 for improved technologies and farmers practices This results clearly indicated higher productivity of castor under improved technologies plots over the years compare to local check due to knowledge and adoption of full package of practices i.e. sowing of latest high yielding hybrids, adoption of improved nutrient, moderate disease resistant hybrid, adoption of improved weed and pest management techniques. Similar results have been reported earlier by (Padmaiah *et al*., 2012). 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

Technology gap

The technology gap shows the gap in the demonstration yield over potential yield and it was highest in Vanivilas sagar (10.1q ha^{-1}) in comparison to Kurubarhalli village (9.2 q ha^{-1}) and Iddilanagenahalli (7.7 q ha^{-1}). On an average technology gap under three year FLD programme was 9.0 q/ha. The observed technology gap was mainly attributed to rain fed conditions prevailing in the district. The other reasons include dissimilarity in soil fertility status, agricultural practices and local climatic situation.

Extension gap

Further the higher extension gap of 3.8 q ha^{-1} was recorded in Iddilanagenahalli and Kurubarhalli village as compare to Vanivilas sagar (3.3 q ha^{-1}). This emphasized the need to educate the farmers through various extension means i.e. front line demonstration for adoption of improved production and protection technologies, to revert the trend of wide extension gap. More and more use of latest production technologies with high yielding varieties will subsequently change this alarming trend of galloping extension gap. (Padmaiah *et al*., 2012) has also opined that depending on identification and use of farming situation, specific interventions may have greater implications in enhancing system productivity.

Technology Index

The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 38.5 to 50.5 per cent (Table 4). The technology index was minimum for Iddilanagenahalli (38.5%) compared to Kurubarhalli village (46.0%) and Vanivilas sagar (50.5%). On an average technology index was observed 45 per cent during the three years of FLD programme, 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 castor.

CONCLUSION

The FLD produces a significant positive result and provided the researcher an opportunity to demonstrate the productivity potential and profitability of the latest technology (Intervention) under real farming situation, which they have been advocating for long time. This could be circum vent some of the constraints in the existing transfer of technology system in the district Chitradurga of Karnataka. The productivity gain under FLD over existing practices of castor cultivation created greater awareness and motivated the other farmers to adopt suitable production technology of castor in the district. The constraints faced by the farmers were different for different technologies. Efforts should, therefore, be made by the extension agencies in their transfer of technology programmes to consider the constraints as perceived by the farmers in this investigations as well as personal. Therefore, for enhancing the production and productivity of castor crop strategy should be made for getting the more and more recommended technologies adopted by the farmers (Padmaiah *et al*., 2012). The variation in per cent increase in the yield was found due to the lack of knowledge, and poor socio-economic condition. With this study concluded that the FLDs programmes were effective in changing attitude, skill and knowledge of improved package and practices of HYV of castor adoption.

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