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RESEARCH ARTICLE

Technology Intervention in CFLD on Chickpea (*Cicer Arietinum* Linn) in Alwar district of Rajasthan, India

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ABSTRACT

The present investigation was carried out to evaluate the performance of improved variety with the scientific package of practices (POP) on production, productivity and profitability adoption and horizontal spread of chickpea. Three hundred CFLDs were conducted in 120 ha area with active participation of farmers and scientific staff of KVK. According to data analysis, the highest grain yield was obtained in demonstrated practices (DP) with an average of 2093 kg/ha as compared to farmer practice (FP) with an average of 1769 kg/ha, The average net return (Rs 662631 /ha) was obtained in the DP and Rs 528941 that was in FP. The most important factor B:C ratio indicates that whether CFLD technology is profitable or not. The average benefit cost ratio was recorded higher in CFLDs (3.36) as compared to FP (3.08) during the period of investigation. An average seedling, maturity and total wilt complex disease occurrence only 14.66, 11.79 and 26.45, respectively showed wilting symptoms in DP as compared to 18.48. 14.69 and 33.18, respectively in FP. Thus, the result undoubtedly indicates that the use of improved variety and POP with scientific interventions under CFLDs program contribute to increase the production, productivity and profitability of chickpea.

***Key words**: Cluster Frontline Demonstrations, Chick Pea, CSJ 515*

Pulses are a great source of vitamins, proteins, minerals, are also popularly known as "rich man's vegetable" and "Poor man's meat". It contributes significantly to the nutritional security of the country (Singh *et. al.* 2020). The frequency of consumption of pulses in the country is much higher than any other source of protein which indicates the importance of pulses in daily food habits (Raj *et al* 2013). Besides, pulses possess several other qualities such as they improve fertility and physical structure of the soil, crop rotations, dry farming, fit in mixed/ inter- cropping system and provide green pods for vegetables and nutritious fodder for cattle (Singh *et al* 2015). India is producing 25.23 million tons of pulses from an area of 29.99 million ha, which holds largest share (26%) of production and consumption (30%) of total pulses of the world. It has been expected that India's population would get to 1.68 billion in 2030 from the present level of 1.31 billion (IIPR 2030). The production share of important pulse crops are Chickpea (45.53 %), Pigeonpa (17.06 %). Urdbean (13.40 %), Mungbean (7.76 %), Field pea (5%) and Lentil (5%). Major areas under pulses are in the states likewise Madhya Pradesh (33%), Maharashtra (13%), Rajasthan (12%), Uttar Pradesh (9%), Karnataka (8%), Andhra Pradesh (5%), Gujarat (4%), Jharkhand (3%), Tamilnadu (2%) and Telangana (2%), which together accounts for about 91 percent of the total production (DES, 2018). The average productivity of pulses in *Rabi* season in the Rajasthan state is about 1159 kg/ ha in 2018-19 (Pocket Book of Agricultural Statistics 2020). KVKs are grass root level organizations intended for the application of technology through assessment, refinement and demonstration of confirmed production technologies under different micro farming situations in a district (*Das 2007*). The main objective of the frontline demonstration is to show the worth or value of the technology. The area, production and productivity of pulses in Rajasthan and Alwar are also quite low as compared to other states, national average and production. Chickpea (*Cicer arietinum* Linn) is a major pulse crop being grown in India occupies 38 percent area (28.28 million hectares) and 48 percent of the total pulse production (23.22 million tons) (*Anonymous, 2020*). In view of this, intensive interventions such as CFLDs on Chickpea were conducted at farmer's field in participatory mode by KVK Alwar 1 to introduce and disseminate improved varieties of chickpea to increase the crop yield during *Rabi* seasons of year 2016-17 to 2019-20.

METHODOLOGY

Alwar district comes under Agro climatic Zone III B (Flood Prone Eastern Plain) of Rajasthan state and agriculturally. The KVK, Alwar 1 conducted CFLDs under NFSM pulses scheme during *Rabi* seasons of year 2016-17 to 2019-20. Evaluation of the performance of new varices and package of practices (POP) on production, productivity and profitability of chickpea the demonstrations were conducted. Interested farmers were identified with the help of participatory rural appraisal (PRA) technique and after selection of farmer and their fields the demonstration were conducted with the active participation of farmers and scientists of KVK. Assessment of gap in adoption of recommended technology by the farmers was taken before laying out the CFLDs through personal discussion with selected farmers. The geo mapping of selected farmer's field for conducting the CFLDs was done. The adopted villages were Sonagarh, Chandigarh ahir, Bamboli, Kanaur and Kanwada during reporting year of Alwar district. Three hundred CFLDs on Chickpea were laid out covering the total area of 120 ha with demonstration practices (DP) with size of each demonstration was 0.40 ha (one acre). All critical inputs *viz*, improved variety (CSJ 515) were demonstrated with full POP *i.e,* field preparation, seed rate, time of sowing, line sowing method, balance dose of fertilizer (20kg N_2, and 40kg P_2O_5 per ha), seed treatment (Carbendazim 50% WP @2.5gm/kg, Imidaclorpid 17.8 SL @7ml/kg, *Trichoderma harzianum* 7gm/kg and *Rhizobium* culture @ 5gm/kg), seed rate 60 kg per ha, irrigation, weed management and plant protection measure were applied (Table 2) at farmers' fields. Crop was sown between October 3rd week to November first week with a spacing of 30 cm X 10 cm. The entire dose of recommended fertilizers was applied as basal dose at the time of sowing. The farmer practice (FP) was considered as control plot (local check), which was maintained by the farmers according to their own traditional cultivation practices with old varieties with broadcasting. Training programmers were organized for selected farmers on improved technology of pulse production including high yielding variety, seed treatment, recommended chemicals (weedicides, fungicides and pesticides), literature and regular visit, monitoring of pest and disease in crop advisory services management by the KVK scientist. Finally, field day and crop cutting experiment were conducted at the time of crop maturity with involving partner farmers and other farmers of the village, scientists from University and ATARI, Jodhpur officials from local extension functionaries. Department of Agriculture to demonstrate the superiority of the technology demonstrated. Crop yield was recorded from the DP and FP plots for the crops at the time of harvesting during last week of March to the first week of April. The most feasible technique by which this could be achieved is by demonstrating the recommended improved technology on the partner farmer's field through CFLDs with the objectives to work out the input cost and monetary returns between DP and FP methods and to identify the yield gaps between FP and DP. The basic information was recorded from the farmer's field and analyzed to comparative performance of DP and FP. However, data about adoption and horizontal spread of technologies were collected from the participating farmers with help of interview schedule. To study the yield attributes, twenty-five live plants were selected by randomly placing of quadrate at five places in DP plots as well as in FPs plots. Yield data from demonstration and FPs were collected after harvesting the crop. For the recording of seed index (100 seeds) was taken and weighed. Economical assessment was done as per prevailing market prices or minimum support price.

The technology gap, extension gap and technology index were calculated as suggested by Samui *et al* (2003) and Dayanand *et al* (2012)

Adoption : To measure the extent of adoption of chickpea through demonstration by the partner farmers. The response under each sub-item was taken on a three-point continuum *viz.,* "always", "sometime" and "never" which were assigned 2, 1 and 0 score, respectively. The minimum and maximum scores which a respondent could obtain on this scale were 0 and 46, respectively.

RESULTS AND DISCUSSION

The gap analysis between the demonstration and existing farmer practice under Chickpea is presented in Table 1. Highest gap (98%) was observed in case of use of bio-fertilizer followed by seed treatment, disease management, application of N and P and use of variety with 90, 85, 50 and 35 percent, respectively. Quality bio fertilizers are not in reach of farmers. Farmers are not aware about seed treatment and having no knowledge about disease management and applying N and P fertilizers without soil testing. The reason behind higher gap is less extension workers are there in the district Alwar the farmers are dependent on advice of retail agro-input dealers those are less educated and having no knowledge about agriculture practices. In each CFLDs, use suitable varieties of chickpea namely: CSJ 515 were considered along with their recommended POP. While in FP, locally available old variety of selected chickpea with traditional FP was followed by the farmers in their local farming situations. A total number of 300 demonstrations covering 120 ha were conducted by the KVKS at Farmers field during *Rabi* season 2016-17 to 2019-20 (Table 2 & 3).

Grain yield : The yield of chickpea obtains over the reported year under improved technology as well as FP is presented in Table 2. The CFLDs productivity of chickpea ranged from 1950 to 2163 kg/ha with average yield of 2093 kg/ha under DP on farmers field as against a yield ranged from 1600 to 1861 kg/ha with a mean of 1769 kg/ ha recorded under FP. Seed index was recorded ranged from 16.4 gm to 31.0 gm in DP as compared to ranged 14.5 gm to 20.0 gm in FP. Average seed index recorded in DP was 26.85 gm as compared to 17.88 gm in FP. Percent yield increase of chickpea ranged from 16.04 to 21.88 with average 19.07 under DP as compared to FP. The higher productivity, seed yield index and percent yield increase were found in the DP as compared to FP during the reporting period, which might be due to use of latest high yielding varieties, Integrated Pest Disease and Nutrient Management practices. The results have been also similar findings *by Rachhoya et al (2018), Biradar et al (2020)* and *Singh et al (2020).*

Economical evaluation : The input and output prices of commodities prevailed during each year of demonstration were taken for calculating cost of cultivation. Net return, additional net return and benefit cost ratio (Table 3). The net return from DP was found Rs. 49500 to Rs. 76481.50. While the net return from FP range from Rs 38000 to Rs 64832.5 was recorded. It means that net return from DP was higher than the FP. The expended additional cost of Rs 1800 to Rs 3086 gave additional net returns it

Table 1. Gap analyses among recommended practice and farmer's practice of chickpea growers

Technology	Recommended practice	Farmer's practice	Gap (%)
Variety	CSJ-515,	Local, RSG-888	35
Seed treatment	Carbendazim 50% WP @2.5gm/kg, Imidaclorpid 17.8 SL @7ml/kg, *T. harzianum* 7gm/kg and *Rhizobium* culture @ 5gm/kg	10 % application	90
Fertilizers (kg/ha) irrigated			
N	20	14.4 kg/ha=50% 10.8 kg/ha=40% <7.2 kg/ha=10%	50
P	40	36.8 kg/ha=50% 27.6 kg/ha=40% <18. 4 kg/ha=10%	50
Bio-fertilizer	Rhizobium (150ml) PSB (150ml)	2 % application	98
Disease management (will & blight)	Blight: spray copper oxy chloride 50% WP @ 3gm/ltr of water Wilt: soil treatment with Trichoderma @ 2.5kg/ha	15 % application	85
Insect management (pod borer)	Quinalphos 25 EC @ 2.0 ml/liter water	65 % application	35

Table 2. Performance of technological intervention (CFLDs) on yield and yield attributed of chickpea

Year	Variety	Potential yield (kg/ha-1)	Area (ha)	Demo	Plant population (No/m2)		Seed yield (kg/ha-1)		Seed index (g/100seed)		% increase over control (FP)
					DP	FP	DP	FP	DP	FP	
2016-17	CSJ-515	2300	20	50	43	39	1950	1600	16.4	14.5	21.88
2017-18	CSJ-515	2680	40	100	42	38	2100	1793	30.0	18.0	19.66
2018-19	CSJ-515	2680	40	100	40	37	2163	1820	30.0	19.0	18.68
2019-20	CSJ-515	2680	20	50	41	37	2159	1861	31.0	20.0	16.04
Average		2585	120	300	41.5	37.75	2093	1769	26.85	17.88	19.07

DP=Demonstration Practices, FP= Farmers Practices

Table 3. Economical comparison between demonstration and farmer's practice of chickpea

Year	Gross cost (Rs.ha-1)		Gross return (Rs.ha-1)		Net return (Rs.ha-1)		Additional return	Effective gain (Rs/ha-1)	B:C ratio	
	DP	FP	DP	FP	DP	FP			RP	FP
2016-17	28600	26000	78000	64000	49500	38000	11500	8900	2.73	2.46
2017-18	26700	24900	94215	74800	67515	49900	17615	1800	3.53	3.00
2018-19	28326	25240	99792	84084	71556	58844	12712	9626	3.52	3.33
2019-20	28786	25875	105267.5	90707.5	76481.5	64832.5	11649	8738	3.66	3.51
Average	28103	25503.8	94318.6	78397.9	66263.1	52894.1	13369.1	7266	3.36	3.08

Table 4. Impact of technological intervention on disease and pest infestation of chickpea.

Year	Percent disease incidence						Infected Pods	
	Seedling stage		Maturity stage		Total wilting			
	DP	FP	DP	FP	DP	FP	DP	FP
2016-17	14.65	18.65	10.43	13.25	25.08	31.90	11.85	21.77
2017-18	13.88	17.66	11.19	14.29	25.07	31.95	10.77	19.45
2018-19	14.45	18.39	12.77	15.64	27.22	34.03	11.29	20.55
2019-20	15.66	19.23	12.78	15.59	28.44	34.82	10.13	19.74
Average	14.66	18.48	11.79	14.69	26.45	33.18	11.01	20.38

Table 5. Impact of CFLDs on extension, technology gap and yield index of chickpea.

Year	Extension gap (qt ha-1)	Technology gap (qt ha-1)	Technology Index (qt ha-1)
2016-17	3.5	3.5	15.22
2017-18	3.07	5.8	21.64
2018-19	3.43	5.17	19.29
2019-20	2.98	5.21	19.44
Average	3.25	4.92	18.90

Tavle 6. Impact of CFLDs on horizontal spread of variety of chickpea in Alwar district.

Variety	Area (ha)		Change in area (ha)	Impact (% change)
	Before demonstration	After demonstration		
CSJ-515	125	550	425	29.41

ranged from Rs 11500 to Rs 17615 per hectare. The increased benefit cost ratio was also calculated; it ranged from 2.73 to 3.66 in DP as compared to 2.46 to 3.51 in FP was recorded. Thus it was clearly showed that the demonstration of chickpea with full package was better than FP. Similar result has been reported by *Rachhoya et al (2018). Biradar et al (2020)* and *Singh et al (2020)*

Disease and incidence : Data recorded on plants infested with wilt (Fusarium wilt) caused by *Fusarium oxysporum* f.sp. *ciceris* revealed that incidence of disease was lower in DP as compared to FP (Table 4). It was observed that on seedling stage, maturity stage and total wilting in wilt disease occurrence ranged from 13.88 to 15.66, 10.43 to 12.78 and 25.07 to 28.44 respectively, observed in DP as compared to 17.66 to 19.23, 13.25 to 15.64 and 31.90 to 34.82 respectively in FP. An average seedling, maturity and total wilting disease occurrence were recorded at 14.66. 11.79 and 26.45 respectively showed wilting symptoms in DP as compared to 18.48. 14.69 and 33.18 respectively in FP. This could be responsible due to seed treatment. The findings are in line with the results reported *by Gangwar et al (2013), Rachhoya et al (2018)* and *Nathawat et al (2020).*

I*nsect infestation:* During the investigation data recorded on the infestation of pod borer (*Helicoverpa armigera*) caused premature dry and shading of pods. Spraying of quinalphos 25 EC @ 2.0 ml/liter water at the time of pod initiation caused lesser pods infected ranged from 10.33 to 11.25 in DP as compared to FP ranged from 19.45 to 21.77 (Table 4). Average infected pods were found in DP of 11.01 as compared to 20.38 found in FP. Similar results quoted by *Patil et al (2018a)* and *Rachhoya et al (2018).*

Extension gap : The extension gap showed an increasing style and calculated in a range between 2.98 to 3.5 q/ha (Table 5) during the period of study highlight the need to educate the farmers through various means for the adoption of improved agriculture production. The trends of technology gap reflected the farmer's co-operation in carrying out such demonstration with encouraging results in sequent year. The technology group observed may be attributed to the dissimilarity in soil fertility status and weather conditions. The technology gap was recorded from 3.5 to 5.8 qt/ha. The technology index showed the achievability of the evolved technology at the farmer's field. The lower value of technology index more is the feasibility of the technology demonstrated (*Rachhoya et al 2018, Biradar et al 2020* and *Singh et al 2020*). As such, reduction in technology index from 15.22 to 21.44 percent recorded during reported year exhibited the feasibility of the demonstrated technology in this district. These results confirm the findings of crop technology demonstration on chickpea crops by *Yadav et al (2003), Lathwal (2010), Rachhoya et al (2018), Biradar et al (2020)* and *Singha et al (2020).* From the above findings, it can be windup that use of scientific method for chickpea cultivation can decrease the technology gap to a considerable extent. This will lead to increase productivity of chickpea in the district. Moreover, extension agencies in the district need to provide proper technological support to the farmers through different educational and extension methods to reduce the extension gap for better pulse production in the district. The improved POP is more important with technological intervention for productivity and profitability of chickpea. It was also observed that farmer's use injudicious and non-recommended insecticides and mostly did not use fungicides *Singh et al (2011), Rachhoya et al (2018), Biradar et al (2020)* and *Singha et al., (2020)* reported similar observations.

*Impact of CFLDs on varietal replacement and horizontal spread of chickpe*a : In the present investigation, efforts were made to study the evaluation of CFLDs the horizontal spread of different varieties of chickpea. It was marked from Tavle 6 that CFLDs organized on chickpea helped to increase the area under improved varieties in adopted villages. There was a significant increase in area from 125 to 550 ha under chickpea varieties viz., CSJ-515 (increased up to 29.41%) in CFLDs programme. The reasons might be their agronomical attributes such as high yielding, wilt resistance, less infestation of pest is recommended in Rajasthan state. The findings are in line with that reported by Patil, *et al* (2018). CFLDs organized by the KVK had enhanced the yield of chickpea vertically and ensured rapid horizontal expansion of recommended technologies of the crops. The CFLDs made a helpful and important increase in yield of chickpea by 39.63 percent. The CFLDs made a great impact on the use of improved varieties, weed management, fertilizer application, seed rate, seed treatment, plant protection measure and line sowing and adoption of other DP of chickpea under investigation. Briefly, the overall trend in adoption

Table 7. Adoption of chickpea production technology by the partner farmer's

Package of practices	Partner farmer's	
	MPS	rank
HYVs	100.00	1
Soil treatment and field preparation	22.30	10
Seed treatment	68.50	5
Time of sowing	74.62	3
Seed rate and spacing	86.00	2
Fertilizer application	65.70	6
Irrigation management	71.25	4
Weed management	39.65	8
Plant protection measures	18.75	11
Physiological aspects (nipping)	25.50	9
Harvesting, threshing & storage	66.00	7

of chickpea crop production technologies by 29.45 per cent in adopted villages. The old mix varieties of pulse crops were replaced by improved cultivars on a large scale in selected villages. The area is under CSJ-515 varieties of chickpea increases and cover from 125 to 550 ha. This leads to conclude that CFLDs is proven extension intervention to demonstrate the production potential of chickpea varieties on farmers' field. Present investigation recommends that extension agencies engaged in transfer and application of agricultural technologies on farmers' field should give priority to organize CFLDs on large scale by adopting cluster approach for harness the productivity possible of chickpea and to ensure rapid spread of flagship technologies developed by National Agricultural Research System (NARS). Furthermore, policy maker may provide adequate financial support to frontline extension system for organizing CFLDs under the close supervision of agricultural scientists and extension professionals, this varietal replacement strategy through CFLDs may help to increase the chickpea productivity at field to country level.

Adoption technology of chickpea production : The level of adoption of chickpea production technology by the partner farmers was measured for eleven important parameters in chickpea DP. The data have been presented in Table 7 and on the basis of data we can say that the partner farmers had fully adopted high yielding varieties on their fields. It can be also inferred that the mean percent score (MPS) pertaining to practices like, seed rate and spacing, time of sowing, irrigation management, seed treatment, fertilizer application, harvesting with threshing and storage were 86.00, 74.62, 71.25, 68.50, 65.70 and 66.00, respectively. On the contrary, other practices such as weed management, physiological aspects, soil treatment, field preparation and plant protection measures were found to be least adopted with 39.65, 25.55, 22.30 and 18.75 MPS, respectively. In conclusion the findings above revealed that the selected varieties of chickpea CSJ-515 gave higher yield in DP than the FP in Alwar district. There is a wide yield gap between research technology and FP, which has resulted in lower yields in FP. The research technology has the potential of doubling production at national level without increasing area under chickpea, if farmers adopt the recommended POP. The extension agencies should demonstrate effects of new technology in chickpea production and inspire farmers for adoption of new technology to bridge this wide yield gap. Economic analysis on different parameters also revealed that net returns and additional gains were recorded higher in DP, which implies that the CFLDs programme is an effective tool for increasing the production, productivity and profitability of chickpea and increasing knowledge, changing attitude and developing skill of farmers. The present investigation calls for reducing the extension and technology gaps in these states through state specific research and extension programs. KVKs in Alwar district have significant role to play towards effective transfer of improved chickpea cultivation practices to farmers through their mandated activities including skill-oriented training and other extension programs with proper technical support. Farmers' awareness on DP through different innovative extension approaches including ICT's. FPOs. CIGS, FIGS, farmers" fairs/field days etc. as well as quality seed availability of improved varieties is the key factors in increasing productivity of chickpea. The identified yield enhancing technology needs to be subsidized for wider adoption among the farmers in their local farming systems and enhancing production and productivity of chickpea crops.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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