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Performance of Chickpea (*Cicer arietinum*) Frontline demonstrations in Rajasthan

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ABSTRACT

Chickpea (*Cicer arietinum* L.) is the most important *rabi* pulse crop of Rajasthan. The intervention of chickpea frontline demonstrations (FLDs) is one of the best ways to educate the conventional cultivators about productivity potential and profitability. The present study was carried out to determine the economic viability of technology transfer and adoption of chickpea in semi-arid region of North-West plain (NWP) zone of Rajasthan. Frontline demonstrations were conducted at Agricultural Research Station, S K Rajasthan Agricultural University, Bikaner, Sriganganagar, Rajasthan, to enhance chickpea production and improve livelihood of small and marginal farmers. Total 260 demonstrations were conducted under 65 ha area in different villages of Sriganganagar district of Rajasthan during *rabi* season of 2012–13 to 2019–20. The seed of newly released chickpea varieties, viz. GNG-1581, GNG-1958, GNG-2144 and GNG-2171 were provided with other production and protection inputs. Results of the study revealed that the package and practices improved the seed yield of chickpea by 17.2%. The annual increase in the yield in different seasons ranged from 12.4% to 23.4%. The average technology gap (6.6 q/ha) and average extension gap (2.5 q/ha) suggested further improvement in the extension activities. The average benefit : cost ratio was significantly higher (2.81) under demonstrated plot as compared to farmers' practice (2.48). Economic studies of individual years over eight years indicated that adoption of improved practices fetched more profit compared to farmers' practices.

Keywords: B:C ratio, Chickpea, Extension gap, Technology index, Technology gap

Chickpea (*Cicer arietinum* L.) is the most widely cultivated crop in the world covering more than 50 countries including Asia, Africa, Europe, Australia, North America and South America. It is the second most important food legume crop after common bean (*Phaseolus vulgaris* L.). India is the largest chickpea producer as well as consumer in the world. Chickpea is cultivated almost in all parts of the country mainly as a rainfed crop (68% area). There has been remarkable increase in chickpea production and productivity in the country from 2014–15 to 2020–21. From level of 7.59 million tonnes in 2014–15, chickpea production rose to an all time high of 12.61 million tonnes during 2020–21 (Project Coordinator's report 2020–21).

The high nutritional value makes chickpea an important food particularly in famine prone areas of the world. The major constraints responsible for lower yield potential are inappropriate production technologies, viz. improper method of sowing, disease and pest susceptible local varieties, limited use of fertilizers and untimely weed management (Prasad *et al.* 2012b). Genotypes may behave differently due to their plant architecture particularly because of poor plant growth. Under such situations plant population may play an important role in improving the productivity of crop (Prasad *et al.* 2012a). The intervention of chickpea front line demonstrations (FLDs) is one of the best techniques to educate the small and marginal farmers about productivity, profitability and livelihood improvement (Verma 2013). The demonstration of improved technologies produced chickpea yield of 18.8 q/ha as compared to farmers' practices (11.2 q/ha) (Rajpoot 2020).

Hence, an effort was made by scientists of ARS, Sriganganagar by introducing the full package and practices of chickpea production along with latest release and high yielding varieties developed by ARS, Sriganganagar through FLDs on farmer's field. The FLDs brought significant positive result and provided an opportunity to demonstrate the productivity potential and profitability of the latest technology (intervention) under real farming situation.

MATERIALS AND METHODS

Frontline Demonstrations on chickpea were carried out at Agricultural Research Station (Swami Keshwanand Rajasthan Agricultural University), Sriganganagar from 2012–13 to 2019–20 (eight years) with the objective to transfer the production technology improving the productivity of chickpea. Sriganganagar district is situated

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in the semi-arid region of North-West plain (NWP) zone Rajasthan. The soil at the demonstration sites was sandy loam, low in organic carbon (0.2%), medium in available P_2O_5 (24 kg/ha) and high in available K_2O (320 kg/ha) with alkaline reaction (*p*H 8.4). Total 260 demonstrations in 65 ha were conducted in different villages during *rabi* season from 2012–13 to 2019–20. Each demonstration was conducted in an area of 0.25 ha area adjacent to the demonstration plot, as farmers' practices i.e. prevailing cultivation practices served as local check.

The sowing in demonstration plots was done during second fortnight of October to second fortnight of November using latest released varieties of chickpea, viz. GNG-1581 (2008), GNG-1958 (2013), GNG–2144 (2016) and GNG-2171 (2017) using seed rate of 60 kg/ha (GNG-1581, GNG-2171, GNG-2144) and 72 kg/ha (GNG-1958). Plant geometry was kept 30 cm and 10 cm, respectively. A basal dose of fertilizers, 20 kg N and 40 kg P_2O_5/ha, was given to the crop. To protect the crop from seed and soil borne pathogens, seed treatment with carbendazim @1.5 g/kg seed or *Trichoderma viride* @8 g/kg seed was accomplished. The soil in the demonstration site suspected of termite infestation was applied with Chlorpyrifos 20% EC @4 l/ha. Incidence of pod borer was controlled through foliar application of Aciphet (75% SP) @2 g/l of water or Indoxacarb (14.5% SC) @1 ml/l water. The crop received two irrigations, one at pre-sowing and the remaining at 60–70 days after sowing (DAS). Finally, yield and ancillary data were obtained and cross sectional data on output and input were collected from frontline demonstration plot. Similarly, observations from an equal-sized area were also recorded on traditional practices followed by the farmers of the corresponding locations. The crop was harvested at maturity. The data of adoption and horizontal spread of technologies were collected from the farmers through interaction. Data were subjected to suitable statistical methods. After collecting the data from FLDs plots and farmers' practice plot (control plot); extension gap, technology gap, and technology index were calculated as per the formula suggested by Samui *et al.* (2000) and Dayanand and Mehta (2012).

$$\text{Increase over farmers practices (\%)} = \frac{\text{(Yield of demonstration plot – Yield of control plot)}}{\text{Yield of control plot}} \times 100$$

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological (kg/ha)}} \times 100$$

$$\text{Technology index (\%)} = \frac{\text{Potential yield – Demonstration yield}}{\text{Potential yield}} \times 100$$

Technology gap = Potential – Demonstration yield

Extension gap = Demonstration yield – Farmers yield

$$\text{B:C ratio} = \frac{\text{Net returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

RESULTS AND DISCUSSION

Yields parameters

Seed yield: The data (Table 1 and Fig 1) revealed that average seed yield of chickpea in improved technology was 17.0 q/ha ranging from 12.8 to 19.1 q/ha whereas that of conventional or farmers' practices was 14.5 q/ha ranging from 10.3 to 15.9 q/ha. This indicated that including use of improved technology variety contributed 17.2% higher production than the local one. Hence, farmers should be discouraged to use local varieties. The yield of chickpea could be improved over the yield obtained under farmers' practices (lack of knowledge on balanced dose of fertilizer, plant protection) of chickpea cultivation. The above findings are in close conformity with the findings of Singh *et al.* (2011), Rachhoya *et al.* (2018), Sharna *et al.* (2020).

Potential yields: It is the maximum yield of a cultivar when grown in environments to which it is adapted, with nutrients and water (non-limiting) and with pests, diseases, weeds, lodging, and other stresses effectively controlled.

Table 1 Impact of chickpea FLDs on straw yield, seed yield and harvest index at farmers' field

Year	Total farmers (no.)	Totals area (ha)	Straw yield (q/ha)		Seed yield (q/ha)		Harvest index (%)	
			Farmers' practices	Demonstration	Farmers' practices	Demonstration	Farmers' practices	Demonstration
2012–13	20	5.0	26.6	27.2	15.7	18.1	37.0	39.9
2013–14	20	5.0	22.3	24.1	14.3	16.5	39.1	40.6
2014–15	20	5.0	18.6	21.1	10.3	12.8	35.8	37.7
2015–16	20	5.0	25.3	27.1	14.9	18.0	37.0	39.9
2016–17	40	10.0	28.0	30.0	15.9	19.1	36.2	38.9
2017–18	40	10.0	25.4	26.4	14.9	17.6	37.0	40.0
2018–19	40	10.0	26.0	25.7	15.3	17.2	37.0	40.0
2019–20	60	15.0	24.7	24.9	14.5	16.6	37.0	40.0
Total	260	65.0	–	–	–	–	–	–
Mean	–	–	24.6	25.8	14.5	17.0	37.0	39.6

(Pooled data of 8 years)

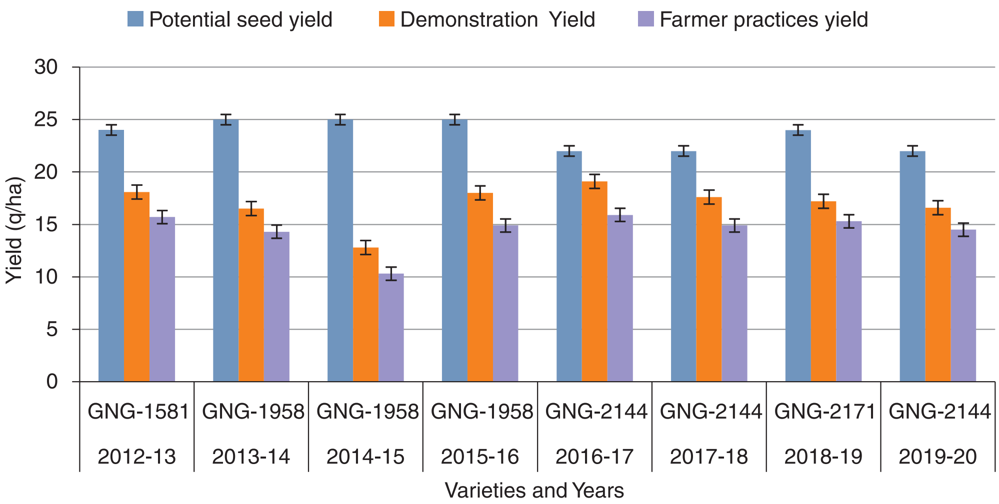

Fig 1 Year wise yield performance of different varieties under FLDs and farmers' practices

Potential yields recorded by plant breeder of different varieties GNG-1581 recorded 24.0 q/ha, GNG-1958 recorded 25.0 q/ha, GNG-2144 recorded 22.0 q/ha, GNG-2171 recorded 24.0 q/ha. (Table 2 and Fig 1)

Straw yield: The average straw yield under improved technology demonstrations was 25.8 q/ha ranging from 21.1 to 30.0 q/ha whereas under conventional or farmers' practices it was 24.6 q/ha ranging from 18.6 to 28.0 q/ha (Table 1) hence, farmers using improved practice were able to harvest more straw yield.

Harvest index: It is the ratio of harvested economic grain to total biomass dry matter and this can be used as a measure of reproductive efficiency. Average harvest index under improved technology demonstration was 39.6% whereas with conventional or farmers practices, it was 37.0%. With improved practices harvest index ranged between 37.7 to 44.3% whereas with conventional or farmers practices it ranges between 35.8 to 39.1% (Table 1).

Yield Gaps and technology index: Overall 17.2% increase was observed in seed yield due to adoption of improved practices (Table 2). The yearly increase in the yield in different seasons ranged from 12.4 to 23.4%. However, there is further scope of improvement in yield with improved practices as the potential yield of chickpea varieties over the seasons had a considerable margin over yield with improved practices. Different fertility levels, soil types, micro farming situations, weather conditions etc. may also be responsible for gap between average potential yield (24.9 q/ha) and average FLDs plot yield (17.0 q/ha). Location specific package of practices are required for bridging up this gap (Siag *et al.* 2002, Rachhoya *et al.* 2018). Technology index showed the feasibility of the demonstrated technology at the farmer's field. The average technology index was 27.7% during 8 years of study ranging from 13.2 to 48.8% showing the effectiveness of technical interventions (Dudhade *et al.* 2009) (Table 2).

Technology and Extension gap: The technology gap during the period of study ranged between 2.9 to 12.2 q/ha compared to extension gap 1.9 to 3.2 q/ha. The average technology gap (6.6 q/ha) and average extension gap (2.5 q/ha) suggested further improvement in the extension activities, to bridge up the gap which may result in better adoption of improved technology (Table 2). Therefore, integrated efforts are needed from research and extension components to strengthen their activities which will enhance the average productivity of chickpea in the district. Same trend was also reported by Rachhoya *et al.* (2018).

Table 2 Impact of chickpea FLDs on potential seed yield, extension gap, technology gap, technology index, productivity and economics analysis

Year	Variety	Potential seed yield (q/ha)	Demonstration yield (q/ha)	Farmer practices yield (q/ha)	% increase over farmer's practices	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)	B:C Ratio		
									FLD practices	Farmers' practices	Difference
2012–13	GNG–1581	24.0	18.1	15.7	15.4	2.4	5.9	24.6	2.37	2.14	0.23
2013–14	GNG–1958	25.0	16.5	14.3	13.2	2.2	8.5	34.0	2.68	2.27	0.41
2014–15	GNG–1958	25.0	12.8	10.3	23.4	2.4	12.2	48.8	2.02	1.73	0.29
2015–16	GNG–1958	25.0	18.0	14.9	20.6	3.1	7.0	28.0	3.73	3.27	0.46
2016–17	GNG–2144	22.0	19.1	15.9	20.1	3.2	2.9	13.2	3.66	3.20	0.46
2017–18	GNG–2144	22.0	17.6	14.9	17.8	2.7	4.4	20.0	2.81	2.50	0.32
2018–19	GNG–2171	24.0	17.2	15.3	12.4	1.9	6.8	28.3	2.67	2.48	0.19
2019–20	GNG–2144	22.0	16.6	14.5	14.8	2.1	5.4	24.6	2.49	2.28	0.22
Mean	–	24.9	17.0	14.5	17.2	2.5	6.6	27.7	2.81	2.48	0.32

Yield and benefit cost ratio: Though the individual year data indicated up and down trend in yield, both in demonstration plot as well as farmers' practice. It may be due to biotic and abiotic stress, an average increase of 2.5 q/ha has been achieved due to adoption of improved practices in frontline demonstrations. The average B:C ratio was found higher (2.81) with demonstrated plot as compared to farmers' practice (2.48). Siag *et al.* (2000) observed similar findings. The economic viability of frontline demonstrations was shown by the B:C ratio between improved (FLDs) and farmers' practice. Economic studies of individual years over eight years indicated the adoption of improved practices yielded more profit compared to farmers practice, though the difference was marginal. The comparative profitability due to improved technology over the years changed from 2.02 to 3.73 and for local farmers' practice from 1.73 to 3.27, respectively. The gap between average benefit : cost ratio of improved technology (2.81) and local practice (2.48) was narrowed down which proves adoption of improved technology by the farmers. The gap between FLDs and Farmers practices (FP) was 0.41, 0.46, 0.46 and 0.32 during year 2013–14, 2015–16, 2016–17 and 2017–18, respectively, which was narrowed down to 0.19 (2018–19) and 0.22 (2019–20). Over all mean basis, the gap was 0.32 which means that the gap had been covered due to adoption of the technologies by the farmers (Table 2). Similar findings were also reported by Rachhoya *et al.* (2018), Singh *et al.* (2018) and Sharna *et al.* (2020).

Consistent efforts are needed to bridge the gap through transfer of technology by various types of demonstrations to the farmers. The intervention of chickpea frontline demonstrations (FLDs) is one of the best ways to educate the conventional cultivators in terms of productivity potential and profitability, and is beneficial for improvement of farmers' income as well as state's and India's agriculture production.

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