Evaluation of technological interventions on the productivity and profitability of chickpea (Cicer arietinum L.) through frontline demonstrations in South-Eastern Rajasthan

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ABSTRACT

The study was conducted to examine the effects of frontline demonstrations on chickpea using scientific production technology for sustainable productivity and profitability on 40-hectare area covering 80 farmer’s fields in the Kota, Bundi and Baran districts of Rajasthan. The average yield of chickpea in the frontline demonstration plots (IP) using integrated crop management technology was 2219 kg/ha, which was significantly higher than the average yield of 1827 kg/ha in the farmers’ practices (FP). The average chickpea yield was found higher (18.88%) in demonstration plots over farmer practices, with the implementation of improved production technologies. During the three years of study (2018-19, 2019-20, and 2020-21), the technological index (17.21%), extension gap (392 kg/ha), and average technological gap (461 kg/ha) were found out. During the years of the study, frontline demonstration plots had the highest average net profit and B:C ratio (INR. 77,357/ha and 3.38), compared to farmer practice (INR. 64,081/ha and 3.24). Economic studies over one or three years showed that adopting improved package generated higher profits than traditional farmers practice.

Key words: Chickpea, B:C Ratio, Frontline demonstration, GNG 1958, Yield.

INTRODUCTION

The 'King of pulses' commonly referred to as Bengal gram, Chana, or chickpea, is a member of the Fabaceae or Leguminosae family. It has origin in South West Asia and is a derived from the ‘Greek’ word ‘kikus’, which means ‘force’ or ‘strength’. Chickpea contain vitamins and minerals including phosphorus, potassium, calcium, magnesium, iron, niacin, riboflavin, thiamin and folate. In addition, it also contains unsaturated fatty acids like oleic and linoleic acid, 4.5% fat and 21.1% protein. In India, 49% of all pulses products are made from chickpea. In India and Rajasthan, it is grown over an area of 9.99 and 2.11 m ha yielding 11.91 and 2.27 mt with average productivity of 1192 and 1072 kg/ha, respectively. Over 30% of the world’s pulses are consumed in India, but local production of pulses which has remained stagnant for the past two decades, has been unable to keep pace with the growing population. Chickpea also improves soil fertility by fixing up to 140 kg/ha of atmospheric N in the soil (Gaur et al., 2010).

Chickpea is an important rabi pulse crops for farmers in Rajasthan’s Humid South-Eastern Plain Zone V (Kota, Bundi, Baran and Jhalawar). In this zone, chickpea is grown on an area of 0.21 m ha, producing 0.39 mt and yielding 1857 kg/ha (Verma et al., 2022; Meena et al., 2023). Although there are many technologies available for the sustainable production of chickpea, farmers still rely on antiquated practices due to their reluctant to adopt improved methods of farming. There are several approaches that have been used to increase the chickpea production and productivity in the region. ARS, Kota, Rajasthan has taken FLDs on chickpea under the ICAR-Indian Institute of Pulses Research, Kanpur AICRP programme to disseminate the improved production technologies. The concept of FLDs was developed with the goal of boosting farmers’ acceptance of new technologies for growing chickpea to minimise yield gap. Farmers were motivated to exchange seed and to share their knowledge with other farmers. The objective of this study or FLDs was to identify the
technological production limitations and extension gap in chickpea production in this region.

MATERIALS AND METHODS

Frontline demonstrations (FLDs) are one of the most successful extension strategies because ‘Seeing is believing’ is a motivating factor. Frontline demonstrations main objective in a micro-farming environment is to display newly developed crop production technologies at farmer’s fields. As part of the All India Coordinated Research Project (AICRP) on Chickpea, the Agricultural Research Station (ARS), Kota carried out 80 FLDs on 40 ha area during the rabi 2018-19 to 2020-21 at farmer’s fields in Kota, Baran and Bundi districts of Rajasthan to show the advantage of improved package (IP) over farmer’s practice (FP) in chickpea yield enhancement. A 0.5 ha plot was used for each FLD with the adjacent 0.5 ha taken for comparison as farmer’s practice (FP). A list of farmers was created after the group discussion, and those who had been selected were given specialized training on prescribed improved production and as well as protection techniques. The technological intervention includes improved HYV of chickpea (GNG 1958) with full package of practices (soil testing, line sowing, seed treatment with a fungicide + bio-fertilizer, recommended dose of fertilizer, weed management, pest management (IPM) and irrigation management recommended for South-Eastern Humid Plain Zone (Zone V) of Rajasthan. During the course of the study period, all demonstrations were planted in 2nd fortnight of October to 1st fortnight of November and harvested in March at physiological maturity stage. Under the FLDs programme, essential inputs such seed, fungicide, culture, pheromone traps, and pesticide were provided to the farmers (Table 1). The random crop cutting method was used to obtain the yield data from both the farmer’s practice and the demonstration plots. The quantitative transformation of qualitative information resulted in its expression as a yield increase stated as a percentage. Simple statistical tools were used to further analyze the data. Frontline experiments were used to assess the technology gap, extension gap, and technology index. Samui et al. (2000) and Dayanand and Mehta (2012) proposed formula were used to obtain these indices.

**Technology gap**: It means the differences between potential yield and demonstration (improve package) plot. It refers to the variations between the yield of the FLD (improve package) plot and the potential yield (PY).

Technology gap = Potential yield (PY) - Improve package (IP)

**Extension gap**: It means the differences between demonstration plot (IP) yield and farmers practice (FP).

Extension gap = IP - FP

**Technology index**: It shows that using advanced technology in agricultural lands is feasible. Higher technology feasibility is associated with lower technology index values.

Technology Index = \[ \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100 \]

Yield increase over Farmers practice = \[ \frac{\text{Demonstration yield} - \text{Farmer practice yield}}{\text{Farmer practice yield}} \times 100 \]

RESULTS AND DISCUSSION

**Yield**

It is evident from the information presented in Table 2, in frontline demonstrations, the yield of the GNG 1958 variety outperformed under IP over FP, suggesting that the FLDs had a positive impact on the farming community since they were encouraged to adopt innovative agricultural techniques used in the FLDs. Under improve package demonstrations, the GNG 1958 recorded maximum yield (2285, 2620 and 2670 kg/ha) and minimum yield (1728, 1980 and 2220 kg/ha) for the rabi season years 2018-19, 2019-20, and 2020-21, respectively. In a similar vein, the mean yield of chickpea under improve package was 1943, 2320 and 2388 kg/ha, and the yield under farmer practice was 1634, 1960, and 1887 kg/ha during the 2018-19, 2019-20, and 2020-21, respectively. Similar, the farmer’s practice (1827 kg/ha) had a lowest three-year mean yield than the improve practice (2219 kg/ha). This showed 18.88% increase in chickpea yield under IP over FP. The results indicated above were in agreement with the chickpea crop reports from Patel et al. (2013), Dwivedi et al. (2014), Jha et al. (2020), Singh et al. (2020), Prasad et al. (2022) and Kantwa et al. (2022).

**Technology gap**

The technology gap is the discrepancy between potential yield and demonstration yield. In the study, technological gap of 737, 355, and 292 kg/ha were recorded during 2018-19, 2019-20, and 2020-21, respectively. The technological disparity may be due to differences in soil fertility levels, management levels and weather patterns. Similar
conclusions have been reached by Mauriya et al. (2017), Rachhoya et al. (2018), Raghav et al. (2021) and Gathiye et al. (2022).

**Extension gap**

Presently, the yield gaps range from 309 to 501 kg/ha, and the extension gaps were recorded at 309, 365, and 501 kg/ha for the year 2018–19, 2019–20 and 2020–21, respectively. Throughout the study period, the average extension gap was 392 kg/ha. This brought attention to the need for farmers to be educated about using better agricultural production technology through a number of channels in order to reduce the propensity for a wide extension gap. The frightening trend of speeding extension gaps will eventually shift as the most modern production techniques are used with high new yielding improved varieties. Farmers will eventually stop using the outdated methods and start using the new ones as a result of the new technologies in FLDs. The aforementioned result was corroborated by a number of other research on chickpea, including Hiremath and Nagaraju (2010), Jha et al. (2020), Ojha and Bisht (2020) and Kumar et al. (2021).

**Table 1:** Recommended practices and farmer’s practices in chickpea crop.

<table>
<thead>
<tr>
<th>Component</th>
<th>Improved technology</th>
<th>Farmer’s practice</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming Situation</td>
<td>Irrigated/rained</td>
<td>Irrigated/rained</td>
<td></td>
</tr>
<tr>
<td>Seed</td>
<td>GNG-1958</td>
<td>RSG 888, GNG 469 and other</td>
<td>Full gap</td>
</tr>
<tr>
<td>Seed rate (kg/ha)</td>
<td>80 kg/ha</td>
<td>90-100 kg/ha</td>
<td>High seed rate</td>
</tr>
<tr>
<td>Sowing method/spacing</td>
<td>Line sowing at the recommended spacing (30×10 cm) with seed cum fertilizer drill</td>
<td>Line sowing (22.5 cm) with seed drill or broadcasting</td>
<td>Partial gap</td>
</tr>
<tr>
<td>Seed treatment and inoculation</td>
<td>Trichoderma spp. 4.0 g/kg + vitavax 1.0 g/kg seed and inoculation with <em>Rhizobium</em> and PSB @ 5 g/kg of seed</td>
<td>Nil</td>
<td>Full gap</td>
</tr>
<tr>
<td>Nutrient management</td>
<td>Balanced fertilizer application as per soil test values, 44 kg/ha urea, 250/ha kg of SSP and 25 kg/ha of Zinc sulphate by farmers.</td>
<td>No use of fertilizers or imbalanced use of fertilizer 50 kg urea as top dressing and 50 kg of DAP as basal dose/ha</td>
<td>Full gap</td>
</tr>
<tr>
<td>Weed management</td>
<td>Application of pendimethalin 30 EC 3 lit ha⁻¹ as pre-emergence.</td>
<td>Manual weeding at 35-40 DAS</td>
<td>Full gap</td>
</tr>
<tr>
<td>Plant protection</td>
<td>Suggest pheromone trap @ 5/ha for insects monitoring. Spray of Acephate 75 WP @ 500 g/ha for control of gram pod borer also</td>
<td>Indiscriminate use</td>
<td>Partial gap with high cost</td>
</tr>
<tr>
<td>Grading &amp; processing</td>
<td>Grading followed</td>
<td>Not followed</td>
<td>Full gap</td>
</tr>
</tbody>
</table>

**Table 2:** Grain yield, technology gap, extension gap and technology index of chickpea in demonstration and farmers practices.

<table>
<thead>
<tr>
<th>Years</th>
<th>Variety</th>
<th>No. of Farmers (Demo.)</th>
<th>Area (ha)</th>
<th>Yield (kg/ha)</th>
<th>% increase in yield over FP</th>
<th>Technology gap (kg/ha)</th>
<th>Extension gap (kg/ha)</th>
<th>Technology Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-19</td>
<td>GNG 1958</td>
<td>20</td>
<td>10</td>
<td>2680</td>
<td>1943</td>
<td>1634</td>
<td>19.16</td>
<td>737</td>
</tr>
<tr>
<td>2020-21</td>
<td>GNG 1958</td>
<td>30</td>
<td>15</td>
<td>2680</td>
<td>2388</td>
<td>1887</td>
<td>18.87</td>
<td>292</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>80</td>
<td>40</td>
<td>2680</td>
<td>2219</td>
<td>1827</td>
<td>18.88</td>
<td>461</td>
</tr>
</tbody>
</table>

**Table 3:** Economics of chickpea cultivation in demonstration and farmers’ practices.

<table>
<thead>
<tr>
<th>Years</th>
<th>Variety</th>
<th>Cost of cultivation (INR/ha)</th>
<th>Net return (INR/ha)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IP</td>
<td>FP</td>
<td>Additional over FP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20100</td>
<td>17200</td>
<td>2900</td>
</tr>
<tr>
<td>2018-19</td>
<td>GNG 1958</td>
<td>33775</td>
<td>29950</td>
<td>3825</td>
</tr>
<tr>
<td>2019-20</td>
<td>GNG 1958</td>
<td>34700</td>
<td>30500</td>
<td>4200</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>29525</td>
<td>25883</td>
<td>3642</td>
</tr>
</tbody>
</table>
Technology index

The technology index demonstrates how practical a given technology is for agricultural use. Greater feasibility is indicated by a lower technology index number. As a result, the range of fluctuations in the technology index was 10.90% to 27.50%, and the average technology index for the study period was 17.21% (Table 2). The results that were reported by Singh et al. (2020), Raghav et al. (2021) and Gathiye et al. (2022) are in agreement with these findings.

Economics

Table 3 provides information on cultivation expenses for IP and FP, net return, and benefit: cost ratio. For the purpose of calculating gross return, net return and benefit cost ratio, the prevailing market price of inputs and MSP were used. During the 3 years of study period, the net return under IP were INR. 65,427, INR. 79,569 and INR. 87,074 per ha as compared to FP (INR. 54,700, 65,600 and 71,942 per ha) in 2018–19, 2019–20 and 2020–21, respectively. The benefit: cost ratio of the IP was higher (3.26, 3.36 and 3.51) than the FP (3.18, 3.19 and 3.36). This could be as a result of the increased yield under the recommended practices that was previously reported on chickpea by Mahadik and Talathi (2016), Rathore et al. (2016), Singh et al. (2018) and Prasad et al. (2022).

CONCLUSION

The findings of the study suggest that there is a significant gap between prospective and demonstrated yields of chickpea, which is mostly caused by a lack of technology, gaps in extension, and a lack of knowledge about advanced production technology in chickpea farming in South-Eastern Humid Plain Zone (Zone V) of Rajasthan. The results of the chickpea production technology under FLDs showed that farmers can achieve higher yields and a net profit by adopting improved package of practices. By educating farmers about these technologies through ongoing campaigns, demonstrations, periodic visits by scientists to the demonstration site, distribution of literature, creation of success stories, and use of information and communication technology (ICT) tools like telephonic consulting and video conferencing, chickpea production can be increased in this region to fulfil the growing demand of increasing population.

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