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# YIELD AND ECONOMICS OF CHICKPEA CULTIVATION AS INFLUENCED BY FRONTLINE DEMONSTRATIONS IN NAGAUR DISTRICT OF RAJASTHAN

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**Abstract:** Pulses are one of the important food crops globally due to higher protein content. Pulses are an important group of crops in India, which is also responsible for yielding large financial gains by amounting for a large part of the exports. Pulses are the major sources of protein in the diet. The frontline demonstrations of chickpea crop was carried out by Krishi Vigyan Kendra, Nagaur-I, Agriculture University, Jodhpur during rabi seasons from 2016-17 to 2021-22 on 92 ha area with 230 demonstrations in different clusters of Nagaur district of Rajasthan. Results of front line demonstrations showed that the cultivation practices comprised under FLDs *viz.*, use of improved varieties, seed and soil treatments, optimum seed rate, balanced application of fertilizers, line sowing, timely management weeds, insects and disease, produced on an average 1709 kg/ha grain yield of chickpea, which was 22.56 per cent higher as compared to prevailing farmers practice (1395 kg/ha). The front line demonstrations fetched more average gross returns (Rs. 80860/ha), net return (Rs. 50879/ha) and B:C ratio (2.69) with slightly higher investment on cost of cultivation (Rs. 2358/ha) as compared to farmers practice. The average increase in gross return, net return, B:C ratio and cost of cultivation was 22.3, 32.1, 13.0 and 8.5 per cent, respectively over farmers practice. The average extension gap, technology gap and technology index was 314 kg/ha, 692 kg/ha and 28.6 per cent, respectively. It is also observed that majority of the respondent farmers expressed high (53.9%) to the medium (30.0%) level of satisfaction regarding the performance of chickpea under demonstrations.

**Keywords:** Chickpea, Economics, Gap, Satisfaction, Technology index, Yield

## INTRODUCTION

The poor nutritional status of the population is a major challenge where low income, small scale's households, has a long term negative implication for economic development. The government has resolved this issue to be addressed through nutritionsensitive agriculture interventions, focusing the pulse crops having multiple nutritional values with essential source of vitamins, micro-nutrient and protein to help in attain nutritional security. Pulses have better enabling environment to promote dietary and production diversity to address hunger and malnutrition at national level. Focus on pulses production and consumption can help overcome malnutrition. India should include pulses in the public distribution system. India, a country with high concentrations of poor and malnourished people, long promoted a cereal-centric diet composed of subsidized staple commodities such as rice and wheat to feed its population of more than a billion. Today, however, dietary patterns are changing. Policy makers, researchers, and health activists are looking for ways to fight hunger and malnutrition in the country. As they shift their focus from calorie intake to nutrition, neglected foods such as pulses (the dried, edible seeds of legumes) are gaining attention. Pulses are one of the important food crops globally due to higher protein content. Pulses are an important group of crops in India, which is also responsible for yielding large financial gains by amounting for a large part of the exports. Pulses are the major sources of protein in the diet. Of all categories of people pulses form an integral part of the Indian diet, providing much needed protein to the carbohydrate rich diet. India is the largest producer and consumer of pulses in the world. Pulses have 20 to 25 per cent protein by weight which is double the protein content of wheat and three times that of rice. Major pulses are grown chickpeas (Gram/Chana), Pigeon pea (Tur/Arhar), Mungbeans, Urdbeans (Blackgram), Masur (Lentil), Peas and various kinds of Beans

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(Minor Pulses). The main regions with high productivity are Madhya Pradesh, Rajasthan, Maharashtra, Karnataka, Uttar Pradesh, Coastal Andhra Pradesh,Gujarat, Tamil Nadu, Jharkhand, Odisha, Chhattisgarh, Telangana, Bihar and West Bengal delta region.

The total world acreage under pulses is about 93.18 (Mha) with production of 89.82 (Mt) at 964 kg/ha yields level. India, with 28.78 Mha pulses cultivation area, is the largest pulse producing country in the world (Anonymus, 2021). It ranks first in area and production with 31 per cent and 28 per cent, respectively. During 2020-21 our productivity at 885 kg/ha, has also increased significantly over last 05 year. Thanks to pro-active pulse programme implementation strategies and robust monitoring mechanism of Govt. of India, significant growth in area, production and productivity of pulses has been recorded. More visible and significant increasing trends during 2016-17, 2017-18 and 2020-21, whereby the pulses production reached at 23.13 Mt, 25.42 and 25.46 Mt respectively, is a grand success story in itself. The productivity of pulses has increased 13 per cent at 885 kg/ha during 2020-21 and 09 per cent at 853 kg/ha during 2017-18 from the level of 786 kg/ha during 2016-17. The production growth has been 10 per cent highest over 2016-17.

Under individual crop category gram with 45 per cent production share to total pulses is the highest contributor followed by tur (17 per cent), urd (11%), mung (10%) and Lentil (6%).

In India, chickpea crop was cultivated in an area of 9.90 million hectares with the production of 10.70 million tons and the productivity of 1086 kg/ha. In Rajasthan state chickpea crop grown in an area of 12.35 lakh hectare with production of 7.50 lakh tones and productivity of 607 kg.ha (Kumar and Kumawat, 2019). In Nagaur district, it is grown in an area of 0.80 lakh hectares and 0.10 lakh tones production and 1004 kg/ha productivity.

The country is now trying to meet the target of 35 million tonnes by 2030 with the challenging reasons like unavailability of quality seed, lack of technical guidance, ignorance of Integrated Pest Management techniques and non-adoption of integrated nutrient management (Kumar *et al*. 2014; 2016). Besides this, major abiotic stress *i.e.* low organic content in soil, low moisture content in the soil, types of soils, seasonal drought due to low rainfall are also responsible for low productivity of the pulses crops (Dubey *et al*. 2017). Among biotic stress, legume pod borer, *Helicoverpa armigera* (Hübner) is responsible for 50 to 60 per cent grain yield losses (Balikai *et al*. 2001) and losses exceeded Rs.12,000 million per year. Therefore, it is a great deal for extension scientists, policy makers, and farming community to meet out the pulses availability demand over the country population in terms of household nutritional security.

To overcome the pulses hunger, government tried to improving pulses production and productivity in the country with Indian Council of Agricultural Research by taking major big step for the same by conducting Cluster Frontline Demonstrations nationwide through Krishi Vigyan Kendras with the mandate of out scaling of farm innovations through FLDs to highlight the specific benefits/ worth of technologies on farmer's fields. Besides this, various programmes like Technology Mission in 1986, National Pulse Development Project in 1990-91, Integrated Scheme of Oilseeds, Pulses, Oil palm, and Maize in 2004, National Food Security Mission in 2007-08 and Accelerated Pulses Production Programme (A3P) has been started by the government (Kumar *et al*. 2018) but gap between demand and supply is still bigger and this demand gap is tried to overcome through import of pulses.

The utmost objective of the frontline demonstration is to large scale technological demonstrate latest technologies of crop production and management practices under diverse climatic conditions as well as farming situations to fill the per cent yield gap. Therefore, the effect of frontline demonstrations on production and productivity of chickpea crop has been studied in Transitional plain of Inland drainage zone of Rajasthan.

## MATERIALS AND METHODS

Krishi Vigyan Kendra, Maulasar, Nagaur-II under Agriculture University, Jodhpur (Rajasthan) conducted Front line demonstrations (FLDs) on integrated crop management in chickpea (*Cicer arietinum*) during the consicutive *rabi* seasons from 2016-17 to 2021-22. Total 230 demonstrations on 92 ha area were conducted in different locations in Nagaur district. Nagaur district falls under agro climatic zone II-A called as transitional plans of inland drainage and situated between 260.25" to 270.40" North latitude and 730.18" to 750.15" East longitude. The average rainfall of the zone is 360 mm. In general, soils of the area under study were sandy to sandy loam in texture with average pH 7.8, organic carbon 0.32, low in nitrogen and medium in phosphorus and potash.

Cluster selections, farmer selection, problem diagnosis, layout of demonstration were carried out according to Choudhary (1999). Assessment of gap in adoption of recommended technology was done before laying out FLD's through personal discussion with selected farmers (Table 1). Trainings was organized about detailed technological intervention with improved package and practice for successful cultivation of pulses. In the demonstrated FLDs the recommended package of practices were followed for crop cultivation and compared with the farmer's practices (Table-1). In case of farmers practice plots, existing practices being used by farmers were followed.

Scientists visited regularly demonstrated fields and farmer's fields. The feedback information from the farmers was also recorded for further improvement in research and extension programmes. The extension activities i.e. trainings, interaction with farmers and field days were organized at the cluster frontline demonstration sites. The basic information were recorded from the farmer's field and analyzed to comparative performance of demonstrated plot and local check. Data on yield parameters from demonstrated plots and farmers practices were collected by random crop cutting method.

The technology gap, extension gap and technology index were calculated using the following formulae given by (Samui *et al*., 2000).

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - yield under existing practice

Technology index = {(Potential yield - Demonstration yield)/Potential yield} x 100

The satisfaction level of participating as well as neighbouring farmers' for the performance of improved variety demonstrated was also assessed. In all, 230 participating farmers' were selected to measure satisfaction level of farmers' for the performance of improved variety under ICM technology demonstrated. The selected respondents were interviewed personally with the help of a pre-tested and well structured interview schedule. Client Satisfaction Index was calculated as below.

Client satisfaction index = (Individual score obtained/ Maximum score possible) x 100

The data collected were tabulated and statistically analyzed to interpret the results. The economic-parameters (gross return, net return and C: B ratio) were worked out on the basis of prevailing market prices of inputs and Minimum Support Prices of outputs.

**Table 1.** Technologies demonstrated under pulses FLDs and farmer's practices

| Components | Demonstration of recommended technology | Farmer's practices | Gap analysis (%) |
|---|---|---|---|
| Variety(s) | GNG-1581, RSG-974, GNG-1958, GNG-2144 | Local/old variety (RSG 896, RSG-974) | 40-50 |
| Seed rate | 75 kg/ha | 90-95 kg/ha | 45-50 |
| Seed treatment | *Trichoderma viride* @ 6-8 gm/Carbendazim 50WP @ 2 gm/kg seed, PSB+Rhizobium culture@ 500 gm/ha/ Use of NPK consortia @ 500 ml/100 kg seed | 30-40 % farmers do seed treatment with Carbendazim | 60-70 |
| Soil treatment | Soil treatment *with Trichoderma viride* @ 2.5 kg/ha | No soil treatment by farmers | 100 |
| Sowing method | Line sowing (30 x 10 cm) | Broadcasting/ line sowing | 20-25 |
| Irrigation | One-two irrigation with sprinkler at pre flowering and pod filling stages | No irrigation or One irrigation | 25-35 |
| Nutrients | Recommended NP (20:40 kg/ha), FYM @ 2.5 tones/ha and foliar spray of NPK 18:18:18 (2.5 kg/ha) | Improper use of fertilizers, N-18 kg/ha; P-46 kg/ha by 30-40% farmers | 40-50 |
| Weed mangement | Pendimethalin @ 0.6 kg/ha as pre-emergence, manual weeding at 30-35 DAS | No use of weedicide, Manual weeding at 30-40 DAS | 40-50 |
| IPM measures | Emamectin Benzoate 5 SG @ 250 gm/ha for pod borer management. Management of ascochyta blight by using Mancozeb @ 1 kg/ ha. | 40-50 % farmers use irrelevant IPM measures | 50-60 |
| Trainings | Audio-video On & Off campus training | No training | 100 |

## RESULTS AND DISCUSSION

The yield performance, extension gap, technology gap and technology index of chickpea crop owing to the adoption of improved technologies were assessed over a period of six years from 2016-17 to 2021-22 and is presented in Table-2 & 3. The economics of the data regarding cost of cultivation, gross return, net return, additional cost, additional return and benefit: cost ratio were analyzed and presented in Table - 4 & 5.

**Grain yield performance:**

The grain of chickpea crop owing to the adoption of improved technologies was assessed over a period of six years and is presented in Table-2. Results of front line demonstrations indicated that the cultivation practices comprised under FLDs *viz.*, use of improved varieties, seed and soil treatments, optimum seed rate, balanced application of fertilizers, line sowing, timely management weeds, insects and disease, produced on an average 1709 kg/ha grain yield of chickpea, which was 22.56 per cent higher as compared to prevailing farmers practice (1395 kg/ha). The higher grain yield from demonstrated plots was due to use of high yielding varieties and other integrated crop management practices. Similarly, Kumar *et al*. (2019) also reported 0.83 to 14 q/ha grain yield of different pulse crops under demonstrations as compared to 0.72 to 8.40 q/ha in farmer's practices. The per cent yield increase of chickpea crop was 28.57 to 30.28% in the similar dry areas was also reported by Kumar *et al*. 2018 and Choudhary *et al*., 2020.

**Table 2.** Chickpea yield performance under FLDs and farmers practice

| Year | Area of demo. (ha) | No. of demo. | Variety(s) | Potential yield (kg/ha) | Demo. yield (kg/ha) | FP yield (kg/ha) | % yield increase over FP |
|---|---|---|---|---|---|---|---|
| 2016-17 | 10 | 25 | GNG-1581 | 2400 | 1430 | 1200 | 19.17 |
| 2017-18 | 12 | 30 | RSG-974 | 2600 | 1580 | 1300 | 21.54 |
| 2018-19 | 30 | 75 | GNG-1958 | 2400 | 1890 | 1410 | 34.04 |
| 2019-20 | 20 | 50 | RSG-974 | 2400 | 1901 | 1450 | 31.10 |
| 2020-21 | 10 | 25 | GNG-2144 | 2300 | 1530 | 1320 | 15.91 |
| 2021-22 | 10 | 25 | GNG-2144 | 2300 | 1920 | 1690 | 13.61 |
| **Total** | **92** | **230** | **Average** | **2400** | **1709** | **1395** | **22.56** |

**Extension gap, Technology gap and Technology index:**

The extension yield gap was the difference observed between demonstrations technology and farmers practices in the respective crop (Table-3). The extension gaps ranged from 210 to 480 kg/ha during the period of demonstration with average 314 kg/ha, which emphasized the need to educate the farmers through various means for the adoption of improved agricultural production technologies to reverse this 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. The new technologies will eventually lead to the farmers to discontinuance of old varieties with the new technology.

According to Jat, *et al*. (2021), the average extension yield gap in chickpea crop was 350 kg/ha under demonstrations which resulted in higher grain yield as compared to farmer's practices. Avoiding the adoption of improved crop production technology by the farmers for better production results in extension yield gaps (Vedna *et al*. 2007).

The results (Table-3) of front line demonstrations and potential yield of chickpea varieties were compared to estimate the yield gaps which were further categorized into technology gap and technology index. The technology gap observed may be attributed to the dissimilarity in the soil fertility status and weather conditions. Hence, variety wise location specific recommendation appears to be necessary to minimize the technology gap for yield level in different situations.

The technology gap shows the wide gap in the demonstration yield over potential yield of chickpea. The average technology gap was 692 kg/ha with maximum (1020 kg/ha) in the year 2017-18 and minimum (380 kg/ha) in the years of 2021-22. The observed technology gap may be attributed to dissimilarities in their soil fertility, uneven & erratic rainfall and vagaries of weather conditions in the area as well as management of the farmers.

The results are in accordance to the findings of Kumar *et al*. (2019), according to them the technology gap in chickpea crop was 9.5 to 13.0 q/ha.

The data (Table-3) further indicated that minimum technology index value 16.52 was noticed in the year 2021-22 followed by 20.79 per cent in 2019-20 whereas, maximum value of technology index of 40.42 % in the year 2016-17 with average value of 28.61 per cent. It is obviously due to uneven & erratic rainfall and vagaries of weather conditions in the area. Technology index also shows the feasibility of the technological package at the farmer's field.

The lower the value of technology index more is the feasibility.

The hypothesis proposed by Ram *et al*. (2014) and Dayanand *et al*. (2014) are in conformity with the present findings. According to them, the technology index of chickpea crop was 25.2 per cent.

**Table 3.** Extension gap, Technology gap and Technology index of chickpea production under FLDs

| Year | Variety(s) | Extension gap (kg/ha) | Technology gap (kg/ha) | Technology index (%) |
|---|---|---|---|---|
| 2016-17 | GNG-1581 | 230 | 970 | 40.42 |
| 2017-18 | RSG-974 | 280 | 1020 | 39.23 |
| 2018-19 | GNG-1958 | 480 | 510 | 21.25 |
| 2019-20 | RSG-974 | 451 | 499 | 20.79 |
| 2020-21 | GNG-2144 | 210 | 770 | 33.48 |
| 2021-22 | GNG-2144 | 230 | 380 | 16.52 |
| **Average** | | **314** | **692** | **28.61** |

**Economic performance of chickpea:**

The economics (Cost of cultivation, gross & net return and B:C ratio) of chickpea under front line demonstrations were estimated and the results have been presented in Table- 4. The front line demonstrations fetched more average gross returns (Rs.80860/ha), net return (Rs. 50879/ha) and B:C ratio (2.69) with slightly higher investment on cost of cultivation (Rs. 2358/ha) as compared to farmers practice. The average increase in gross return, net return, B:C ratio and cost of cultivation was 22.3, 32.1, 13.0 and 8.5 per cent, respectively over farmers practice. The results are the supportive evidences of improved interventions/ technologies under demonstrations practices. Farmers can adopt the demonstrated technology to improve his monetary returns from their fields and leads to improve socio economic status and livelihood under the unpredictable drought conditions of the district.

Increasing in monetary returns and benefit: cost ratio in pulses crops have been also reported by earlier workers (Ram *et al*. 2014; Dayanand *et al*. 2014). Similarly, demonstrations of improved technologies at farmer's field proven best to a great extent in enhancing the production and productivity of chickpea crop (Singh *et al*. 2017; Jat, *et al*. 2021).

**Table 4.** Economic performance of chickpea cultivation under front line demonstrations and farmers practice

| Year | Cost of Cultivation (Rs./ha) | | Gross Return (Rs./ha) | | Net Return (Rs./ha) | | Benefit: Cost ratio | |
|---|---|---|---|---|---|---|---|---|
| | Demo. | FP | Demo. | FP | Demo. | FP | Demo. | FP |
| 2016-17 | 23800 | 21650 | 57200 | 48000 | 33400 | 26350 | 2.40 | 2.22 |
| 2017-18 | 32000 | 28500 | 69520 | 57200 | 37520 | 28700 | 2.17 | 2.01 |
| 2018-19 | 30355 | 27933 | 87318 | 65142 | 56963 | 37209 | 2.88 | 2.33 |
| 2019-20 | 30542 | 28050 | 92674 | 70688 | 62132 | 42638 | 3.03 | 2.52 |
| 2020-21 | 30844 | 28800 | 78030 | 67320 | 47186 | 38520 | 2.53 | 2.34 |
| 2021-22 | 32340 | 30800 | 100416 | 88387 | 68076 | 57587 | 3.11 | 2.87 |
| **Average** | **29980** | **27622** | **80860** | **66123** | **50879** | **38501** | **2.69** | **2.38** |

Further, data (Table-5) shows that the average additional cost of cultivation of Rs. 2358 per hectare under integrated crop management demonstrations and has fatched additional net returns of Rs. 12379 per hectare with incremental benefit: cost ratio of 0.31. The results suggested that higher profitability and economic viability of chickpea demonstrations under local agro-ecological situation.

**Table 5.** Additional cost of cultivation and net return under front line demonstrations compared to farmers practice

| Year | Variety(s) | Additional cost of cultivation (Rs./ha) in demonstration | Additional net return (Rs./ha) in demonstration |
|---|---|---|---|
| 2016-17 | GNG-1581 | 2150 | 7050 |
| 2017-18 | RSG-974 | 3500 | 8820 |
| 2018-19 | GNG-1958 | 2422 | 19754 |
| 2019-20 | RSG-974 | 2492 | 19494 |
| 2020-21 | GNG-2144 | 2044 | 8666 |
| 2021-22 | GNG-2144 | 1540 | 10489 |
| **Average** | | **2358** | **12379** |

**Farmer's Satisfaction**

The extent of satisfaction level of respondent farmers over performance of demonstrated technology was measured by Client Satisfaction Index (CSI) and results presented in Table-6. It is observed that majority of the respondent farmers expressed high (53.91%) to the medium (30.00%) level of satisfaction regarding the performance of chickpea under demonstrations. Whereas, very few (16.09%) of respondents expressed lower level of satisfaction. The higher to medium level of satisfaction with respect to performance of demonstrated technology indicate stronger conviction, physical and mental involvement of in the frontline demonstration which in turn would lead to higher adoption. The results are in close conformity with the results of Jat, *et al*. (2021).

**Table 6.** Extent of farmer's satisfaction over performance of demonstrated technology

| Satisfaction level | Number | Per cent |
|---|---|---|
| High | 124 | 53.91 |
| Medium | 69 | 30.00 |
| Low | 37 | 16.09 |

*****(n=230)

## CONCLUSION

It may be concluded that integrated crop management technology in chickpea has found more productive, profitable and feasible in Nagaur district under Transitional plain of Inland drainage zone of Rajasthan as compared to prevailing farmers practice. Even though more than 20 per cent yield increase of chickpea crop over farmer's practices are witnessed of creating confidence and friendly relationships between farm scientists and farming community. Farmers were motivated by results of demonstrations of integrated crop management practices in chickpea and they would adopt these technologies in the coming years. In Nagaur district of Rajasthan, the production and productivity of pulses was quite low earlier. Now, National Food Security Mission a government initiative tried to bridges a connection to enhance the same due to popularization of improved technologies though KVKs at farmer's fields. But, there is still a wide gap between potential and demo yield which needs more extension service among farming community for better crop production, productivity and net monetary returns of pulses with more emphasis.

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