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# Adoption of Improved Crop Management Practices for Enhancing Productivity of Pigeonpea on Farmers' Fields in Kalaburagi District of India

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author DHP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PSR and ZA managed the analyses of the study. Author AN managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

The present study was carried out at Agricultural Research Station and Krishi Vigyan Kendra, Gulbarga district of India, to know the yield gap between improved package and farmers' practice under Front Line Demonstration. Pigeonpea [*Cajanus cajan* (L.) Millsp.]. Being one of the major Kharif pulse crop of Karnataka, it is having lower yield in farmer's field due to multiple constraints. The major constraints of its lower productivity are non-adoption of improved technologies or Improved Crop Management practices. Front line demonstrations on Improved Crop Management practices were conducted at 99 framer's fields in five adopted villages of Gulbarga district during Kharif seasons of 2010-11 to 2014-15. The Improved Crop Management practices included use of wilt resistant pigeonpea variety (WRP 1 and TS 3R), Seed treatment with *Trichoderma* (4 gm $kg^{-1}$ seeds), use of biofertilizers (Rhizobium and PSB), Integrated nutrient management (25:50:0 NPK kg $ha^{-1}$ + Zinc Sulphate @ 15 kg $ha^{-1}$ + Sulphur @ 20 kg $ha^{-1}$) and Integrated Pest Management. The

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improved technologies recorded a mean yield of 13.54 q $ha^{-1}$ which was 18.69 percent higher than the yield obtained with farmers practice (11.10 q $ha^{-1}$), besides having higher mean net income of Rs.22876 $ha^{-1}$ with a B:C ratio of 2.68 when compared to farmers practice (Rs. 16177 $ha^{-1}$ and 2.12).

*Keywords: Pigeonpea; front line demonstrations; productivity; participatory approach; farmer's field; net returns.*

## 1. INTRODUCTION

Pulses occupy an area of 76 million hectares and contribute 69 million tonnes to the world's food basket [1]. India has the distinction of being world's largest producer of pulses with the annual production of 24.6 lahk tonnes with an area of 37.5 lakh hectares [2]. India contributes nearly 25 per cent of global pulse production from 30 per cent area [3]. The level of productivity of pulses in India ranging between 600-650 kg $ha^{-1}$ which is far below the average global productivity of pulses 904 kg $ha^{-1}$ [4]. Pigeonpea is one of the protein rich legumes of the semi-arid tropics grown predominantly under rainfed conditions. The productivity of pigeonpea in India (758 kg $ha^{-1}$) is far below the average productivity of world (879 kg $ha^{-1}$) as per the reports of Ministry of Agriculture [5]. Globally Pigeonpea is grown on an area of 62.19 lakh ha with a production of 47.42 m t with a productivity of 863 kg $ha^{-1}$ of which 91 per cent of the world's pigeonpea is produced in India [6,7].

In Karnataka, pigeonpea occupies an area of 0.73 million hectares having 0.47 m. tones of production with an average productivity of 651 kg $ha^{-1}$ [8]. Pigeonpea is grown in almost all the states and larger portion of the area is in the states like Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka and Gujarat. In Karnataka, around 90 per cent of the Pigeonpea area is under northern Karnataka [9]. Gulbarga district which is popularly called as "Pulse bowl of Karnataka" ranks first in both area (0.36 m ha.) and production (0.18 m. tones) which accounts 55 percent area and 46 percent production of the state [10]. The productivity of pigeonpea in Karnataka (651 kg $ha^{-1}$) and India (729 kg $ha^{-1}$) are far below the average productivity of the world (879 kg $ha^{-1}$) [11]. Pigeonpea is cultivated for grain purpose as *dhal* which is a major source of protein for poor farmers. It has three times proteins as compared to cereals. Tender green seeds are used as vegetable, crushed seeds are used as animal feed, green leaves as fodder, stem is used as fuel wood and to thatch huts. The major constraints or lower yield of pigeonpea is mainly attributed to their cultivation on poor soils with inadequate and imbalanced nutrition, use of local varieties, use of disease susceptible varieties, lack of seed treatment, lack of Integrated Weed Management (IWM) and lack of Integrated Pest Management (IPM) [12].

Front line demonstration (FLD) is one of the most powerful tools of extension because farmers, in general, are driven by the perception that "Seeing is believing". The main objective of front line demonstrations is to demonstrate newly released crop production and protection technologies and its management practices in the farmer's field. During demonstration in the farmer's field, scientists are required to study the factors contributing higher crop production, field production constraints and there by convince the farmer to adopt the technology for higher yield. Here in front line demonstration farmer's participatory approach is very useful method of owning and continuous interacting with scientists and getting the useful tips for getting higher yield in farmers own field which otherwise get lower yields [13,14]. Keeping this in view Frontline demonstrations on Pigeonpea were conducted to demonstrate the production potentials and economic benefits of latest improved technologies of pigeonpea on farmer's fields.

## 2. MATERIALS AND METHODS

Front line demonstrations were conducted on 99 farmers' fields of five adopted villages viz., Melkunda, Bellamagi, Gudur, Bodhan and Kamalnagar of Gulbarga district during *Kharif* seasons of 2010-11 to 2014-15 in rainfed conditions on medium to deep black soils with low to medium fertility status under pulse based cropping system. Before conducting FLDs, a list of farmers was prepared from group meetings and specific skill training was imparted to the selected farmers regarding different aspects of cultivation and was followed as suggested [15]. In case of farmer's practice plots, existing practices being used by farmers were followed. In general, soils of the area under study were medium to deep black soils with low to medium fertility status. Visit of farmers and the extension functionaries was organized at demonstration plots to disseminate the message at large scale. The demonstration farmers were facilitated by scientists of Krishi Vigyan Kendra (KVK) and Agricultural Research Station (ARS) in performing field operations like sowing, seed treatment, fertilizer application, pest management, weed management, harvesting etc. during the course of training and visits. The traditional practices were maintained in case of local checks (Gulyal local). The data output were collected from both FLD plots as well as farmer's practice plot and finally the extension gap, technological gap, technological index along with the benefit cost ratio were worked out [16] as given below:

Technological gap= Potential yield-demonstration yield

Extension gap= demonstration yield - farmer's practice yield

Technological Index =

$$\frac{\text{Potential yield - demonstration yield}}{\text{Potential yield}} \times 100$$

Each demonstration was conducted on an area of 0.4 ha and the same area adjacent to the demonstration plot was kept as farmer's practices. The package of improved technologies included *Fusarium* wilt and Sterility Mosaic Disease (SMD) resistant varieties, Seed treatment, Integrated Nutrient Management (INM), Integrated Disease Management (IDM) and Integrated Pest Management (IPM). The varieties of pigeonpea included WRP 1 and TS 3R (both wilt resistant) in demonstration. Sowing was taken up from July 1$^{st}$ – 2$^{nd}$ week in all the years with the seed rate of 10 kg ha$^{-1}$. Entire dose of N and P through diammonium phosphate @ 25:50:0 kg ha$^{-1}$ was applied as basal dose. Zinc Sulphate @ 15 kg ha$^{-1}$ was applied 30 days after sowing. The seeds were treated with *Trichoderma viride* @ 4 gm kg$^{-1}$ seeds and *Rhizobium* @ 375 gm ha$^{-1}$. IPM practices were taken up as and when pests appeared. The IPM schedule included (i) Ovicidal spray i.e. Profenophos 50 EC @ 2 lit ha$^{-1}$ (ii) Pheromane traps @ 5 ha$^{-1}$ (iii) Bird perches @ 10 ha$^{-1}$ (iv) Neem based insecticide @ 2 lit ha$^{-1}$ (v) Ha.NPV @ 500 LE ha$^{-1}$ (vi) contact insecticide @ 2 lit ha$^{-1}$. The percent pest and disease incidence and yields were recorded.

To popularize the demonstrated technology, Agricultural Research Station (ARS) / Krishi Vigyan Kendra (KVK) in collaboration with developmental departments, NGO's and mass media organized the technology dissemination means like on campus training and off campus training. Extension functionaries training, group discussions, farmers-scientist interaction, publication and distribution of literatures. Rapid rowing survey for pests and diseases, pest and disease forecast through All India Radio, Doordarshan and Print Media was also done.

## 3. RESULTS AND DISCUSSION

The results of seed yield of pigeonpea (both farmers practice and technology demonstrated) was recorded and presented in Table 1.

The productivity of Pigeonpea in Gulbarga district of Karnataka under ICM practices ranged between 1007 and 1378 kg ha$^{-1}$ with mean yield of 1354 kg ha$^{-1}$. The yield under improved technologies varied from 1170 to 1430, 1100 to 1310, 1500 to 2000, 1322 to 1378, 1007 to 1250 kg ha$^{-1}$ with a mean yield of 1280, 1230, 1750, 1350 and 1160 kg ha$^{-1}$ during 2010-11, 2011-12, 2012-13, 2013-14 and 2014-15 respectively. The yield under local check (Farmers practice) ranged between 10.8 and 1375 kg ha$^{-1}$ with a mean of 1110 q ha$^{-1}$. The additional yield under improved technologies over local practice ranged from 1.5 to 3.75 q ha-1 with a mean of 234 kg ha$^{-1}$. There was an increase of 15.31, 13.8, 27.27, 22.20 and 14.9 percent in productivity of pigeonpea with a mean of 1869 kg ha$^{-1}$ under improved technologies in respective years when compared to local check (farmers practice) [17].

The data on the economics of improved practices is presented in the Table 2. The economic viability of improved technologies and farmers practice was calculated depending on prevailing prices of inputs and outputs costs. The cost of production of pigeonpea under improved technologies varied from Rs. 13,225 to 13,850 ha$^{-1}$ with an average of Rs. 13,525 ha$^{-1}$ as against Rs. 14,330 to 14500 ha$^{-1}$ with an average of Rs. 14,392 ha$^{-1}$ in farmers practice. The farmers practice recorded an additional cost ofproduction ranging from Rs. 481 to 1105 ha$^{-1}$ with a mean of Rs. 870 ha$^{-1}$ over improved technologies. The additional cost incurred in farmers' practice was mainly due to more cost involved with indiscriminate use of pesticides for controlling *Heliothis* pod borer.

**Table 1. Increase in yield of pigeonpea with improved package of practices over local check in farmers' field**

| Year | Area (ha) | No. of demonstrations (Ac) | Yield (kg ha$^{-1}$) | | | | Additional yield (kg ha$^{-1}$) over local check | % increase in yield over local check |
|---|---|---|---|---|---|---|---|---|
| | | | Improved technology | | | Local check | | |
| | | | Maximum | Minimum | Average | | | |
| 2010-11 | 05 | 12 | 1430 | 1170 | 1280 | 1110 | 170 | 15.31 |
| 2011-12 | 05 | 12 | 1310 | 1100 | 1230 | 1080 | 150 | 13.8 |
| 2012-13 | 10 | 25 | 2000 | 1500 | 1750 | 1375 | 375 | 27.27 |
| 2013-14 | 10 | 25 | 1378 | 1322 | 1350 | 1104 | 246 | 22.20 |
| 2014-15 | 10 | 25 | 1250 | 1007 | 1160 | 930 | 230 | 14.9 |
| Total /Average | 40 | 99 | 1473 | 1232 | 1354 | 1110 | 234 | 18.69 |

**Table 2. Economics of improved technologies and farmers practice in Pigeonpea**

| Year | Total cost of cultivation (Rs. ha$^{-1}$) | | Gross Returns (Rs. ha$^{-1}$) | | Net Return (Rs. ha$^{-1}$) | | B:C ratio | | Additional cost of cultivation (Rs. ha$^{-1}$) | Additional net returns (Rs. ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Improved technology | Local check | Improved technology | Local check | Improved technology | Local check | Improved technology | Local check | | |
| 2010-11 | 13500 | 14400 | 28160 | 24420 | 14660 | 10020 | 1:2.08 | 1:1.69 | 900 | 4640 |
| 2011-12 | 13850 | 14331 | 27060 | 23760 | 13834 | 9429 | 1:1.9 | 1:1.65 | 481 | 4405 |
| 2012-13 | 13225 | 14330 | 38500 | 30250 | 24500 | 15919 | 1:2.91 | 1:2.11 | 1105 | 8581 |
| 2013-14 | 13500 | 14500 | 43200 | 35328 | 29700 | 20528 | 1:3.2 | 1:2.43 | 1000 | 9172 |
| 2014-15 | 13550 | 14400 | 45240 | 39390 | 31690 | 24990 | 1:3.33 | 1:2.73 | 867 | 6700 |
| Average | 13525 | 14392 | 36432 | 30629 | 22876 | 16177.2 | 2.68 | 2.12 | 870 | 6699 |

The cultivation of Pigeonpea under improved technologies gave higher net returns which ranged from Rs. 13,834 to 31,690 $ha^{-1}$ with a mean value of Rs. 22,876 $ha^{-1}$ as compared to farmers' practice which recorded Rs. 9,429 to 24,990 $ha^{-1}$ with a mean of Rs.16,177 $ha^{-1}$. There was an additional net return of Rs. 4,640 in 2010-11, 4,405 in 2011-12, 8,581 in 2012-13, 9,172 in 2013-14 and 6,700 in 2014-15 under demonstration plots. The improved technologies also gave higher B:C ratio of 2.08, 1.9, 2.91, 3.2 and 3.33 as compared to 1.69, 1.65, 2.11, 2.43 and 2.73 under farmers practice in the respective corresponding years. Similar results have been obtained with frontline demonstrations of various research trials conducted elsewhere by different workers.

It was reported that adoption of IPM in pigeonpea recorded highest yield, less pod damage by pod borer and higher benefit cost ratio when compared to non IPM plots under farmers fields [18].

Seed treatment with PGPR and Rhizobium [19], application of RDF + Zinc [20] and use of Fusarium wilt resistant variety TS 3R and seed treatment with *Trichoderma* [21,22] helped in increasing the growth and yield parameters in pigeonpea.

It was reported that improved technologies like resistant variety, seed treatment, weeding etc. increased the yield and economics in black gram [23].

It was revealed that by following the integrated crop management technologies particularly proper crop rotation, good land preparation and by adopting improved varieties the yields of could be can be increased considerably compared to farmers practice [24].

It was observed that application of recommended fertilizer dose increased the yield to 8-12 percent and application of micronutrients could boost the yields of pulses by 10 per cent compared to farmers practice by adopting FLD technologies [17,25].

There was 11.5 per cent higher yield of pigeonpea by following weeding and irrigation to pigeonpea at critical periods along with recommended crop management technologies compared to farmers' practices [26].

It was observed that percentage increase in the yield in demonstrations over farmer practices was 34.4 per cent. The benefit: cost ratios of chick pea and pigeonpea cultivation under improved practices were 2.31 and 2.26 as compared to 2.02 and 1.94 under farmer practices for the two consecutive years [27].

The higher yield of pigeonpea by 9.6 per cent by adopting IPM (pheromone traps, ovicidal chemicals, neem based sprays, contact insecticides) extracts practices along with improved package of technologies over farmers' practices [15].

It was observed that productivity and economic returns of maize, paddy and pigeon pea in improved technologies were higher compared with the corresponding farmer's practices (local checks). They 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 [28].

The per cent Sterility Mosaic Disease (<5 per cent), *Fusarium* wilt, *Helicoverpa* pod borer (5-10 per cent) and pod fly (<8%) incidence was less in demonstration plots when compared to farmers' practice where in per cent Sterility mosaic disease, *Fusarium* wilt, *Heliothis* pod borer and pod fly incidence was 5-15, 5-20, 15-20 and 12-15 per cent respectively (Table 3). The lower incidence of diseases and insect pests are due to inbuilt wilt resistance of both the varieties WRP 1 and TS 3R and thorough training, constant visit and monitoring and demonstrating the integrated pest management (IPM) strategies in the implemented farmer's fields by the scientists.

**Table 3. Effect of IPM practices on pest and disease incidence in Pigeonpea (Average of five years)**

| Sl. no. | Parameter | Demonstration plot (%) | Farmers practice plot (%) |
|---|---|---|---|
| 1 | Sterility mosaic disease (SMD) | <5% | 5-15% |
| 2 | *Fusarium* wilt | <5% | 5-20% |
| 3 | *Heliothis* pod borer | 5-10% | 15-20% |
| 4 | Pod fly | <8% | 12-15% |

**Table 4. Extension programmers / activities organized on improved technologies in Pigeonpea**

| Sl. no. | Extension Programme/ activity | No. of programmers organized | No. of participants |
|---|---|---|---|
| 1 | On campus training | 10 | 459 |
| 2 | Off campus training | 12 | 692 |
| 3 | Training to extension personnel | 06 | 238 |
| 4 | Field days | 05 | 557 |
| 5 | Group discussion / farmers – scientist interaction | 09 | 258 |
| 6 | Rapid rowing survey of pest and diseases | Once in a every week (October to January) | - |
| 7 | Doordarshan Programmes | 06 | - |
| 8 | AIR Programme | 05 | - |

**Table 5. Indication of potential yield, demonstration yield, farmer's yield technological gap, extension gap and technological index**

| Sl. no. | Potential yield (kg $ha^{-1}$) | Demo yield (kg $ha^{-1}$) | Farmers yield (kg $ha^{-1}$) | Technological gap | Extension gap | Technological Index |
|---|---|---|---|---|---|---|
| 1 | 2000 | 1280 | 1110 | 720 | 170 | 36 |
| 2 | 2000 | 1230 | 1080 | 770 | 150 | 38.5 |
| 3 | 2000 | 1750 | 1375 | 250 | 375 | 12.5 |
| 4 | 2000 | 1350 | 1104 | 650 | 246 | 32.5 |
| 5 | 2000 | 1160 | 930 | 840 | 230 | 42 |
| Total /Average | 2000 | 1354 | 1110 | 646 | 244 | 32.3 |

In order to improve the knowledge of farmers regarding understanding of ICM practices, KVK conducted several extension activities which included training programmes i.e. On campus (02 Nos. involving 136 participants) and Off campus (03 Nos. involving 329 participants) and training to extension functionaries (01 Nos. involving 36 participants) belonging in to line departments and NGO's for horizontal spread to the technology and to develop effective linkages so as to create awareness about the technology (Table 4).

Periodic visit of KVK scientists to demonstration fields, farmers visit to KVK, phone calls, distribution of literature through leaf let, pamphlets etc. rapid rowing survey for pest and disease incidence monitoring and forecast through AIR, Doordarshan and Local print media was done for horizontal spread of the technology and also create awareness about the technology.

For mass interaction of farmers with scientists and farmers with farmers, a district level Krishmela and field day in the demonstration fields were organized where in major emphasis was given to spread the technology.

The techniques on improved production technologies in pigeonpea were stepwise and effective. It was reported that farmers' scientist participatory approach is the best one as compared to other methodologies in which education knowledge about the farming practice, mass media use, participation in training programme, and extension agency participation had significant relation with attitudes of farmers [22].

The work is a part of growing experience in participatory research, farmers training and demonstration. Collaboration among farmer groups, Agricultural Research station, Krishi Vigyan Kendra, and scientists on improved production technologies has provided opportunities to strengthen our bonds for emerging conviction that participatory approaches can facilitate changes in farmers' knowledge, attitudes and practices with improved access to latest information & technology.

## 4. CONCLUSION

Thus, it may be concluded that on an average the yield and returns in pigeonpea crop increased substantially (1354 kg $ha^{-1}$ and Rs. 22876 $ha^{-1}$ respectively) with the improved production technologies in participatory approach. The yield level under FLDs (1232 to 1473 kg $ha^{-1}$) was better than the farmer practice (930 to 1375 kg $ha^{-1}$) and performance of these varieties could be further improved by adopting recommended production technologies. So, there is need to disseminate the improved production technologies among the farmers with effective extension methods like training and field demonstrations. The farmers should be encouraged to adopt the recommended agro-techniques for enhancing pigeonpea production and economic gains in rainfed condition.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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