

Original Research Article

"Adoption of improved crop management practices for enhancing productivity of pigeonpea in Kalaburagi district of India on farmers' fields"

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, 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 were conducted at 99 farmer'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 *Trichoderma* (4gm 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 improved technologies recorded a mean yield of 13.54 q ha⁻¹ which was 18.69 percent higher than that obtained with farmers practice yield (11.10 q ha⁻¹) besides 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).

Key words: Pigeonpea, Front line demonstrations, Productivity, Participatory approach, farmer's field, Net returns

INTRODUCTION:

Pulses occupy an area of 76 million hectares and contribute 69 million tonnes to world's food basket (Anonymous, 2015a). India has the distinction of being world's largest producer of pulses, with the production of 24.6 lakh tonnes annually from an area of 37.5 lakh hectares (Anonymous, 2016a). India contributes nearly 25 per cent of global pulse production from 30 per cent area (Singh *et al.* 2015). The level of productivity of pulses in India ranging between 600-650 kg ha⁻¹, which is far below compared to average global productivity of pulses 904 kg/ha

Comment [U1]: Refer original source of data; cited reference is not appropriate.

31 (Anonymous, 2015b) Pigeonpea is one of the protein rich legumes of the semi-arid tropics grown
32 predominantly under rainfed conditions. The productivity of pigeonpea in India (758 kg ha⁻¹) is
33 far below the average productivity of world (879 kg ha⁻¹) as per the reports of Ministry of
34 Agriculture (Anonymous, 2016b). Globally Pigeonpea is grown on an area of 49.6 lakh ha with a
35 production of 42.6 m t with a productivity of 803 kg ha⁻¹ of which 91 per cent of the world's
36 pigeonpea is produced in India. (Singh, 2016).

Comment [U2]: Original source should be referred; Moreover, area and production figures are wrong.

37 In Karnataka, pigeonpea occupies an area of 0.73 million hectares having 0.47 m.tones
38 production with an average productivity of 651 kg per hectare (Anonymous, 2016c). Pigeonpea
39 is grown in almost all the states and larger portion of the area is in the states like Maharashtra,
40 Uttar Pradesh, Madhya Pradesh, Karnataka and Gujarat. In Karnataka, around 90 per cent of the
41 Pigeonpea area comes under northern Karnataka (Singh, *et al.* 2015). Gulbarga district which is
42 popularly called as "Pulse bowl of Karnataka" ranks first in both area (0.36 m ha.) and
43 production (0.18 m.tones) which accounts 55 percent area and 46 percent production of the state.
44 (Anonymous, 2015c) The productivity of pigeonpea in Karnataka (651 kg/ha) and India (758
45 kg/ha) are far below the average productivity of the world i.e 879 kg/ha. (Sharma, 2009).
46 Pigeonpea is cultivated for grain purpose as *dhal* which is a major source of protein for poor
47 farmers. It has three times protein as compared to cereals. Tender green seeds are used as
48 vegetable, crushed seeds are used as animal feed, green leaves as fodder, stem is used as fuel
49 wood and to thatch huts. The major constraints or lower yield of pigeonpea is mainly attributed
50 to their cultivation on poor soils with inadequate and imbalanced nutrition, use of local varieties,
51 use of disease susceptible varieties, lack of seed treatment, Integrated Weed Management (IWM)
52 and Integrated Pest Management (IPM).

Comment [U3]: Recent data should be incorporated from source such as FAO, DAC or PC report of AICRP.

Comment [U4]: Without any reference; appears just like an essay????

53 A front line demonstration (FLD) is one of the most powerful tools of
54 extension because farmers, in general, are driven by the perception that
55 "Seeing is believing". The main objective of front line demonstrations is to
56 demonstrate newly released crop production and protection technologies and
57 its management practices in the farmer's field. During demonstration in the
58 farmer's field, scientists are required to study the factors contributing higher
59 crop production, field production constraints and there by convince the farmer
60 to adopt the technology for higher yield. Here in front line demonstration

61 farmer's participatory approach is very useful method of owning and
62 continuous interacting with scientists and getting the useful tips for getting
63 higher yield in farmers own field which otherwise get lower yields. Keeping this
64 in view Frontline demonstrations on Pigeonpea were conducted to demonstrate
65 the production potentials and economic benefits of latest improved technologies of
66 pigeonpea on farmer's fields.

Comment [U5]: Without any reference???

67 **Materials and Methods:**

68 Front line demonstrations were conducted on 99 farmers' fields of five adopted villages
69 viz., Melkunda, Bellamagi, Gudur, Bodhan and Kamalnagar of Gulbarga district during *Kharif*
70 seasons of 2010-11 to 2014-15 in rainfed conditions on medium to deep black soils with low to
71 medium fertility status under pulse based cropping system. Before conducting FLDs, a list of
72 farmers was prepared from group meeting and specific skill training was imparted to the selected
73 farmers regarding different aspects of cultivation and was followed as suggested by Kumar *et al.*
74 (2010). In case of farmer's practice plots, existing practices being used by farmers were
75 followed. In general, soils of the area under study were medium to deep black soils with low to
76 medium fertility status. Visit of farmers and the extension functionaries was organized at
77 demonstration plots to disseminate the message at large scale. The demonstration farmers were
78 facilitated by scientists of Krishi Vigyan Kendra (KVK) and Agricultural Research Station
79 (ARS) in performing field operations like sowing, seed treatment, fertilizer application, pest
80 management, weed management, harvesting etc. during the course of training and visits. The
81 traditional practices were maintained in case of Gulyal local (Local check). local checks The
82 data output were collected from both FLD plots as well as farmer's practice plot and finally the
83 extension gap, technological gap, technological index along with the benefit cost ratio were
84 worked out (Samui *et al.*, 2000) as given below:

85 **Technological gap**= Potential yield-demonstration yield

86 Extension gap= demonstration yield - farmer's practice yield

87 Potential yield - demonstration yield

88 **Technological Index** = $\frac{\text{Potential yield - demonstration yield}}{\text{Potential yield}}$ X 100
89
90

91 Each demonstration was conducted on an area of 0.4 ha and the same area adjacent to the
92 demonstration plot was kept as farmer's practices. The package of improved technologies
93 included *Fusarium* wilt and Sterility Mosaic Disease (SMD) resistant varieties, Seed treatment,
94 Integrated Nutrient Management (INM), Integrated Disease Management (IDM) and Integrated
95 Pest Management (IPM). The varieties of pigeonpea included WRP 1 and TS 3R (wilt resistant)
96 in demonstration. Sowing was taken up from July 1st – 2nd week in all the years with the seed rate
97 of 10 kg ha⁻¹. Entire dose of N and P through diammonium phosphate @ 25:50:0 kg ha⁻¹ was
98 applied as basal dose. Zinc Sulphate @ 15 kg ha⁻¹ was applied 30 days after sowing. The seeds
99 were treated with *Trichoderma viride* @ 4 gm kg⁻¹ seeds and *Rhizobium* @ 375 gm ha⁻¹. IPM
100 practices were taken up as and when pests appeared. The IPM schedule included (i) Ovicidal
101 spray i.e. Profenophos 50 EC @ 2 lit ha⁻¹ (ii) Pheromane traps @ 5 ha⁻¹ (iii) Bird perches @ 10
102 ha⁻¹ (iv) Neem based insecticide @ 2 lit ha⁻¹ (v) Ha.NPV @ 500 LE ha⁻¹ (vi) contact insecticide
103 @ 2 lit ha⁻¹. The percent pest and disease incidence and yield was recorded.

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

110 RESULTS AND DISCUSSION:

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

113 The productivity of Pigeonpea in Gulbarga district of Karnataka under ICM practices
114 ranged between 1007 and 1378 kg ha⁻¹ with mean yield of 1354 kg ha⁻¹. The yield under
115 improved technologies varied from 1170 to 1430, 1100 to 1310, 1500 to 2000, 1322 to 1378,
116 1007 to 1250 kg ha⁻¹ with a mean yield of 1280, 1230, 1750, 1350 and 1160 kg ha⁻¹ during 2010-
117 11, 2011-12, 2012-13, 2013-14 and 2014-15 respectively. The yield under local check (Farmers
118 practice) ranged between 10.8 and 1375 kg ha⁻¹ with a mean of 1110 q ha⁻¹. The additional yield
119 under improved technologies over local practice ranged from 1.5 to 3.75 q ha⁻¹ with a mean of
120 234 kg ha⁻¹. There was an increase of 15.31, 13.8, 27.27, 22.20 and 14.9 percent in productivity

121 of pigeonpea with a mean of 1869 kg ha⁻¹ under improved technologies in respective years when
122 compared to local check (farmers practice).

123 The data on the economics of improved practices is presented in the Table 2. The
124 economic viability of improved technologies and farmers practice was calculated depending on
125 prevailing prices of inputs and outputs costs. The cost of production of pigeonpea under
126 improved technologies varied from Rs. 13,225 to 13,850 ha⁻¹ with an average of Rs. 13,525 ha⁻¹
127 as against Rs. 14,330 to 14500 ha⁻¹ with an average of Rs. 14,392 ha⁻¹ in farmers practice. The
128 farmers practice recorded an additional cost of production ranging from Rs. 481 to 1105 ha⁻¹
129 with a mean of Rs. 870 ha⁻¹ over improved technologies. The additional cost incurred in farmers'
130 practice was mainly due to more cost involved in indiscriminate use of pesticides for controlling
131 *Heliothis* pod borer. The cultivation of Pigeonpea under improved technologies gave higher net
132 returns which ranged from Rs. 13,834 to 31,690 ha⁻¹ with a mean value of Rs. 22,876 ha⁻¹ as
133 compared to farmers' practice which recorded Rs. 9,429 to 24,990 ha⁻¹ with a mean of Rs.16,177
134 ha⁻¹. There was an additional net return of Rs. 4,640 in 2010-11, 4,405 in 2011-12, 8,581 in
135 2012-13, 9,172 in 2013-14 and 6,700 in 2014-15 under demonstration plots. The improved
136 technologies also gave higher B:C ratio of 2.08, 1.9, 2.91, 3.2 and 3.33 as compared to 1.69,
137 1.65, 2.11, 2.43 and 2.73 under farmers practice in the respective corresponding years. Similar
138 results have been obtained with frontline demonstrations of various research trials conducted
139 elsewhere by different workers.

140 Penchala raju *et al.*, (2005) reported that adoption of IPM in pigeonpea recorded highest
141 yield, less pod damage by pod borer and higher benefit cost ratio when compared to non IPM
142 plots under farmers fields.

143 Seed treatment with PGPR and Rhizobium (Gundappagol *et al.*, 2007), application of
144 RDF + Zinc (Verma *et al.*, 2004) and use of Fusarium wilt resistant variety, TS3-R and seed
145 treatment with *Trichoderma* (Anonymous, 2008 and Rajanna *et al.*, 2009) helped in increasing
146 the growth and yield parameters in pigeonpea.

147 Tomar *et al.*, (2009) reported that improved technologies like resistant variety, seed
148 treatment, weeding etc. increased the yield and economics in black gram.

149 Thakur *et al.* (2016) revealed that by following integrated crop management technologies
150 particularly proper crop rotation, good land preparation and by adopting improved varieties the
151 yields of could be can be increased considerably compared to farmers practice.

152 Singh *et al.* (2016) and Meena *et al.* (2017) observed that application of recommended
153 fertilizer dose increased the yield to 8-12 percent and application of micronutrients could boost
154 the yields of pulses by 10 per cent compared to farmers practice by adopting FLD technologies.

155 Ramesh *et al.* (2016) recorded 11.5 per cent higher yield of pigeonpea by following
156 weeding and irrigation to pigeonpea at critical periods along with recommended crop
157 management technologies compared to farmers' practices.

158 Bhargav *et al.* (2017) revealed that percentage increase in the yield in demonstrations
159 over farmer practices was 34.4. The benefit: cost ratios of chick pea and pigeonpea cultivation
160 under improved practices were 2.31 and 2.26 as compared to 2.02 and 1.94 under farmer
161 practices for the two consecutive years.

162 Mishra *et al.* (2017) obtained higher yield of pigeonpea by 9.6 percent by adopting IPM
163 (pheromone traps, ovicidal chemicals, neem based sprays, contact insecticides) extracts practices
164 along with improved package of technologies over farmers' practices.

165 Thakur and shurya Bhushan (2017) The productivity and economic returns of maize,
166 paddy and pigeon pea in improved technologies were higher compared with the corresponding
167 farmer's practices (local checks). They higher gross returns, net return and benefit cost ratio in
168 improved technologies as compared to the plots where farmers were using traditional practices in
169 their cultivation

170 The per cent Sterility Mosaic Disease (<5 per cent), *Fusarium* wilt, *Heliothis* pod borer
171 (5-10 per cent) and pod fly (<8%) incidence was less in demonstration plots when compared to
172 farmers' practice where in per cent Sterility mosaic disease, *Fusarium* wilt, *Heliothis* pod borer
173 and pod fly incidence was 5-15, 5-20, 15-20 and 12-15 per cent respectively (Table 3). The
174 lower incidence of diseases and insect pests are due to thorough training, constant visit and
175 monitoring and demonstrating the integrated pest management (IPM) strategies in the
176 implemented farmer's fields by the scientists.

Comment [U6]: Author was suggested to substitute the word with *Helicoverpa*.

Comment [U7]: Was there any role of inbuilt resistance/tolerance of variety???

177 In order to improve the knowledge of farmers regarding understanding of ICM practices,
178 KVK conducted several extension activities which included training programmes i.e. On campus
179 (02 Nos. involving 136 participants) and Off campus (03 Nos. involving 329 participants) and
180 training to extension functionaries (01 Nos. involving 36 participants) belonging in to line
181 departments and NGO's for horizontal spread to the technology and to develop effective linkages
182 so as to create awareness about the technology (Table 4).

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

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

190 The techniques on improved production technologies in pigeonpea were stepwise and
191 effective. Rajanna *et al.*, (2009) reported that farmers' scientist participatory approach is the best
192 one as compared to other methodologies in which education knowledge about the farming
193 practice, mass media use, participation in training programme, extension agency contract and
194 extension participation had significant relation with attitudes of farmers.

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

201 **CONCLUSION:**

202 Thus, it may be concluded that on an average the yield and returns in pigeonpea crop
203 increased substantially (1354 kg ha⁻¹ and Rs. 22876 respectively) with the improved production
204 technologies in participatory approach. The yield level under FLDs (1232 to 1473 kg ha⁻¹) was

205 better than the farmer practice (930 to 1375 kg ha⁻¹) and performance of these varieties could be
206 further improved by adopting recommended production technologies. So, there is need to
207 disseminate the improved production technologies among the farmers with effective extension
208 methods like training and field demonstrations. The farmers should be encouraged to adopt the
209 recommended agro-techniques for enhancing pigeonpea production and economic gains in
210 rainfed condition.

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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

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	<i>Fusarium</i> wilt	<5%	5-20%
3	<i>Heliothis</i> 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

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