Original Research Article

Productivity enhancement of pigeonpea in farmers fields with adoption of ICM practices through participatory approach

ABSTRACT:

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

INTRODUCTION:

Pulses occupy an area of 76 million hectares and contribute 69 million tonnes to world's food basket (Anon., 2015). India has the distinction of being world's largest producer of pulses, with the production of 2.46 million tonnes annually from an area of 3.75 million hectares (Anon., 2016). India contributes for 25 per cent of global pulse production from 30 per cent area. 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 (Anon., 2015) Pigeonpea is one of the protein rich legumes of the semi-arid tropics grown predominantly under rainfed conditions.

It is one of the important pulse crops of India and 91 per cent of the world's pigeonpea is produced in India. 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 (Anon., 2016).

In Karnataka, pigeonpea occupies an area of 0.73 million hectares having 0.47 m.tones production with an average productivity of 651 kg per hectare (Anon., 2016). 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 comes under northern Karnataka. 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. (Anon., 2015) The productivity of pigeonpea in Karnataka (651 kg/ha) and India (758 kg/ha) are far below the average productivity of the world i.e 879 kg/ha. (Arjun Sharma, 2009). Pigeonpea is cultivated for grain purpose as *dhal* which is a major source of protein for poor farmers. It has three times protein 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, IWM and IPM.

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.

METHODOLOGY:

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 meeting and specific skill training was imparted to the selected farmers regarding different aspects of cultivation and was followed as suggested by Venkatta Kumar *et al.* (2010). 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 KVK and ARS scientists 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. The data output were collected from both FLD plots as well as farmer's practice plot and finally the extension gap, technology gap, technology index along with the benefit cost ratio were worked out (Samui *et al*., 2000) as given below:

Technology gap= Potential yield-demonstration yield

Extension gap= demonstration yield - farmer's practice yield

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

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 (wilt resistant) in demonstration. Sowing was taken up from July 1st – 2nd 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 yield was recorded.

To popularize the demonstrated technology, ARS / 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.

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 10.7 and 13.78 q ha^{-1} with mean yield of 13.54 q ha^{-1}. The yield under improved technologies varied from 11.7 to 14.3, 11.0 to 13.1, 15.0 to 20.0, 13.22 to 13.78, 10.7 to 12.50 q ha^{-1} with a mean yield of 12.8, 12.3, 17.5, 13.5 and 11.6 q 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 13.75 q ha^{-1} with a mean of 11.1 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 2.34 q 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 18.69 q ha^{-1} under improved technologies in respective years when compared to local check (farmers practice).

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 of production 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 in indiscriminate use of pesticides for controlling *Heliothis* pod borer. 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. 10,020 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.

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

Seed treatment with PGPR and Rhizobium (Gundappagol *et al*., 2007), application of RDF + Zinc (Verma *et al*., 2004) and use of Fusarium wilt resistant variety, TS3-R and seed treatment with *Trichoderma* (Anonymous, 2008 and Jayalakshmi *et al*., 2003) helped in increasing the growth and yield parameters in pigeonpea.

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

Thakur *et al.* (2016) revealed that by following 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.

Singh *et al.* (2016) and Meena *et al.* (2017) 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.

Amule Ramesh *et al*. (2016) recorded 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.

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

The per cent Sterility mosaic disease (<5 per cent), *Fusarium* wilt, *Heliothis* 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)

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. Rajanna *et al*., (2009) 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, extension agency contract and extension participation had significant relation with attitudes of farmers.

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.

CONCLUSION:

Thus, it may be concluded that the yield and returns in pigeonpea crop increased substantially with the improved production technologies in participatory approach. The yield level under FLDs was better than the farmer practice 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 through participatory approach. The farmers should be encouraged to adopt the recommended agro-techniques for enhancing pigeonpea production and economic gains in rainfed condition.

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Table 1: Effect of improved practices on seed yield of Pigeonpea in farmers' field

Year	Area (ha)	No. of Demonstrations (Ac)	Yield (q ha-1)				Additional yield (q/ha) over local check	% increase in yield over local check
			Improved technology			Local check		
			Maximum	Minimum	Average			
2010-11	05	12	14.3	11.7	12.8	11.10	1.7	15.31
2011-12	05	12	13.1	11.0	12.3	10.8	1.5	13.8
2012-13	10	25	20.0	15.0	17.5	13.75	3.75	27.27
2013-14	10	25	13.78	13.22	13.50	11.04	2.46	22.20
2014-15	10	25	12.50	10.07	11.60	9.3	2.30	14.9
Total /Average	**40**	**99**	**14.73**	**12.32**	**13.54**	**11.10**	**2.34**	**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	*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: indicating potential yield, demo yield, farmers yield technology gap, extension gap and technology index

Sl.No.	Potential yield (q/ha)	Demo yield (q/ha)	Farmers yield (q/ha)	Technology gap	Extension gap	Technology Index
1	20	12.8	11.10	7.2	1.7	36
2	20	12.3	10.8	7.7	1.5	38.5
3	20	17.5	13.75	2.5	3.75	12.5
4	20	13.50	11.04	6.5	2.46	32.5
5	20	11.60	9.3	8.4	2.3	42
Total /Average	**20**	**13.54**	**11.10**	**6.46**	**2.44**	**32.3**