The Pharma Innovation Journal 2023; 12(5): 1399-1402

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 1399-1402

www.thepharmajournal.com
Received: 07-03-2023
Accepted: 15-04-2023

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Unlocking the hidden production potential of papaya through deployment of frontline demonstration programmes in north eastern transitional belts of Kalyan Karnataka, India

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Abstract
Papaya is one of the important fruit crop of Karnataka grown particularly during *kharif*, occupying about an area of 73900 ha and production of 50756000 Mt with the productivity of 68.68 t ha^{-1} respectively. The productivity of papaya is low, because lack of adoption of available newer technologies by the farmers. The frontline demonstration concept has been evolved by Indian Council of Agricultural Research, with the inception of the technology mission on Agriculture Crops. The frontline demonstration was conducted by the Krishi Vigyan Kendra, Bidar on papaya with deployment of improved package of practices at farmers fields successfully for two consecutive years. Results obtained clearly revealed that the per cent increase in the yield, due to the fluctuations in the agroclimatic parameters. Other parameters such as technology gap, extension gap and technology index were also analysed for the assessment of technology adoption rate with extension activities and feasibility of demonstrated technologies at grass root level. Moreover the results clearly connotes, the signs of positive impact of FLDs over the existing practices enhancing the productivity of papaya in the irrigated regions of Bidar district. Demonstrated technologies were proved most remunerative and economically feasible over traditional production systems. The average of two years pooled data from 2015 to 2017 reveals that demonstrated yield 93.65 t ha^{-1} and check plot yield 62.50 t ha^{-1} during the implementation period. Maximum average of papaya yield in demonstration plots over the years compare to local check, it's mainly due to knowledge and adoption of full package of practices.

Keywords: extension gap, net returns, papaya, technology gap, technology index

Introduction
Papaya (*Carica papaya* L.) belongs to the family Caricaceae is one of the important crops of the country The origin of papaya is Southern Mexico (Decandolle 1984) [5]. It is cultivated in India, Brazil, Mexico, Nigeria, Jamaica, Indonesia, China, Taiwan, Peru and phillipines (Jayaveli *et al*., 2011) [6]. Papaya fruit is known for its high nutritive and medicinal source of vitamin A,B,C and proteolytic enzymes *viz*, papain, carotene helps in prevention of cancer, diabetics and heart diseases. Papaya is usually eaten fresh and can be processed into jam, jelly, marmalade and it is being used extensively in the pharmaceutical and cosmetic industries (Retuta AMO *et al*., 2012) [7]. The total production of papaya in the world has been estimated at 12.67 milion metric tons. (Anonymous., 2015) [2].
According to the statistics (National Horticulatural Board., 2015-16) In India, the area and production under papaya was estimated at 1,32,000 ha,56,67,000Mt with the productivity of 42.8 t ha^{-1} respectively. With special reference to Karnataka state, the area and production was estimated at 73,900 ha,and 5,07,56,000 Mt with the productivity of 68.68 t ha^{-1} respectively. Karnataka is one of the progressive states of India with great potential development for fruit crops. The state is bestowed with ten agro climatic regions suitable for growing variety of fruits all around the year in Karnataka. The major districts growing fruit crops in the state are Belgaum, Bidar, Bangalore, Bijapur, Gulbarga, Dharwad, Tumkur, Bagalkot and Chitradurga.
In Bidar district, the papaya is grown in an area of 3800 ha, with the production and productivity of 2,15,500 tonnes and 56.71 t ha^{-1} respectively. Papaya which mainly thrives better, under tropical and subtropical regions of the world, but instantaneously exposed to various types of biotic and abiotic stress (pests & diseases). There are several constraints, associated with the production and productivity of papaya in bidar district. of them, the pests to little extent known to inflict damage to crop but manageable.

The main reasons for low productivity in papaya mainly attributes to, two main predominating factors namely biotic and abiotic factors respectively. Amongst the two, the former one, of course the latter which mainly influence the aphid population (biotic) which serves as source of transmission for papaya ring spot virus (PRSV). Unfortunately the invisible living entity (Papaya ring spot virus) known to infect the crop in most dreadful manner and sometimes, based on the severiety of the virus, the entire papaya plantation gets ruined. So in this context, frontline demonstrations were conducted during 2015-16 and 2016-17 at Krishi Vigyan Kendra Bidar, to identify the factors responsible for decline in the yield of papaya and also the technological and extension gaps, adoption levels of integrated crop management practices over farmers practice.

Material and Methods

Frontline demonstrations were carried out in the farmers field to demonstrate the impact of integrated crop management technology on papaya productivity over two years during the monsoon period 2015-16 and 2016-17 respectively. Total 7 FLDs were conducted in 5 farmers field. The area under each demonstration was laid out at 0.7 ha and adjacent 0.7 ha (farmers field). The selection of farmers was made in consultation with the local AAOs and Scientists of KVK of bidar district, Karnataka. Layout of the demonstration and farmers participation, procedure for site and farmers selection, etc. were followed as per the methodology adopted by Choudhury (1999). The ICM technology consisted of popular improved varieties (Coorg honey dew, solo, surya), Proper land preparation, Seed rate, Sowing methods, selection of genuine seed material, Seed soaking seeds are soaked in required quantity of Cow urine, raising nursery seedlings, proper nutrient, pest management & post harvest management (Table 1). The Frontline demonstration study was conducted to know the technology gap between the potential yield and demonstrated yield, Extension gap between demonstrated yield and yield under existing practice and technology index. Yield data was collected from demonstration fields and farmers practice by random crop cutting methods and analysed by using simple statistical tools. The technology gap, extension gap and technological index (Samui *et al*., 2000) [8] were calculated by using the formula as given below.

$$\text{Per cent Increase in yield} = \frac{\text{Demonstration Yield-Farmers Yield}}{\text{Farmers yield}} \text{x100}$$

Technology gap = Potential Yield-Demonstrated Yield

Extension gap = Demonstrated Yield-Yield under existing practice (farmers practices)

$$\text{Technology Index} = \frac{\text{Potential Yield-Demonstrated Yield}}{\text{Farmers yield}} \text{X100}$$

Results and Discussion

The gap between the existing and recommended technologies of papaya in Bidar district presented in Table1 Cent per cent gap was observed in varieties, nursery raising and pre sowing post-harvest measures, partial gap was observed in land preparation, sowing methods, fertiliser dose and plant protection measures. All the above gaps which clearly connotes that, their exists a technological gap, mainly resulted in low potential yields. Farmers were not aware about the recommended technologies. Either they used locally available resources or the outdated (traditional varieties), despite of the recommended improved varieties. Non availability of the genuine seed material, farmers used high seed rate, than the recommended improved varieties. These were the following reasons, responsible for the gap in the yield levels.

Table 1: Criteria's taken for integrated crop management (improved practices) over farmers practices in papaya

Sl. No	Technology	Improved practices	Farmers practice
1.	Varieties	Coorg honey dew, solo and surya	local
2.	Land preparation	Ploughing and harrowing, suitable windbreak should be planted around the boundary of the orchard	Local
3.	Seed rate	250 gram ha^{-1}	400 gram ha^{-1} unscientific
4.	Nursery raising	a) 2-3 beds measuring 8mt(L) X1.25mt(W)X10 cm (Ht) b) 15 kg Farm yard Manure & 0.5 kg 15:15:15 complex fertiliser c) seed beds are moistened with cereson (2gram lit^{-1} of water)	local
5.	Pre-sowing treatments	Prior to sowing, papaya seeds are soaked in required quantity of Cow urine overnight, favours in uniform seed sprouting & better germination.	Lack of awareness
6.	Sowing methods	Fresh seeds are sown at a spacing of 2.5cm (plant to plant), 2cm (depth) 15cm (rows) March-April months are most preferred for raising nursery seedlings. Transplanting of nursery seedlings to the main field. June-july months most preferred.	unscientific
7.	Fertilizer dose	250:250:500 gram NPK $plant^{-1}$	unscientific
8.	Plant protection measures	Adoption of Integrated plant and disease management measures	unscientific
9.	Post harvest management measures	Measures are taken in most scientific way especially during papain extraction, storage and drying.	unscientific

Yield

From table 2 and fig1(a), clearly implies that the yield obtained during 2015-16 and 2016-17 was 95.75 and 91.55 t ha^{-1} with the average productivity of 93.65 t ha^{-1} respectively, while it was 65.25 and 59.75 t ha-1, with the average yield of 62.50 t ha-1respectively. The average yield obtained in the demonstration plot (93.65 t ha-1) was found maximum compared to check (62.50 t ha-1). The increase in yield in the demonstration plot mainly attributes to the knowledge and adoption of full package of practices, such as suitable improved varieties, timely raising of nursery seedlings, use of genuine seed material, maintaining uniform crop stand, proper spacing, adoption of need based integrated pest and disease management practices. The present findings are in conformity

with Singh *et al.* (2014) who observed that the increase in the yield of chickpea was due to the knowledge and adoption of full package of practices.

Per cent increase in yield

It was observed from table 2, that per cent increase in the yield over check during 2015-16 (46.74) while it was 53.22 with the average of 49.98 per cent respectively.

Economic returns

From table 2, that the net returns (Rs 641000) obtained from demonstration plot, during 2015-16 while (Rs 507400) during 2016-17, with the average economic net return of (Rs 624200) Compared to check (402000) during 2015-16 and 2016-17 (358000) with average net returns of Rs 380000 respectively.

Similarly the benefit cost ratio was 6.12 and 5.86 in the demonstration plot with the average of 5.99 during 2015-16 and 2016-17 respectively, while in the check it was 4.35 and 3.98 with the average of 4.16 respectively. The present findings were in accordance with Sharma *et al.* (2010) who observed that the expenditure incurred on papaya cultivation by the high adopter (Rs 217673) and the revenue generated (Rs 427406) respectively and also the B:C ratio was higher for high (2.96) adopters compared to low (2.65) adopters.

Technology gap

During 2015-16 and 2016-17 it was observed from table 2 and fig 1(b), that the technological gap, the differences that exists between the potential yield and yields from demonstrated plots were 34.25 t ha-1 and 38.45 t ha-1 with the average technology gap, stood at 36.35 t ha-1 respectively. The gap observed mainly attributes to the heterogenous nature of the soil fertility, non-adoption of good agricultural practices (GAP), timely non availability of genuine seed material and the prevailence of local weather conditions.

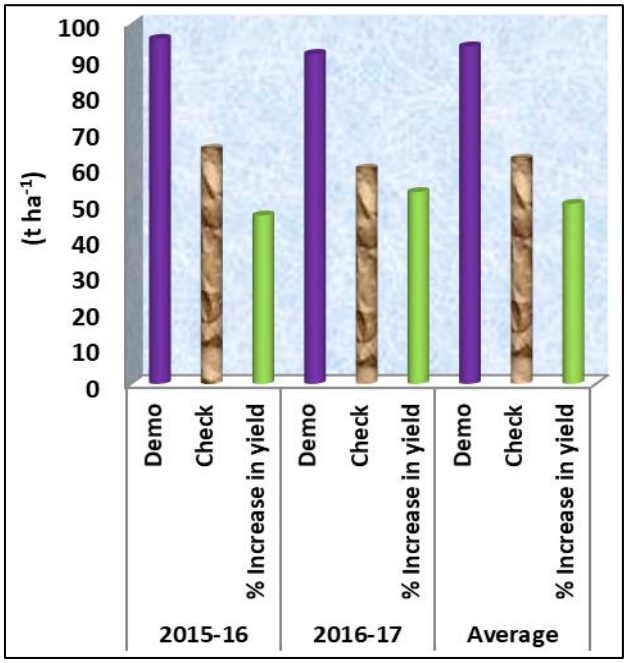

Fig 1(a): Performance of Papaya (Coorg honey dew) yield through integrated crop management technologies.

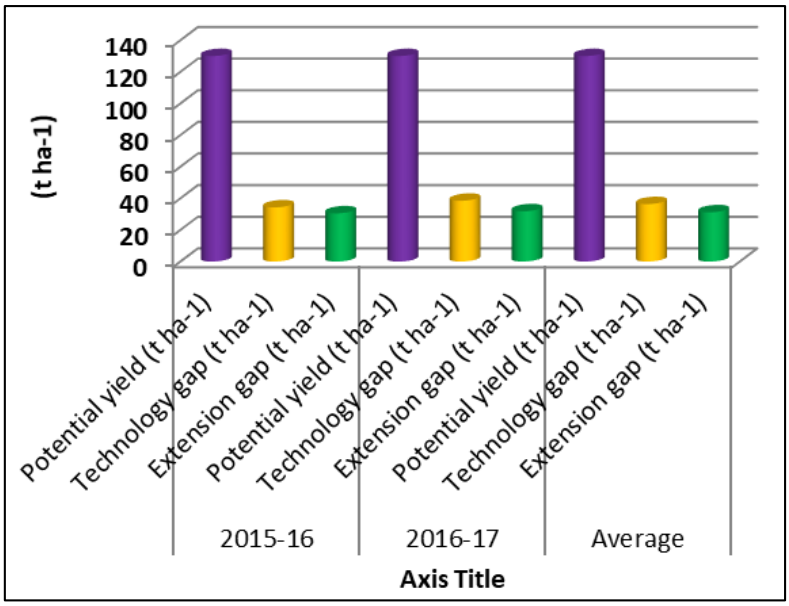

Fig 1(b): Yield gap analysis of Papaya (Coorg honey dew) through integrated crop management technologies.

Extension gap

From table 2 and fig1(b),the extension gap during 2015-16 (30.5 t ha-1) and 2017 (31.8 t ha-1) was observed with the average yield of 31.1 t ha-1 respectively, which necessitated the extension functioneries to educate farmers through various extension measures mainly through frontline demonstrations for adoption of improved production and protection technologies to narrow down the extension gap.

The decline in the papaya yield mainly through the extension gap, involves non deployment of frontline demonstration in the farmers field, lack of capacity building measures from extension functioneries, lack of effective communication ways for technological transfer, mainly through social (WhatsApp, Facebook), print media (local newspaper, leaflets, monographs, extension bulletins, and lack of access to exposure visits agricultural exhibitions, demonstration plots, attending field days, farmers to farmers interaction, which will serve as platform for grasping innovative ideas and knowledge sharing in agriculture.

Technology index

From table 2, it clearly implies that the technology index mainly predicts the feasibility of the demonstrated technology in the farmers field. The technology index greatly varied from 53.01 to 64.35 with the average of 58.68 per cent, which shows the effectiveness of the technical intervention over years. This will not only accelerate the adoption of demonstrated technologies, but also helps in sustaining the yield performance of the papaya.

Table 2: Performance of Papaya (Coorg honey dew) through demonstration of integrated crop management technologies

Year	No of demos	Area (Ha)	Yield (t ha^{-1})		% Increase in yield	Net returns (Rs ha^{-1})		Benefit-cost ratio		Potential yield (t ha^{-1}))	Technology gap (t ha$^{-1)}$	Extension gap (t ha$^{-1)}$	Technology Index (%)
			Demo	Check		Demo	Check	Demo	Check				
2015-16	2	1	95.75	65.25	46.74	6,41,000	402000	6.12	4.35	130	34.25	30.5	53.01
2016-17	5	4	91.55	59.75	53.22	6,07,400	358000	5.86	3.98	130	38.45	31.8	64.35
Average	3.5	2.5	93.65	62.50	49.98	6,24,200	380000	5.99	4.16	130	36.35	31.15	58.68
Total	7	5											

Conclusion

Frontline demonstrations generated a positive results, and has ultimately provided scope for the research scientists who were involved in assessing the production potential of papaya, which they have been guiding the papaya farming community for quite long period. This could obviously surpass some of the prevailing bottlenecks in the existing transfer of technology system in bidar district.

Acknowledgement

The authors are highly grateful to the eminent scientists of Agricultural Technology Application Research Institute (ATARI Zone-VIII), Indian Council Of Agricultural Research, New Delhi and the University of Agricultural Sciences, Raichur, who have not only supported in terms of monetary assistance, but also shared lot of innovative technological information which ultimately proved successful.

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