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Yield Gap Analysis in Adoption of Production Technology and Economics of Coconut at Farmers Field of Tumkuru District, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted with analysis of yield gap in adoption of production technology and economics of coconut through frontline demonstrations(FLD) at farmer's field of Tumkur district, Karnataka state during the year from 2017-18 to 2019-20.The demonstrated plot yield obtained through frontline demonstrations was higher (9,932 nuts/ha) than the actual yield obtained by the farmers on their farm under own management practices (7,852 nuts/ha), but lower than the potential yield of coconut (12,300 nuts/ha).The data revealed that the total yield gap between potential yield and actual yield of coconut was 36.16 per cent, in which 20.92 per cent of yield gap between demonstration plot and actual farmers plot yield and 19.25 per cent of technological gap.

The maximum number of coconut growers adopted intercropping system (90.00 %) followed by irrigation method (86.66 %), whereas lesser adoption of harvesting of coconuts by coconut climber (26.67 %). More number of farmers were found to increase in adoption per cent of growing of green manure crops & incorporation (56.67 %) and soil sample analysis from coconut plot (53.33 %) and also improved soil fertility status of demonstrated plot as compared to farmers practices. There was significantly increased the yield of coconut (26.49%) after conducted the frontline demonstrations. The gross return, net return and B:C ratio was also found to increased in demonstrated plots as compared to farmers' practice. The adoption of different production package of practices in coconut shows positive impact on yield and economics of coconut through adoption of demonstrated technology.

Keywords: Adoption; coconut; frontline demonstration; production technology and yield gap.

1. INTRODUCTION

"The coconut (*Cocos nucifera* L.) palm is referred to as 'Kalpavriksha' – the '*tree of heaven*' as each and every part of the palm is useful in one way or the other. Ten million people in India depend on coconut for their livelihood either directly or indirectly. India ranks third in an area and first in production of coconut in the world. As per the latest statistics available" [1], the annual coconut production in India is 23.90 billion nuts from an area of 2.08 million ha with an average productivity of 11481 nuts/ha. Coconut cultivated in 19 states and 3 Union Territories in India. "The four southern states *viz.*, Kerala, Tamil Nadu, Karnataka and Andhra Pradesh are the major coconut producing states in India, which contribute more than 90 per cent of the area and production in India" [2].

"The need of present era is to increase the productivity of each and every crop. This could be achieved by adopting improved production practice, high yield varieties and new technologies of crop. Krishi Vigyan Kendra, Konehalli, Tiptur conducted frontline demonstrations at farmers' field. The main objective of frontline demonstration is to demonstrate newly released crop production and protection technologies and its management practices at the farmer's field under different agro-climatic regions and farming situations and also convincing farmers and extension functionaries together about the coconut production technologies for further wide scale diffusion. Keeping in view of an effective extension approach of frontline demonstrations for dissemination of coconut production technology, its impact of FLDs conducted to be assessed" [3,4]. Therefore, the present study was conducted with analysis of yield gap in adoption of production technology and economics of coconut through frontline demonstration and to know the impact of FLD on coconut growing farmers.

1.1 Main Objective

1. To study the extent of adoption of coconut production technology at farmers practices and after conduct of frontline demonstration.
2. To study yield gap identified in coconut production in Tumkuru district.
3. To study the economics of coconut production at farmers practices and after conduct of frontline demonstration.

2. MATERIALS AND METHODS

The study was conducted with analysis of yield gap in adoption of production technology and economics of coconut through frontline demonstration (FLD) at farmer's field of Tumkuru district, Karnataka state during the year from 2017-18 to 2019-20. 30 coconut farmer's field

with 15 acre of area was selected for conducting frontline demonstration at different villages of Tiptur and Gubbi taluks of Tumkuru district with uniform age (34 years old) of Tiptur tall variety of coconut palm planted with 9 m x 9 m spacing under ICAR project. KVK conducted capacity building programme (On campus and Off campus training programmes), workshops to create awareness among the coconut growers and to update their knowledge as part of frontline demonstrations (FLD). The critical inputs were provided to farmers by the KVK and applied as per the package of practices of new demonstrated technology for coconut crop recommended by University of Agricultural Sciences, GKVK, Bengaluru and CPCRI, Kasaragod [5]. Regularly demonstrated plot has been monitored at farmer's fields by KVK scientists during all stage of coconut palm, harvesting and marketing every year in selected coconut grower of the district.

Collected the basic information on farmers production practices and demonstrated package of practices as mentioned in Table 1. The data were recorded initiation of farmers production practices and after initiation of frontline demonstration for the study. The data were analyzed with appropriate statistical procedures. The demonstrated plot yield was recorded in the farmer's field under the close supervision of scientists from Krishi Vigyan Kendra, Konehalli in different locations of the district. Further, information on actual yield obtained by the farmers under their own (existing) management practices was collected. The using these data, the differences between potential yield and demonstration plot yield obtained technological gap (Yield gap-I), thedifference between demonstration plot yield and actual yield as extension gap (yield gap- II) and total yield gap obtained by difference between potential yield and actual yield were worked out.

Technological gap (yield gap-I) = Potential yield - Demonstration plot yield

Extension gap (yield gap- II) = Demonstration plot yield - Actual yield (Farmers practice)

Total yield gap = Potential yield - Actual yield

Table 1. Demonstrated production technologies and farmers practices in coconut production

Sl. No.	Technologies	Frontline demonstrated (FLD) production technologies	Farmers practices (Local check)
1	Soil sample analysis from coconut plot	Collected soil sample and analyzed	Not soil sample analyzed
2	Growing green manure crops& incorporation	Mucuna/cowpea as green manure crop andincorporated into soil during pre-monsoon season	Nil
3	Recommended quantity of FYM application	Applied 50 kg per palm per year	Applied 2-3 bucket or basket per palm per year
4	Application of bio-fertilizer	Applied *Arka Microbial consortium* at 100 g/palm	Not applied
5	Application recommended dose of inorganic fertilizer based on soil analyzed report	500 g N + 320 g P_2O_5 + 1200 g K_2O per palm per year (1/3 of NPK during May-June and 2/3 of NPK applied at Sep.-Oct.) based on soil sample analysis report	Applied one time 19:19:19 NPK + 20:20:0 NPK mixed fertilizer (Approx. 1 kg/tree/year)
6	Application of secondary and micro-nutrient	Applied 50 g Borax and 500 g Magnesium sulphate per palm per year	Not applied any secondary and micronutrients
7	Method of manures and fertilizers application	Circular basins method of 1.8 m radius and 20 cm depth around the palm	At the base of the palm
8	Irrigation	Drip irrigation at the basins of 1.8 m radius (near	Flood/drip irrigation

Sl. No.	Technologies	Frontline demonstrated (FLD) production technologies	Farmers practices (Local check)
	method	absorptive root zone)	at base of palm
9	Soil moisture conservation method	Applied coconut leaf mulching or coconut frond	Not any soil moisture conservation
10	Cropping system	Intercropping with French beansas legumes for additional income and also improved the soil fertility	Intercropping with fodder maize as exhaustive crops
11	Integrated Pest Management (IPM)	1) Red palm weevil : Spot applied the indoxicarb 14.5 EC @ 2.5 ml/litre of water, Installed the pheromone traps 2) Rhinoceros beetle: Leaf axils filled with powdered neem cake @ 250 g per palm + fine sand (250 g) per palm or Placed perforated sachets contained with fipronil 3 g 3) Black Headed Caterpillar (BHC): Cutting and burned the heavily infested and dried leaves, biological controlled by released of the larval parasitoids *Goniozusnephantidis*@ 20 parasitoids per palm, 4)*Eriophyid mite*: Root feeding with azadirachtin @ 10 ml + 10 ml water orsprayed the neem oil 0.5% @ 5 ml per litre of water 5)Rugose spirallingwhitefly : sprayed the 0.5% neem oil @ 5 ml/litre of water	Not followed, Spraying of plant protection chemical combined together with growth regulators without knowing compatibility of chemicals and without identified pest and disease.
12	Integrated Disease Management (IPM)	1) Basal stem rot/ *Ganoderma* disease :Isolation of diseased palms from healthy palms, Applied 100 g *Trichoderma* with neem cake@ 5 kg neem cake/palm /year, Root feeding of hexaconazole @ 3 ml with 100 ml of water per palm at quarterly intervals for one year 2) Stem bleeding disease: Applied a paste of talc based formulation of *Trichoderma harzianum*on bleeding patches, Applied 100 g *Trichoderma* with neem cake@ 5 kg neem cake/palm /year 3) Bud rot disease : The wounded part was treated with Bordeaux paste (10%) or Mancozeb + Metalaxyl solution (2 g/litre of water) and covered with polythene cover to prevent entry of rain water	Not followed, Spraying of plant protection chemical combined together with growth regulators without knowing compatibility of chemicals and without identified pest and disease.
13	Harvesting method	Harvested by coconut climber	Harvested by local harvesting sticks

3. RESULTS AND DISCUSSION

3.1 Yield Gap in Production of Coconut

The realized yield and estimated yield gaps are presented in Table 2. The demonstrated plot yield obtained through frontline demonstrations was higher (9,932 nuts/ha) than the actual yield obtained by the farmers on their farm under own management practices (7,852 nuts/ha), but lower than the potential yield of coconut (12,300 nuts/ha). The magnitude of technological gap (yield gap-I) was 2,368 nuts/ha, which was 19.25 per cent lesser than the maximum attributable yield. Extension gap (yield gap-II) refers to the difference between demonstration plot yield and actual yield and it was 2,080 nuts/ha. There was 20.92 per cent reduction in yield as compared to demonstration plots yield. A sizable total yield gap of 4,448 nuts/ha was observed and it accounted for 36.16 per cent. These findings are in line with that [3,6].

The causes for such large total yield gap might be due to non adoption of production technology [7] and [8] and also attributed by environmental differences between research stations, extension

Table 2. Yield gap in production of coconuts

Particulars	Yield (Nuts/ha)	Percentage gap
Potential yield	12,300	--
Demonstration plot yield	9,932	--
Actual yield (Farmers practice)	7,852	--
Technological gap (Yield gap I)	2,368	19.25
Extension gap (Yield gap II)	2,080	20.92
Total yield gap	4,448	36.16

Potential yield - Demonstration plot yield = Technological gap (yield gap-I)

Demonstration plot yield - Actual yield (Farmers practice) = Extension gap (yield gap- II)

Potential yield - Actual yield = Total yield gap

worker and farmer's fields. The co-ordination between researchers, extension workers and farmers could be reduced. These results are found to similarly with [9,10].

3.2 Adoption of Demonstrated Production Technologies in Coconut

The data presented in Table 3 depicts that that maximum respondents adopted recommended production practices such as intercropping system (90.00%) followed by irrigation method (86.66 %), Whereas lesser adoption of harvesting of coconuts by coconut climber (26.67 %). This could be due to that maximum number of coconut growers adopted a simple production technology compared to complicated technology. These finding are in conformity with the results reported by [11,12,10].

The increased in adoption percentage of package of practices were found to growing of green manure crops & incorporation (56.67 %) and soil sample analysis from coconut plot (53.33 %). Whereas, the package of practices *viz*., harvesting of coconuts by coconut climber, application of recommended quantity of FYM and application of recommended dose of inorganic fertilizer based on soil analyzed report for coconut were found to lesser increased in adoption percentage after frontline demonstrations. These causesmight be due to high reduction in yield. Similar results were reported by [2,13,14].

3.3 Impact of Frontline Demonstration on Yield of Coconut

Impact of yield of coconut through frontline demonstrations are presented in Table 4. The significantlyincreased in yield of coconut per hectare by 26.49percent in frontline demonstration plots (9,932 nuts/ha) as compared to farmer practice (7,852 nuts/ha). The yield of coconut was significantly different in farmers practices and after conduct of FLD. It means that increased yield by wider adoption of demonstrated technologies. These similar results reports with [15,16].

3.4 Effect of Demonstration on Soil Fertility Status of Coconut Plots

The soil fertility status *viz*., NPK availability, pH and electrical conductivity (EC) in soil were analyzed before and after the experiment period of three years (Table 5) in both farmers practice field and demonstrated plot. The numerical increased in all the three major nutrients wererecorded over the pre-treatment observation. The increased the available of N (262 kg/ha), P (21 kg/ha) and K (164 kg/ha) in demonstrated plot as compared lowest available of N (238 kg/ha), P (16 kg/ha) and K (152 kg/ha) content in soil of farmers field plot. This might be due to that incorporation of residual after harvest of French beans. These results are similarity with reported by Maheswarappa et al. [17] and high biomass of french bean, which fixes atmospheric nitrogen, residue incorporated into soil as results in improvement of soil fertility status [18].

3.5 Impact of FLD on Economics of Coconut Production

The economic impact of demonstrated production practices of coconut are presented in Table 6. Total cost of cultivation, gross return, net return and B:C ratio (BCR) at farmers field and after frontline demonstrated plot were calculated. The data revealed that yield of coconut was obtained 9,932 nuts/ha after frontline demonstration and farmers practices (7,852 nuts/ha). The farmers sold coconut at average rate Rs. 12 per nut at farmer field and base on that profitability was calculated [19]. Which shows that obtained higher net returns Rs.

1,00,684/ha from coconut after FLD as compared farmers practices Rs. 48,724/ha from coconut, The B:C ratio under farmers practices(1.74) was lower, which was increased to 2.41 after FLD. It was evident from the results that B:C ratio of coconut in FLD was higher than farmers production practices in coconut. This might be due to higher in adoption of all the demonstrated package of practices recommended for coconut production in the region and good extension contact by FLD farmers with the scientist and extension workers. Similar results were reported by Patel et al. [16,20].

Table 3. The adoption of demonstrated production technologiesin coconut (n=30)

Sl. No.	Demonstrated production technologies	Adoption in farmers practices		Adoption in frontline demonstration		Increased in adoption	
	Technologies	No.	Per cent	No.	Per cent	No.	Per cent
1	Soil sample analysis from coconut plot	06	20.00	22	73.33	16	53.33
2	Growing of green manure crops & incorporation	04	13.33	21	70.00	17	56.67
3	Recommended quantity of FYM application	16	53.33	22	73.33	06	20.00
4	Application of bio-fertilizer	06	20.00	14	46.67	08	26.67
5	Recommended dose of inorganic fertilizer application based on soil analyzed report	14	46.67	23	76.67	09	30.00
6	Application of secondary and micro-nutrient	06	20.00	19	63.33	13	43.33
7	Method of manures and fertilizers application	09	30.00	21	70.00	12	40.00
8	Irrigation method	11	36.67	26	86.66	15	50.00
9	Soil moisture conservation method	08	26.67	17	56.67	09	30.00
10	Cropping system	15	50.00	27	90.00	12	40.00
11	Integrated Pest Management (IPM)	06	20.00	17	56.67	11	36.67
12	Integrated Disease Management (IPM)	05	16.67	15	50.00	10	33.33
13	Harvesting by coconut climber	03	10.00	08	26.67	05	16.67

Table 4. Yield of coconut at farmers practice and after frontline demonstrations (n= 30)

Average yield of coconut (Number of nuts/ha)		Per cent increased in yield
Yield at Farmers practice	Yield after frontline demonstration	
7,852	9,932	26.49

Table 5. Soil fertility status of coconut plots

Soil fertility status	Before initiation of experiment	After experiment	
		Farmers practices plot	frontline demonstrated plot
N (kg/ha)	241	238	262
P (kg/ha)	17	16	21
K (kg/ha)	155	152	164
PH	7.6	7.7	7.4
EC (ds/m)	0.34	0.33	0.32

Table 6. Economics of coconut production at farmer's practices and after frontline demonstration

Sl. No.	Particular	Farmer's practices	After FLD
1	Cost of cultivation (Rs/ha)	65,500	71,600
2	Yield of coconut (No. of nuts/ha)	7,852	9,932
	Yield of intercropping (Q/ha)	Maize fodder yield 105.50	French bean yield 35.40
3	Gross Return (Rs/ha)	1,14,224	1,72,284
4	Net Return (Rs/ha)	48,724	1,00,684
5	B:C ratio	1.74	2.41

Fig. 1. Demonstration of soil sample collection from coconut plot

Fig.2 Demonstration of fertilizer application in coconut palm

Fig. 3 Growing of green manure crops in coconut garden

Fig. 4 Intercrops with French beans

Fig. 5 Intercrops with french beans

Fig. 6. Demonstration of coconut root feeding with hexaconozal for ganoderma disease control method

Fig. 7. Coconut harvesting by coconut climber

4. CONCLUSION

The Frontline Demonstration Program was successful in encouraging farmers to embrace agricultural technology. Following the frontline demonstration in farmers' fields, the majority of farmers learned about the recommended methods for producing coconuts. When compared to farmers' practices, more farmers were found to have adopted the percentage of cultivating green manure crops and incorporating them, as well as analyzing soil samples from coconut plots. In comparison to farmers' practices, it was discovered that the displayed

plot had higher coconut yield, net return, and B:C ratio. Even after the FLD program, a distinct set of practices were adopted, demonstrating the beneficial effects of FLD on the uptake of proven technology. The concept of Frontline demonstration may be applied to all farmer categories including progressive farmers for speedy and wider dissemination of the recommended practices to other members of the farming community.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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