Effect of crop combinations on nut equivalent yield and economics of coconut based cropping system

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ABSTRACT

The experiment conducted with an objective to evaluate the effect of different combinations and floor crop nutrition on nut equivalent yield and economics of coconut revealed that interrow spaces of coconut can be successfully intercropped with Nendran banana and papaya and floor crops like turmeric, ginger, amorphophallus and tapioca. Among the different crop combinations, the nut equivalent yield was significantly higher for coconut + banana + turmeric system (687.3 nuts per unit). Results on floor crop nutrition indicated that 75 per cent recommended dose of fertilizers (RDF) for the floor crop resulted in higher nut equivalent yield (519.5 nuts unit⁻¹). Interaction effect was also significant and coconut + banana + turmeric system with 75 per cent RDF for the floor crop turmeric (c_1n_2) recorded significantly higher nut equivalent yield (738.12 nuts unit⁻¹), gross income (Rs 11,071.8), net income (Rs. 6,291.8) and B:C ratio (2.31).

Keywords: Banana, coconut, economics, nut equivalent yield, papaya

Coconut is mainly cultivated by the small farmers having less than 2 ha area (Magat, 2007). Monocropping is mainly followed by these farmers which does not offer satisfactory income and employment for livelihood. Morphological features of coconut necessitate wider spacing and hence, commonly recommended spacing was 7.5m x 7.5m under square system of planting. Maheswarappa *et al.* (2010) pointed out that, coconut planted at the optimum spacing efficiently utilized only 45-50 per cent of sunlight and occupied only 22.3 per cent of the land area. Approximately 74 per cent of the roots of a well managed palm concentrated within 2 m lateral distance and out of this, 82 per cent of the roots were found at a depth of 30 to 120 cm, leaving the remaining region financially exploitable (Kushwah *et al.*, 1973). This could be effectively utilized for intercropping or farm diversification. Further in India, economic challenges to the coconut farmers have been exacerbated by uncertain copra pricing on national markets, small and marginal landholdings, lack of value added facilities, storage and market facilities etc. A multistoried cropping system which fit to a given agro-ecological unit resulted in higher monetary returns and helped the farmers to meet their several needs of the

family like food, feed, and fuel (Ghosh and Hore, 2007). The Government of India has announced Doubling Farmers' Income by 2022. One of the targets is to increase the cropping intensity thereby enhancing the income of farm families within a reasonable period. The scope for increasing the land area under cultivation is negligible, intensive cultivation of crops and raising the productivity per unit area were the only means of increasing food production. In the case of coconut which remains committed to the land for decades with a long gestation period, it is advisable to practice inter/mixed cropping for getting additional income. Hence, the present study is proposed to investigate the suitability of crops that can be intercropped in coconut gardens which would generate high income throughout the year.

The investigation was carried out during 2021-2022 in a 50 year old coconut plantation at Coconut Research Station, Balaramapuram, Thiruvananthapuram located at 8°22′52″ North latitude and 77°1′47″ East longitude and at an altitude of 9 m above mean sea level. In the plantation, coconut was planted at a spacing of 7.5 m x 7.5 m. A warm humid climate was prevailed over the experimental site. The experiment was conducted in Randomised Block Design with eight crop combinations

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as first factor and two nutrient levels for the floor crop as second factor in three replications. The crop combinations were coconut + banana+ turmeric (C_1), coconut + banana+ ginger (C_2), coconut + banana + cassava (C_3), coconut + banana + amorphophallus (C_4), coconut + papaya + turmeric (C_5), coconut + papaya+ ginger (C_6), coconut + papaya + cassava (C_7) and coconut + papaya + amorphophallus (C_8). The nutrient level for the floor crop includes, RDF for the floor crops as per the POP recommendations (N_1) and 75 per cent RDF (N_2). Inter row space available between the four coconuts palms was treated as one unit. Nendran banana and Red lady papaya were planted 2 m away from the base of the palm as per the treatment. Three rows of banana / papaya were there in one unit. Banana and papaya were fertilized as per POP recommendations (Anon. 2016) and floor crops were fertilized as per the treatment. Floor crops (turmeric, ginger, cassava or amorphophallus) were planted in the inter row spaces available between the three rows of banana or papaya. Turmeric and ginger were planted in beds, cassava in mounds and amorphophallus in pits. The intercrops were arranged in such a way that they get maximum incident light.

All the coconut palms in the experimental unit received the same amount of manure (25 kg per palm yr^{-1}), and fertilizers (0.50:0.32:1.20 kg NPK palm^{-1} yr^{-1}). Other cultural operations *viz.*, weeding, irrigation, cleaning of the crown and cutting of leaves were done periodically. Coconut was harvested at every 45 days interval until the harvesting of component crops. The yield of intercrops was also recorded treatment wise. Nut equivalent yield and economics of the treatments were calculated based on the prevailing market price of input and output. The details of crops grown in the cropping system in the experimental period are presented in Table 1. The nut equivalent yield was calculated using the following formula

$$\text{Nut equivalent yield} = \frac{\text{Yield of intercrop x Market price of intercrop}}{\text{Market price of coconut}}$$

Statistical analysis was carried out and the treatment means were compared at 5 per cent probability level (Panse and Sukhatme, 1985).

Effect of crop combinations and floor crop nutrition on nut equivalent yield

Significant difference in nut equivalent yield was observed among the different crop combinations. The nut equivalent yield was significantly superior for coconut + banana + turmeric (C_1) system (687.3 nuts unit^{-1}) followed by coconut + banana + ginger (563.4 nuts unit^{-1}) and it was statistically on par with coconut + banana +cassava (533.8 nuts unit^{-1}). However, the lowest equivalent yield was recorded in coconut + papaya + cassava system (395.2 nuts unit^{-1}). The nutrient management for floor crop also significantly influenced the nut equivalent yield. Significantly higher nut equivalent yield (519.5 nuts unit^{-1}) was obtained with the application of 75 per cent RDF for the floor crop (N_2) compared to the full dose of fertilizer (N_1) which recorded a nut equivalent yield of 497.3 nuts unit^{-1} (Table 2).

The C x N interaction also had significant influence on the nut equivalent yield. A higher nut equivalent yield (738.1 nuts unit^{-1}) was recorded in coconut + banana + turmeric system with 75 per cent RDF for the floor crop (c_1n_2) followed by coconut + banana + turmeric system with 100 per cent RDF for the floor crop (636.4 nuts unit^{-1}). The lowest nut equivalent yield (383.4 nuts unit^{-1}) was recorded in coconut + papaya + cassava

system with 100 per cent RDF for the floor crop (Table 3).

Devi *et al.* (2011) pointed out that Nendran banana, ginger, turmeric, cassava, elephant foot yam and vegetable cowpea can be successfully intercropped in coconut gardens in different combinations. According to Maheswarappa *et al.* (2010), coconut palms when reaching 40 years old can transmit more than 50 per cent of the incident light. Higher nut equivalent yield recorded in coconut + banana + turmeric system might be due to the better incidence of solar radiation that resulted in more photosynthetic activity and higher dry matter accumulation of the component crops. Chaudhary and Deka (1997) revealed that coconut + betel vine + banana + Assam lemon + turmeric + *Colocasia* cropping system resulted in higher coconut yield (8365 nuts ha^{-1}). Out of the several coconut based cropping system model with spices and tuber crops, maximum projected mean nut yield of 18550 numbers ha^{-1} was recorded in the crop combination coconut+black pepper + turmeric + elephant foot yam (Ghosh *et al.*, 2021). Among the two different fruit crops tried in the system, banana recorded significantly higher nut equivalent yield than papaya (Table 3), which was attributed to higher economic yield as well as the price of the produce. The tall growing stature, morphology and orientation of leaves of the Nendran banana might have contributed more than 25 per cent shade than that of papaya, which aids in the better performance of the shade loving crops like turmeric and ginger (Lambers *et al.*, 1998). Moreover, the studies conducted by Kurien *et al.* (2006)

Table 1: Agronomic aspects of the crops under different coconut based cropping systems

Crop	Variety	Spacing (cm)	FYM	NPK
Coconut	WCT	750 x 750	25 kg palm^{-1} yr^{-1}	0.34:0.17:0.68 kg palm^{-1} yr^{-1}
Banana	Nendran	250 x 175	10 kg plant^{-1}	190:115:300 g plant^{-1}
Papaya	Red Lady	250 x 175	10 kg plant^{-1}	40:40:80 g plant^{-1}
Turmeric	Varna	25 x 25	40 t ha^{-1}	30:30:60 kg ha^{-1}yr^{-1}
Ginger	Maran	25 x 25	30 t ha^{-1}	75:50:50 kg ha^{-1}yr^{-1}
Cassava	Vellayani Hraswa	90 x 90	1 kg pit^{-1}	100:50:50 kg ha^{-1}yr^{-1}
Amorphophallus	Gajendra	90 x 90	2 kg pit^{-1}	100:50:150 50 kg ha^{-1}

Table 2: Effect of crop combinations and floor crop nutrition on nut equivalent yield and economics of coconut based cropping systems

Treatment	Nut equivalent yield per unit (56.25m^2)	Gross return (Rs. unit^{-1})	Net return (Rs. unit^{-1})	B:C ratio
Crop combinations (C)				
C$_1$ (C+B+T)	687.3	10308.9	5522.0	2.15
C$_2$ (C+B+G)	563.4	8451.0	3649.7	1.76
C$_3$ (C+B+Cassava)	533.9	8008.2	3255.2	1.68
C$_4$ (C+B+A)	509.4	7440.7	2654.9	1.55
C$_5$ (C+P+T)	501.6	7642.6	2589.4	1.51
C$_6$ (C+P+G)	452.0	6779.5	1747.7	1.35
C$_7$ (C+P+Cassava)	395.2	5927.4	947.8	1.19
C$_8$(C+P+A)	426.7	6369.7	1353.5	1.27
SEm(±)	**11.51**	**117.21**	**120.34**	**0.03**
LSD (0.05)	**33.413**	**340.154**	**349.236**	**0.072**
Nutrient level for the floor crop (N)				
N$_1$ (RDF)	497.31	7489.4	2585.4	1.53
N$_2$ (75% RDF)	519.51	7742.7	2844.7	1.59
SEm(±)	**5.76**	**58.60**	**60.17**	**0.01**
LSD (0.05)	**16.707**	**170.077**	**174.618**	**0.036**

(C- coconut, B- banana, T-turmeric, G-ginger, A- amorphophallus)

also suggested that the banana is a good combiner in the coconut garden. In a cropping system, both the main crop and the component crops should be separately nourished. Since banana is a heavy feeder and the Red lady variety of papaya is a hybrid, both of them were given with the full dose of recommended fertilizers. Application of organic manure for coconut + 75 per cent RDF for the constituent crops in the multitier cropping system was the best in enhancing the nut yield of coconut palm to the tune of 53.59 per cent (Farsanashamin, 2015). Subramanian *et al.* (2005) reported that two third dose of RDF for the component crops resulted in higher biomass production in coconut +clove + banana + pineapple high density multispecies cropping system. It was revealed from the results that, turmeric at 75 percent RDF recorded higher yield under both Nendran banana and papaya. This indicated that turmeric is the best crop that can be intercropped as a floor crop in coconut. Nagwekar *et al.* (2010) reported that coconut + turmeric cropping system resulted in an increase in nut equivalent yield of 56 per cent followed by coconut + ginger (33%) and coconut + tapioca (29%). The present findings were also in conformity with the observations of Nagwekar *et al*. (2010). Muralidharan (1980) also pointed out that the growth and yield of turmeric was higher when it was intercropped in arecanut than in open area. The yield of ginger was higher under banana than in papaya, which may be due to greater shade under banana. Kandiannan *et al*. (1996) reported that rhizome yield increased up to 25 per cent under shade and thereafter declines. Shading increases the plant height, tiller number and net assimilation rate of ginger while under full sunlight there was reduction in the number of leaves. The nut equivalent yield

Table 3: Interaction effect of crop combinations and floor crop nutrition on nut equivalent yield and economics of coconut based cropping systems

Treatment combinations	Nut equivalent yield unit^{-1} (56.25 m^2) (nuts unit^{-1})	Gross return (Rs. unit^{-1}) (56.25 m^2)	Net return (Rs. unit^{-1}) (56.25m^2)	BCR (56.25 m^2)
c_1n_1	636.4	9546.1	4752.1	1.99
c_1n_2	738.1	11071.8	6291.8	2.31
c_2n_1	557.8	8366.8	3560.2	1.74
c_2n_2	569.0	8535.2	3739.2	1.78
c_3n_1	535.7	8035.9	3280.9	1.69
c_3n_2	532.0	7980.5	3229.5	1.68
c_4n_1	513.2	7698.5	2910.2	1.61
c_4n_2	505.5	7182.8	2399.5	1.50
c_5n_1	474.9	7360.4	2308.7	1.46
c_5n_2	528.3	7925.0	2870.0	1.57
c_6n_1	479.7	7195.8	2162.8	1.43
c_6n_2	424.2	6363.3	1332.6	1.26
c_7n_1	383.4	5751.2	768.5	1.15
c_7n_2	406.9	6103.7	1127.0	1.23
c_8n_1	397.3	5960.2	939.50	1.19
c_8n_2	452.0	6779.2	1767.7	1.35
SEm(±)	16.28	165.75	170.18	0.04
LSD (0.05)	47.254	481.050	493.894	0.102

(Price of coconut-Rs.15 no.$^{-1}$, Banana- Rs.35 kg^{-1}, Papaya-Rs.25kg^{-1}, Turmeric and Ginger- Rs.60 kg^{-1}, Cassava-Rs.15kg^{-1}, Amorphohallus- Rs.20 kg^{-1})

obtained from the cropping system with tuber crops was recorded the lowest, which may be due to the lesser yield and marketable price of amorphophallus and tapioca.

Effect of crop combinations and floor crop nutrition on economics

The ultimate aim of any cropping system is to get maximum profit compared to monocropping. In the present study, it was observed that all the cropping systems recorded a benefit cost ratio (BCR) of more than one and hence, it was economically viable. Among the systems tried, the highest gross return (Rs. 10308.9 unit^{-1}), net return (Rs. 5522.0 unit^{-1}) and BCR (2.15) were recorded from coconut + banana + turmeric system (C_1), followed by coconut + banana + ginger (C_2) which recorded a gross return of Rs. 8451.0 unit^{-1}, net return of Rs. 3649.7 unit^{-1} and BCR of 1.76. The lowest gross return (Rs. 5927.4 unit^{-1}), net return (Rs. 947.8 unit^{-1}) and BCR (1.19) was reported in coconut + papaya + cassava (C_7). The nutrient management practices for floor crop also had significant influence on the economics of the system. Significantly higher gross return (Rs. 7742.7 unit^{-1}), net return (Rs. 2844.7 unit^{-1}) and BCR (1.59) were obtained with the application of 75 per cent RDF for the floor crop (N_2) compared to 100 per cent RDF for the floor crop (N_1) which recorded

a gross return of Rs. 7489.4 unit^{-1}, net return of Rs. 2585.4 unit^{-1} and BCR of 1.53 only.

Among the interaction effect (Table 3), significantly higher gross return (Rs. 11071.8 unit^{-1}), net return (Rs. 6291.8 unit^{-1}) and BCR (2.31) were recorded in coconut + banana + turmeric system with 75 per cent RDF for the floor crop (c_1n_2) followed by coconut + banana + turmeric system with 100 per cent RDF for the floor crop (c_1n_1) which recorded a gross return (Rs. 9546.1 unit^{-1}), net return (Rs. 4752.1 unit^{-1}) and BCR of 1.99. The lowest gross return (Rs. 5751.2 unit^{-1}), net return (Rs. 768.5 unit^{-1}and BCR (1.15) were recorded in coconut + papaya + cassava system with 100 per cent RDF for the floor crop.

The system involving tuber crops recorded the lowest BCR due to the low market value of the crop. Devi *et al.* (2010) reported that cropping systems with cassava resulted in the lowest BCR of 1.02, and the net return. Similar results were also reported by Ravindran (1997). Thamban and Arulraj (2007) reported that when Nendran banana was intercropped with coconut, Nendran banana recorded a bunch yield of 10-12 kg plant^{-1} and net return of Rs. 6,400. Benefit cost ratio was the highest in the system where arecanut was intercropped with banana and turmeric (Chandrashekhar and Bhattacharjee, 2018).

Crop intensification is one of the best ways to overcome the economic crisis of the coconut farmers under the shrinking land resources coupled with market fluctuations. Coconut plantations have the greater potential to accommodate multi species including, annuals, biennials and perennials in the inter space. It could be concluded from the results that, coconut palms planted at 7.5 m x 7.5 m spacing and had 50 years age can be successfully intercropped with Nendran banana and turmeric. Coconut + Nendran banana + turmeric with 75 % recommended RDF for turmeric recorded the highest nut equivalent yield (738.1), gross return (Rs. 11071.8), net return (Rs 6291.8) and BCR (2.31).

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