International Science Journal
(Peer-Reviewed)

ISSN: 2348 – 604X (p); 2348 – 6058 (e)

DAMA INTERNATIONAL

YIELD AND ECONOMICS OF COCONUT (*COCOS NUCIFERA*) BASED AGROFORESTRY SYSTEM IN PURI DISTRICT OF ODISHA

Shishir Kumar Sarangi, Suryakanta Behera*, N.Bhola**
Project Director, Shristi NGO, Keonjhar, Odisha
*Department of Silviculture and Agroforestry, College of Forestry, Orissa University of Agriculture & Technology, Bhubaneswar, Odisha, India
** Associate Professor, Department of Silviculture and Agroforestry, College of Forestry, Orissa University of Agriculture & Technology, Bhubaneswar, Odisha, India
Email:suryakantarrr@gmail.com
Bhubaneswar, Odisha-751003, India

ABSTRACT
The experiment was carried out in the Puri district of Odisha during June, 2012 - May, 2013. The experiment was laid out in randomized block design with three replications. For this the district was divided into three regions, each region representing one replication. The treatments were coconut based agroforestry system under fifteen different holding sizes such as 0.1 acre, 0.2 acre, 0.3 acre, 0.4 acre, 0.5 acre, 0.6 acre, 0.7 acre, 0.8 acre, 0.9 acre, 1.0 acre, 1.1 acre, 1.2 acre. 1.3 acre, 1.4 acre and 1.5 acre. From each replication 30 sample plots were selected (2 for each treatment) from four different villages located closely and made into 15 composite samples, one for each treatment. The chosen coconut based agroforestry systems were visited in three cropping seasons such as kharif, rabi and summer and the observations regarding different parameter were recorded. As the natural forest cover is less in coastal Odisha, substantial quantity of fuel wood was found to be derived from home garden and the contribution of fuel wood production increased with increase of holding size up to 1.2 acre, the efficiency of smaller holdings was comparatively more in terms of net return. The net return varied from Rs. 5,617.00 to Rs. 32,850.00 per annum showing the income level increased with increase in holding size while the economics was calculated on acre basis the net income ranged from Rs. 56,167.00 to Rs. 21,900.00 indicating decreasing trend towards higher holding sizes. In terms of market orientation, the smaller unit sizes were found more subsistence and less commercial than bigger holding sizes and vice versa.

KEYWORDS: *Cococ nucifera*, Agroforestry, Yield, Economics

INTRODUCTION

Coconut (*Cocos nucifera*) plays a significant role in the agrarian economy of India. Coconut is grown in more than 93 countries of the world in an area of 12.29 million ha with a total production in terms of copra equivalent of 11.04 million MT. Indonesia (25.63%), Philippines (23.91%) and India (19.20%) are the major coconut producing countries of the world. In India the coconut based agroforestry are generally found in tropical and sub-tropical areas and characterized by high species diversity and usually three to four vertical canopy strata. These agroforestry systems consist of different layer of species starting from seasonal crops, perennial crops, and woody components. The lower most being dominated by different vegetables like brinjal, greens, turmeric, ginger, mushroom, okra, chili, tomato, cabbage, dioscorea, etc. and the second layer is comprising food plants such as banana, papaya, lemon, etc. The third layer is occupied by fruit trees like guava, drumstick, custard apple, etc. The upper layer is the tree layer which can be divided into two, consisting of the emergent full grown timber and fruit trees having height more than 20m and medium size trees of 10-20m. In the upper layer species like *Mangifera indica, Samanea saman, Bambusa vulgaris, B. tulda, Cocos nucifera, Areca catechu, Samania saman, Artocarpus heterophyllus, Aegle mormalus, Tamarindus indica, Azadirachta indica, Leucaena leucocephala,* etc. are grown. In developing countries particularly in India coconut is either grown as mono-crop or as major component in the multiple cropping systems with or without livestock. In Odisha it occupies more than 60 % of the perennial crop area and more than 30% of the total cropped area in costal districts mostly Puri, Jagtsingpur, Balasore, Kendrapada and Khurda. The

coconut farming system is very promising as spacing is wide, the system affords higher incidence of light under the canopy and the limited effective root zone of the coconuts allows other crops within the grove.

MATERIALS AND METHODS

The experimental area is the Puri district of Odisha, India which is located at 19^0 28' N latitude 26^0 35' N, 84^0 29' E. longitude 86^0 25' E. along the Bay of Bengal.Paddy, coconut, banana, vegetables, wheat, mung, biri, kulthi and groundnut are some of the major crops grown in the district. The study area lies in agro climatic Zone of East and South Eastern Coastal Plain and the agro ecological sub region (ICAR) of Sub-humid to humid Eastern and South Eastern Upland. It has warm and moist climate characterized by humid summer and mild winter. It experiences coastal climate because it is located by the side of the Bay of Bengal. The meteorological data for the study period are given in Table 3.1.The study area normally receives rainfall of about 1408 mm from south-western monsoon during June-September, about 90 mm from north-east monsoon during October-December, very less during winter (January-March) and 123.8mm in summer (April-May) accounting a total of 1712 mm per annum. This amount of rainfall is distributed over 69 rainy days in a year. The rainfall received during the study period was 1713.8 mm.The normal daily temperature ranges from a minimum of 13.1^0C to a maximum of 36.9^0C. May is the hottest month of the year with a mean daily maximum temperature of 36.9^0C while January is the coolest month of the year with a mean daily minimum temperature of 13.1^0C. The average temperature during the study period ranged from 21.18 ^{0}C to 31.18 ^{0}C. The meteorological data of the district is presented in table1.

Table .1 Meteorological data of Puri district from June, 2012 to May, 2013

Month/Year	Rainfall (mm)	Temperature (^{0}C)	
		Mean Max.	Mean Min.
Jun-12	246.2	32.1	24.6
Jul-12	309.5	31.1	25.5
Aug-12	341.2	30.7	26.2
Sep-12	295.8	32.1	24.4
Oct-12	199.2	31.9	22.5
Nov-12	49.2	30.1	18.5
Dec-12	22.1	27.4	13.3
Jan-13	0.0	26.4	13.1
Feb-13	2.3	30.3	15.9
Mar-13	0.7	34.7	20.8
Apr-13	95.3	34.2	23.4
May-13	152.3	36.9	25.8

Out of 348,102 ha of geographical area of the district, 6.8% area is saline, 52.2% area under alluvial soils, 40.3% area under acidic soils and 0.8% area under red laterite soil. The experiment was carried out in a Randomized Block Design (RBD) with three replications. For this the district was divided into three regions, each region represented one replication. The region-I covered the eastern part of the Puri district comprising four blocks such as Gop, Kaktpur, Astaranga and Puri. The region-II covered North central part of the district comprising Pipili, Delanga, Satyabadi and Kanasa blocks. The region-III covered the western part of the district comprising Chilika, Krushnaprasad and

Brahmagiri blocks. In each region, the structure, function and chemical properties of soil under Coconut based agroforestry of 15 different sizes were studied.

Floral composition of the Coconut based agroforestry system was recorded in terms of perennial species, annual species and seasonal species growing in the same unit of land management. The number of common plant species was recorded in terms of number of perennial, annual and seasonal plant species growing in the same unit of land management. Height of plants growing in different strata under the coconut plant was measured from ground level to the tip of main shoot with the help of measuring staff and altimeter. The plant species stratification was recorded by measuring height of different plants growing in coconut based agroforestry with the help of scale, measuring staff and altimeter and grouping them under different height level. Number of trees in Coconut based agroforestry system was recorded by counting number of trees of individual perennial species having height ≥ 5 m. Number of livestock animals and birds was recorded by counting the number of cattle, buffalo, sheep, goat, duck and poultry per Coconut based unit which were reared for more than six months in the year. Economics of different treatments were worked out on area basis considering the cost of cultivation of all components of Coconut based agroforestry system in the year of study and gross return obtained. The net return was calculated by deducting the cost from gross return. The benefit cost ratio was worked out by dividing the gross return with the cost of cultivation.

RESULT AND DISCUSSION:

Yield of different components of coconut based agroforestry system

The yield of different components has been depicted in Table 2. The number of coconut obtained per annum differed significantly under different unit sizes of coconut based agroforestry system. The higher size units registered significantly, more number of coconuts in comparison to the lower unit size. The number of coconut produce per annum ranged from 565 to 5300 under different unit size. The numbers progressively increases with the increase of unit size. The yield of fruits obtained from different perennial plant other than coconut varied significantly among different unit sizes. The fruit production varied from 27kg to 181kg per annum per unit of agroforestry system. The lowest yield (27kg) was recorded in 0.1acre and the highest yield (181kg) was recorded in 0.8 acre. The fruit yield steadily increased from 0.1acre to 0.8acre unit size. On the other hand the yield gradually decreases from 0.9acre unit size (122kg) to 1.5acre unit size (33kg). The parity in yield was observed between some adjacent unit sizes such as T_6 and T_7, T_7 and T_8, T_{11} and T_{12}, T_{12} and T_{13}, T_{13} and T_{14} as well as T_{14} and T_{15}.

With regards to yield of seasonal crops is concerned which comprised kharif, rabi and summer crop a significant variation was also noticed among all the holding size. The yield varied from 85kg to 1970kg per annum. The yield under different unit progressively increased with increase of holding size. T_1 registered 85kg per annum and T_{15} registered 1970kg per annum.Regarding fish production in coconut based agroforestry system the yield varied from 24kg to 126 kg per unit in a year. T_{12} registered the maximum fish production (126kg) while T_1 registered minimum (24kg) fish production. The fish production steadily increased with increase of unit size of coconut based system from T_1 to T_{12}. However beyond T_{12} i.e. T_{13}, T_{14} and T_{15} no fish production was there because of absence of fish pond.

The yield of mushroom varied remarkably under different unit sizes of coconut based agroforestry system. The yield was confined to the unit size from T_4 to T_{10}. T_8 registered highest yield whereas T_{10} registered lowest yield. The yield between T_6 and T_7 as well as T_7 and T_8 remained statistically as par with each other. The yield of various components under the coconut based agroforestry system varied remarkably among different holding sizes the number of coconuts per annum varied from 565 to 5300, the number of coconut increases progressively with increase of holding size. This is due to more number of trees in higher holding. The yield of fruit other than coconut varied significantly among the holding sizes it increase from 27 kg (T_1) per annum to 181 kg (T_8) per annum. With increase of holding size. This may be attributed to presence of more fruit bearing trees in higher holding. However beyond T_8 the yield of fruit other than coconut decreases with increase of holding size. This may be described reduction of fruit trees in higher holding sizes. The yield of seasonal crops comprising kharif, rabi and summer crop varied from 85kg to

1970kg per annum. The yield increase with increase of holding size. This is obliviously because of more space available towards higher holding for cultivation of seasonal crops. The fish production varied from 24 kg to 126 kg per annum in the holdings 0.1acre to 1.2acre. The production increased gradually towards higher size holding. This is due to presence of comparatively higher size fish pond in higher size holding under coconut based agroforestry system. The yield of mushroom also varied among various holding sizes, mushroom production mostly confined to holding size 0.4acre to 1.2acre homestead size having coconut trees. The holding sizes of 0.6 to 0.8acre were found supporting higher mushroom production in comparison to other holdings. Perhaps farmers having such middle category land holding are more diversifying their system to increase their income. The small holding people generally not practising mushroom cultivation as because the basic materials like straw and input required and adequate space are not available. Similarly the larger holding people are also not practising mushroom cultivation because they are more oriented towards monoculture.

Table 2. Yield of different components of coconut based agroforestry system in Puri district of Odisha

Treatment (Holding size)	Number of Coconut per annum	Yield of fruits other than coconut (kg/annum)	Yield of seasonal Crops(kg/annum)	Yield of fish (kg/annum)	Yield of mushroom (kg/annum)
T_1 (0.1 acre)	565	27	85	24	0
T_2 (0.2 acre)	933	49	137	55	0
T_3 (0.3 acre)	1123	73	260	61	0
T_4 (0.4 acre)	1270	94	440	70	140
T_5 (0.5 acre)	1486	126	527	80	190
T_6 (0.6 acre)	1657	163	660	87	241
T_7 (0.7 acre)	1765	172	763	92	264
T_8 (0.8 acre)	1953	181	820	98	281
T_9 (0.9 acre)	2137	122	940	108	186
T_{10} (1.0 acre)	2347	98	1221	115	102
T_{11} (1.1 acre)	2580	64	1503	120	0
T_{12} (1.2 acre)	2740	62	1620	126	0
T_{13} (1.3 acre)	4300	53	1787	0	0
T_{14} (1.4 acre)	4533	43	1910	0	0
T_{15} (1.5 acre)	5300	33	1970	0	0
SEm(±)	**95**	**4**	**12**	**1.4**	**21**
$CD_{(0.05)}$	**274**	**11**	**33**	**4.2**	**49**

Economics of coconut based agroforestry system

The economics of coconut based agroforestry system in Puri district has been presented in terms of cost involved, gross return, net return and benefit cost ratio under different holding size (Table. 3). The cost involved per holding in a year varied significantly from one another. It ranged from Rs. 5600.00 to Rs. 33417.00. The highest cost

involvement was recorded in T_8 (0.8acre) and lowest in T_1 (0.1acre). It increased from T_1 to T_8 with increase of holding size. However it gradually decreases from T_8 to T_{15} with increases of holding size.The highest cost involvement per acre was registered under T_1 (Rs. 56000.00) and lowest under T_{15} (Rs. 19311.00). On acre basis the cost involved progressively decrease T_1 to T_{15} with increase of holding size.

The gross return per holding witnessed significant variation among the holding sizes. It has found that the gross return per year per holding varied from Rs. 11217.00 to Rs. 67893.00. T_8 scored the highest gross return while T_1 scored the lowest gross return. It increased from T_1 to T_8 with increase of holding size. There after the value decreased from T_9 to T_{15}. When the gross return was calculated on acre basis the trend was different. The gross return per acre decreased from T_1 to T_{15} with increase of holding size. T_1 accounted the highest gross return of Rs. 112167.00 per acre while T_{15} accounted the lowest gross return of Rs. 41211.00.

Table 3. Economics of coconut based agroforestry system

Treatment (Holding size)	Cost involved (Rs.)		Gross return (Rs.)		Net return (Rs.)		B : C ratio	Market Orientation
	Per holding	Per acre	Per holding	Per acre	Per holding	Per acre		
T_1 (0.1 acre)	5600	56000	11217	112167	5617	56167	2.00	100 : 0
T_2 (0.2 acre)	10410	52050	21363	106817	10953	54767	2.05	100 : 0
T_3 (0.3 acre)	15260	50867	30847	102822	15587	51956	2.02	96 : 4
T_4 (0.4 acre)	19228	48071	38733	96833	19505	48763	2.01	85 : 15
T_5 (0.5 acre)	23227	46453	45667	91333	22440	44880	1.97	80 : 20
T_6 (0.6 acre)	27647	46078	53530	89217	25883	43139	1.94	75 : 25
T_7 (0.7 acre)	30560	43657	59893	85562	29333	41905	1.96	69 : 21
T_8 (0.8 acre)	33417	41771	67893	84867	34477	43096	2.03	61 : 29
T_9 (0.9 acre)	31550	35056	65700	73000	34150	37944	2.08	54 : 46
T_{10} (1.0 acre)	30367	30367	64167	64167	33800	33800	2.11	47 : 53
T_{11} (1.1 acre)	30533	27758	64117	58288	33583	30530	2.10	45 : 55
T_{12} (1.2 acre)	30400	25333	63717	53097	33317	27764	2.10	42 : 58
T_{13} (1.3 acre)	29833	22949	63167	48590	33333	25641	2.12	34 : 66
T_{14} (1.4 acre)	29617	21155	62700	44786	33083	23631	2.12	24 : 76
T_{15} (1.5 acre)	28967	19311	61817	41211	32850	21900	2.13	15 : 85
SEm(±)	232	266	600	572.00	592	578	0.02	3 : 0.6
$CD_{(0.05)}$	671	770	1766	1673	1,716	1673	0.07	9. : 1

With regards to net return is concerned it differed significantly per holding. The maximum net return of Rs. 34477.00 was achieved by T_8 and the minimum of Rs. 5617.00 by T_1 per year. The net return per holding was enhanced progressively from T_1 to T_8 with increase of the holding size. Beyond T_8 it decreased gradually up to T_{15}. However the net return under the holdings from T_8 to T_{15} was statistically alike. The net return from different holding size while converted to per acre basis the values differed significantly among the treatments. The highest net return (Rs. 56167.00) was achieved by T_1 and the lowest net return (Rs. 21900.00) by T_{15}. The net return per acre basis decreased gradually from T_1 to T_{15} with increase in holding size.As regards to benefit cost ratio in coconut based agroforestry system studied a significant difference was also noticed among various unit sizes. The B:C ratio ranged from 1.94 to 2.13. The highest B:C ratio was noticed under T_6. However the values under the holding sizes from T_9 to T_{15} are statistically alike. Similarly the values of T_1, T_4, T_5 and T_6 are statistically similar.

The cost involved per holding increase from 0.1acre to 0.8acre size with increase of holding size. This is due to increase area of operation however the cost involvement per holding decreases from 0.9 acre to 1.5 acre which may be ascribed to reduction in diversity towards higher size holdings. In terms of cost involved per acre it ranged from

Rs 19311.00 to Rs 56000.00. It steadily decreases towards higher holding size. This may be due to reduction of species and component diversity towards higher holding sizes. The gross return exhibited similar trend like cost involved per holdings. The gross return per acre also reflected similar trend like cost involved per acre.The net return per holding progressively increased from T_1 to T_8. This may be because of increase in unit size having diversity of components and the other hand net returns per holding decrease from T_9 (Rs 34150.00) to T_{15} (Rs 32850.00) with increase in holding size. This has happened may be due to reduction in species and component diversity in the coconut based agroforestry system.The net return per acre decreased steadily from T_1 to T_{15} with increase of holding size. This may be attributed to decrease in diversity and components towards higher holding size. The B:C ratio varied from 1.94 to 2.13 under different holding sizes. Relatively higher ratio was obtained in higher holdings may be due to more mechanization of the farming. Economics of coconut based agroforestry has also been reported by some researcher like Remold, (2000), Maheswarppa *et al.* (2000), Nath, (2002-2003), and Pires *et al*, (2004).

CONCLUSION

Coconut based agroforestry systems particularly up to 1.2 acre size are contributing various types of tangible and intangible benefits to the households including food, fuel, timber, fodder, oil, thatching and broom material, cash, employment, shade, good microclimate, habitat for birds, learning ground for children, aesthetic, cultural and religious values. The net return was assessed to be Rs. 5,617.00 to Rs. 34,770.00 per annum depending on the home garden size from 0.1 to 1.5 acre. The contribution of coconut based system towards fuel production and household female engagement was found significant.

REFERENCES

Maheswarappa H.P., Hegde M.R. and Nanjappa H.V. (2000). Arrowroot (*Maranta arundinacea* L.): a potential intercrop in coconut garden. *Indian Coconut J.* 31:20-21.

Maheswarappa H.P., Hegde, M. R., Dhanapal R., Sairam C.V. and Singh T.V. (2000). Impact of integrated mixed farming system in coconut (*Cocos nucifera*) garden on coconut yield and economic analysis. *Indian J. Agronomy.* 46:56-63.

Maheswarappa H.P., Nanjappa H.V. and Hegde M.R. (1999). Influence of planting material, plant population and organic manures on galangal (*Kaempferia galanga* L.) grown as intercrop in coconut (*Cocos nucifera* L.) garden. *J. Spices Aromatic Crops.* 8: 35-40.

Maheswarappa H.P., Nanjappa H.V. and Hegde M.R. (2000). Influence of agronomic practices on growth, productivity and quality of galangal (*Kaempferia galanga* L.) grown as intercrop in coconut garden. *J. Plantation Crops*.28:72-81.

Maheswarappa H.P., Nanjappa H.V., Hegde M.R. and Biddappa C.C. (2000). Content and uptake by galangal (*Kaempferia galanga* L.) as influenced by agronomic practices as intercrop in coconut (*Cocos nucifera* L.) garden. *J. Spices Aromatic Crops.* 9:65-68.

Maheswarappa H.P., Sairam C.V., Dhanapal R., Singh T.V. and Hegde M.R. (2000). Coconut based mixed farming systems and its economic advantages. *Indian Coconut J.* 31: 17-19.

Maheswarappa H.P., Nanjappa H.V. and Hegde M.R. (1998-99). Effect of sett size, plant population and organic manures on growth components of arrowroot (*Maranta arundinacea* L.) grown as intercrop in coconut garden. *Mysore J. Agricultural Sci*..32: 257-263.

Nath J.C. (2002-03). Prospects of coconut based high density multistoreyed cropping in Assam. *Indian Coconut J.* 33:10-11.

Pires M.de.M., Costa R.S., Jose A.R.S., Midlej M.M.B.C. and Alves J.M. (2004). Coconut cultivation: an economic analysis. *Revista Brasileira de Fruticultura.* 26:173-176.

Remold M. (2000). Costs benefit analysis of coconut cultivation (rainfed). *Indian Coconut J.* 31:7-9.

Remold M. (1999). Costs benefit analysis of coconut cultivation under irrigated condition. *Indian Coconut J. Cochin.* 30:5-8.

