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MIXED FARMING IN COCONUT GARDEN: ITS IMPACT ON SOIL, PHYSICAL AND CHEMICAL PROPERTIES, COCONUT NUTRITION AND YIELD

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ABSTRACT

A mixed farming experiment consisting of cultivation of fodder grasses in the interspaces of coconut,maintaining milch animals, poultry birds and recycling of farm yard manure and poultry manure is in progress at CPCRI, Kasaragod since 1989. Studies on soil properties showed that there was an increase in maximum water holding capacity and porosity and decrease in bulk density. There was build up of organic carbon, N, P, K and Fe status, whereas there was decrease in the available Ca, Mg, Mn, Cu and Zn. Leaf nutrient status of coconut palms was increased resulting in increased nut yield.

Keywords: Coconut, Mixed farming, Soil Properties, yield

INTRODUCTION

The integrated farming system approach is the need of the day to improve the efficient use of natural resources such as soil, water and solar radiation. This is specially true for wide spaced crops like coconut. Since the land holding in Kerala is less than 0.2 ha, this warrants such integrated approach to make the coconut production sustainable. The integration of dairy, poultry, fisheries etc. in coconut garden requires careful studies. The non-availability of fodder during dry months is the major handicap for popularising dairy in Kerala. Thus introduction of grass cultivation in coconut gardens would enhance the scope for dairy to meet the milk requirement.

A pilot model has been evolved at Central Plantation Crops Research Institute, Kasaragod, integrating grasses, dairy, poultry, rabbitry and fish culture in 1989 to understand the impact of various components on the productivity of coconut as well as on soil. It has been reported that mixed farming system generally improves soil physico - chemical and biological environment besides improving the productivity of coconut (Abdul Khader *et al.*, 1991 and Liyanage and Dassanayake, 1993). In the present paper, the influence of coconut based mixed farming system on soil properties, productivity and nutrition of the main crop has been summarised.

MATERIALS AND METHODS

Experimental site

The field experiment was conducted during 1989 in 1.2 ha coconut plantation aged over 18 years at the Central Plantation Crops Research Institute, Kasaragod, Kerala which is situated at 12°30'N latitude and 75°00'E longitude at an elevation of 10.7 m above mean sea level. Kasaragod receives an average annual rainfall of 3401 mm. The maximum temperature ranges between 28.8°C and 32.4°C and minimum temperature varying between 19.4°C and 24.2°C. The relative humidity ranges between 81 per cent and 94 per cent. Maximum evaporation is

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recorded during the months of March to May.

The soil of the experimental site was red sandy loam with the mechanical composition of 72.3% coarse sand, 7.2% fine sand, 4.3% silt and 16.2% clay. The field capacity of the soil was 10.0% and permanent wilting point was 5.2%. The bulk density of the soil was 1.54 g cc^{-1}. The soil was low in available N and K and was rich in available P.

Fodder Grasses

Two types of grasses viz., Guinea grass (*Panicum maximum*) and Hybrid Napier (NB 21) were planted with the spacing of 60 cm x 30 cm in the interspaces of coconut by leaving 2 m radius around coconut. For grasses NPK dose of 150:80:80 per hectare was adopted. Before planting grass slips, 10 tonnes of FYM, full dose of P and K was applied in the trenches. Nitrogen was applied as top dressing at the rate of 20 kg per hectare after each cutting of the grass. Grasses were replanted four years after planting. For coconut, 500:320:1200 g of NPK per palm was applied in two splits. Irrigation was provided during summer months with the sprinkler system @IW/CPE ratio of 1.00 maintaining 20 mm depth.

Dairy Unit

Five to six Jersey and Holstein friesian breed cows were maintained in the system.

Poultry unit

Layers (100 nos.) and 100 nos. broiler Giriraja (for each batch) birds were maintained in the system. In a year, six batches of broilers were reared.

By-products

By-products obtained from the system viz., FYM, poultry manure, biogas slurry, urine and cowshed wastes were recycled into the coconut + grass plantation from 1989. Quantity of by-products obtained and their nutrient contribution per year is given in the

Table 1. ***Nutrients recycling per year from the by-products in mixed farming***

By-products/year	N(kg)	P(Kg)	K(kg)
FYM-15 tonnes	75	40	75
Poultry manure-2 tonnes	20	38	12
Cows urine and cowshed washings-50000 litres	30	-	28
Total	125	78	115

Table 1. For coconut 25 kg of FYM and one kg of poultry manure was applied per palm per year. For grass plot 10 tonnes of FYM and one tonne of poultry manure was applied in between the rows per year. The urine, cowshed washings and slurry collected were pumped into the coconut + grass plot every year. Total quantity of nutrients added from 1989 to 1995 into the system was 750 kg N, 468 kg P and 690 kg K.

Soil sampling

Soil samples were collected in the interspaces of coconut and coconut basins randomly at 0-25, 25-50 and 50-100 cm depth before initiation of the experiment and analysed for various constituents. From the grass culture, soil samples were collected from 0-25 and 25-50 cm depth in between two rows of grass. Soil samples were collected from six locations both in coconut basins and grass interspaces, pooled and made into three replications. Finally the soil samples were processed and analysed for various constituents by adopting standard analytical procedures as described by Black (1965). Bulk density, maximum water holding capacity and porosity were measured for top 0-25 cm depth by adopting standard procedures.

The leaf samples were collected from the index leaf (14^{th}) of West Coast Tall (WCT) and Laccadive Ordinary (LO) from 15 palms each before the initiation of the experiment and during 1995-96 and analysed for different nutrient concentration by adopting standard procedures.

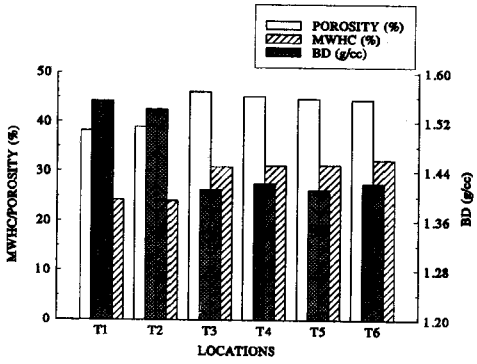
RESULTS AND DISCUSSION

Performance of grasses

The studies revealed that, the grass crops would be ready for harvest 75-80 days after planting and subsequently it can be cut at 45-50 days interval. The guinea grass and hybrid napier (NB 21) found to produce on an average 50 and 52 tonnes of green grass per hectare per year respectively.

Impact of mixed farming on soil physical properties

The data on the physico-chemical properties of the soil in different depths is presented in Fig. 1 and Table 2. In the top layer of 0-25 cm depth, the maximum water holding capacity of the soil was increased to 30.4 to 33.6 per cent under mixed farming system from the initial value of 24.0 per cent both in coconut basins and grass cultured plots. The porosity of the soil was also improved (44.5 to 46.0 %) from the initial value (38.2 to 39.0%). However, the bulk density of soil under mixed farming was



Sites

T1: Pre-experimental (Coconut basin)
T2: Pre-experimental (Interspace)
T3: Coconut+Guinea grass (Coconut basin)
T4: Coconut+Guinea grass (Guinea)
T5: Coconut+Hybrid napier (Coconut basin)
T6: Coconut+Hybrid napier (Napier)

Fig. 1. Soil physical properties in different sites

Table 2. ***Nutrient status in coconut based mixed farming system****

Location	Depth (cm)	Avail. N (kg/ha)	Avail. P (Kg/ha)	Avail. K (Kg/ha)	Avail. Ca (ppm)	Avail. Mg (ppm)	Avail. Fe (ppm)	Avail. Mn (ppm)	Avail. Cu (ppm)	Avail. Zn (ppm)	OC (%)	pH
Pre-experimental (1988-89)												
Coconut basin	0-25	173.6	220.1	120.6	321.1	62.3	23.3	16.5	3.6	3.4	0.40	5.05
	25-50	198.7	120.6	138.1	107.9	17.3	24.2	17.1	3.9	2.5	0.25	4.90
	50-100	209.8	78.3	101.7	87.3	9.9	20.1	15.5	1.3	1.1	0.21	4.86
Coconut interspace	0-25	176.3	200.7	110.2	123.5	25.9	22.4	17.2	3.5	2.5	0.38	5.13
	25-50	201.8	86.3	141.2	182.8	34.7	20.8	17.5	3.5	2.6	0.30	5.13
During 1995-96:												
Coconut+Guinea grass												
Coconut basin	0-25	197.6	273.2	255.0	223.6	48.3	27.3	13.3	1.2	2.2	0.69	5.49
	25-50	208.8	243.8	305.4	103.7	15.2	26.3	12.6	1.1	2.8	0.53	5.29
	50-100	218.6	188.4	338.8	100.4	20.2	24.3	14.8	1.1	1.3	0.41	5.13
Guinea grass	0-25	192.6	222.2	258.2	225.9	31.1	24.9	14.3	1.7	3.2	0.54	5.21
	25-50	210.1	109.4	325.8	75.3	18.1	20.8	14.1	1.0	0.9	0.44	5.09
Coconut+Hybrid napier												
Coconut basin	0-25	180.8	275.8	157.2	307.9	48.8	26.6	15.7	1.5	2.4	0.74	5.22
	25-50	194.3	198.8	260.2	214.9	39.2	25.6	25.9	2.2	2.9	0.57	5.08
	50-100	210.3	98.0	316.6	166.3	17.9	24.0	16.3	1.7	1.5	0.50	5.00
Hybrid Napier	0-25	186.3	229.0	143.3	93.9	19.8	26.3	14.7	3.4	1.7	0.58	5.24
	25-50	193.2	158.2	187.1	79.8	22.6	24.4	15.7	2.7	1.0	0.43	5.16

*Values are mean of three observations

found to decreased (1.40 to 1.42 g cc^{-1}) from the initial value of 1.54 g cc^{-1}. The reason for increase in maximum water holding capacity, porosity and decrease in bulk density have been primarily attributed to the increase in soil organic matter owing to the recycling of FYM/poultry manure and dead roots of grasses. Improvement in soil physical properties in mixed farming under coconut has been reported by Liyanage and Dassanayake (1993). Improvement in soil physical properties in different soil types due to build up of organic matter has been reported by several workers (Manickam, 1993, Shivaramu *et al.*, 1994 and Sudhir *et al.*, 1996).

Impact of mixed farming on soil chemical properties

The organic carbon status and pH of the soils under mixed farming system at all the three depths were found to increase marginally compared to initial status due to the contribution from root biomass and re-cycling of dairy and poultry wastes (Table 2). Liyanage *et al.* (1989) also reported similar changes in pH and organic carbon under mixed farming system. The available soil nitrogen showed almost a similar trend as that of organic carbon. The available nitrogen content was found to increase in soils both in the coconut basin and interspaces of grass cultured area. The available nitrogen status in the lower depths was more compared to surface soil. This may be due to the molecular movement of organic matter or nitrate from surface soil downwards (Gardner, 1965). Almost a similar trend of data has been recorded for available P and K in different depths of soil under mixed farming. Bopaiah and Shetty (1991) reported higher phosphatase enzyme activity in the coconut mixed farming plot, which favoured the release of fixed P. It is also evident from the data that the soil cultured with hybrid napier appeared to exhaust more of N, P and K than the soil under guinea grass due to its higher yield capacity. Biddappa *et al.* (1993) and Liyanage *et al.* (1989) also have reported the higher N, P and K status under grass cultured plot. The secondary and micronutrient status of soils showed the reverse trend as that of N, P and K. The soils under mixed farming generally showed relatively lower value of available Ca, Mg, Mn, Cu and Zn whereas there was marginal increase in available Fe status. This is obvious because besides coconut, grasses also found to exhaust these nutrients from the soil. Biddappa *et al.* (1993) also reported the lower secondary and micronutrient status under coconut + grass culture.

Impact of mixed farming on leaf nutrient status and yield of coconut

The nutrient content in the index leaf of coconut was found to be higher when compared to the initial status in both the varieties (Table 3). This is due to the beneficial effect of mixed farming system in improving the soil physical, chemical and biological environment which favoured the higher uptake from the soil nutrients pool. The higher uptake of Ca and Mg may be due to the continuous irrigation of mixed farming plot, which favoured the higher removal of these nutrients. The nut yield increased under mixed farming by 39.6% in WCT and 33.5% in LO as compared to the pre-experimental yield. (Table 4) concomitant with improved nutritional status

Table 3. ***Effect of mixed farming on coconut leaf nutrient status****

	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Pre-experimental					
WCT	1.65	0.19	0.99	0.26	0.14
LO	1.61	0.18	1.01	0.21	0.10
During 1995-96					
WCT	2.23	0.23	1.35	0.41	0.46
LO	2.24	0.21	1.28	0.43	0.39

*Values are mean of 15 observations

Table 4. ***Effect of mixed farming on coconut nut yield (nuts/palm/year)***

	WCT	LO
Pre-experimental (Av. of 1986-88)	58.6	101.7
Transitional Period (1989-92)	60.3	106.8
Experimental Period excluding transitional period (Average of 1992 - 96)	81.8	135.8

of the palm as well as due to irrigation and improvement in the soil nutrient availability status. Similar increase in leaf nutrient status and nut yield of coconut has been reported by Sahasranaman *et al.*, (1983) in root (wilt) affected garden when mixed farming was adopted.

From the above study, it can be concluded that, by following integrated mixed farming system in coconut involving irrigation, recycling of by-products, there would be improvement in the soil physico-chemical properties leading to increase in coconut yield.

REFERENCES

ABDUL KHADER, K. B., BALASIMHA, D. and BHAT, N. T. 1992. *J. Plantn. Crops*, **20** (suppl.) : 19-24.

BIDDAPPA, C. C., BOPAIAH, M.G., KAILASAM, C., SHANAWAS, M. and GEORGE, K.M. 1993. *J. Plantn. Crops*, **21** (suppl.): 41-46.

BLACK. C. A. 1965. Methods of Soil Analysis. Part 1 & 2. *American Soc. Agron.*, Inc., Pub. Wisconsin, USA.

BOPAIAH, B.M. and SHETTY, H.S. 1991. *Trop. Agri.*, **68**(2):135-138.

GARDNER, W.R. 1965. Movement of nitrogen in soil. In: Soil Nitrogen, (Eds.), Bartholomew, W.V. and Clark, F.E. *American Society of Agronomy*, Inc., Publisher, Madison, Wisconsin, USA. pp. 559-564.

LIYANAGE, L.V.K., JAYASUNDARA, H.P.S., MATHES, D.T. and FERNADO, D.N.S. 1989. *CORD*, **5**: 53-56.

LIYANAGE, M. De. S. and DASSANAYAKE, K.B. 1993. Experiences in coconut based farming systems in Sri Lanka. In : Advances in Coconut Research and Development. (Eds.) Nair. M.K. Khan, H.H., Gopalasundaram, P and Bhaskara Rao, E.V.V.B., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. pp. 358-367.

MANICKAM, T.S. 1993. Organics in soil fertility and productivity management. In: Organics in soil health and crop production. (Ed.) Thampan, P. K., Peekay Tree Crops Development Foundation. Cochin, India. pp. 87-104.

SAHASRANAMAN, K.N., PILLAI, N.G., JAYASANKAR, N.P., POTTY, V.P. VARKEY, T., AMMA, P.G.K. AND RADHA, K. 1983. Mixed farming in coconut gardens: Economics and its effect on root (wilt) disease. pp. 160-165. In: Coconut Res. and Develop., (Ed.) Nayar, N.M., Wiley Eastern, New Delhi.

SHIVARAMU, H.S., SHIVASHANKAR, K. and SIDDARAMAPPA, R. 1994. *Mysore J. agric. Sci.*, **28**: 39-44.

SUDHIR, K., SIDDARAMAPPA, R. and MARISWAMY GOWDA, S.M. 1996. Long Term Fertiliser Experiments-A Decade's Experience. University of Agricultural Sciences, Bangalore. P. 14.