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Production potential of high value cropping systems in coastal ecosystem

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ABSTRACT

An experiment was conducted during 2001–02 and 2002–03 at the Cropping Systems Research Centre of Kerala Agricultural University, Karamana, to study the production potential and economics of new cropping systems. The highest production potential and net income were obtained by rice (*Oryza sativa* L.), banana (*Musa paradisiaca)* followed by rice–rice–okra [*Abelmoschus esculentus* (L.) Moench] cropping systems. The nutrient management above the present package of practices (POP) recommendations also increased net income in all the cropping systems included in the study. However, the highest benefit : cost ratio was obtained in rice–rice–green manure crop *dhaincha* [*Sesbania cannabina* (Retz.) Pers.] cropping system.

Key words : Coastal ecosystem, Cropping systems, Rice, Nutrient management, Productivity

In the coastal ecosystem of Kerala, the rice cultivation has been reduced to 40% of its area during the last 1 decade alone (FIB 2004) due to various socio-economic reasons. The fragmentation of farm holdings and various biotic and abiotic stresses prevailed during the crop-growth period had resulted in low productivity and unremunerative returns to the farmers. Hence they are compelled to convert rice fields for various agricultural and non-agricultural purposes. Recently, under lease land tenancy conversion of rice fields for high-value crops, *viz.* various vegetable crops, banana or cassava, are gaining popularity in many parts of Kerala. However, irrational use of chemical inputs for short-term benefit has not only resulted in poor-quality produce but also deteriorated the fragile coastal ecosystem. Hence a study was carried out to evaluate the recommended and emerging cropping systems under different nutrient management options for the productivity and profitability in the coastal ecosystem.

MATERIALS AND METHODS

The experiment was conducted at the Cropping Systems Research Centre, Karamana, from rainy *(kharif)* season of 2001–02 to the summer season of 2002–03. The soil of the experimental site was clayey loam, low in available nitrogen (140.6 kg/ha), phosphorus (14.5 kg/ha) and potassium (103.4 kg/ha), with pH 5.9. The experiment was laid out in split-plot design with 3 replications. Treatments comprised 4 cropping systems in the main plots, viz. the most common practice of the region rice–rice–fallow (C_1), and improved cropping systems of rice–rice–green manuring with *dhaincha* (C_2), rice–rice–okra (C_3) and the emerging cropping system of rice–banana in the first year and banana alone in the second year (C_4). The sub-plots comprised 3 nutrient management options of 75% (F_1), 100% (F_2) and 125% (F_3) of each crop as per the package of practices of Kerala Agricultural University (KAU, 2002) for crops. In the emerging cropping system (C_4) Nendran (Musa AAB) cv. 'Kaliethan', uniform suckers were used for planting in both the years. An integrated pest-management practice was adopted in all the crops and plant-protection chemicals were used only when the pest population exceeds the economic threshold limits as per POP recommendations of crops of Kerala Agricultural University (2002). A total of 2,068 mm and 1,370 mm rainfall was received during the first and second year of study.

RESULTS AND DISCUSSION

Performance of cropping systems

The pooled mean yield of rice and other crops and rice equivalent per annum in each cropping systems are given in Table 1. The rice yield was positively influenced by the summer crops and recorded higher yield than sequential cropping of rice–rice–fallow in all the fertility levels. Organic matter increases owing to green manuring and has positive impact on succeeding crop (Abrol and Palaniappan, 1998). The beneficial effect of okra on succeeding rice crop was noticed in experiments conducted at Karamana (CSRC, 2002). The slow mineralization, chelating properties and improved physical conditions through the application of FYM to vegetable crop might be the reason for enhanced yield of rice after vegetable crop in the cropping system.

The rice equivalent per year due to the recommended and emerging cropping systems showed its superiority to traditional cropping system of 2 crops of rice and fallow. The highest rice equivalent was noticed in rice–banana cropping system. The potential productivity of banana is very high in wetland conditions, where nearly full absorption of incoming solar radiation taken place through the 12 to 14 fully opened leaves at the grand growth stage of the crop cover the entire land area. Duration of Nendran banana (AAB) was also reduced to 1 to 1½ months from the normal duration of 10 to 11 months due to the favourable soil moisture and micro meteorological parameters existed in the wetland conditions. The rice–rice–okra or *dhaincha* cropping system also enhanced the productivity to the tune of 77 and 18%, respectively, over rice-rice-fallow.

The economics of the cropping systems clearly revealed that the improved cropping systems tested in the study appreciably enhanced the net income and benefit : cost ratio over sequential cropping of rice–rice–fallow. The highest net income (Rs 77,108/ha) was registered in rice–banana cropping system, followed by rice–rice–okra. However, the benefit : cost ratio was highest in the cropping systems involving rice–rice–*in situ*–green-manuring of *dhaincha.*

Nutrient management

In all cropping systems, the nutrient response to rice crop was higher in the rainy *(kharif)* season than the winter *(rabi)* season. Usually the fertilizer-use efficiency was more in *rabi* season than in *kharif* season due to the better water-management practices and other favourable climatic conditions. However, lower response to fertilizers in *rabi* season might be due to the slower removal of toxic compounds formed in the root zone under reduced conditions. Under reduced conditions, the conversion of Fe^{2+} to Fe^{3+} is common in the coastal zone after the cessation of North-East monsoon, which comes around the panicle initiation to flowering stages of the crop. During *kharif* season, such toxic substances were removed by the continuous washing and leaching through the torrential rainfall. Reduced plant growth and productivity in rice through the accumulation of toxic compounds in the root zone was

Table 1. Effect of cropping systems and nutrient management on the yield of rice (kg/ha), productivity (rice equivalent) and economics

Treatment	Rice yield (q/ha) *Kharif* season Pooled Mean of two seasons	Rice yield (q/ha) *Rabi* season Pooled Mean of two Seasons	Mean rice yield (q/ha/ year)	Mean yield of other crops (q/ha)	Rice equivalent (q/ha/year)	Net income (Rs/ha/year)	Benefit : cost ratio
Rice–rice–fallow (C_1)							
F_1	41.00	30.90	71.90		71.96	73.92	1.17
F_2	43.47	37.25	80.72		80.71	119.97	1.27
F_3	50.74	39.42	90.16		90.16	171.12	1.37
Mean	45.07	35.86	80.93		80.94	121.67	
Rice–rice–green manure (dhaincha) (C_2)							
F_1	44.36	32.18	76.54	145.00	86.90	163.30	1.34
F_2	46.93	38.84	85.77	146.50	96.23	213.61	1.43
F_3	51.48	41.25	92.73	146.00	103.16	247.12	1.48
Mean	47.59	37.42	85.01	145.83	95.43	208.01	
Rice–rice–vegetable (okra) (C_3)							
F_1	43.78	38.18	81.96	105.78	134.84	283.88	1.33
F_2	46.05	39.83	85.88	145.10	145.10	335.70	1.40
F_3	49.00	40.50	89.50	500.49	150.49	353.43	1.40
Mean	46.28	39.50	85.78	133.79	143.48	324.34	
*Rice–banana (C_4)**							
F_1	43.00		10.75	213.38	254.61	654.77	1.32
F_2	45.20		11.30	245.50	291.87	811.84	1.37
F_3	51.00		12.75	261.55	311.66	846.62	1.36
Mean	46.40		11.60	240.14	286.05	771.08	
CD (P=0.05) for							
Cropping system (CS)	NS	2.25					
Nutrient management (NM)	2.02	2.60					
CS x NM	NS	NS					

*Only in the first year *kharif* season

Table 2. Effect of cropping systems and nutrient management on uptake (pooled data) of macronutrients and soil-nutrient status after experimentation

Treatment	Uptake of nutrients (kg/ha)									Soil-fertility status after experimentation		
	Kharif season			*Rabi* season			Summer season					
	N	P	K	N	P	K	N	P	K	Organic carbon (%)	Available P (kg/ha)	Available K (kg/ha)
Rice–rice–fallow (C_1)												
F_1	89.9	13.8	101.8	60.4	8.9	80.7				0.7	11.8	53.0
F_2	92.8	13.9	109.5	64.2	10.2	88.3				0.7	10.8	52.3
F_3	94.3	14.6	108.7	66.9	10.0	87.9				0.7	11.6	51.3
Mean	92.3	14.1	106.7	63.8	9.7	85.6				0.7	11.4	52.2
Rice–rice–green manure (dhaincha) (C_2)												
F_1	88.5	14.1	103.5	61.1	9.9	89.0				0.7	11.4	52.5
F_2	89.7	14.2	108.9	63.6	9.7	84.9				0.7	11.3	52.0
F_3	94.7	14.1	107.1	63.9	9.6	88.0				0.7	11.4	52.0
Mean	91.0	14.1	106.5	62.8	9.7	87.3				0.7	11.4	52.2
Rice–rice–vegetable (okra) (C_3)												
F_1	90.6	14.0	104.4	62.2	9.7	84.4	58.5	24.3	89.4	0.7	11.5	52.6
F_2	91.1	14.5	109.3	64.6	9.8	84.5	60.1	25.5	90.4	0.7	11.4	52.0
F_3	90.9	14.2	106.3	64.2	9.8	84.9	60.3	25.8	90.8	0.7	11.6	52.4
Mean	90.8	14.2	106.3	64.2	9.8	84.9	60.3	25.8	90.8	0.7	11.6	52.4
*Rice–banana (C_4)**												
F_1	88.7	14.5	103.5				475.0	88.0	983.0	0.7	11.5	50.3
F_2	89.5	13.9	104.5				485.0	92.0	995.0	0.8	11.6	53.0
F_3	89.0	14.1	105.3				483.0	96.0	990.0	0.8	11.8	54.3
Mean	89.1	14.1	104.4				481.0	92.0	989.3	0.7	11.6	52.5
CD (P=0.05) for												
Cropping system	NS	NS	NS	NS	NS	NS				NS	NS	NS
Nutrient management	NS	NS	NS	NS	NS	NS				NS	NS	NS

*Only in the first year *kharif* season

reported from *kari* soil of Kuttanad (Battacharya, 1996). The accumulation of toxic substances discoloured the roots and reduces its activity. According to Ramasamy (2002), root activity if restricted may affect the cytokinin production and check the remobilization of stored reserve in rice crop and reduce the yield. The nutrient management above the present package of practices recommendations–exhibited its superiority to rice crop only during the *kharif* season. However, the rice equivalent per annum computed in each cropping systems indicated that an enhancement of 25% nutrients above recommendations as per package of practices had an appreciable influence.

Nutrient uptake and fertility status

In general, the uptake of nutrient by rice crop was higher during the *kharif* season than in *rabi* season. The uptake of nutrients by banana crop was substantially higher than other crops tested in the study. However, soil-fertility status did not vary significantly after 2-year cropping cycle. In the cropping system involving banana crop, the recycling of pseudostem and other underground parts might have enriched the soil and maintained a comparable soil fertility status.

The emerging cropping system of rice–banana, the permanent conversion of rice field is not taking place and can easily be reconverted to rice crop with nutrient enrichment and carbon sequestration. Thus the study revealed that for environmental safety and food security the emerging cropping system of rice–banana is advantageous to the coastal ecosystem.

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