Evaluation of System of Rice Intensification (SRI) in rice (Oryza sativa)

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Evaluation of System of Rice Intensification (SRI) in rice (*Oryza sativa*) – groundnut (*Arachis hypogaea*) system under Island ecosystem

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ABSTRACT

Field experiment was conducted during wet and dry seasons of 2007-09 at Field Crops Research Farm of Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands to evaluate System of Rice Intensification (SRI) in rice and its residual effect on groundnut in rice (*Oryza sativa* L.) – groundnut (*Arachis hypogaea* L.) systems. Time of planting, spacing and nitrogen practices evaluated significantly influenced the yield attributes and yield of rice, while the residual effect of N management practices had a positive influence on the yield attributes and yield of succeeding groundnut. Early planting in second fortnight of June with 20 cm × 20 cm spacing recorded higher panicles/m² (9.1 %), higher number of filled grains/ panicle (108), higher grain yield (4 678 kg/ha), about 3% higher REY, productivity (26.8 kg/ha/day), and total profitability (₹ 62 882/ha) compared to the same time of planting with wider spacing (25 cm × 25 cm). Though application of 100% Recommended Dose of Nitrogen (RDN) through urea recorded highest grain yield (4 465 kg/ha) of rice, it was comparable with 50% RDN through *Gliricidia* + 50% RDN through urea and 75% RDN through *Gliricidia* + 25% RDN through urea. Application of 50% RDN through *Gliricidia* + 50% RDN recorded nearly 6% higher REY and ₹ 6 565/ha more profitability higher output energy in rice-groundnut sequence compared to application of 100% RDN through urea. N management practices of rice, in the crop sequence of rice- groundnut were found to improve the soil nitrogen status. Early planting of rice in second fortnight of June at 20 cm × 20 cm with the application of 50% RDN through *Gliricidia* + 50% RDN through urea can be recommended for achieving higher productivity, profitability and energy use efficiency of rice - groundnut system in Island ecosystem.

Key words: Energetics, Island ecosystem productivity, Profitability, Rice-groundnut system, System of rice intensification

Rice (*Oryza sativa* L.) is the most important staple food for nearly half of the world's population. It is grown under wide range of latitudes and altitudes and can anchor the food security of world with the challenges of climate change (Swaminathan 2006). Island food security is vulnerable and under threat due to physiographic, edaphic and environmental factors besides disasters like Tsunami. Lifeline cereal food commodity of Islanders is rice due to its demographic features of Bengali, Tamil and Malayali populations. Rice is cultivated in 8 549 ha with annual production and productivity of 26 249 tonnes and 2 200 kg/ha respectively necessitating an import of about 27 188 tonnes of rice from the Indian mainland (A&N Administration 2009). The low yield of rice is mainly due to growing of rice with traditional low or no input management practices. Shrinking of land, water, labour, capital and energy are found to be a challenge in the Island ecosystem, thus requiring innovative research and technologies which can increase the unit area production of rice. System of rice intensification (SRI), originated through participatory on farm experimentation conducted in Madagascar during 1980s by Fr. Henri de Laulanie, represents an integrated and ecologically sound approach to rice cultivation and the productivity is higher in SRI compared to conventional rice farming. A well developed and healthy root system in SRI plays an important role in uptake and translocation of nutrients from the soil than conventional system (Uphoff 2005) and which results in healthy plant growth, better tillering, higher biomass and higher yields. Increased yield in SRI compared to conventional method were reported by several authors (Uphoff 2005, Samidurai *et al*. 2004 and Satyanarayana *et al*. 2006). Practices of SRI such as number of seedling and spacing developed elsewhere would not be suitable for

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Island ecosystem as it receives annual average rainfall of 3000 mm from May to November. After harvest of rice, lands were either left fallow or little area is grown with black gram, green gram, groundnut or vegetables like okra and chilli. Table purpose groundnut has great marketing potential in Islands as it can be used in many forms, like boiled peanuts, fried nuts etc. besides the green haulms as fodder. Considering the potential value and use of table purpose groundnut along with its suitability to island soil conditions in rice based cropping systems, an attempt was made to study management practices of SRI, viz. time of planting, spacing, seedling number and nitrogen management practices and its residual impact on succeeding groundnut with due emphasis on system productivity, profitability and energy use efficiency of rice-groundnut (*Arachis hypogaea* L.) sequence in high rainfall areas of Island ecosystem.

MATERIALS AND METHODS

Field experiment was carried out during wet and dry seasons of 2007- 09 at Field crops research farm, Bloomsdale of Central Agricultural Research Institute, Port Blair, Andaman & Nicobar Islands. The soil was clay loam in texture having slightly acidic pH (6.2), normal EC (0.2 dS/m), medium in organic carbon (0.6%), low in available nitrogen (210 and 245 kg/ha), medium in phosphorus (11.1 and 11.2 kg/ha) and low in available potassium (112 and 128 kg/ha). The experiment was laid out in split plot design having time of planting and spacing in main plot [second fortnight of June with 20 cm × 20 cm (M_1), second fortnight of June with 25 cm × 25 cm (M_2), second fortnight of July with 20 cm × 20 cm (M_3) and second fortnight of July with 25 cm × 25 cm (M_4)] and seedling number [One (H_1), Two (H_2)] and nitrogen management [100% of recommended dose of N through *Gliricidia* (N_1), 100% RDN through urea (N_2), 50% RDN through *Gliricidia* + 50% RDN through urea (N_3) and 75% RDN through *Gliricidia* + 25% RDN through urea (N_4)] in subplot and replicated thrice. Seedlings of rice variety 'Bhavani' were raised in MAT nursery and 15 day old seedlings were transplanted as per the treatments. Fertilizer dose of 90-60-40 kg N-P_2O_5-K_2O/ha was adopted and accordingly 100% P_2O_5 and 50% K_2O was applied as basal and remaining 50% K_2O was applied at panicle initiation stage through inorganic sources as per the treatment. The quantity of P_2O_5 supplied by *Gliricidia* (*Gliricidia sepium*) was estimated and the remaining quantity was supplemented with inorganic sources. *Gliricidia* contained 2.9% N, 0.5% P_2O_5 and 2.8% K_2O on fresh weight basis. However, no addition of K from inorganic source was done as *Gliricidia* leaf incorporation met the entire K requirement. Nitrogen in the form of urea, phosphorus in the form of single super phosphate and potassium in the form of muriate of potash was used as inorganic sources. Criss–cross conoweeding was carried out on 10, 25 and 40 DAT. Table purpose groundnut var 'ICGS 76' was grown as residual crop after harvest of main experiment during dry season without disturbing the plots to study the residual effect of nutrient management practices. Observations on yield parameters of rice and groundnut were recorded as per standard procedure. Rice grains and groundnut pods from individual net plot were sun-dried, cleaned and weighed and yield was expressed at 14% moisture basis, while straw and haulm was sun-dried for 4 days and weighed separately. Rice equivalent yield was determined by converting the economic yield of groundnut on the basis of their marketable price prevailed during the cropping period and expressed in tonnes/ha. Economic evaluation was done by calculating the gross return, net return, cost of cultivation and net return per rupee invested (NRPRI) based on the prevalent market rate. Cultural energy (Mega Joules) used through various inputs in the cropping period was computed as described by Mittal *et al.* (1985) and the energy use efficiency (energy ratio) was worked out using the formula of Energy output divided by Energy input and Specific energy was calculated in terms of energy required to produce a kilogram of economic yield and expressed in MJ/kg. Plant samples collected for dry matter estimation at harvesting stages were oven dried and finely ground into fine powder in a Willey mill and used for estimating nitrogen, phosphorus and potassium. Plant N, P and K were estimated following the methods as advocated by Jackson (1973). Soil samples were collected from each plot after harvest of crop from 0-30 cm depth, air-dried and sieved (2 mm mesh). Soil available nitrogen, phosphorus and potassium were estimated by alkaline permanganate method (Subbiah and Asija 1956), sodium bicarbonate (Olsen *et al*. 1954) and ammonium acetate (Stanford and English 1949) method respectively. All the observed data were subjected to statistical analysis as per the prescribed standard procedures for the similar kind of study.

RESULTS AND DISCUSSION

Performance of rice

Among the yield components, the productive tillers are considered as the most important because the final yield is mainly a function of the number of panicle bearing tillers per unit area. The yield attributes, viz. panicles/m^2, panicle length and filled grains/panicle were significantly influenced by the time of planting, spacing and N management practices, while number of seedlings/hill did not show much variations on the yield attributes and yield (Table 1). Early planting in second fortnight of June with 20 cm × 20 cm spacing recorded 9.1% higher panicles/m^2, lengthier panicle with higher number of filled grains/panicle (108), higher grain and straw yield compared to the same time of planting in 25 cm × 25 cm. The number of panicles/m^2 was higher at increased plant density and decreased with wider spacing. This may be due to greater plant population per unit area rather than more tillers/plant. Similar results were earlier reported by Choudhury *et al.* (2007). Similarly, the increase in grain yield was 466 kg/ha and 28% higher straw yield compared to the same time of planting with wider spacing of 25 cm × 25 cm. At the same time one month delay in planting (second fortnight of July) accounted 362 and 420

Table 1 Influence of management practices on yield components and yield of rice-groundnut cropping sequence (pooled data)

Treatment	Yield components of rice				Yield component of groundnut				Yield of rice (kg/ha)		Yield of groundnut (kg/ha)	
	No. of panicles/ m^2	Panicle length (cm)	Filled grains/ panicle	Test weight (g)	No. of pods/ plant	Pod weight/ plant (g)	Kernel weight/ plant (g)	100- pod weight (g)	Grain	Straw	Pod	Haulm
Time of planting and spacing												
M_1 - June second fortnight + 20 × 20 cm	239	23.0	108	23.9	10.6	17.7	13.3	167	4 678	6 575	2 558	5 808
M_2 - June second fortnight + 25 × 25 cm	219	21.2	99	23.4	10.7	18.2	13.6	174	4 212	5 134	2 657	5 706
M_3 - July second fortnight + 20 × 20 cm	221	21.8	101	23.6	10.6	17.9	13.6	171	4 316	5 250	2 652	5 704
M_4 - July second fortnight + 25 × 25 cm	155	19.8	92	23.4	11.4	18.4	13.8	172	3 792	4 744	2 721	5 790
SEm±	3	0.3	2	0.4	0.2	0.2	0.2	3	68	84	37	89
CD (*P*=0.05)	11	1.2	5	NS	NS	NS	NS	NS	234	292	NS	NS
Number of seedlings/hill												
H_1 - One seedling	205	21.2	99	23.4	10.5	18.2	13.7	173	4 214	5 447	2 696	5 674
H_2 - Two seedlings	211	21.6	100	23.7	10.7	17.9	13.5	169	4 285	5 404	2 598	5 829
SEm±	3	0.3	1	0.4	0.2	0.4	0.3	4	63	81	58	125
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen management												
N_1- 100% RDN through *Gliricidia*	193	19.9	92	23.0	11.5	19.2	14.5	182	3 929	4 883	2 827	6 231
N_2- 100% RDN through urea	218	22.3	105	24.4	9.2	15.8	12.1	151	4 465	5 770	2 360	5 058
N_3- 50% RDN through *Gliricidia* + 50% RDN through urea	212	21.9	102	23.6	11.1	18.4	13.7	174	4 362	5 547	2 682	5 962
N_4- 75% RDN through *Gliricidia* + 25% RDN through urea	210	21.6	101	23.1	11.2	18.8	14.1	176	4 241	5 502	2 718	6 000
SEm±	4	0.5	2	0.5	0.2	0.4	0.3	4	90	115	52	113
CD (*P*=0.05)	13	1.3	6	NS	0.6	1.0	0.8	10	254	326	146	320

kg/ha reduction in yield with same density of population. This can be attributed to better growth and yield components due to efficient utilization of resources which in turn improved the yield attributes and thereby increased the yield. It clearly indicates that early planting enabled the plants to have longer time for growth before flowering and had potential for higher source capacity from which more dry matter could be produced for storage in the economic organs. Further, due to more number of panicles/m^2 produced in the early planting with closer spacing must have contributed to higher grain yield. Similarly, Gill *et al.* (2006) also reported that delayed transplanting in July compared to June resulted in sharp reduction in grain yield due to reduction in favourable growing period. Wider spacing may increase yield per plant but may often lead to a decrease in grain yield per unit area due to less plant population. This is true in the present findings. Closer spacing gave higher yield in comparison with wider spacing. Karmakar *et al.* (2004) reported that closer spacing gave higher yield in comparison with wider spacing. Number of seedlings/hill had no significant effect on yield. Though planting two seedlings/hill recorded numerically higher grain and straw yield, but it was in close comparison with one seedling/hill. Similar findings were reported by Latif *et al.* (2009).

Among the nitrogen management practices, N_2 (100% RDN through urea) recorded the higher number of panicles (218), filled grains/panicle, highest grain (4 465 kg/ha) and straw yield (5 770 kg/ha), but the same was at par with N_3 (50% RDN through *Gliricidia* + 50% RDN through urea) and N_4 (75% RDN through *Gliricidia* + 25% RDN through urea). This may be due to the conjunctive use of inorganic fertilizer with organic source (*Gliricidia* green leaf manuring), which might have not only attributed steady and uninterrupted supply of nutrients throughout the crop growth period, but also increased the fertilizer use efficiency and improved the physical, chemical and biological properties of soil thereby paving the way for better utilization of nutrients resulting in similar trend in yield as compared to RDN only through urea. This is in line with the findings of Das *et al.* (2009).

Performance of groundnut

Time of planting, spacing and number of seedlings/hill did not exhibit any residual effect on the yield components and yield of groundnut, while the residual effect of N management practices had a positive influence on the same. Application of 100% RDN through *Gliricidia* to preceding rice had recorded more number of pods/plant, higher pod weight (19.2 g/plant), kernel weight and 100-pod weight (182 g), which in turn resulted in higher pod yield (2827 kg/ha) in succeeding groundnut (Table 1) and the same was at par with application of 75% RDN through *Gliricidia* + 25% RDN through urea and application of 50% RDN through *Gliricidia* + 50% RDN through urea. The magnitude of increase was about 21 to 25% in number of pods/plant, 16.5 to 21.5% in pod weight/plant, 15 to 21% in 100-pod weight and 14 to 20% in pod yield respectively compared to application of 100% RDN through urea. This might be due to the beneficial effect of organic material that it modified the soil environment besides improving the physical properties of soil and also the slow decomposition of humus gradually increased the availability of nutrients during the succeeding crop, which was manifested higher nutrient uptake by the groundnut resulted in increased growth along with the better expression of yield attributes and higher yield. In addition, more carry over effects in these treatments might be due to reduced loss of nitrogen during wet season that improved the availability of nitrogen to the succeeding groundnut crop. This is in agreement with the findings of Prasad *et al.* (2002) and Umamaheswari *et al.* (2006).

System productivity, economics and energetics

The productivity of rice-groundnut system as a whole was influenced by the management practices. Early planting in second fortnight of June with 20 cm × 20 cm spacing recorded about 3% higher REY, productivity (26.8 kg/ha/day), and total profitability (₹ 62 882/ha) compared to the same time of planting with wider spacing (25 cm × 25 cm) (Table 2). Among the N management practices, application of 50% RDN through *Gliricidia* + 50% RDN (N_3) recorded nearly 6% higher REY and ₹ 6 565/ha more profitability compared to application of 100% RDN through urea. System productivity depends upon the management practices that cannot accomplish the present demand of the crop, but also carry forward sufficient amount of nutrients for the succeeding crop. This could be the cause for obtaining maximum total productivity of the system. In the present findings, though application of 100% RDN through urea (N_2) resulted higher grain yield in rice and the same was at par with N_3 (50% RDN through *Gliricidia* + 50% RDN through urea) and N_4 (75% RDN through *Gliricidia* + 25% RDN through urea), but the system productivity was higher in the later treatments because of higher pod yield of succeeding groundnut due to higher residual soil fertility built up by the organic sources. The results are in conformity with the findings of Bejbaruaha *et al*. (2009) and Sharma and Banik (2012).

The economic analysis revealed marked variation in cost of cultivation due to spacing. Higher cost was incurred under the closer spacing (20 cm × 20 cm) which reduced correspondingly with further widening in plant spacing (25 cm × 25 cm). This may be due to higher labour cost involved for transplanting and harvesting. However, the economic efficiency of the system was also higher in case of early planting of rice in second fortnight of June at 20 cm × 20 cm(₹ 172.3/ha/day) and with the application of 50% RDN through *Gliricidia* + 50% RDN through urea (₹ 170.8/ha/day) respectively, which was attributed to higher yield and net returns (₹ 62 882 and 62 346/ha) obtained in these treatments because of the positive effect of *Gliricidia* green leaf manuring in restoring the soil fertility status for the succeeding groundnut crop.

Among the treatments, early planting of rice in second fortnight of June at 20 cm × 20 cm with the application of

Table 2 Influence of management practices on system productivity, economics and energetics of rice-groundnut cropping sequence (mean of two years)

Treatment	System productivity (REY) t/ha	Cost of cultivation (₹/ha)	System profitability (₹/ha)	Production efficiency (kg/ha/day)	Economic efficiency (₹/ha/day)	Input energy (MJ/ha)	Output energy (10^3MJ/ha)	Specific energy (MJ/kg)	Energy ratio
Time of planting and spacing									
M_1 - June second fortnight + 20 × 20 cm	9.79	44 538	62 882	26.8	172.3	18 156	4 412	1.87	24.6
M_2 - June second fortnight + 25 × 25 cm	9.53	42 510	60 738	26.1	166.4	18 097	4 198	1.92	23.6
M_3 - July second fortnight + 20 × 20 cm	9.62	44 538	59 760	26.4	163.7	18 156	4 162	1.93	23.2
M_4 - July second fortnight + 25 × 25 cm	9.23	42 510	57 467	25.3	157.4	18 097	4 170	1.97	23.4
Number of seedling/ hill									
H_1 - One seedling	9.60	43 471	60 871	26.3	166.8	18 120	4 201	1.91	23.5
H_2 - Two seedlings	9.48	43 578	59 553	26.0	163.2	18 137	4 271	1.94	23.9
Nitrogen management									
N_1- 100% RDN through *Gliricidia*	9.58	43 088	60 735	26.3	166.4	18 501	4 329	1.95	23.8
N_2- 100% RDN through urea	9.18	44 372	55 781	25.2	152.8	18 037	3 960	1.99	22.4
N_3- 50% RDN through *Gliricidia* + 50% RDN through urea	9.73	43 446	62 346	26.7	170.8	17 026	4 346	1.75	25.8
N_4- 75% RDN through *Gliricidia* + 25% RDN through urea	9.67	43 192	62 087	26.5	170.1	18 950	4 307	2.00	22.8

RDN, Recommended dose of nitrogen; * Cost of cultivation of groundnut = ₹ 22 950/ ha; ** Input energy for groundnut = 7 356 MJ

50% RDN through *Gliricidia* + 50% RDN through urea recorded higher output energy (4 412 and 4 346 10^3 MJ/ha) and energy ratio (24.6 and 25.8), respectively, due to higher rice equivalent yield because energy output depends on grain and straw yield. Similarly the energy ratio indicates the ratio in terms of energy between output and input, which was higher under N_3 (50% RDN through *Gliricidia* + 50% RDN through Urea). This might be due to the combined effect of reduced energy consumption and more output in terms of grain and straw yield. This is in agreement with the findings of Balakrishnan *et al.* (2010). In contrast, specific energy, a measure of energy required to produce one kilogram of paddy was higher (1.99 MJ/kg) with application of 100% RDN through urea (N_2) was mainly due to lesser rice equivalent yield coupled with more energy intake in terms of inputs. Similar findings were reported earlier by Ravisankar *et al.* (2008).

Nutrient uptake

Except N management practices, other management practices, viz. time of planting, spacing and number of seedlings/hill did not exhibit significant effect on nutrient uptake in rice – groundnut cropping sequence (Table 3). The result revealed that, though maximum N, P and K uptake in rice (93.9, 32.1 and 103.4 kg/ha, respectively) was recorded with the application of 100% RDN through urea which was at par with the application of 50% RDN through *Gliricidia* + 50% RDN through urea and application of 75% RDN through *Gliricidia* + 25% RDN through urea. In contrast, better uptake of nutrients in succeeding groundnut (12.8, 19.6 and 26 kg/ha) N, P and K, respectively, was recorded with the residual effect by the application of 100% RDN through *Gliricidia,* followed by application of 75% RDN through *Gliricidia* + 25% RDN through urea and application of 50% RDN through *Gliricidia* + 50% RDN through urea. This may be due to addition of organic material in soil enhance soil organic carbon status and microbial activity/diversity, which subsequently enhance soil enzyme synthesis and accumulation, which in turn would booster soils capability to cycle and provide nutrients for crop growth (Dinesh *et al*. 2000), thereby resulted in better uptake of nutrients by the succeeding crop.

Balance sheet of soil available N

Among the N management practices, application of 100% RDN through *Gliricidia* recorded net gain of 9.2 and 4.3 kg/ha of available N after harvest of groundnut during 2007-08 and 2008-09, respectively, followed by application of 75% RDN through *Gliricidia* + 25% RDN through urea, whereas, application of 100% RDN through urea resulted in depletion of N in the tune of 1.9 and 7.2 kg/ha in 2007-08 and 2008-09 respectively (Table 4). It can be observed from the present findings that N management practices of rice in the crop sequence of rice-groundnut were found to improve

Table 3 Influence of management practices on nutrient uptake in rice-groundnut cropping sequence (Mean of two years)

Treatment	Nutrient uptake of rice (kg/ha)			Nutrient uptake of groundnut (kg/ha)			Nutrient uptake by rice-groundnut cropping sequence (kg/ha)		
	N	P	K	N	P	K	N	P	K
Time of planting and spacing									
M_1 - June second fortnight + 20 × 20 cm	98.0	33.1	107.5	12.3	18.2	23.9	110.3	51.3	131.5
M_2 - June second fortnight + 25 × 25 cm	88.5	30.4	96.3	12.5	18.8	24.7	100.9	49.2	120.7
M_3 - July second fortnight + 20 × 20 cm	91.2	30.9	98.6	12.1	18.2	24.3	103.3	49.1	122.7
M_4 - July second fortnight + 25 × 25 cm	80.9	28.1	88.6	12.6	19.1	25.0	93.4	47.2	113.6
SEm±	1.4	0.4	1.5	0.2	0.3	0.4	2.7	1.3	3.2
CD (P=0.05)	4.8	1.7	5.1	NS	NS	NS	8.2	NS	9.7
Number of seedling/hill									
H_1 - One seedling	90.1	30.5	98.2	12.4	18.9	24.6	102.4	49.4	122.3
H_2 - Two seedlings	89.3	30.7	97.3	12.3	18.3	24.0	101.5	49.0	121.7
SEm±	1.3	0.4	1.5	0.3	0.4	0.5	1.9	0.9	2.3
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen management									
N_1 - 100% RDN through *Gliricidia*	83.1	28.3	90.3	12.8	19.6	26.0	95.9	47.9	116.3
N_2 - 100% RDN through urea	93.9	32.1	103.4	11.6	16.9	21.0	105.5	48.9	124.4
N_3 - 50% RDN through *Gliricidia* + 50% RDN through urea	91.8	31.4	98.9	12.4	18.7	24.8	104.2	50.6	124.2
N_4 - 75% RDN through *Gliricidia* + 25% RDN through urea	89.8	30.8	98.4	12.7	19.2	25.4	102.3	49.5	123.2
SEm±	1.9	0.6	2.1	0.2	0.4	0.5	1.9	0.9	2.3
CD (P=0.05)	5.4	1.8	5.8	0.7	1.0	1.3	5.4	NS	6.4

Table 4 Balance sheet of soil available N (kg/ha) as influenced by the N management practices of rice under rice-groundnut cropping sequence

Parameters	2007-08				2008-09			
	N_1	N_2	N_3	N_4	N_1	N_2	N_3	N_4
Initial value	210.0				245.0			
Addition	90.0				90.0			
Uptake by rice	85.5	96.7	94.9	92.5	80.7	91.2	88.7	87.0
Computed balance after rice	214.5	203.3	205.1	207.5	254.3	243.8	246.3	248.0
Actual balance after rice	217.9	188.5	200.6	201.0	242.8	207.3	226.2	233.8
Uptake by groundnut	13.0	11.7	12.5	12.7	12.6	11.4	12.2	12.6
Computed balance after groundnut	201.5	191.6	192.6	194.8	241.7	232.4	234.1	235.4
Actual balance after groundnut	219.2	208.1	211.2	217.4	249.3	237.8	242.6	247.8
Net gain or loss from initial value	+ 9.2	- 1.9	+ 1.2	+ 7.4	+ 4.3	- 7.2	- 2.4	+ 2.8

the soil N status compared to the initial level. The magnitude of increase was about 3.5 - 4.4% in 2007-08 and 1.1 - 1.8% in 2008-09 under 100% RDN through *Gliricidia*. This positive influence on soil available N may be due to the combined effect of *Gliricidia* green leaf manuring as well as the legume effect of groundnut crop because legumes make less demand on the soil resources and at the same time they have the capacity to fix atmospheric nitrogen in their root nodules. Moreover, crop rotation with legumes and integration of nutrient sources found to improve the multiplication of microbes, which could convert the organically bound nitrogen to inorganic forms. The result also corroborates the findings of Pillai *et al.* (2007).

Thus, it can be concluded that, early planting of rice in second fortnight of June at 20 cm x 20 cm and with the application of 50% RDN through *Gliricidia* + 50% RDN through urea can be recommended for achieving higher productivity, profitability and energy use efficiency of rice-groundnut system in Island ecosystem.

REFERENCES

A & N Administration. 2009. Basic Statistics-2. *Directorate of Economics and* Statistics, Andaman & Nicobar Administration, p 8–12.

Balakrishnan M, Ravisankar N, Swarnam T P and Din M. 2010. Influence of prickly sesban (*Sesbania cannabina*) intercropping in wet-seeded rice (*Oryza sativa*) on productivity, profitability, energetic and nitrogen balance under island ecosystem. *Indian Journal of Agricultural Sciences* **80** (1): 21–3.

Bejbaruah R, Sharma R C and Banik P. 2009. Direct and residual effect of organic and inorganic sources of nutrients on rice based cropping systems in sub-humid tropics of India. *Journal of Sustainable Agriculture* **33**: 674–89.

Choudhury B U, Anil Kumar Singh, Bouman B A M and Jagdish Prasad. 2007. System of Rice Intensification and irrigated transplanted rice: Effect on crop water productivity. *Journal of Indian Society of Soil Science* **55** (4): 464–70.

Das Anchal, Sudhishri S and Lenka N K. 2009. Integrated nutrient management for upland rice in eastern ghats of Orissa. *Oryza* **46** (3): 220–6.

Dinesh R, Dubey R P, Ganeshamurthy A N and Shyam Prasad G. 2000. Organic manuring in rice-based cropping system: Effects on soil microbial biomass and selected enzyme activities. *Current Science* **79** (12): 1 716–20.

Gill M S, Ashwani Kumar and Pardeep Kumar. 2006. Growth and yield of rice (*Oryza sativa*) under various methods and times of sowing. *Indian Journal of Agronomy* **51** (2): 123–7.

Jackson M L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt Ltd, New Delhi.

Karmakar B, Ali M A, Mazid M A, Duxbury J and Meisner C A. 2004. Validation of System of Rice Intensification (SRI) practices through spacing, seedling age and water management. *Bangladesh Agronomy Journal* **10**: 13–21.

Latif M A, Ali M Y, Islam M R, Badshah M A and Hasan M S. 2009. Evaluation of management principles and performance of the system of rice intensification (SRI) in Bangladesh. *Field Crops Research* **114**: 255–62.

Mittal V K, Mittal T P and Dhawan K C. 1985. Research bulletin on energy requirements in agriculture sector. *Punjab Agricultural University*, Ludhiana, p 20–3.

Olsen S R, Cole C V, Watanabe F S and Dean L A. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Circular No. 939.

Pillai Shalini P, Geethakumari V L and Sheeba Rebecca Issac. 2007. Balance sheet of soil nitrogen in rice (*Oryza sativa*) based cropping systems under integrated nutrient management. *Indian Journal of Agronomy* **52** (1): 16–20.

Prasad P V V, Satyanarayana V, Murthy V R K and Bootee K J. 2002. Maximizing yields in rice-groundnut cropping sequence through integrated nutrient management. *Field Crops Research* **75**: 9–21.

Ravisankar N, Raja R, Din M, Elanchezhian R, Swarnam T P, Deshmukh P S and Ghoshal Chaudhuri S. 2008. Influence of varieties and crop establishment methods on production potential, economics and energetic of wet-seeded rice (*Oryza sativa)* under Island ecosystem. *Indian Journal of Agricultural Sciences* **78** (9): 807–9.

Sharma R C and Banik P. 2012. Effect of integrated nutrient management on baby corn- rice cropping system: economic yield, system productivity, nutrient –use efficiency and soil nutrient balance. *Indian Journal of Agricultural Sciences* **82** (3): 220–4.

Samidurai R**,** Chellaiah N, Chandrasekaran B, Rajendran K, and Maikandadevan D. 2004. System of Rice Intensification (SRI): An innovative crop establishment technique to boost the rice yield. *In: Proceedings of World Rice Research Conference*, Tsukuba International Congress Center, Tsukuba, 5-7 November 2004, Japan, p 380.

Stanford G., and English L. 1949. Use of flame photometer in rapid soil test for K and Ca. *Agronomy Journal* **41**: 446–7.

Subbiah B V and G L Asija. 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Science* **25**: 598–609.

Swaminathan M S. 2006. Science and shaping the future of rice. *In: Proceedings of Second International Rice Congress*, 9-13 October 2006, New Delhi, p 1.

Satyanarayana A, Thiyagarajan T M and Uphoff N. 2006. Opportunities for water saving with higher yield from the system of rice intensification. *Irrigation Science* 1 432–519.

Uphoff N. 2005. Possible explanations for the productivity gains achieved with the System of Rice Intensification (SRI). (*In)* Transitions in Agriculture for enhancing water productivity. *Proceedings of International Symposium,* held at Killikulam, Tamil Nadu, 23-25 September 2005.

Umamaheswari P, Krishna Murthy S K, Adinarayana G, Balaguravaiah D. and T Yellamanda Reddy. 2006. Influence of inorganic and organic sources of nutrition and crop rotation on yield of groundnut and castor. *Legume Research* **29** (1): 32–7.