Journal of Applied and Natural Science 9 (1): 286 – 290 (2017)

JANS

Productivity, water use efficiency and economics of system of rice intensification (SRI) in Nichabanadhi sub basin of southern Tamil Nadu

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Received: February 28, 2016; Revised received: November 26, 2016; Accepted: January 26, 2017

Abstract: Four hundred and sixteen on-farm demonstrations on system of rice intensification (SRI) were carried out in 350 hectares of farmer's fields in Sankarankovil, Vasudevanallur and Kuruvikulam blocks of Tirunelveli district of Tamil Nadu from 2008-09 to 2010-11 under Tamil Nadu – Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN-IAMWARM) project. Two methods viz., SRI and conventional were compared. The results revealed that the adoption of SRI favorable influenced yield attributes and yield of rice. The maximum grain yield (8222 kg ha^{-1}) obtained from SRI which was higher than conventional method (6534 kg ha^{-1}). Higher grain yield coupled with substantial water saving to the tune of 37.1 per cent resulted in higher water use efficiency of rice under SRI method. The best net income (Rs. 50, 587) and benefit: cost ratio (3.64) were also associated with SRI than conventional method of rice cultivation. The cost of cultivation was comparatively lesser in SRI which resulted in gaining an additional income of Rs. 8080 ha^{-1} as compared to conventional method of rice cultivation. The system of rice intensification (SRI) proved its benefits in this basin.

Keywords: Conventional method, Economics, Grain yield, SRI, Water use efficiency, Yield attributes

INTRODUCTION

Rice is the most important stable food crop in the world and is grown under abroad rage of environmental conditions. The global production of rice has been estimated to be at the level of 680 million tones and the area of production is estimated as 150 million ha (Fageria, 2014). India is the second largest producer of rice after China. In India, it is cultivated in an area of 43.97 million ha with the production of 106.29 million tonnes with productivity of 2.37 t/ha (DAC-2014). In Tamil Nadu the production is 7.46 million tonnes from the area of 2.01 million hectares with the productivity of 3.9 t/ha (DES, 2014).

The major constraints in rice production are lack of integrated management practices involving land, labour, crop, water and inputs such as seeds, fertilizers, optimum plat population etc. Increasing the rice productivity by the use of appropriate agronomic management practices with proper nutrient management becomes an essential component of rice production technology. Improper planting technique is one of the important factors limiting rice yield. The traditional rice planting system comprises conventional planting with many numbers of seedlings per hill and dumping of nitrogenous fertilizers. Closer spacing is also one of the main constraints in obtaining high yield under conventional method .

Hence, a new method of rice cultivation must be tried aiming at higher crop productivity. System of Rice Intensification (SRI) is a new production technology, now gaining popularity as it is found to increase the productivity and reduce the cost of cultivation. It has its own components viz., transplanting of young seedlings usually 14-16 days as single seedling per hill at wider spacing in a square geometry and use of mechanical weeder, soil test based fertilizer application and optimum use of water for better growth especially soil aeration (Kumar an d Shivay, 2004).

The present water status demands for the scientific management of available water efficiently to achieve the twin objectives of higher productivity and better water use efficiency. The availability of water and labour, escalating input cost leads to unprofitable rice cultivation. SRI is the modern and alternative method of rice cultivation for reduced usage of water and other such as seeds, manures and fertilizers. Nichabanadhi originates in Vasudevanallur reserve forest on the eastern slopes of Western Ghats in Sivagiri Taluk of Tirunelveli District. Ullatrumottai and Pudumalai Kavu are the other two hills on the other side of Kerala State. This sub basin area is 565 sq.km out of which the hilly area is 62 sq.km. There are 18 anicuts, 15 system tanks, and 151 non-system tanks in this sub basin. The command area is 5684 ha. The taluks covered by this sub basin are Sivagiri and Sankarankoil in Tirunelveli district and Sivakasi in Virudhunagar district of Tamil Nadu. The sub basin area is

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fully benefited by the North East Monsoon and marginally by South East Monsoon. The study was under taken to create the awareness of SRI to rice growers of this basin.

MATERIALS AND METHODS

Four hundred and sixteen on-farm demonstrations on system rice intensification (SRI) were carried out in 350 ha of farmer's fields in Sankarankovil, Vasudevanallur and Kuruvikulam blocks of Tiruvelveli distriuct of Tamil Nadu from 2008-09 to 2010-11 under Tamil Nadu – Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN-IAMWARM) project during September to January. The detail of on farm demonstrations in study area is furnished in Table 1. The available soil fertility status of the study area was low in nitrogen, medium in phosphorus and high in potassium. Soil samples were analysed for alkaline permanganate oxidizable N as described by Subbiah and Asija (1956), 0.5 M Na-HCO_3-extractable P (Olsen *et al.,* 1954) and available potassium by flame photometry after extracting 1 N NH_4OAC (Schollenberger and Simon, 1965). The texture of the soil was varied from sandy clay loam to clay. Two methods of rice cultivation *viz.,* SRI and conventional were compared by using the improved varieties *viz.,* ASD 16, TRY 1, ADT 45 and PBT 6420. In SRI, the components *viz.,* low seed rate of 8 kg ha^{-1} raised in 100 m^{-2} mat nursery, transplanting of young seedlings (14 days old) at wider spacing of 25 × 25 cm, irrigating 2.5 cm depth of water after formation of hairline crack in the field, weeding with conoweeder/ rotary weeder at 15,3 and 45 days after transplanting were followed. In conventional method of rice cultivation, use of seed rate of 30 kg ha^{-1} in 800 m^{-2} nursery area, age of seedling 21 – 30 days old, transplanting in closer spacing of 15 × 10 to 20 × 15, irrigation to 5 cm depth one day after disappearance of pond water and manual weeding twice at 25 and 45 days after transplanting were practiced. The total water use was calculated by adding irrigation water applied and effective rainfall. The biometric observation on yield attributes and grain yield were recorded. The water use efficiency and the economic benefits were also analysed.

RESULTS AND DISCUSSION

Yield attributes: The results on yield attributes such as productive tillers and number of grains per panicle of rice in SRI revealed showed a favorable influence on all the yield attributes of rice during the entire study period (Table 2). Adoption of SRI recorded an average of 668 of productive tillers m^{-2} which was 19.71 percent higher than that of conventional method of rice cultivation (558) productive tillers m^{-2} . The number of grains $panicle^{-1}$ was also higher under SRI than farmer's practice of rice cultivation. SRI registered a mean of 234 grains $panicle^{-1}$ while it was only 184 in conventional method. Similar results on higher yield attributes with SRI than conventional method was reported by Senthil Kumar (2002) and Shanhan *et al.* (2008). Agronomic evaluation studies of rice under SRI conducted at Godavari delta region of Andhra Pradesjh indicated higher values of root volume and root weight in all the varieties studied under SRI than conventional method of rice cultivation. This could be the reason for higher yield attributes of rice under SRI (Radha Kumar and Srinivasalu Reddy, 2009). The yield attributes of rice *viz.,* number of productive tillers m^{-2}, panicle length, number of filled grains $panicle^{-1}$ and 1000 grain weight were higher under SRI than conventional method in Karnool district of Andhra Pradesh. This was also observed by Krishnaji *et al.* (2008). Sivagnanam *et al., (*2015) reported that under SRI cultivation taken in Coimbatore, where the total number of panicles and their individual grain sizes, consequently total grain yield of rice were potentially increased.

Grain yield: In the present study the grain yield of rice was substantially increased due to adoption of SRI (Table 2). SRI registered a mean grain yield of 8222 kg ha^{-1} which was 34.5 per cent higher than conventional method of rice cultivation (6534 kg ha^{-1}). Among the period of study, the year 2009-10 recorded higher grain yield than other periods. Veeraputhiran *et al.* (2008) also obtained 23.1 per cent yield improvement in rice under SRI than farmer's practice in Tamirabarani command areas in Tirunelveli district of southern Tamil Nadu. These results on higher grain yield of rice in SRI corroborate with the earlier findings of Makarim *et al*. (2002) and Ganesaraja *et al.* (2008). Rajendran *et al.* (2003) also obtained 48 and 35 per cent higher yield of rice under SRI than traditional method of rice cultivation at TRRI, Aduthurai, Tamil Nadu and SWMRI, Thanjavur, Tamil Nadu respectively. Similarly Bommaisamy (2005) reported that planting with 14 days old seedlings at 20 × 20 cm spacing with single seedling was a viable establishment technique for SRI method of rice cultivation which recorded 7.2 per cent higher yield than 21 days old seedling used in conventional method.

Water use efficiency: During the present study water use studies in both methods of rice cultivation clearly indicated the beneficial effect of SRI in terms of water saving and higher water use efficiency (WUE) (Table 2). The total water use of rice including effective rainfall was drastically reduced (939 mm) due to intermittent and alternate wetting and drying type of irrigation under SRI, which was lesser than that of traditional practice (1287 mm). Thus, there was a substantial quantity of water saving by 37.1 percent over the three years of study was evident due to adoption of SRI. The higher grain yield coupled with enormous water saving under SRI method resulted in higher WUE of rice in the study area. The mean WUE

Table 1. Details of field demonstrations of SRI in the study area.

Sl. No.	Particulars	2008-09			2009-10			2010-11			Total		
1.	Area of demonstration (ha)	80			70			200			350		
2.	Number of farmers	108			86			222			416		
3.	Number of villages	9			11			8			28		
4.	Name of the variety used	ASD 16, TRY1, ADT 45			ASD 16, TRY1, ADT 45			ASD 16, ADT 39, ADT 45, BPT 5204			-		
5.	Soil fertility status (No. of samples)	L	M	H	L	M	H	L	M	H	L	M	H
	N	75	33	0	58	22	6	126	69	27	259	124	33
	P	23	68	17	36	44	6	78	106	38	137	218	60
	K	12	44	52	14	34	38	42	62	118	68	140	208

N-Nitrogen, P-Phosphorus, K- Potassium, L-Low, M- Medium, H-High

Table 2. Comparison of SRI and conventional method (CM) on yield attributes, grain yield, water use and economic of rice.

Sl. No	Parameters	2008-09		2009-10		2010-11		Pooled Mean	
		SRI	CM	SRI	CM	SRI	CM	SRI	CM
1.	No. of productive tiller m^{-1}	688	573	693	584	623	518	668	558
2.	No. of grains $panicle^{-1}$	232	183	248	196	222	173	234	184
3.	Yield (kg ha^{-1})	8808	6672	8975	6883	8632	6048	8222	6534
4.	Per cent yield increase	34.5	-	36.3	-	32.7	-	34.5	-
5.	Total water use (mm)	918	1248	943	1318	956	1295	939	1287
6.	Per cent water saving by SRI	35.9	-	39.8	-	35.5	-	37.1	
7.	Water use efficiency (kg ha^{-1} mm^{-1})	9.59	5.34	9.51	5.22	9.03	4.67	9.38	5.08
8.	Cost of cultivation (` ha^{-1})	21,420	24,125	22,345	26,075	21,230	23,960	21,665	24,720
9.	Net income (` ha^{-1})	47,235	30,410	51,135	34,185	53,390	33,805	50,587	32,800
10.	B:C ratio	3.21	2.28	3.78	2.32	3.94	2.71	3.64	2.44

in SRI was 9.38 kg ha^{-1} mm^{-1} and it was only 5.08 kg ha^{-1} mm^{-1} in conventional method. Similar water saving and higher water use efficiency under SRI was also observed by Veeraputhiran *et al.* (2010) in Sivagangai and Madurai district of Tamil Nadu. Raju and Sreenivas (2008) observed 40 per cent water saving along with higher water use efficiency of 6.18 kg ha^{-1} mm^{-1} in rice under SRI in Godavari delta region of Andhra Pradesh

Economic analysis: The economic feasibility of both method of rice cultivation (Table 2) revealed that the cost of cultivation was comparatively lesser in SRI than that of conventional method. The mean cost of cultivation over the study period for SRI and conventional method was ` 21,665 $ha^{-1}$ and ` 24,720 ha^{-1}, respectively. Thus it is evident that adoption of SRI was found to reduce the cost of cultivation ` 3055 ha^{-1}.

In addition, higher gross income, net profit and benefit: cost ratio was also associated with SRI than conventional method of rice cultivation. Averaging the three years of study, SRI registered a total income of ` 72,252 $ha^{-1}$ and net profit of `50,587 ha^{-1} as compared to ` 57, 520 $ha^{-1}$ and ` 32,800 ha^{-1}, respectively under conventional method. Regarding benefit: cost ratio (BC ratio), higher BC ratio was also associated with SRI (3.64) than conventional method (2.44). Lesser cost of cultivation coupled with higher gross and net income under SRI resulted additional economic benefit. Adoption of SRI gained an additional net profit of ` 17,787 ha^{-1} as compared to traditional method of rice cultivation. The present findings of the results are conformity with the findings of Shekhar *et al.,* (2009) in north western region of Himalayas and Singh *et al.,* (2012). The economic superiority of SRI as compared to conventional method of rice cultivation was also documented by Veeraputhiran *et al.,* (2010) in Tamirabarani command areas of southern Tamil Nadu.. The result of the field experiments at Bhadra command area of Bangalore showed that monetary benefit in terms of net return and benefit cost ratio were significantly superior than conventional method (Hugar *et al.,* 2009). Similar results were also obtained in rice by Singh and Batta, (2008).

Conclusion

The results of the present investigation revealed that the system of rice intensification (SRI) increased the yield of rice (8222 kg ha^{-1}), increased the water use efficiency (9.38 kg ha^{-1} mm^{-1}) and better economic benefit (` 50, 587) respectively during three years of study in Sankarankovil, Vasudevanallur and Kuruvikulam blocks of Tirunelveli district of Tamil Nadu. It was concluded that the System of Rice Intensification (SRI) method is effective to maximize the production of rice (8222 kg ha^{-1}), increase the water use efficiency (9.38 kg ha^{-1} mm^{-1}), sustaining the soil health and to bring better economic benefit (` 50, 587) of living of the farming community of the Nichabanadhi sub basin.

ACKNOWLEDGEMENTS

The authors are thank full to the World Bank aided Tamil Nadu- – Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN-IAMWARM) project for giving opportunity to work in this project and acknowledge the same.

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