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Influence of System of Rice Intensification on Yield, Water Use and Economics Through Farmers' Participatory Approach

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Eight hundred and thirty two on-farm demonstrations on System of Rice Intensification (SRI) were carried out in six hundred hectares of farmers fields in Sivagangai and Madurai districts of Tamil Nadu from 2007-08 to 2010-11 under Tamil Nadu-Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN – IAMWARM) Project. Two methods of rice cultivation viz., SRI and Conventional were compared. The results of large scale on - farm demonstrations revealed that adoption of SRI favorably influenced all the yield attributes of rice viz. number of tillers m^{-2} and numbers of grains $panicle^{-1}$. Superiority of SRI in terms of grain yield was also evident due to 24.0 per cent yield increment than conventional method of rice cultivation. Higher grain yield coupled with substantial water saving to the tune of 24.3 per cent resulted in higher Water Use Efficiency of rice under SRI method. Higher gross income, net income and benefit cost ratio were also associated with SRI than - conventional method of rice cultivation. The cost of cultivation was comparatively lesser in SRI which resulted in an additional net profit of Rs.13,340 ha^{-1} as compared to conventional method of rice cultivation.

Key words : SRI, yield attributes, grain yield, water use effiiency, economics.

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Rice is the most water consuming food crop of India and Tamil Nadu. In Tamil Nadu rice crop alone consumes about 80 per cent of the total water available in the state. 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. At present, non- availability of labour, escalating input cost coupled with water shortage leads to poor economic benefits in rice cultivation. System of Rice Intensification (SRI) is a modern and alternative method of rice cultivation for reduced usage of water and other inputs. The concept of SRI includes transplanting young seedlings, carefully, singly and widely spaced with soil kept well aerated. Large scale demonstrations of modern technologies like SRI in farmers field through farmers participatory approach will have great potential to improve the rice productivity and thus increase the standard of living of farming community. The Manimuthar sub basin is one of the sub basins in Tamil Nadu with a drainage area of 16751 ha. This basin comprises of four minor-basins viz., Manimuthar, Virisuliyar, Thirumanimuthar and Palar and it spreads over six taluks in three districts of the state namely Madurai, Sivagangai and Ramanathapuram. The major focus of this study in the basin is to promote water saving

technologies, enhance crop and water productivity and increase the cropped area by diversification. Therefore an attempt was made to study the performance of SRI in comparison with the conventional method of rice cultivation in the Manimuthar sub basin area.

Materials and Methods

Eight hundred and thirty two on - farm demonstrations on SRI were carried out in six hundred hectares of farmers fields in forty six villages in Sivagangai and Madurai districts of Tamil Nadu from 2007-08 to 2010-11 under Tamil Nadu-Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN – IAMWARM) Project. The details of field demonstrations in the study area are furnished in Table 1. The available soil fertility status of the study area was low in nitrogen, high in phosphorus and potash and mainly sandy clay loam in nature. Two methods of rice cultivation viz., SRI and Conventional planting were compared by using the varieties ADT 36, ADT 39, ADT 45, ASD 16 and BPT 5204. In SRI, the concepts viz., lesser seed rate of 7.5 kg ha^{-1} raised in 100 m^{-}

^{2} mat nursery, square transplanting of 14 days old single seedlings at 25 x 25 cm spacing were followed. Irrigation water was applied at 2.5 cm depth after hair line crack formation upto panicle initiation and thereafter one day after disappearance

of 5.0 cm ponded water and weeding using rotary or cono weeder at 10, 20, 30 and 40 days after transplanting (DAT) was practiced under SRI. In conventional method of rice cultivation, a seed rate of 30-60 kg ha^{-1} in 800 m^{-2} nursery area, transplanting 3-6 seedlings at 21-30 days age in a spacing of 15 x 10 to 20 x 10 cm, irrigation to 5 cm depth one day after disappearance of ponded water and manual weeding twice at 15 and 30 DAT 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. Water use and economics were also worked out.

Results and Discussion

Yield attributes

The results on yield attributes (Table 1) revealed that SRI showed a favorable influence on all the yield attributes of rice during all the years of study. Adoption of SRI recorded an average of 611 tillers m^{-2} which was 16.8 per cent higher than that of conventional method of rice cultivation (523). Higher number of grains $panicle^{-1}$ was also associated with SRI than farmer's practice of rice cultivation. SRI registered a mean of 213 grains $panicle^{-1}$ while it was only 180 in conventional method. Similar results of higher yield attributes with SRI than conventional method was reported by Senthil Kumar (2002) and Veeraputhiran *et al.* (2010). Agronomic evaluation studies of SRI conducted at Godavari delta regions indicated higher values of root weight and root volume in all the varieties studied under SRI than conventional method of rice cultivation (Raju and Sreenivas, 2008). In the present study also higher root volume and root weight under SRI might have absorbed more nutrients and water which inturn improved the production of more tillers and filled grains. This could be the reason for higher yield attributes under SRI. The yield attributes of rice viz., number of productive tillers m^{-2} , panicle length, number of filled grains per panicle and 1000 grain weight were higher under SRI than conventional method in Kurnool of Andra Pradesh which was observed by Krishnaji *et al.* (2008).

Grain yield

The grain yield of rice was substantially increased during all the period of experimentation due to adoption of SRI (Table.2). SRI registered a mean grain yield of 5633 kg ha^{-1} which was 24.0 per cent higher than conventional method of rice cultivation (4542 kg ha^{-1}). Veeraputhiran *et al.* (2008) also obtained 23.1 percent yield improvement under SRI than farmers practice in Tamirabarani Command areas in Thirunelveli district of Southern Tamil Nadu. Higher yield attributes like number of productive tillers m^{-2}, and number of grains $panicle^{-1}$ could be attributed for the production of higher grain yield of SRI. These results of higher grain yield with SRI was in line with findings of Makarim *et al* (2002) and Ganesharaja *et al* (2008). Rajendran *et al* (2003) also registered 48 and 35 per cent higher yield under SRI than traditional method of rice cultivation at Tamil Nadu Rice Research Institute, Aduthurai and Soil and Water Management Research Institute, Thanjavur respectively. Similarly, Bommaiasamy (2005) reported that planting 14 days old seedlings at 20 x 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 seedlings. In Godavari Delta Regions of Andra Pradesh, intermittent flooding in SRI registered grain yield of 6.34 t ha^{-1} while continuous flooding recorded lower grain yield of 5.63 t ha^{-1} (Raju and Sreenivas, 2008).

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

Particulars		2007-08	2008-09	2009-10	2010-11	Total
Area of demonstrations (ha)		42	175	83	300	600
Number of farmers		100	211	120	401	832
Number of villages		6	8	9	23	46
Varieties used		ADT 36 and ADT 39	ADT 36, ADT 39 and ADT 45	ADT 39 and ADT 45	ADT 39 , ADT 43, ADT 45, ASD 16, BPT 5204	-
.Soil fertility status		L M H	L M H	L M H	-NA-	L M H
(No. of samples)	N	95 -5- 0	206- 5- 0	120 - -		421 - 10 -
	P	10-8-82	14- 26-171	0 - 0-120	-NA-	24 - 34-373
	K	6- 9 -85	10- 61-130	13 -89 -18	-NA-	29 – 159-233

N - Nitrogen, P - Phosphorus, K- Potash, L- Low, M- Medium, H- High, NA – Not available

Water use studies

The water use studies of both the rice cultivation methods (Table.2) clearly indicated the beneficial effect of SRI in terms of water saving and higher Water Use Efficiency (WUE). The total water use of rice including effective rainfall was drastically reduced (1055 mm) due to intermittent and alternate wetting and drying type of irrigation under SRI which was lesser than that of farmers practice (1370 mm).Thus, a substantial quantity of water saving by 24.3 per cent over the four years of study was evident due to the adoption of SRI. The higher grain yield

Table 2. Comparison of SRI and Conventional method on grain yield, water use and economics of rice

Particulars	2007-08		2008-09		2009-10		2010-11		Pooled Mean	
	SRI	Conv.	SRI	Conv.	SRI	Conv.	SRI	Conv.	SRI	Conv.
No. of tillers m^{-2}	617	534	668	556	595	503	562	498	611	523
No.of grains panicle $^{-1}$	215	184	221	191	211	179	206	167	213	180
Yield (kg ha^{-1})	5437	3992	5877	4663	5141	4331	6080	5182	5633	4542
Percent yield increase	36.2	-	27.7	-	19.2	-	17.6	-	24.0	-
Total water use (mm)	1042	1326	1195	1481	945	1272	1036	1400	1055	1370
Percent water saving by SRI	21.4	-	24.0	-	25.6	-	26.0	-	24.3	-
Water use efficiency (kg $ha^{-1}mm^{-1}$)	5.22	3.01	4.87	3.05	5.44	3.40	5.81	3.72	5.33	3.29
Cost of cultivation (Rs ha^{-1})	19105	21569	20203	22367	21784	25067	22989	25543	21010	23636
Gross income (Rs ha^{-1})	48935	35930	58765	46644	56555	47651	63270	54407	56881	46158
Net income (Rs ha^{-1})	29830	14359	38562	24277	34771	22584	40280	28863	35861	22521
Additional net income by SRI (Rs ha^{-1})	15471	-	14285	-	12,187	-	11417	-	13340	-
Benefit - Cost ratio	2.56	1.67	2.91	2.11	2.58	1.90	2.74	2.13	2.69	1.95

coupled with enormous water saving under SRI method resulted in higher WUE of rice in the study area. The mean WUE of SRI was 5.33 kg ha mm^{-1} and it was only 3.29 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.* (2008) in Thirunelveli District of Southern Tamil Nadu. Similarly SRI required three and six irrigations lesser than normal transplanted rice during summer and *kuruvai* seasons respectively which was documented by Geethalakshmi *et al* (2009). Raju and Sreenivas (2008) also observed 40 per cent lesser water requirement (1025 mm) along with higher WUE of 6.18 kg ha mm^{-1} in intermittent flooding in SRI as against 1482 mm with WUE of 3.79 kg ha mm^{-1} under continuous flooding.

Economic analysis

The economic feasibility of both the 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 Rs. 21,020 ha $^{-1}$ and Rs. 23,637 ha^{-1} respectively. Adoption of SRI was found to reduce the cost of cultivation by Rs.2517 ha^{-1}. In addition, higher gross income, net income and benefit cost ratio were also associated with SRI than conventional method of rice cultivation. Averaging the four years of study, SRI registered a total income of Rs.56,881 $ha^{-1}$and net income of Rs.35, 861 ha^{-1} as compared to Rs.46,158 ha^{-1} and Rs. 22,521 ha^{-}

^{1}respectively under conventional method. Regarding Benefit-Cost ratio (BC ratio), higher BC ratio was also associated with SRI (2.69) than conventional method (1.95). Lesser cost of cultivation coupled with higher gross and net income under SRI resulted in additional economic benefit over farmers practice. Adoption of SRI gained an additional net profit of Rs.13,340 ha^{-1} as compared to conventional method of rice cultivation. The economic superiority of SRI as compared to farmers practice of rice cultivation was also documented by Veeraputhiran *et al.* (2008). The results of the field experiments at Bhadra Command areas of Banglore showed that monetary benefits in terms of net return and benefit cost ratio were superior in SRI than conventional transplanting method (Hugar *et al.,* 2009) . In the field study at Patna the highest net returns of Rs.34,706 ha^{-1} was obtained under SRI whereas the lowest returns (Rs.13,726 ha^{-1}) was recorded under farmers' method (Singh and Batta, 2008).

Thus the results of the On- farm demonstrations clearly indicated that adoption of SRI lead to 24.0 per cent higher yield, substantial water saving (24.3 per cent), higher water use efficiency and better economic benefits which will pave way for sustainable rice production and higher standard of living of the farming community of the Manimuthar sub basin study area.

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