

## Enhancing Rice (*Oryza sativa*) Productivity through Demonstrations of SRI Method of Cultivation in Mid-Altitude Region of Indo-Himalayan Belt of Sikkim

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### ABSTRACT

*Sixty front-line demonstrations (FLDs) on System of Rice Intensification (SRI) method of rice cultivation conducted by KVK, East Sikkim at farmer's field of different villages in East Sikkim district over the last three kharif seasons starting from 2009-10 to 2011-12 showed an increasing trend in yield performance accounting for 25.44 per cent more yield over Traditional Random Planting (TRP) method. Maximum pooled grain yield of rice was recorded in case of System of Rice Intensification (21.45 q ha<sup>-1</sup>) as compared to Traditional Random Planting (17.10 q ha<sup>-1</sup>). In case of SRI, the growth parameters like plant height (145.67 cm), effective tillers/hill (12 nos), panicle length (23 cm), No. of grains/panicle (120.33nos) and test weight (20.67 g) were found to be more as compared to TRP method. Comparative economics of SRI and TRP method of rice cultivation revealed that SRI method realized 61.23 per cent higher net return than TRP method of rice cultivation. The B:C ratio of 1.70 in case of SRI over and above the TRP (1.40) proved the efficacy of SRI in terms of productivity. Results further revealed that the grain yield in both cases was positively and significantly correlated with growth and yield parameters of rice viz., plant height(cm), effective tillers/hill, panicle length (cm), No. of grains/panicle, test weight(g) both under SRI and TRP methods. Hence, the higher positive relationship between the grain yield and growth parameters influenced the increasing pattern of grain yield which leads to larger adoption of SRI method of rice cultivation over TRP.*

**Key words:** *System of Rice Intensification (SRI); Traditional Random Planting (TRP); Growth parameters;*

Rice is the major staple food crop in North Eastern Region of India covering 3.51 million hectares that accounts for more than 80% of the total cultivated area in the and 7.8 per cent of the total rice area country. The total rice production of NE region is estimated to be around 5.50 million tonnes and it's share in national rice production is barely 5.9 per cent. The region has a deficit of 1.40 million tonnes of rice, mainly due to its low productivity (1.72 t ha<sup>-1</sup>) which is much below the national average of 2.08 t ha<sup>-1</sup> (Anonymous, 2000). Though the advent of green revolution has brought a spectacular improvement in rice production in our country due to adoption of high-yielding varieties (HYVs), utilization of irrigation facilities, application of fertilizer, plant protection measures and use of improved farm implements etc., but the essence of it has not been

actually realized in North Eastern states. Among the eight North -Eastern states of the country, Sikkim is a tiny hill state, strategically located at the foothills of the North-Eastern Himalayan range between 27°00'46'' to 28°07'48'' north latitude and 88°00'58'' to 88°52'25'' east longitude with an altitude ranging from 300 m in South to more than 8000 m in North and climate varies from subtropical to alpine. It is a high rainfall region (2000 - 5000 mm annum<sup>-1</sup>) with cool, cloudy weather and high humidity (>70 %) in most of the days.

Rice is the staple food grain in Sikkim next to maize grown exclusively during kharif season. Among the four districts of Sikkim, East Sikkim district accounts for the largest area coverage of more than 5,500 hectares under rice out of total rice area of 14150 hectares in Sikkim. The rice productivity of East Sikkim district is at a very

dismal figure of 1.55 t ha<sup>-1</sup>. East Sikkim district alone shares around 26.3% of total food grain production of the state (109.11 tonnes) against the state food grain requirement of about 216.34 tonnes with a deficit of 107.23 tonnes (Anonymous 2006-07). In order to meet the future food demands for the teeming population of the state, it is vital to give much emphasis on enhancing rainfed rice productivity through water use efficiency (WUE). Most of the farmers now-a-days are hesitant to take up rice cultivation as its total factor of productivity is declining (*Das et al., 2009*) and its profitability is in question with the rise in input costs. Hence new innovations and initiatives are required to make rice production system more sustainable and economically profitable. Under these circumstances, System of Rice Intensification (SRI) appears to be a viable alternative for rice cultivation that saves expensive inputs, water, improves soil health and ensures environmental sustainability (*Kumar and Shivay 2004, Satyanarayana et al. 2006, Balasubramanian et al. 2007, Sinha and Talati, 2007*). Keeping view upon this, Krishi Vigyan Kendra, ICAR Sikkim Centre, East Sikkim, Ranipool has taken up front line demonstrations to introduce and popularize System of Rice Intensification (SRI) over Traditional Random Planting (TRP) method of rice cultivation. The yield performance of rice and its relationship with growth and yield attributes under SRI and TRP method of cultivation were studied at farmers' fields' in East Sikkim district of Sikkim. The specific objectives of the study were

- i. To assess the comparative yield performance of rice through water use efficiency based SRI method over TRP method in mid altitude of Indo-Himalayan region of Sikkim.
- ii. To analyze the performance of SRI technology over farmers' TRP method of rice cultivation in terms of profitability in East Sikkim district of Sikkim.
- iii. To correlate between grain yield and yield attributes as influenced by SRI and TRP method of rice cultivation in East Sikkim district of Sikkim.

## METHODOLOGY

As an initiative for promotion of System of Rice Intensification (SRI) over Traditional Random Planting (TRP) method of rice cultivation in farmers' field, the Krishi Vigyan Kendra, ICAR Sikkim Centre, Ranipool,

East Sikkim conducted more than 60 front line demonstrations on SRI method (local cv. Thulo Attey) in comparison with farmers' practice *i.e.* TRP method continuously for three years during *kharif* 2009-10, 2010-11 and 2011-12 at farmer's field in different villages in East Sikkim district of Sikkim. The intervention was undertaken to assess the productivity performance, extent of profitability and relationship of grain yield with growth and yield attributes as influenced by system of rice intensification (SRI) and traditional random planting (TRP). Beneficiary selection for FLDs on SRI was made through discussion and personal contact with farmers on the basis of certain socio-personal characteristics like SES, innovativeness, progressiveness and risk orientation. In case of SRI method, nursery bed was prepared in 100 m<sup>2</sup> area in raised bed by using 6 kg of good quality seeds for transplanting in one hectare area, whereas for TRP method nursery was prepared in 1000 m<sup>2</sup> area with 60 kg seeds in wet methods for transplanting in one hectare area. Transplanting for SRI was done with 10-12 days old seedlings @ 1 seedling per hill at 25 cm x 25 cm spacing and under TRP method; more than 21 days old seedlings @ 3-4 seedlings/hill was transplanted in random zigzag way. In both the cases, nutrient management was done by applying organic manures @ 5 t/ha in main field 10 days ahead of transplanting of rice followed by application of biofertilizers. Soil water management practices were followed through alternate wet and dry under SRI method to maintain soil moisture whereas continuous flooding was maintained under TRP method of rice cultivation. In SRI weed management was done by running cono-weeder between the lines that in turn increase the soil fertility whereas under TRP method of rice cultivation, weeds were manually removed from the rice field. Local cultivar of rice "Thulo Attey" was used as test variety in all three years as the objective of FLD was to demonstrate the advantage of SRI method of rice cultivation over the conventional method of rice transplanting. Data on various yield attributes and yield for both SRI and TRP method of rice cultivation were recorded during the three years (2009-10 to 2011-12) and pooled. Statistical tools were used for data analysis and correlation analysis was done between selected parameters of both SRI and TRP methods of rice cultivation (*Gomez and Gomez, 1984*). A total of sixty

**Table 1. Comparative performance of rice under SRI and TRP methods of cultivation at farmers' field of East Sikkim district, Sikkim**

Parameters	System of Rice Intensification (SRI)				Traditional Random Planting (TRP)				t- test value
	2009-10	2010-11	2011-12	Pooled	2009-10	2010-11	2011-12	Pooled	
Plant height (cm)	151	145	141	145.67	135	134	134	134.33	4.35*
Effective tillers/ hill	12	11	13	12	8	8	9	8.33	11.0**
Panicle length (cm)	24	22	23	23	19	20	21	20	3.67
Grains per panicle	125	121	115	120.33	98	98	109	101.67	3.98
Test weight (g)	21	21	20	20.67	20	21	20	20.33	1
Yield (q ha <sup>-1</sup> )	23.45	20.80	20.01	21.45	17	17.1	17.2	17.1	4.45*
% increase in yield <sup>x</sup>	37.94	21.64	16.24	25.44	-	-	-	-	
Crop duration (days)	114	116	115	115	125	135	130	130	
Days saved for 2 <sup>nd</sup> crop <sup>x</sup>	11	19	15	15	-	-	-	-	
No. of demonstrations	10	18	32	50	10	18	32	50	
Area expansion (ha) (SRI over TRP)	0.50	1.0	2.0	3.50	-	-	-	-	

\* Significant at P=0.05 level of probability and \*\* significant at P=0.05 and P=0.01 level of probability; X=SRI over TRP

(60) front-line demonstrations were carried out in three years i.e. 10 nos. during 2009-10, 18 nos. during 2010-11 and 32 nos. during 2011-12 in both SRI versus TRP method of rice cultivation.

## RESULTS AND DISCUSSION

*Yield attributes and productivity performance of SRI over TRP* : The observations in respect of yield attributes of rice were found to be the highest in SRI as compared to TRP method of rice cultivation. The three years pooled data in both the cases revealed that in case of SRI method the yield attributes like plant height (145.67 cm), effective tillers/hill (12 nos.), panicle length (23 cm), No. of grains/panicle(120.33 nos.) and test weight (20.67) were significantly higher as compared to TRP methods (Table 1). Maximum grain yield of rice was recorded in System of Rice Intensification with 23.45, 20.80 and 20.01 q/ha starting from 2009-10 to 2011-12 over the yield rate of 17, 17.11 and 17.2 q ha<sup>-1</sup> in case of TRP method respectively. The pooled yield of SRI (21.45 q ha<sup>-1</sup>) was significantly higher at 5 percent level of significance as compared to Traditional Random Planting (17.10 q ha<sup>-1</sup>) which was 25.44 per cent lower than that of SRI. The increased in productivity might be due to higher yield attribute in SRI over TRP method of rice cultivation and better yield attributes justifies the lead of SRI over TRP method of rice cultivation.

Results further revealed that due to adoption of

SRI technology the crop duration for the same variety was reduced by at least 15 days as compared to TRP method of rice cultivation which might help the farmers to go for second crop after rice in 15 days advance in comparison to TRP (Table 1). The reduced duration and yield enhancement of crop in case of SRI might also help the farmers to expand their area of rice cultivation from zero to 3.5 ha during the three years of SRI technology interventions by KVK. The statistical analysis of yield attributes and yield of rice under SRI and TRP practice with t-test (Table 1) signified that the comparative performance between the parameters of both the practices were significant in plant height and grain yield at 5 per cent level of significance. However, the important yield attribute like effective tillers per hill was found to be highly significant at both 5 and 1 per cent level of significance. However, the important yield attribute like effective tillers per hill was found to be highly significant at both 5 and 1 per cent level of significance. On the other hand, the yield parameters like panicle length (cm), grains per panicle and test weight (g) were not statistically significant but recorded high numbers in SRI than TRP practices.

*Economic performance of SRI over TRP* : The front line demonstrations conducted in East Sikkim district of Sikkim showed that the estimated input cost of rice under SRI was ten times lower than TRP method of rice cultivation as per the figures in Table 2 presents the

**Table 3. Correlation coefficient between yield attributes and grain yield as influenced by SRI and TRP method of rice cultivation in East Sikkim district, Sikkim**

Parameters		Plant height (cm)	Effective tillers /hill	Panicle length (cm)	Grains/panicle	Test weight (g)	Grain Yield (t/ha)
Plant height (cm)	SRI	1	0.492*	0.596*	0.489*	0.651*	0.392*
	TRP	1	0.073	0.552*	0.057	0.649*	0.106
Effective tillers/hill	SRI		1	0.313	0.746*	0.378	0.670*
	TRP		1	0.270	0.674*	0.242	0.266
Panicle length (cm)	SRI			1	0.483*	0.516*	0.482*
	TRP			1	0.320	0.359	0.368
Grains/panicle	SRI				1	0.487*	0.511*
	TRP				1	0.029	0.304
Test weight (g)	SRI					1	0.420
	TRP					1	0.115

\*Significant at P=0.05 level of probability (2-tailed),

**Table 2. Economic evaluation of rice cultivation under SRI over TRP method at farmers' field of East Sikkim district, Sikkim (Rs/ha)**

Particulars	SRI	TRP
Seed (Rs.)	180	1800
Organic manures (Rs.)	6486	4100
Labour (human and animal) (Rs.)	7750	7450
Organic plant prot. chemicals (Rs.)	250	155
Interest on working capital @ 10 % (Rs.)	489	450
Total cost (Rs.)	15155	13955
Average Productivity (q/ha)	21.45	17.1
Gross returns (Rs.)	25740	20520
Net returns (Rs.)	10585	6565
Per cent profit of SRI over TRP	61.23	-
Benefit : Cost ratio (B:C)	1.70	1.47

comparative economics of SRI over TRP method of rice cultivation. Although having similar cost of production, SRI realized 61.23 per cent higher net return over TRP method of rice cultivation. The benefit: cost ratio of 1.70 was also much higher than the TRP (1.47). The lower net return of Rs. 6565 and low benefit : cost of 1.40, indicated non-profitability of rice cultivation under TRP method in East Sikkim. The study concludes that SRI is a highly remunerative crop production method in rice as compared to TRP method in the KVK district, in particular and in the state of Sikkim, in general. The adoption of SRI technology thus, would improve farmers' profit and eventually contribute towards sustainable livelihood security and healthy environment. In spite of several constraints of SRI like planting of young, single

seedlings, labour scarcity for cono-weeding, poor land terrain (slope) causing water logging and drainage problem etc. farmers relaxed with the adoption of this practice through realizing additional yield over TRP, leading to better net return from rice cultivation.

*Correlation between growth and yield attributes and grain yield as influenced by SRI and TRP method of rice cultivation:* The correlation analysis of growth and yield attributes of rice with its grain yield under System of Rice Intensification (SRI) and Traditional Random Planting (TRP) were worked out as depicted in Table 3. Results revealed that the grain yield was positively and significantly correlated with growth and yield parameters of rice viz., plant height(cm), effective tillers/hill, panicle length (cm), grains/panicle, test weight (g) both under SRI and TRP methods (Table 3). The higher positive relationship between the grain yield and crop growth parameters influenced the increasing pattern of grain yield which leads to higher adoption of SRI method of rice cultivation over TRP by the farmers of East Sikkim district. The positive correlation between yield attributes indicated the influence of number of panicle bearing tillers/hill, number of filled grains/panicle by rice in increasing the grain yield which was supported by the studies conducted in the same line by *Saha et al.,(2003), Mukharjee (2006), Singh et al.,(2008)* and *Sampath et al.,(1989)*.

**CONCLUSION**

The study concluded that SRI is a highly resource ful crop production method as compared to TRP method of rice cultivation followed in the East Sikkim district

that projected maximum yield to the tune of 21.45 q ha<sup>-1</sup> in case of SRI accounting for 25.44 per cent higher yield over TRP. The positive correlation between yield attributes indicated the influence of number of panicle bearing tillers/hill, number of filled grains/panicle of rice in increasing the grain yield. Hence, the higher positive relationship between the grain yield and crop growth parameters resulted in increase in grain yield which leads to higher preference of farmers for adoption of SRI method of rice cultivation over TRP. Major constraints in the adoption of SRI practices were found to be lack of timely and skilled manpower for planting operations, poor water control in the fields and unsuitable

soils beside the transaction (managerial) cost though it seems to be insignificant is also constraining the full adoption of SRI due to difficulties in mobilizing the resources for SRI. However, this successful demonstration and remarkable performance of SRI over the conventional TRP method of rice cultivation gained a momentum in up-scaling the rice productivity which created an impact in the state government to launch SRI Mission all over the state to bring sustainable food and livelihood security in the mid altitude of Indo-Himalayan region.

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