Potential Water Saving through System of Rice Intensification (SRI) in *Terai* Region of West Bengal, India

Biplab Mitra[1*], Saikat Mookherjee[1], Sujan Biswas[1] and Prabir Mukhopadhyay[2]

[1]Cooch Behar Krishi Vigyan Kendra, [2]Directorate of Extension Education, Uttar Banga Krishi Viswavidyalaya Pundibari, Coochbehar, West Bengal (736 165), India

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Correspondence to

**E-mail*: bipmitra@yahoo.com

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Abstract

On farm demonstrations were conducted during three consecutive years (Summer, 2009, 2010 and 2011) in farmer's field of four adopted villages of Cooch Behar Krishi Vigyan Kendra to assess the potential water saving in *boro* rice through SRI. A total of 40 demonstrations were conducted covering an area of 85.6 ha. In each year, 12-15 innovative and receptive farmers were selected from the villages for conducting the trials ensuring their active participation. Experimental results indicated the superiority of SRI (72.64 q ha^{-1}) over conventional method (54 q ha^{-1}) in *boro* season. The yield increment in SRI was recorded to be 34.51% over the conventional method. The water application was significantly higher in conventional method (15200 m^3) as compared to SRI method (12100 m^3) as measured through water meter. Water productivity indicated the lower values in conventional system (0.36 kg grain m^{-3}) as compared to SRI (0.60 kg grain m^{-3}) signifying higher grain yield with application of lesser irrigation water under SRI. The SRI method also registered higher net income (₹ 41204 ha^{-1}) and benefit-cost ratio (2.11) against the conventional practice of rice cultivation. Moreover, there was a saving of 20.39% irrigation water besides achieving higher grain yield.

1. Introduction

Rice being the staple food crop holds the key for food security of India. In *terai* region of West Bengal, the crop is grown in about 0.41 mha during *kharif* season and 0.06 mha during *boro* season. Though rice farming accounts for a significant sown area, the productivity still remains low (1615 in *kharif* rice and 2223 kg ha^{-1} in *boro* rice). Recent estimates indicated that there will be acute shortage of water in coming years and area under rice is expected to be reduced in next 25 years due to water shortage and rapid urbanization. Globally the per capita availability has decreased from 19,000 m^3 in 1950 to 6,800 m^3 in 2000. This is estimated to decline further to 5,400 m^3 by 2025 (Nayar and Ravichandran, 2012).The agricultural sector is the major consumer of water, to the extent of 70% of all water withdrawals with rice as the most important food crop (IWMI, 2010). The conventional flooding technique in rice cultivation is very high water consuming and is being under threat due to increasing scarcity of fresh water. The concept of aerobic rice offers an opportunity to produce more rice with less water and in this perspective SRI has a tremendous role. High yield performances in rice varieties under aerobic condition is attributed to higher water use efficiency (Neelima and Ashok Kumar, 2011; Pasha et al., 2013). SRI is a potential technology in rice cultivation considering the looming water crisis and it represents an integrated and ecologically sound approach in irrigated rice cultivation. Considering the huge exploitation of ground water during cultivation of summer rice, this study was undertaken to assess the potential water saving in summer rice through SRI under sub Himalayan plains of West Bengal.

2. Materials and Methods

The on-farm demonstrations were conducted for three consecutive years (*boro,*2009, 2010 and 2011) in four adopted villages of *Krishi Vigyan Kendra*, viz., Khagribari, Petbhata-Chandanchowra, Dhangdhinguri and Satmile of Cooch Behar district. A total of 40 frontline demonstrations were conducted covering an area of 85.6 ha. The villages with a significant area under *boro* rice were selected for conducting the experiment. Before conducting the trial, the need for conducting them was assessed through agro-ecosystem analysis using Participatory Rural Appraisal (PRA) tools.

In each year, 12-15 innovative and receptive farmers were selected from the villages for conducting the trials ensuring their active participation. The selected farmers were imparted skill-training on 6 specific aspects of SRI, viz., nursery management, early transplanting, wider spacing, weed management with rotary weeder, organic manuring and water management.

The soils of the demonstration blocks were acidic (pH-4.9 to 5.8), sandy loam in nature with low available N (144-207 kg ha^{-1}), medium P (50-73 kg P_2O_5 ha^{-1}) and K (138-224 kg K_2O ha^{-1}).

In the demonstrations, rice hybrid RH-664 was used with recommended fertilizer dose of N-P_2O_5-K_2O @120-60-60 kg ha^{-1} respectively. Nearly 14-16 days old seedlings were transplanted in SRI method; whereas in conventional practice, 30-35 days seedlings were transplanted. The spacing was maintained at 25×25 cm^2 and 20×10 cm^2 in SRI and conventional methods, respectively. Water in SRI plots were managed depending on soil moisture content, once in 3-4 days while it was irrigated regularly or on alternate days under conventional methods to keep the lands under continuous submergence. In SRI plots, weeding was done with the help of weeder at an interval of 10 days starting from 10 days after transplanting. Water applied in each method was measured periodically with water meter installed at source point. At harvest, grain yields were recorded and production economics were calculated based on prevailing price of inputs and labour and market price of rice grain.

For comparing various observations taken on water parameters as well as yield under both SRI and conventional methods, mean values of three year demonstrations were taken into consideration and two independent sample t-tests were performed. Entire analysis was done in statistical Analysis System software (SAS, version: 9.2) using statement proc ttest.

3. Results and Discussion

Experimental results indicated the superiority of yield (72.64 q ha^{-1}) in SRI is 34.51% over conventional method (54.00 q ha^{-1}) in *boro* season. A well developed and healthy root system in SRI plays an important role in uptake and translocation of nutrients from the soil than the conventional system (Uphoff, 2005) and this ultimately results in better tillering, higher biomass and higher yield. Well-managed irrigation system with balanced fertilization triggered the crop to respond better under SRI system. Islam et al. (2013) reported 209% yield increment under SRI with 78% water saving in north-eastern states. Increased yield in SRI compared to conventional method were previously reported by several workers (Thiyagarajan et al., 2005; Satyanarayana et al., 2006).

The water application was significantly higher in conventional method (15200 m^3) due to continuous flooding as compared to SRI method (12100 m^3) where only saturation of soil was maintained (Table 1). That is why the number of irrigation was much less under SRI system (26 nos.) compared to conventional system (37 nos.).

Water productivity, computed based on grain yield divided by total irrigation in cubic meters, indicated the lower values in conventional system (0.36 kg grain m^{-3}) as compared to SRI method (0.60 kg grain m^{-3}) signifying higher grain yield with application of lesser irrigation water. Experimental results indicated the saving of 1149 liters of water for production of 1 kg rice grain in intensified system. In totality, there was water saving to the tune of 20.39% under SRI over conventional method. Mahendar kumar et al. (2011) reported 32% water saving under SRI over conventional method. It was also revealed that SRI registered higher water use efficiency (6.00 kg ha^{-1} mm^{-1}) in comparison to conventional system of irrigation (3.55 kg ha^{-1} mm^{-1}). Higher yield performances with less water requirement attributed to this increased water use efficiency. SRI method saved irrigation water without any penalty on yield compared to conventional method. Uphoff et al. (2002) reported a yield increase of 1.4-2.5 t ha^{-1} in SRI over conventional system. Using intermittent irrigation, Thiyagarajan et al. (2002) reported water saving of 50% over traditional flooding.

Perusal of data (Table 2) revealed that SRI registered higher net income (₹ 41204 ha^{-1}) and benefit-cost ratio (2.11) against the conventional practice of rice cultivation (net income of ₹ 19628 ha^{-1} with benefit-cost ratio 1.51). Though there was a huge cost involvement in manual weeding through cono weeder under SRI, this practice curtailed a significant irrigation cost (Table 2) resulting in a lesser cost of cultivation compared to conventional system. SRI recorded ₹ 21576 ha^{-1} more income over the conventional practice with higher benefit-cost ratio which might be attributed to higher yield performances under SRI.

Table 1: Yield and water parameters under SRI and conventional system

Methods	Yield (q ha^{-1})	No. of irrigation	Water requirement (m^3)	Water productivity (kg grain m^{-3})	WUE (kg ha^{-1} mm^{-1})	Water required for 1 kg grain	% Water saving
Conventional	54.00	37	15200	0.36	3.55	2815	-
SRI	72.64	26	12100	0.60	6.00	1666	20.39
CD (p=0.05)	6.73	-	1413	0.04	0.53	-	-

Table 2: Production economics of rice under SRI and conventional practice

Method	Cost of cultivation (₹ ha^{-1})	Gross income (₹ ha^{-1})	Net income (₹ ha^{-1})	Benefit-cost ratio	Irrigation cost (₹ ha^{-1})	Saving (₹ ha^{-1})
Conventional	38692	58320	19628	1.51	24050	7150
SRI	37247	78451	41204	2.11	16900	-

4. Conclusion

From three years of on-farm demonstrations, it can be concluded that SRI can be recommended in *boro* rice in view of its yield, water and cost advantages over conventional flooding method under *terai* region of West Bengal.

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