Effect of System of Rice Intensification (SRI) on rice yield in Bangladesh, Boro Season, 2005-2006

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Abstract

In an on-going effort of the FoSHoL project of ***ActionAid Bangladesh*** *to evaluate the farmers' perception and effect of system of rice intensification on the yield, 85 farm families of Tala, Satkhira Sadar, Biswamvampur, Noakhali, Ulipur and Koira Upazilla of Satkhira, Sunamganj, Noakhali, Kurigram and Khulna districts conducted the study in their own lands in a participatory action research approach in Boro season 2005-2006. Differences in yield, income and pest & disease incidence were compared between the plots under system of rice intensification (SRI) and farmers' practice (FP).*

From the study, farmers obtained an average ***yield*** *of 6.09 ton/ha from SRI plots that was 36% higher than farmer's practice plots (4.45 ton/ha). The rice yield in SRI plot was found to be significantly different from FP plots at 1% level. On an average,* ***gross margin*** *from SRI plots was Tk. 38,650.29/ha, which was 148% higher than that from FP plots, 15,752.20./ha. (see Table 3.) The* ***benefit-cost ratio*** *calculated was found to be higher for SRI plots (2.3) as compared to FP plots (1.5). Overall* ***costs of production*** *were 12.7% less per hectare with SRI.*

.Number of ***effective tillers*** *per hill was 25.06 and 14.52 in SRI and FP plots, respectively. Average* ***plant height*** *was 94.81 and 87.96 cm in SRI and FP plots, respectively. On average,* ***panicle length*** *of 24.20 cm and 21.29 cm. was obtained from SRI and FP plots, respectively. Average number of* ***spikelets per panicle*** *was 162.89 and 137.35 in SRI plots and FP plots, respectively. Average number of* ***unfilled grains*** *per thousand spikelets was 17.12 and 20.12 in SRI plots and FP plots, respectively. The average* ***weight*** *of thousand grains was 22.41 gm and 19.62 gm in SRI plots and FP plots, respectively (Table 6).*

The report revealed that the SRI plots were found better compared to control plots in cases of all rice varieties and geographical areas. Rice leaves were found to be affected by bacterial blight, bacterial leaf spot, brown spot and narrow brown leaf spot, while the tillers were found to be affected by sheath blight and sheath rot disease. Grain discoloration of seed was also found in both plots. However, SRI plots were affected in lower degree compared to the farmers' plots.

Key words: *SRI, effect, rice, yield, spike, panicle, thousand grain weight.*

Introduction

Bangladesh is an agro-based developing country in South Asia with much highly fertile land. More than 80 percent people of the rural community are involved in agricultural activity to capitalize on land and water resources for their livelihood. Agriculture is the main source of income for around 85 percent of the people involved in the agricultural sector. Rice, the staple food of Bangladeshi people, is the main crop in the sector and covers around ten million hectares of land.

Bangladesh is a small country (144,000 sq. km.) with a population density of more than 700 persons per sq. km. The environment is very favorable for increasing population, so population growth rate is around 4.7 percent per annum. On the other hand, the area for growing rice is gradually reducing due to continuous development of infrastructure, house construction, etc. So, to meet the food requirements of its gradually increasing population, Bangladesh needs to produce more rice from each unit area of land.

To address the food requirements of the gradually increasing population in Bangladesh, agricultural scientists from the Bangladesh Rice Research Institute, the Bangladesh Department of Agricultural Extension, Bangladesh Agricultural University, the Poverty Elimination Through Rice Research Assistance (PETRRA) project, and many other research institutions have developed different improved technologies (high-yielding rice varieties, chemical fertilizer, irrigation facilities, pesticides, weedicides, improved agricultural machinery, improved cultural practices, etc.) in order to enhance rice yield, which on average, 2.50 to 4.50 -5.00 tons/ha.

At present it is observed that rice yields are in stagnant condition, because farmers do not follow fully the improved techniques in an integrated way, which creates a yield gap. In this situation, farmers, researchers and scientists are looking for new methods or technologies to get higher yield of rice.

The System of Rice Intensification (SRI) is a method of rice cultivation to increase rice yield through intensive cultivation practices. The technology was developed in Madagascar with the support of Cornell International Institute for Food, Agriculture and Development (CIIFAD) and resulted in revolutionary yield increases, from on average, 2.2 to 8.8 tons per hectare. This was accomplished by adjusting the management practices of rice cultivation and taking advantage of the full genetic potential of the rice plants to produce more healthy and viable tillers, leading to more grain production.

The main elements of SRI are: to transplant young seedlings, to preserve their potential for tillering and root growth when also benefiting from other favorable growing conditions; to give the plants wide spacing, without competition in hills or between hills; to keep the soil well-aerated and also with sufficient moisture so that the roots can “breathe”; and to provide nutrients that ‘feed the soil’ as a rich and healthy soil gives nutrients to plants and the positive environment needed for best growth and performance.

In 1990, Association Tefy Saina (ATS) was formed as a Malagasy NGO to promote SRI. Four years later, ATS and CIIFAD, supported by the U.S. Agency for International Development, began cooperating to introduce SRI around Ranomafana in eastern Madagascar. It has been tested in China, India, Indonesia, the Philippines, Sri Lanka and Bangladesh and several other countries with positive results.

Scientists are not certain, and many are very skeptical, about how such yields can be obtained on such poor soil as found in Madagascar. Fortunately, SRI methods have been found to produce much-improved yields in other countries as well. Therefore, it may be said that SRI is not a methodology limited to one country.

Much more remains to be studied about and learned from SRI. Scientists are now taking an interest in it and considering SRI not only as a technology to be applied mechanistically, but more as a methodology to be tested and adapted to farmers' conditions. Farmers need to be good observers and good learners to make the best use of the insights that SRI provides.

CARE-Bangladesh and the Department of Agriculture Extension (DAE) introduced SRI practices to farmers for the first time in Bangladesh in 1999 and examined the potentiality of this new practice. Later on, different government and non-government organizations have been conducting experiments with their associated beneficiaries. Finally, under the 'Poverty Elimination Through Rice Research Assistance' (PETRRA) project funded by DFID, experiments were conducted through BRRI, DAE and some other national non-government organization to test SRI validity and to review the effects of SRI based on different agroecological conditions of Bangladesh in 2002-2004 calendar years.

The **FoSHol Project** of ActionAid Bangladesh has been working with poor and marginal farm families to enhance their food security by increasing production and income significantly. This project had already identified the low production level of rice as a major factor governing the food insecurity of rice-farming households. Attempting to increase overall rice production, SRI practices were introduced with selected farm families. To examine the potentials of this new system, project participants were involved in participatory research trials in the districts of Satkhira, Khulna, Noakhali, Sunamganj and Kurigram during the boro season 2005-2006, using different rice varieties. In that season, a total of 85 farm families conducted experiments in the above-mentioned districts with their production closely monitored by ActionAid staff. Three rice varieties – BRRI's Dhan 28, BRRI's Dhan 29, and Sonar Bangla -- were cultivated with SRI and farmers' methods. This report offers the findings from these SRI experiments.

Materials and methods

Experiments were conducted during the boro season of 2005-2006 in Tala and Satkhira Sadar upazilas of Satkhira district; Biswamvampur upazila of Sunamganj district; Noakhali Sadar upazila of Noakhali district; Ulipur and Kurigram Sadar upazilas of Kurigram district; and Koira and Rupsha upazila of Khulna district. A total of 85 replications were conducted in the reported season.

Each participant set up the experiment on the same plot consisting two treatments, viz., rice production following conventional practice (referred to as Farmer's Practice, FP), and rice production following System of Rice Intensification (SRI) methods. Plot sizes varied from 1 decimal to 20 decimal for both of the treatments of different participants, who used one of three rice varieties (Dhan 28, Dhan 29, and Sonar Bangla, a Chinese variety).

Transplantation was made on the same day with different aged-seedlings. The experiment was set up considering the factors shown in Table 1. Entire amount of organic matter (cow dung/compost), TSP, gypsum and zinc were applied during the final land preparation. Urea was applied in three split doses: one during early tillering stage (20 DAT), second in mid-tillering stage (35 DAT), and third one just before panicle initiation.

Table 1: Seedling age, number of seedlings per hill, plant spacing, irrigation, and use of organic manure in SRI and control plots.

Production factors	SRI practice	Farmer's practice (control)
Seedling age	12-15 days	30 – 40 days
No. of seedlings per hill	1	5/6
Spacing in cm.	25-30 cm x 25-30 cm	15 cm x 15 cm
Irrigation	Alternate irrigation and drying	Continuous irrigation
Organic manure	Available	Available

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Monitoring and Data Processing: Required information was collected by the Community Development Facilitators (CDF) of ActionAid with the assistance of participants on a regular basis as per pre-designed structured formats at different stages of rice cultivation, and the monitoring was completed with the harvesting of the crop. At the end of the season, the data were encoded into the computer and analyzed statistically using SPSS (Statistical Program for Social Science) and Excel programs for final presentation. 'T' test was performed for significant of the yield value (ton/ha) of total plots.

Results and Discussion

Agronomic analysis

- Calculations from the monitoring of all the replications showed that the average number of **tillers per hill** was 34.98 and 22.53 in SRI and FP plots, respectively. The average was 55.26% more tillers in SRI plots as compared to FP plots.
- The number of **effective tillers per hill** was 25.06 and 14.52 in SRI and FP plots, respectively.
- The average **plant height** was 94.81 and 87.96 cm in SRI and FP plots, respectively.
- On average, the **length of panicles** obtained from SRI and FP plots, respectively, was 24.20 cm and 21.29 cm.
- The average number of **spikelets per panicle** was 162.89 and 137.35 in SRI and FP plots, respectively.
- Average **number of unfilled grains per thousand spikelets** was 17.12 and 20.12 in SRI and FP plots, respectively.
- The average **weight of 1,000 grains** was 22.41 gm and 19.62 gm in SRI plots and FP plots, respectively (Table 6).

With respect to rice variety,

- In SRI plots, a higher **number of tillers** was found with the variety Dhan-28 (35.40/hill) and the lowest number of tillers with Sonar Bangla (32.00/hill). On the other hand, with farmers' methods, the highest number of tiller was found in Dhan-29 (23.80/hill) and lowest number with Sonar Bangla (15.00/hill).
- In SRI plots, the highest number of **effective tillers** was found with Dhan-28 (25.51/hill) and lowest number of tillers with Sonar Bangla (22.40/hill). On the other hand, with farmers' methods, highest number of effective tillers was found in Dhan 28 (14.96/hill) and lowest number in Sonar Bangla (11.00/hill).
- In SRI plots, **plant height** was found to be highest with Dhan 28 (96.28 cm.) and lowest with Dhan 29 (85.60 cm.); in farmers' method plots, height was found to be highest with Dhan 28 (88.36 cm.) and lowest with Dhan 29 (85.20 cm.).
- **Panicle length** in SRI plots was to be found highest with Dhan 29 (25.70 cm.) and lowest with Sonar Bangla (20.00 cm.); in farmers' method plots, it was found highest with Dhan 29 (23.80 cm.) and lowest with Sonar Bangla (17.80 cm.).
- Number of **spikelets per panicle** was found highest with SRI for Dhan 29 (200.60/panicle) and lowest for Sonar Bangla (147.40/panicle); in farmers' method plots, this number was found highest with Dhan 29 (165.90/panicle) and lowest with Sonar Bangla (132.60/panicle).

- Number of **unfilled grains per panicle** was found highest in SRI plots with Dhan 28 (18.03/panicle) and lowest with Sonar Bangla (10.40/panicle), while in fields with farmers' methods, the number of unfilled grains per panicle was found highest with Dhan 28 (21.09/panicle) and lowest with Sonar Bangla (11.40/panicle).
- **Thousand-grain weight** was found highest with Dhan 29 (23.50 gm) and lowest with Sonar Bangla (21.00 gm) in SRI plots. On the other hand, thousand-grain weight was found highest with Dhan 29 (20.50 gm.) and lowest with Dhan 28 (19.49 gm.) in farmers' plots (Table 7).

Varietal comparisons

Differences among the three varieties evaluated are summarized in Table 2. Average increases in the respective parameters measured on the replicated SRI plots compared with FP plots are shown in percent:

Table 2: Summary of varietal differences according to agronomic parameters

Parameter / Variety	**Dhan 28**	**Dhan 29**	**Sonar Bangla**
Tillers per hill	35.35%	28.96%	53.13%
Effective tillers	41.38%	43.10%	50.89%
Plant height	8.22%	0.47%	5.18%
Panicle length	12.76%	7.39%	11.00%
Spikelets	15.75%	17.30%	10.04%
Unfilled grains*	-16.96%	-25.53%	-9.62%
1000-grain weight	12.81%	12.77%	6.67%

*Percent of unfilled grains was lower in SRI plots compared to FP plots, as indicated by minus sign.

Insects and diseases

With respect to rice insects, average monitoring values (SRI and FP combined) showed 50% of plots infested by stem borer only; 8.70% by stem borer and leaf folder; 21.56% by stem borer, leaf folder, rice hispa and rice bug; 3.40% by rice hispa and rice bug; 4.63% by short-horned grasshopper; and 3.52% by brown leafhopper. No distinction was made in the distributions of insect pests by type of plot.

For diseases, average monitoring values showed 20.65% and 21.74% of SRI and FP plots, respectively, infected by bacterial blight (*pata jolshano* disease) caused by *Xanthomonas campestres* pv. Oryzae. Average monitoring values showed 4.49% of both SRI and FP plots affected by leaf blast diseases. Average monitoring values showed 0.92% of FP plots affected by bakanae diseases. Average monitoring values showed 2.36% of both SRI and FP plots affected by sheath blight disease, caused by *Rhizoctonia solani*. Average monitoring values showed 67.42% of all plots (SRI and FP combined) not affected by diseases.

Average monitoring values showed 60.53% and 10.36% of SRI and FP plots, respectively, were treated with IPM techniques, using sweep net to capture insects, set up light traps to control light-loving insects, and regular field visits to performing necessary inter-cultural operations to control the insects. Average monitoring values showed 41.92% of SRI plots were treated with both IPM techniques and chemicals to control insects, while 5.45% and 88.44% of SRI and FP plots, respectively, were treated only with chemicals to control insect infestation. 25.61% and 29.10% of SRI and FP plots, respectively, were treated with chemicals to control diseases, whereas 77.42% and 73.85% of SRI and FP plots, respectively, were not so treated.

Yield

Farmers have got an average production of 6.09 and 4.45 tons/ha in the SRI plots and FP plots, respectively. Production was 36.18 % higher in SRI plots compared to FP plots. A 't' test showed that SRI plot yield was significantly different at a 1% level of confidence from the yield of FP plots (Table 3).

Economics

The average gross margin was TK.38,650.29/ha and TK.15,752.20/ha from SRI and FP plots, respectively, showing that net income from SRI plots was much higher compared to FP plots. The total cost of the SRI and FP plots was Tk. 29,710.12 and Tk.33,774.17/ha, respectively, a reduction of 10.4%. Benefit-cost ratio was 2.3 and 1.5 for SRI and FP plots, respectively.

With regard to rice varieties, analysis of data gathered revealed the highest gross margin achieved in SRI plots with Sonar Bangla (43,172.34 tk./ha) and lowest gross margin with Dhan 28 (37,813.83 tk./ha). Benefit-cost ratio in SRI plots was found to be highest with Sonar Bangla (1.96) and lowest with Dhan 29 (1.22), whereas in farmers' plots the highest gross margin was found with Dhan 29 (23,401.56 tk./ha) and lowest with Dhan 28 (14,028.07 tk./ha). Benefit-cost ratio in farmers' plots was found highest with Sonar Bangla (0.92) and lowest with Dhan 28 (0.49) (Table 5).

Average cost of seed was Tk. 706.32 /ha and Tk. 2,051.78/ha for SRI and FP plots, respectively. Average cost of fertilizer, including organic manure, was Tk. 8060.52/ha and 6019.88/ha for SRI and FP plots, respectively. Average cost of irrigation was Tk. 11,796.22/ha and 13,516.13/ha from SRI and FP plots, respectively. Average cost of labor was Tk. 6,500.00/ha and 6,250.00/ha for SRI and FP plots, respectively. Average cost of pesticide was Tk. 2,647.06/ha and 5,876.23/ha for SRI and FP plots, respectively (Table 4).

Table 3: Economic analysis of rice production under SRI and FP

Plot	Yield (tons/ha) (14% moisture)	Gross return (Tk./ha) [A]	Cost (Tk./ha) [B]	Gross margin (Tk./ha) [A-B]	Benefit-cost ratio [A/B]
SRI practice	6.06 (0.740)	68,360.41	29,710.12	38,650.29	2.3
Farmers' practice	4.45 (0.460)	50,265.40	33,774.17	15,752.20	1.5

Limitations reported by farmers

- Rice variety and quality of seed were not the same for all participants.
- Poor and marginal farmers had not enough access to irrigation facilities which hampered them in carrying out continuously alternating drying and wetting of rice fields.
- In some cases, SRI plots were a small area in any corner of a larger control plot with no strong boundary between the treatments, which also hampered the alternate drying and wetting process.
- Sometimes farmers were not able to transplant SRI seedlings with an age of 10-15 days due to problems with timely availability of irrigation water
- Farmers were not accustomed to uprooting and transplanting tiny/small seedling so that is why it took more time and cost at first.
- Use of organic manure was very low in amount.

Lessons learned and recommendations

- Practice of SRI has potential effect on increasing rice yield and income through growing healthy plants and reducing incidence of pests and diseases due to proper management practices in the crop field while maintaining scientifically validated principles of crop production.
- Farmers are able to practice the SRI process, for which they have expressed their opinion to extend the area coverage with SRI in the next boro season.
- Conduct more farmer-participatory action research/experiments on SRI practice in different agro-ecological zones of Bangladesh, which is required for refinement and adjustment of SRI principles and variable factors
- Facilitate initiative of community approach which ensures better and more effective participation of community people in an irrigation command area to ensure timely availability and management of irrigation water.
- Whole portion of a plot should be covered by SRI practices.
- Initiate a process to add enough organic manure with the soil.

- Different government and non-government organizations that are providing support to the farmers in agricultural field may conduct the same experiment with the farmers.

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Table 4: Cost of inputs (all costs in Tk. per hectare)

Rice systems	Cost of seed	Cost of fertilizer, including organic manure	Cost of labour	Cost of pesticides	Cost of weedicides	Cost of irrigation	Total cost of production
SRI practices	706.32	3,474.26	6,500.00	2,647.06	0.00	11,796.22	25,124
Farmers' practices	2,051.78	1,078.43	6,250.00	5,876.23	0.00	13,516.13	28,773
Variation in %	*-65.58*	*222.16*	*4.00*	*-54.95*	*0.00*	*-12.72*	*-12.68*

Table 5: Variety-wise economic analysis,

Rice variety		Total income in taka per hectare		Total cost in taka per hectare		Total gross margin per hectare in taka		Benefit-cost ratio	
		SRI	FP	SRI	FP	SRI	FP	SRI	FP
Dhan 28		67,153.88	49,187.78	29,340.05	34,167.25	37,813.83	14,028.07	1.40	0.49
Dhan 29		78,378.91	59,132.81	36,134.38	35,731.25	42,244.53	23,401.56	1.22	0.67
Sonar Bangla		65,214.84	47,617.19	22,042.50	24,750.00	43,172.34	22,867.19	1.96	0.92

Table 6: Some agronomic characteristics of SRI and FP

Rice plots	Total tillers per hill (no.)	Total effective tillers per hill (no.)	Plant height (cm)	Length of panicle (cm)	Spikelets per panicle (no.)	Unfilled grains per panicle (no.)	Thousand grain weight (gm)
SRI practices	34.98	25.06	94.81	24.20	162.89	17.12	22.41
Farmers' practices	22.53	14.52	87.96	21.29	137.35	20.12	19.62

Table 7: Variety-wise differences in some agronomic characteristics under SRI and FP

Rice variety cultivated	Total tillers per hill (no.)		Total effective tillers per hill (no.)		Plant height (cm)		Length of panicle (cm)		Spikelets per panicle (no.)		Unfilled grains per panicle (no.)		Thousand grain weight in gm.	
	SRI	FP	SRI	FP	SRI	FP	SRI	FP	SRI	FP	SRI	FP	SRI	FP
Dhan 28	35.40	22.89	25.51	14.96	96.28	88.36	24.29	21.19	158.61	133.61	18.03	21.09	22.36	19.49
Dhan 29	33.50	23.80	23.20	13.20	85.60	85.20	25.70	23.80	200.60	165.90	14.10	17.70	23.50	20.50
Sonar Bangla	32.00	15.00	22.40	11.00	92.60	87.80	20.00	17.80	147.40	132.60	10.40	11.40	21.00	19.60