Feasibility Study to support System of Rice Intensification (SRI)

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OBSERVATIONS ON THE STUDY OF SRI IN WEST BENGAL & BIHAR

CONTENTS

EXECUTIVE SUMMARY

Rice is the staple food for majority population in India. Global and domestic demand for rice is increasing with the ever growing population. Policy makers and rice research managers are looking for methods of increasing rice production with less land and less water at affordable price to consumers. System of rice intensification, known as SRI method has the potential of increasing the rice yield. It has become popular in many states. Considering the principles and potential of SRI, the trustees of Sir Dorabji Tata Trust suggested for a systematic study on all aspects of SRI in the districts of Purulia, Gaya and Nalanda before the Trust could take up the program at national level.

The SRI program in these districts has been implemented by Professional Assistance for Development Action (PRADAN). The team comprising of Dr. Pradeep Kumar Bora, Scientist, Dept. of Agricultural Engineering, Assam Agricultural University, Jorhat, Assam; Shri C. Udayshankar, Centre for World Solidarity; and myself, Ex-Principal Scientist, Division of Genetics, IARI, reached Purulia on 27th November. Next day we had a briefing session with the staff of PRADAN, represented by Shri Dinabandhu Karmakar, Shri Arnab Chakravarty, Shri Debashish, Shri Avijit Choudhury at Purulia, and with Shri Anil Verma at Gaya on 2nd December, 2007.

In District Purulia, five blocks namely – Bara Bazar, Bagmundi, Balrampur, Jhalda 1, and Jhalda 2 -- were covered. Observations were recorded in the standing rice crop grown by SRI method. Number of tillers, grains per panicle, and grain weight were found to be more in fields transplanted by SRI methodology. Dwarf high-yielding rice varieties, namely Lalat, MTU-7029, MTU-1001 and Super Rice, were grown by the farmers. In the focus group discussion, it became clear that farmers have realized better yields with same inputs as in the traditional methods.

In the district of Gaya, the team visited the villages Shekhwada, Ghantadi and Ghusia. A focus discussion was held with the Self-Help Groups. In crop-cutting experiments, yields of 10.8, 12.73, and 14.26 tonnes/hectare have been recorded in the presence of Dr. S.P. Sinha, Project Director, ATMA, and Dr. A. K. Singh, Head, Krishi Vigyan Kendra, Manpur. In this method, field preparation, nursery management and integrated crop management are properly implemented. Farmers with small holdings if properly trained will be able to increase their rice yield substantially.

Even in rainfed conditions, farmers can easily adopt this method. The major constraints are lack of small-scale agricultural implements like power tillers, mechanical weeders, harvesters and threshers. Soil fertility is very poor. Practice of green manuring, application of farmyard manure, availability of genetically-pure and healthy seeds of high-yielding varieties suited to the growing conditions, and large-scale training to farmers on integrated crop management will help in increasing the rice production. In our overall observations, we are convinced that SRI methodology should be taken up at national level. All the state and central government organizations engaged in agriculture in any way should try to take the technology to the farmers and make available essential inputs timely.

INTRODUCTION

Rice is the staple crop in India. It contributes about 65% of the total food grain production. About 45 million ha area is under rice cultivation, of this about 22.5 million ha is under irrigation, and 38% of the rice-growing area comprises rainfed shallow lowland and deep-water areas. Less than 6 million ha are upland unirrigated area. The productivity of the rainfed upland areas and lowland deep-water areas are 1.5 t/ha and 0.9 t/ha, respectively.

Rice production in India has increased by 4.5 times over the last 57 years, from 30.9 m-t in 1950 to 139.4 m-t in 2006.[1] However, rice productivity is growing at a much slower rate compared to that recorded in the earlier decades. All-India mean growth rate is literally stagnant at 0.54% only.[1] Stagnant productivity, on one hand, and the higher food grains demand, on the other hand, to feed the ever-growing population are becoming the major challenges in India.

Rice needs about 3000 to 5000 liters of water to produce 1 kg of grain. Equally competing crop like sugar cane is also grown in India in large areas. At global level, 70-80% of fresh water is withdrawn to meet the demands of agriculture, and rice accounts for 85% of this. Considering the increased rice requirement in the coming years, it is unlikely that the available fresh water would be sufficient to meet the total demand. According to International Water Management Institute, India is already experiencing physical water scarcity. It is obvious that with limited arable land and limited fresh water for agriculture, the country is not in a position to increase rice production. A time has come to use the water judiciously in agriculture by enhancing the Water Use Efficiency in irrigated areas with the limited water resources available without compromising productivity. It is expected that improved cop management practices with good varieties can solve the problem to a greater extent.

The System of Rice Intensification, better known as SRI or as Madagascar method of rice cultivation, is gaining popularity among the farmers of several states of the country. This method has the potential to improve the productivity of land, capital, water and labour simultaneously. The method was first developed in 1983 by Fr. Henri de Laulanie in highlands of Madagascar. Till 1998, it was confined to Madagascar. At present, the whole of Southeast Asia, including China is starting to practice SRI methodology. In India, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal have started SRI practice. Tripura has witnessed phenomenal growth of SRI. With the active participation of the State Government and the Department of Agriculture along with the Panchayati Raj Institutions, about 7% of total rice growing area has been converted to SRI practice. The state plans to have 15% of its total cropped area under this method in 2008. The Government of Tripura has also reported about 2 t/ha incremental yield of rice by adopting this method.

With a view to extend the practice of SRI with large numbers of farmers in new areas at national level, Sir Dorabji Tata Trust has planned a systematic study. In this context, a team represented by Dr. V. P. Singh, Ex-Principal Scientist, Division of Genetics, Indian Agricultural Research Institute, New Delhi; Sri C. Uday Shankar, Advisor, Natural Resources Management, Centre for World Solidarity, Hyderabad; and Dr. Pradip Kumar Bora, Scientist, Assam Agricultural University, Jorhat, Assam, has been given the responsibility to critically study the impact made by SRI methods and its feasibility for extending to other areas where it can easily be practiced.

STUDY METHODOLOGY

As per the TOR (Annexure No.1) the study team met at PRADAN, Purulia on 28.11.2007. Mr. Dinabandhu Karmakar, Programme Director, PRADAN made a brief presentations on SRI programme in Purulia district, West Bengal, and gave an introduction to SRI in Gaya and Nalanda districts of Bihar. Necessary reference material on PRADAN's SRI programme was collected.

The methodology of the study comprised:

- Briefing sessions both at Purulia and Gaya
- Focus group discussions with service providers and resource persons
- Field visits
    - Observations recorded on number of hills per square meter, number of tillers per hill, and number of grains per panicle
    - Educating the farmers for possible incidence of insect pests and diseases.
    - Discussions with farmers and labourers working in rice fields.
    - Focus group discussions with women-SHGs/VOs and also combined groups of male and female farmers and workers. In Bihar, the focus group meetings in different villages were attended by the respective skilled extension workers engaged by PRADAN (three of them are tribal farmers from Purulia and one from Gaya region).
    - Photography
- Discussions with staff of Krishi Vigyan Kendra (KVK), Joint Director, Agriculture (JDA), District Agriculture Officer (DAO), Project Director ATMA on SRI problems and prospects.

System of Rice Intensification: The method

In SRI method of rice cultivation, seedlings are raised in such a way that they can be transplanted along with the seedbed soil without disturbing the root system. 8-12 days old seedlings are transplanted to the main field in order to tap the maximum tillering potential. In rice, each tiller produces another tiller two phyllochrons later. A phyllochron is an interval of plant growth usually about 5 days, but it can be longer or shorter depending on varieties, temperature, depth of transplanting, and soil conditions. When the soil and other conditions are favorable rice plant can go through as many as 12 phyllochrons before it moves from vegetative phase to reproductive phase. The number of tillers can increase exponentially with as many as 84 or more from a single plant. Transplanting after the 4^{th} phyllochron sets back the growth momentum of the rice plants, so that their full potential of producing tillers, roots and grains are not achieved. If 10^{th} to 12^{th} phyllochron of growth is not materialized because of late transplanting, about 75% of tillering potential is lost. Single seedling per hill is recommended. Seedlings should be transplanted within 15-30 minutes after removal from the seedbed to avoid any kind of shock. A spacing of 25 cm x 25 cm or more is provided to create better micro-environment for higher number of tillers. Sufficient FYM to the tune of 10 t/ha should be applied to make the soil rich in organic matter. Frequent mechanical weeding is recommended. The first weeding should follow after 10-12 days of transplanting. No chemical weeding is recommended. Against the traditional wisdom, only alternate wetting and drying is followed to create an aerobic condition at the root zone. A sub-saturated to saturated soil-water environment is preferred. This helps in channeling the energy required to create aerenchyma (air pockets) in the roots under anaerobic conditions to better productivity.

SRI method has the following advantages:

- Plants get proper environment to grow at an appropriate stage, resulting in more number of productive tillers and synchronous flowering.
- Since 8-12 days old seedlings are planted, main field leveling becomes a necessity. Proper leveling helps in water saving and better use of other inputs.
- It helps in maintaining adequate plant population per unit area.
- Timely weeding with cono-weeder makes more nutrients available to plants.
- Proper spacing allows more sunlight and aeration to the lower leaves, making them active for a longer period.
- This results in sturdy stems, active leaves, more number of filled grains per panicle, and more grain weight.
- With proper sunlight and aeration, a favorable micro-climate is formed which helps in minimizing the incidence of insect-pests and pathogens.
- SRI can increase both land and labour productivity compared to conventional practice.
- An average paddy yield of 8-9 tons per hectare is possible with high-yielding varieties.
- Mechanical weeding adds about 2 t/ha weed bio-mass to the soil during the crop season, thereby improving the soil health.
- The cost of seeds is reduced drastically because only about 2.0 kg of seeds per acre is required in this method.
- It is a good method for organic farming as high yield can be achieved by green manuring and compost application.

- Total water requirement for rice production is also reduced as continuous submergence is not needed.
- With a large number of tillers, the rice bio-mass is also increased. Rice straw has multiple uses to the farming families.
- It is a very valuable alternative for small farmers with limited land endowment.
- Dr. S.P. Sinha, CEO, ATMA at Gaya, informed that many rich farmers including some of their Board members took to SRI covering 6 to 8 hectares each and reaping a harvest of 6 to 7 tons per hectare.

SRI is essentially an irrigated rice technology wherein the farmers need good control over the water. Agronomic practices and water management aspects take over other issues. Early management in this method is crucial. It is considered to be a low-external-input method, but it is labour-intensive until the farmers become experienced. It is more a framework of resource management rather than a technology.

Table: Comparison of SRI with Traditional Method of Rice Cultivation

Operation	SRI Method	Traditional Method
Nursery Preparation	Nursery bed should be nearer to the main field. About 5 kg/ha seed is sown in the seed bed. Chemical fertilizers are not recommended.	Nursery bed is not necessarily prepared near the main field. About 30 kg/ha or more seeds are used
Main Field Preparation	Careful plowing, puddling, leveling, and raking is done. Thirty cm wide channels are made at an interval of 2-meter across the field to drain excess water.	No cross drain is made as inundation is encouraged and drainage is not a priority.
Transplanting	Eight-ten day old seedlings are transplanted singly soon after they have two leaves and at least below 15 days after sowing. The seedlings must be transplanted with their roots intact while the seed sac remains attached. They must not be plunged too deep and placed at on the ground at appropriate point on the planting grid. Square pattern of planting grid is preferred to facilitate weeding. Transplanting should be done quickly after gently removing seedling from the nursery. The root should not dry. Seedlings remain green and establish early.	About 25 day old or more seedlings are transplanted. 2-3 nos. of seedlings per hill are used. Seedlings are uprooted from the nursery; the nursery bed soil is removed from the root zone before binding and transporting to the main field. Seedlings are generally not transplanted as quickly as in SRI method. Random planting is preferred. Seedlings generally turn yellow and take about a week to establish.
Spacing	Seedling should be planted precisely at a spacing of 25 cm X 25 cm or more depending upon the tillering capacity of the variety.	Usually 20x15 cm spacing is maintained.

	About 16 to 20 hills per m^2 is maintained.	
Soil Nutrient	SRI is promoted as an organic culture. This promotes proper microbial activity in the soil. Farmers who do not have sufficient organic matter may use less amount of chemical fertilizer.	Farmers generally do not apply balanced nutrients to soil. Farmers are prone to use more nitrogenous fertilizers and give less emphasis on organic manures.
Watering	SRI requires root zone to be kept moist, not submerged. Water application can be intermittent.	Inundation is preferred. Standing water helps in weed suppression thereby eliminate weeding.
Weeding	Since there is no standing water in the field, weeds tend to proliferate hence requires frequent weeding. First weeding should be done 10-12 days after transplanting. Further weedings are required at an interval of 10-12 days. Weed bio-mass is generally mixed with the soil with weeder (cono-weeder) which enhances organic matter in the soil.	Limited weed growth and random planting does not warrant mechanical weeding. Sometimes manual weeding is done which does not churn the soil.

TRACK RECORD AND GROWTH OF SRI

Purulia

Purulia district of West Bengal is one of the poorest districts in the country. This falls under Agro-Ecological Zone VII characterized by endemic poverty. Rice productivity in these areas is abysmally poor, at about 2.2 t/ha. Small land holdings, unfavorable topography, and poor soil quality to sustain intensive cultivation make it more challenging to increase rice production. Most of the farmers are found to be food-insecure. PRADAN was involved in this district for livelihood improvement programme through *Kharif* paddy stabilization where farmers were motivated to use high-yielding improved seeds, seed treatment, proper nursery management, etc. These steps increased the yield of paddy to 4.5 t/ha. This could help in increasing food sufficiency up to 8-9 months, leaving a gap of about 3-4 months of food availability.

PRADAN started promoting SRI practices under rainfed situation in Purulia since 2002, with 4 farmers in the first year. Combining the effort of their Service Providers as per its earlier model, PRADAN has started its extension effort and exposed the SHG members along with their husbands to SRI methods. It has also started conducting training programme for SHG members. PRADAN has so far trained about 230 SHGs of four blocks, *viz*. Barabazar, Balarampur, Bagmundi and Jhalda-1.

Genetically-pure and healthy seeds, water, weedicides, fungicides, pesticides and fertilizers etc. are the crucial inputs in rice cultivation. PRADAN has developed a mini-kit of input for an area of 0.33 acre which included seeds, fertilizers and pesticides. PRADAN has also

ensured field training for nursery preparation and main field preparation to 1-2 farmers in each village. Beginning with 4 farmers, PRADAN has covered about 1,580 farmers in five blocks with an area of 196.29 ha. (Table 1)

Table 1: Distribution of SRI Farmers in 2006-07

Blocks	No. of Villages	No. of Farmers	No. of Dropouts from Previous Year *	New Farmers	Old Farmers
Barabazar	36	598	87	393	205
Bagmundi	6	84	23	67	17
Balarampur	4	36	1	33	3
Jhalda-I	27	764	65	568	196
Jhalda-II	7	98	0	98	0
Total	80	1,580	176	1159	421

* As explained by the professionals of PRADAN, most drop-out cases were due to non-availability of holdings in medium land situation where they could do rice cultivation through SRI method.

Gaya

Like Purulia in West Bengal, Gaya district of Bihar is also poor. The general distribution of land is highly skewed, as 18-20% of well-off families command 60-70% of the land resources, and the poor community in general, and SC, ST and OBC in particular, have very marginal operational holdings. The average landholding among poor masses varies from 0.5 acre to 1 acre. The productivity of paddy is also extremely low. It is also because the farmers have been facing continuous draught since 2002.

Bihar Rural Livelihood Project society (BRLPS), Patna, is an autonomous body created by Govt of Bihar with financial assistance from World Bank. BRLPS has identified 6 districts of Bihar on the basis of poverty and area affected by Naxalites, *viz*. Gaya, Nalanda, Madhubani, Mujaffarpur, Purnia and Khagaria. BRLPS is supported by State Project Managers at state level and Block Project Implementation Unit (BPIU) at block level. The BPIU has 16 staff members led by a Block Project Manager. These BPIUs are engaged in promotion and nurturing of women SHGs. These SHGs and their federations called Village Organisations (VOs) are reported to be qualitatively better than SHGs promoted by other local NGOs/block staff.

On invitation from BRLPS to pilot SRI project for enhancing livelihoods of rural families of Gaya and Nalanda, PRADAN started the pilot work with 200 families.

PRADAN started functioning with a professional and four Skilled Extension Workers (SEW) with support from ARU in Bodh Gaya and Harnaut blocks of Gaya and Nalanda districts respectively. During June to August 2007, focus was on exploring new villages, concept seeding, motivating poorer community to participate, nursery raising and transplanting, and ensuring transportation of nurseries to other villages. With the active participation from BRLPS, PRADAN could cover 132 families that season (102 in Gaya and 30 in Nalanda).

Training, exposure and orientation on SRI in Gaya

Month (2007)	Total Participants	Male	Female	No. of SHG members	No. of non-SHG members
June	262	144	118	252	10
July	169	50	119	152	17
August	300	300	-	-	300
September	62	62	-	-	62
Cumulative	793	556	237	404	389

The important statistics of SRI project under BRLPS

Target number of farm families in 2007:

- 200 families with average 1 acre per family
- Preparation of manual on SRI
- Concrete strategies for fast replication

Achievement so far

Number of individual nurseries established: 157
Number of central nurseries established to ensure young seedlings: 4
Total number of families who adopted SRI: 132
Number of families whose SRI plots got damaged due to excess rainwater/Plots submergence: 6 (2 in Gaya and 4 in Nalanda)
Present number of families in to SRI right now: 126 (100 in Gaya and 26 in Nalanda)

Total area transplanted SRI: 79.73 acres
Destroyed transplanted area: 4.22 acres
Net transplanted area as on 30th September 2007: 75.51 acres
Average transplanted area/household: 0.59 acres

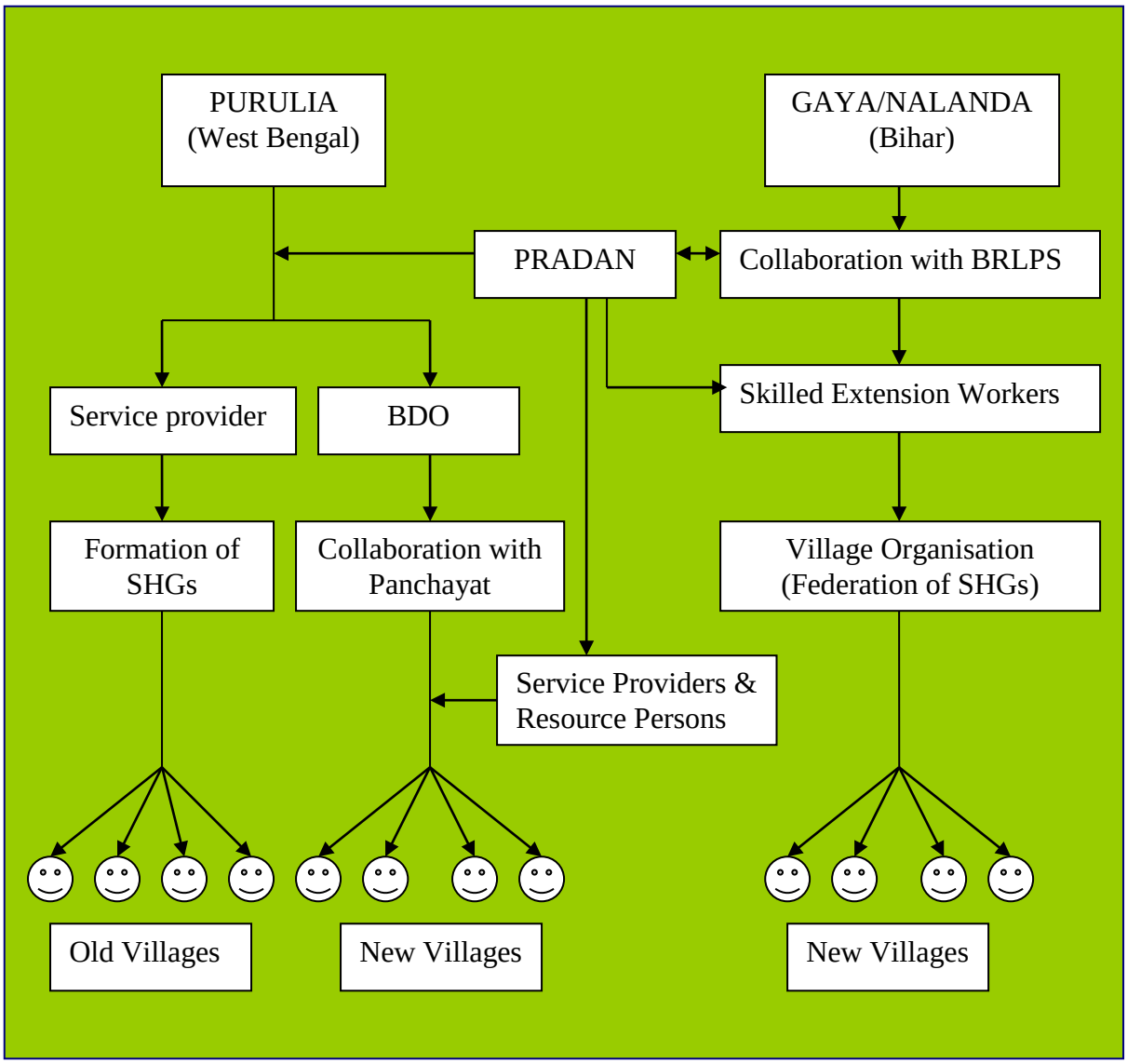
Analysis of Adoption and Extension Support

SRI practice has been adopted in Purulia in West Bengal and Gaya in Bihar with the initiative of PRADAN on a larger scale. The field visits and the focus group discussions revealed the acceptability of the system as an alternative practice to the age-old rice cultivation method. The farmers are found to be convinced about the benefits of rice cultivation under SRI method. However, the credit must be given to the relentless effort put out by the professionals of PRADAN for the expansion of SRI method among the marginal farmers who were able to meet their daily rice requirement for only 4-8 months. It was a delight to observe that all the non-SRI farmers present in the focused group discussions held at different places in these two areas are clear and vocal about the benefits of the system and were ready to adopt the method in the next season.

PRADAN has been working mainly with the marginal farmers whose land holding is less than 1 ha. The farmers in the villages where SRI has been introduced are very poor and mainly following mono-cropping. Rice productivity in these villages was hovering around 1.5 t/ha under rainfed conditions. PRADAN was able to enhance the productivity of rice in

some of the old villages through their earlier programme *viz.* the *Kharif* Paddy Stabilization to about 4 t/ha. It was a challenge in front of the professionals to increase rice productivity further given the limited natural resource endowment by which the poor farming families could become food-secure. System of Rice Intensification was definitely an option to try with this organization. SRI is basically a framework of crop management rather than a technology. Hence, introduction of SRI is an extension challenge. PRADAN has devised a mechanism to involve the farmers in the endeavor to introduce the system in the areas where their presence has already been appreciated. The institutional linkages and extension mechanism of PRADAN have been depicted in the following flow chart:

INSTITUTIONAL LINKAGES AND EXTENSION MECHANISM -- PRADAN


PURULIA
(West Bengal)
GAYA/NALANDA
(Bihar)
PRADAN
Collaboration with BRLPS
Service provider
BDO
Skilled Extension Workers
Formation of SHGs
Collaboration with Panchayat
Village Organisation (Federation of SHGs)
Service Providers & Resource Persons
Old Villages
New Villages
New Villages

Critical Review and Limitations

The team visited Purulia district of West Bengal and Gaya and Nalanda districts of Bihar and traversed several villages:

Purulia (West Bengal)			Gaya (Bihar)		
Block	Panchayat	Village	Block	Panchayat	Village
Jhalda-II	Rigid	Dimu (N) Rigid (N)	Bodh Gaya	Shekhawara	Shekhawara Ghantadi
				Jhinkatia	Jhinkatia
		Jhalda-II (PRADAN office) discussion with SPs and RPs		Nama	Bhusia
Jhalda-I	Madhari Khamad	Luskudi (N)		Jhinkatia	Bedichak
		Kachidi (N)			
		Uhatu (N)			
		Jajahatu (N)			
	Nabadi	Birudi (O)			
	Dorda	Tanashi (O)			
Barabazar	Berada	Gokulnagar-Majhidi (O)			
		Suraidhi (O)			
	Banshbeda	Banshbeda (O)			

N: New Village O: Old Village

The team visited the fields where paddy cultivation with SRI practices was done. Observations were recorded on number of hills per sq. meter, number of tillers per hill, and number of filled grains per panicle in both SRI and non-SRI fields wherever both practices are in adjacent fields. It also calculated 1000-grain weight for both SRI practice and conventional practice of Lalat variety which was commonly grown in that area. Estimated cost comparisons were also carried out through focus group discussions on recall basis. The team organised focus group discussions in Purulia (PRADAN office in Jhalda-II Block with SPs and RPs, SHGs in Tanashi and Gokulnagar-Majhidi villages) and in Gaya (VO of Shekhawara , VO of Bhusia, farmer group in Ghantadi and farmer group in Jhinkatia along with SEW posted there).

In Gaya district, discussions were held with different stakeholders like Project Director of Agricultural Technology Management Agency (ATMA), Bihar; District Agricultural Officer; Joint Director of Agriculture; and Scientists of KVK in their respective offices. BRLPS members were also invited for a discussion to know about their involvement and future strategies to expand SRI practice in Bihar.

The observations have been recorded here in the following Tables.

Table: Labor input as reported in group discussions by the service providers and resource persons in Purulia

Item	Traditional		SRI	
	Male	Female	Male	Female
Seed bed preparation	8	2	2	
Main field preparation	19.5	-	21.5	
Uprooting and transplanting		70	7	28
1st weeding		72		14
2nd weeding				7
Spraying	2.5		2	
Harvesting and binding	7	42	8	49
Threshing	35			35
Total (hrs)	72	186	40.5	133
Man-days	9	23.25	5.06	16.63
Cost of labour (Rs.)	450	960	250	680
Total (Rs.)	1410		930	

Cost of Labour/day: Male: Rs.40/- Female: Rs.30/-

Table: Cost of Inputs as reported by the service providers and resource persons in Purulia (Rs. per bigha; one bigha is about 0.33 acre)

Item	Traditional	SRI
Seed	210	10.5
Chemical for seed treatment	-	0.8
DAP	63	115.5 +52.5=168
Urea	63	55
MOP		
Pesticides	77	77
Cowdung	400	600
Ploughing	400	400
Labour cost	1410	930
Grand Total	2623.00	2241.00

Table: Labor input as reported in group discussion by Village Organisation and BRLP representatives in Shekhawara Village, Budhgaya Block, Gaya

Item	Traditional		SRI	
	Male	Female	Male	Female
Seed bed preparation	2	-	1	-
Compost spreading in the main field	10	-	10	-
Main field preparation	15	-	15	
Uprooting	13	-	1	1
Transplanting	-	13	-	13
1st weeding	-	12	1	1
2nd weeding	-	9	1	1
Fertilizer application	1	-	1	-
Spraying	-	-	1	-
Water management	1	-	2	
Harvesting	-	10	-	12
Binding	3	2	3	2
Threshing	5	5	6	6
Man-days	50	51	42	36
Cost of labour (Rs.)	2000	1530	1680	1080
Total (Rs.)	3530		2760	
Yield (t/ha)	2.70		10.8	

Cost of Labour/day: Male: Rs.40/- Female: Rs.30/-

N.B. Except for seeds and water, all other inputs are reported to be same for both traditional and SRI method of rice cultivation.

Two farmers from Bhusia village of Bodh Gaya reported their labour requirement in transplanting and harvesting in both SRI and traditional methods

Name of farmers	Activity	Deshi		SRI	
		Female	Male	Female	Male
Mr.Ranjan Kumar Gupta	Transplanting	9	4	5	3
	Harvesting	5	3	5	3
Ms. Sumitra Devi	Transplanting	10	7	10	3
	Harvesting	7	3	2	4
Ave. total		15.5	8.5	11	6.5

"I did not get loan for buying fertilizers for cultivating paddy under SRI. I am growing local variety of paddy under deshi method"

- Mr. Chitto Majhi of Rigid Village, Jhalda-2 Block, Purulia

Some field observations

- The incidence of pest and insect attacks as reported by the SHG members and other farmers during focus group discussions and observed during field visits is on account of variety-related factors (MTU 7029 and Sonam).
- Insufficient organic content in the soil or insufficient application of green manure. FYM, vermi-compost, etc. is a problem.
- Imbalanced nutrition practices.
- Improper water management under rainfed condition and excessive water application under wells.
- Soil testing has not been practiced to determine the doses of various nutrients including organic manure.
- To sustain the higher yields reported, integrated crop management (ICM) with thrust on organic components (bio-pesticides and bio-fertilizers) and water management as per SRI principles become vital.

Green Manuring and Bio-fertilizers

The use of FYM, vermi-compost, and green manure is negligible in both West Bengal and Bihar. Making of bio-fertilizers, bio-pesticides and vermi-compost can be on the basis of micro-enterprise by progressive SHGs.

Uplands (*tanr)* in West Bengal and Bihar and the field bunds and other wastelands need to be planted with green manure trees (such as Pongemia, Glyricidia, drum stick, *etc*.). That suits the agro-climatic zones covered by PRADAN. Integrated Crop Management saves crops from insect-pests and also reduces cost of production.

Extension workers, SHG members and other farmers need to be trained on ICM with focus on organic manure, bio-pesticides, green manuring, and non-chemical techniques for controlling insect-pests and diseases.

Water Management

SRI principles are adopted to grow paddy under rainfed conditions in Purulia district where the average annual rainfall is around 1300 mm. Only one crop (Kharif, July-December) of paddy is cultivated in most of the villages covered under SRI in Jhalda I, II and Barabazar sub-districts (West Bengal). Villagers follow their experience for the rainfall trend in a given season and also the general rainfall pattern to decide on the day for starting work related to the paddy nursery.

SRI-paddy is grown under both rainfed conditions and under dug-cum-bore wells in Gaya and Nalanda districts of Bihar. SRI-paddy in medium uplands performs better than in low lands due to better drainage.

Social Regulations and Water Use:

The traditional tank at Gokulnagar Majhiri (Santhal), Berada Panchayath, Purulia district, West Bengal, is only for ground water recharge and drinking water purpose. No direct pumping of water from the tank is allowed for irrigation. However, farmers are allowed to carry pots of water from the tank for irrigation purposes. One farmer was seen filling a big jar with pots of water from the tank and used a diesel pump to lift water from the jar to his field for vegetable cultivation (December 2007)!

Water management as per SRI norms is yet to be practiced under direct irrigation from the tanks (Suraidih village, Berada Panchayath, Borabazar Block, West Bengal). Only seed rate, nursery management, transplantation and weeding are done as per SRI norms.

Work in Bihar has been started only in June 2007. The results of the first SRI crop both under rainfed conditions and under water well irrigation woke up the districts of Gaya and Nalanda and even the State authorities. SRI norms of water management are followed to some extent under conditions of well irrigation. That is mostly due to unreliable power supply and cost of diesel.

Dug-cum-bore wells in Gaya and Nalanda districts are being used for irrigation on sharing basis largely due to fragmented land holdings. Also, majority of the farmers do not have funds for drilling wells – a blessing in disguise that ensures sustainability of pumping water levels/ water table.

The terms of sharing water from wells are negotiated among the farmers. Not only lands for SRI, but also wells are taken on lease (Ghantadih, Shekhwara Panchayath, Gaya).

Mr. Bechu Prasad Gupta of Jhinkatia of Bodhgaya block said, “If power supply is ensured, water from my well can be shared with 12 other farmers”. In rural Bihar, there are no separate power lines for domestic supply and irrigation purposes. Breakdown of transformers due to overload is a frequent phenomenon in rural Bihar. Diesel pumps are used on a sharing basis only for life-saving irrigation.

All most all the dug-cum-bore wells at Bhusia, Nawa Panchayath, Bodhgaya block are under sharing mechanism. Both men and women farmers at Bhusia said that SRI required 40% less water in comparison with conventional paddy cultivation. They do not consider sharing of irrigation wells as business. The explanation given was that the well owner required money for maintenance and paying electricity bills.

The potential of residual moisture after harvesting Kharif paddy and seepage under tanks for raising a second crop (Purulia) is not yet fully realized. In Gaya and Nalanda districts, multiple crops are grown under dug-cum-bore wells. Rainwater harvesting in 5% of the land owned by the farmer is essential not only for life-saving irrigation but also for better water management.

There is need for on-farm training of male and female farmers on water management as per SRI norms at least under tanks and wells in both Bihar and Bengal.

Purulia, West Bengal

Table : Observations on yield components

Names of Farmer	Variety	No. of hills per sq. m		No. of tillers/ hill		No. of grains per panicle		1000-grain wt. (gm)		Remarks
		SRI	Traditional	SRI	Traditional	SRI	Traditional	SRI	Traditional	
Ms. Thahuran Biwi M/o Jabir Ansari, Dimu Village- Rigid Panchayat, Jhalda-2	Lalat	17	55	21	6	-		30	25	Other data was not recorded
	Pratiksha	16	47	17	10	-				
Mr. Chitto Majhi Rigid Village- Rigid Panchayat, Jhalda-2	Sona Dhusri	-	-	-	6	-				Farmer's statement: Expected yield of SRI: 4 t/ha and Traditional : 2.1 t/ha
Mr. Daman Majhi Nephew of Mr. Chitto Majhi Rigid Village- Rigid Panchayat, Jhalda-2	MTU-7029	16	-	17	-	-				
In the focus group discussion of the Service Providers and the Resources Persons who themselves are farmers reported that SRI yield during normal-monsoon year was 4.95 t/ha, whereas under conventional practice, it was 2.23 t/ha. During severe drought year (2004-05), SRI yielded at least 0.03 t/ha whereas the conventional paddy yielded nil.										
Mr. Pandu Mahato Kasidih Village Mathudi Khamar, Jhalda –I	Lalat	24	37	15	6	185	122			
Mr. Mangal Mahato Uhatu Village Mathudi Khamar, Jhalda –I	Not noted	29	-	12	-	187	-			
Mr. Badal Kumar Birudi Village Nawadi Panchayat, Jhalda-I	Super Rice	17	-	22	-	181				

Gaya, Bihar

Names of Farmer	Variety	No. of hills per sq. m		No. of tillers/ hill		No. of grains per panicle		Remarks
		SRI	Traditional	SRI	Traditional	SRI	Traditional	
Mr. Kishor Yadav, Vill. Shekhawara, Bodh Gaya Block	Sarayu 52	16	-	17	-	-	-	Reported yield in SRI 11.04 t/ha and in traditional practice :5.5 t/ha
Mr. Kameswar Yadav Shekhawara, Bodh Gaya Block	Rajendra Mahsuri-1	16	-	17	-	270	-	Not yet threshed
Mr. Kuleswar Yadav Shekhawara, Bodh Gaya Block	Bauna Mahsuri	-	-	-	-	-	-	Reported yield 8 t/ha
Mr. Prem Kumar Ghantadi, Bodh Gaya	Bauna Mashuri	18	-	22	7	245	120	Not yet threshed
Ms. Vaijayani Devi Bhusia Village Bodh Gaya	Sarayu 52	-	-	-	-	-	-	Reported yield 8 t/ha under SRI
Mr. Nada Kishore	Sarayu 52	-	-	-	-	-	-	Reported yield under SRI 12 t/ha

Focus Group Discussions

Gokul Nagar Majhidi Village
Berada Panchayat
Barabazar Block

This is the village where PRADAN started SRI cultivation in 2002. Three farmers came forward for SRI cultivation in the beginning. In 2006, the number went up to 35 from mere 3 in 2002. However, the crop was not successful in the medium upland areas in that year due to drought. Therefore, the medium upland families have not taken SRI cultivation in the current 2007. At present, the village has 20 families growing rice with SRI method covering total area of 3.15 ha out of 65 families.

One of the first SRI farmers, Mr. Atul Ch. Mandi, who is cultivating SRI in the year 2007 in an area of 1 ha, said that the yield from 1 ha would be enough for his 20 member-joint family. Mr. Atul Ch. Mandi was a food-deficit farmer before the introduction of SRI. He used to grow maize and boro rice on leased land to meet the food demand for his family even though *boro* rice cultivation was difficult due to lack of sufficient water. Now Mr. Atul is food self-sufficient with the yield that he is getting through SRI cultivation and he has stopped doing *boro* cultivation on leased land. However, he observed that the yield of paddy was gradually declining in the plots where continuous SRI had been practiced. He reported that he received the highest yield of rice in the first year (2003), which was about 10.8 t/ha. The yields in the succeeding years as reported by him were 7.8 t/ha, 7.5 t/ha and 8.4 t/ha in 2004, 2005, and 2006, respectively. In 2006, Mr. Atul Ch. Mandi got a yield of rice about 6.6 t/ha through traditional method. However he reported that in the tradition plot, the previous crop was vegetables where he applied high doses of fertilizers and FYM. He could not specify the exact dose for further interpretation.

Another farmer Mr. Nimai Mandi reported that the rice yield in their village is about 5-6 t/ha with traditional cultivation, whereas they could harvest through SRI in the range of 8 t/ha. The farmers of the village reported higher incidence of pest and diseases in the SRI plots.

It came to the fore that SRI made an overhauling change in the labour distribution for rice cultivation. Agriculture was traditionally a male-dominated job, and womenfolk used to help only in case of uprooting of seedlings, transplanting and harvesting. With the introduction of SRI, most of the operations are now shared by the women labour of the family along with the male. It is perhaps due to the effect of SHGs which is formed by female members only, and the concept of SRI had been introduced by them in the field. This made the women labour/ family member more responsible towards the success of the practice. The distribution of labour is given in the Table below.

Table: Distribution of labour in various operations

Operation	Traditional	SRI
Choice of variety	Male	Male
Seed treatment	-	Female
Seed bed preparation	Male	Both male and female
Seed sowing	Male	Both male and female
FYM+ Fertilizer	Male	Female

Preparation of drainage channels in the main field	-	Female
Seedling transportation	Male	Male, female, children
Transplanting	Female	Male, female, children
1st weeding	-	Male
2nd weeding onwards	-	Female
Spraying	-	Female
Harvesting	Female	Mostly female
Transportation	Male	Both male and female
Threshing	Both male and female	Both male and female
Cleaning and bagging	Both male and female	Both male and female
Marketing	Male	Male

Some of the constraints reported by the farmers about SRI practice:

- Lack of water caused problems in timely sowing and transplanting
- In low-lying areas, lack of drainage facilities was a problems for transplanting
- SRI practice causes nutrient depletion
- Pest and disease incidence has increased in paddy under SRI
- Weed is more in paddy under SRI

In Banshberda village, Barabazar Block, MTU 7029 is performing very good under SRI practice. The team visited the filed of the Service Provider of the Block, Mr. Sripathi, and observed that his field had the symptoms of leaf and neck blast, although it came at a very late stage which did not affect the yield of crop.

Social Inclusion and SRI

PRADAN made a deliberate choice to work with the marginalized tribes (ST), schedule castes (SC) and Backward Castes (BC) of Purulia and with the SCs and BCs of Gaya and Nalanda for their food security through the System of Rice Intensification (SRI). SRI in Purulia district is under rainfed conditions whereas in Gaya and Nalanda, SRI is under both well-irrigated and also rainfed conditions. The strategy of working through Self Help Group (SHG) in the old villages in Purulia ensured recognition of women as farmers and also ensured effective implementation of SRI. The new villages in Purulia are being covered through Panchayat and village-level Service Providers with a focus on poor women and men farmers.

In Bihar, PRADAN collaborates with the Bihar Rural Livelihood Programme Society (BRLPS), a World Bank-supported programme. There is a convergence of approaches to food security between PRADAN and BRLPS whose strategy is to implement the livelihood programme including SRI through village-level federations of SHGs known as Village Organisations (VO).

A majority of the families (70%) being covered in both states are joint families, owning around 0.5 ha of land; not more than 20% of these farming families own 1-2 ha. Only a few of the farmers at Tanashi (Purulia) and Shekhwara (Gaya) own more than 2 ha.

SC families at Shekhwara and poor tribal families at Gokul Nagar Majhidri, Berada Panchayat of Bara Bazar Block clearly expressed that SRI was a boon to them as the paddy yields got more than double (≥ 10 t/ha).

Atul Chandra Mandi (Santhal) of Gokul Nagar Majhidi said that his 7 bighas (approx. 1 ha) of land under SRI yielded more than 7 tonnes of paddy, sufficient for the 20 members of his joint family. SRI helped poor farmers belonging to SC and STs familie to increase their food grain sufficiency from 3-6 months before SRI, to 5-9 months after adoption of SRI, depending upon how much land was owned and/or accessed for SRI and the number of joint family members. The food security-gap of 3-5 months in a year is at present being managed, to some extent, by the poor through their out-migration for wage labour, bidi-making, NREGA employment, etc.

As SRI is basically a method involving intensive care and management of the nursery, water and weeds, the interaction among farm hands at home, particularly between wife and husband, on the field got enhanced.

Decisions regarding paddy varieties to be sown, selection of plot to be brought under SRI, and procurement of inputs on a collective basis are made through a consultative process in groups, at home and on field.

The resource persons (RP) and service providers (SP) drawn from different groups within the tribes (in Purulia) or in communities within heterogeneous villages (in Gaya and Nalanda) indicate that socially-inclusive approaches to extension result in faster adoption of an innovative method like SRI. PRADAN could induct 133 farmers into SRI covering approximately 35 ha. within 6 months in Bihar. Both female and male farmers expressed, during focus group discussions, that they would increase their area under SRI next *kharif*.

Agricultural Mechanization and Social Inclusiveness:

Traditionally, paddy transplantation, weeding and harvesting have been in the domain of female farmers/labourers. Introduction of mechanical weeders under SRI has both positive and negative social impacts. Mechanical weeders are needed not only to hasten up the process of weeding but also to provide aeration to the root zone of paddy seedlings/tillers and to reduce the number of labourers required, thereby reducing the cost of cultivation. PRADAN could easily motivate tribal women in Purulia to take up the operation of mechanical weeders (cono weeders), but in the heterogeneous villages in Gaya and Nalanda where the feudalistic society still tends to confine women to traditional activities this was not so feasible. That the Village Organizations (federations of SHGs) are gaining in financial strength and negotiating skills is a positive indication that over time, women in Gaya and Nalanda districts will also start operating various agricultural implements/machinery as part of their micro-enterprise. PRADAN has initiated the process of motivating the SHGs to own farm machinery and operate the same on rental basis.

SRI is proved to be highly productive (2 to 8-fold increase in paddy yields over conventional methods) in the context of small and marginal farmers. There are bright indications doe increases in the number of farmers and area under SRI. The Programme Director of ATMA, Gaya, said that even rich farmers were taking to SRI covering larger areas. This necessitates mechanization of tilling, of marking the fields for transplantation (roller markers), weeding, harvesting, threshing, and even the parboiling of paddy, which

again has been in women's domain. Thus there is ample scope for improving the stakes of SHGs.

Number of agricultural labourers has grown only 1.5 times (1991/113,970 to 2001/172,114) whereas there is a 2.75 times increase in the number of female agricultural labourers (1991/86,235 to 2001/234,804). Although the sex ratio favours men, it is women who are more in numbers under the marginal worker and non-worker categories. All this is despite the West Bengal Government giving priority to women in promoting household industry, a 6.5 times increase in household enterprrises held by women (1991/7,186 to 2001/45,115 units). Hence in Bengal, it is relatively easier than in Bihar to keep agricultural machinery in the domain of SHGs. The World Bank-assisted Bihar rural livelihoods programme with its emphasis on empowerment of SHGs and increasing their livelihoods is effective, as evidenced by PRADAN'S achievements within six months of starting SRI in Gaya and Nalanda. It is creating a conducive environment for women to acquire technical skills and to run micro-enterprises such as rendering services on charge-for-service basis by operating and maintaining agricultural/processing machinery/units.

Illegal alienation of *bhudan* lands and assigned lands and the extent of landlessness in Gaya and Nalanda demand a special focus on the marginalized farmers and on agricultural labourers. BRLPS and PRADAN are addressing this issue. Social inclusion for equity demands that the swelling numbers of agricultural labourers and of able-bodied among the non-workers will have to be given priority while forming SHGs and building capacities for micro-enterprises.

Incentives to SHGs for starting innovative micro-enterprises such as the ones mentioned above, for the sake of food security, are the immediate need. As per the enquiries made at the District Agricultural Office at Gaya, subsidies are available for agricultural machinery (power tillers with necessary attachments, roller markers, weeders, harvesters, threshers, etc.) and mini-agro-processing units such as parboiling units. Either the farmers' collective/ cooperative, if promoted, or the federation of SHGs would be able to do collective marketing of what they want to sell, but this will be successful only if they are trained well on negotiating/ bargaining/ marketing skills.

There is conclusive evidence that SRI can support inclusive management of land, water and other inputs for cultivating paddy. Expansion of SRI would ensure gains in total food grain security.

Sustainability of SRI: Farmers' Pperspective

Farmers were of the view that with the higher production and the same amount of chemical fertilizer application, the productivity of the soil will go down gradually. In villages of Purulia it was reported that the production in SRI-followed fields has gone down as compared to that they have harvested in the first year (4.4 tons/ha compared to 3 tons/ha). It needs to be understood that SRI productivity depends in good part on maintaining organic soil fertilization.

The villagers of Purulia are adopting the method under rainfed situation where proper water management could not be achieved. In spite of that, they were getting 7.5 t/ha yields. With zero or little input of organic matter to the fields, the farmers are destined to bear the cost of declining productivity. There is a perception among farmers of a need to further increase the use of fertilizers in the coming days, so as to sustain the targeted productivity, but this will definitely lead to further deterioration of the soil quality. Hence, it was observed that Integrated Nutrient Management (INM) principles should be followed by the farmers in these areas to maintain the soil health. If proper and enough organic matter is added to the soil on a regular basis through vermi-compost, FYM, green manure, and rice stubble, the productivity of the soil will definitely be sustained. SRI emphasizes organic cultivation of paddy. The sustainability issue needs to be addressed by exploring the possibilities of enhancing the availability of organic inputs.

The focus group discussions in both Purulia and Gaya revealed that contrary to the perception that SRI is a labour-intensive system of rice cultivation, in practice it requires less labour. Although the farmers are not yet so experienced in adopting SRI, they found the uprooting and transplanting of seedlings for SRI use to be much easier than that in traditional method. This indicates that SRI method will not be a problem in regard to labour availability when all the farmers adopt the method and have gained experience. Also the demography of the districts being covered in Bihar and Bengal does not indicate a shortage of farm workers.

Institutional Sustainability

PRADAN's strategy is to work with SHGs and service providers (SPs) and skilled extension workers (SEWs) in the old villages of Purulia and the BRLPS villages in Bihar, to ensure continuity of efforts in the promotion of SRI. SHGs are known as 'Building Blocks" of poverty eradication. However, the stumbling blocks appear to be a lack of crystallized linkages between the SHGs and the Panchayats at village level. In the new villages of Purulia, PRADAN began working through the Panchayat and the village-level SPs and resource persons (RPs). It is in the process of forming SHGs.

The most fundamental element of sustainability is the capacity building of the local institutions and other stakeholders, an aspect well taken care of by PRADAN in both West Bengal and Bihar.

Despite excellent performance of SRI in terms of enhanced yields, efforts to share the learning with the state and district authorities in West Bengal are not yet effective,

probably because of the negative perception entertained by the establishment towards the civil society organizations (CSOs) and NGOs. This barrier can be broken through multi-lateral partnership among Sir Dorabji Tata Trust (SDTT), the World Wide Fund for Nature (WWF), CSOs/NGOs, Tripura officials, KVKs of the State Agricultural University, and ICAR institutions and by organizing promotional state-level workshops on SRI at Purulia, West Bengal.

BRLPS in Bihar is planning scaling-up of SRI in 18 Development Blocks falling in 6 districts: Gaya, Nalanda, Madhubani, Mujafarpur, Purnia and Khagaria, with effect from February, 2008. At present, SRI work in Bihar is initiated in two blocks, one each in Gaya and Nalanda districts, and it would be extended to 16 blocks (for a total of 18 blocks). BRLPS, being a para-statal body, is likely to be continued beyond the project period for the benefit of mainstreaming the institutional learning which would contribute to the sustainability of efforts for food security. The Chief Executive Officer (CEO) of BRLPS, Mr. Arvind Choudhary, IAS, and the Development Commissioner of Bihar, Secretary of Rural Development, Bihar and most importantly the Dy. Chief Minister of Bihar are all favorably inclined towards propagating SRI. They appreciated the performance of SRI in the field. That indicates political will, bureaucratic commitment, and appropriate institutional mechanism: BRLPS working through VOs/SHGs facilitated by Panchayat, DAO and ATMA, for implementing SRI on a large scale in Bihar.

Mr. Ajit Kumar Singh, Block Project Manager, BRLPS, took the initiative in conducting a village-level meeting at his native village Akabarpur in Asthawan Block, Nalanda district, for propagating SRI under rainfed conditions during his leave period! Mr. Ajit claimed positive response to his initiative from the farmers of his village which indicates that BRLPS staff are not only dutiful but also convinced about the effectiveness of SRI.

PRADAN is promoting collective procurement of inputs through SHGs and the SPs based on advanced crop planning. Collective marketing strategy will have to be worked out for better returns. The need for collective marketing would arise when SRI coverage increases resulting in marketable surpluses.

Immediate need is to motivate and train SHGs with priority to the landless, on power tillers with required attachments, harvesters and threshers which can be operated on a service-charge basis, micro enterprises and appropriate storage structures for preventing losses on account of the present harvesting, threshing, drying and storing practices being sub-optimal. Mechanization of harvesting and post-harvest operations/processing, including small parboiling and drying units, would reduce drudgery and save time which can be utilized better for growing a second crop in areas where residual moisture is considerable and in seepage areas below the traditional tanks.

For institutional sustainability, the linkages between the Panchayat, VLW, BDO, District Development Authority, on one side, and the BRLPS including VOs, on the other side, need to be crystallized and cemented. On the whole, there is positive environment for the sustainability of SRI as a movement for resource conservation, cost reduction, and food grain security.

Rationale for Further Funding

Global and domestic demand for rice is bound to increase with every coming year. It is now established that rice yield in risk-free irrigated eco-systems has reached a plateau. There is very little scope for increasing the area under rice except during the *boro* season, which offers a great potential.

Also water tables are falling in most states including Punjab, Haryana and almost all the states in Southern India. With thousands of irrigation wells going dry each year, India finds it increasingly difficult to feed the 18 million people added to its population each year (August 2004, USDA Report). A situation has come where we have to produce more rice with less water and less land, and with more efficient utilization of monetary and non-monetary inputs.

In the Package of Practices (POP) of all the state agricultural universities and central institutions, 10% of the main field has been recommended for raising rice nursery, with a seed rate of 15-20 kg/ha depending on the seed size of the rice variety. Farmers are also advised to transplant 20 to 30-day old seedlings, depending on the growth duration of the variety, and with 2-3 seedlings/hill. In spite of all the extension and transfer of technology programme, rice nursery management is very poor. Farmers in conventional method use 5% of their main field, a seed rate of 40 kg/ha, and transplant seedlings 35-40 days old, 10-15 seedlings per hill, at depths of 6-10 cm.

At this seed rate, seedlings are very weak and thin. There is unhealthy competition resulting in the formation of few weak tillers with poor root systems. This results in formation of underdeveloped grains and finally lower grain yield. The grain milling and cooking quality of such a product is also poor. In general, nursery management is very poor in the entire country. 8 to 12-day-old seedlings when transplanted at proper spacing depending on the tiller capacity of the variety, at a depth of just 2 cm and with a single seedling per hill produces more number of tillers per hill.

In the SRI method of cultivation, all the fundamental principles of good agronomy are taken care of. Seed rate of 5 kg/ha in 500 m^2 area leads to the development of healthy seedlings. Transplanting 8-12 day old seedlings helps in timely tillering. Since seedlings are very small, perfect field leveling becomes a necessity. This directly helps facilitate uniform light irrigation with less water, allowing needed aeration of the soil for microbial activity around the root zone. Weeds are a problem in *kharif* season. By proper spacing, mechanized weeding is possible. This method is even more relevant to small/marginal farmers in completely rainfed ecosystems on medium upland and lowlands. Nursery is grown in the same field on receiving the first rain and simultaneously the preparation for the main field begins. By the time the second rain comes, the nursery as well as the main field are ready for transplanting.

During our visits to farmers' fields in the districts of Gaya, Nalanda and Purulia, we have observed that farmers have been able to raise a better crop by following SRI method with the same variety and same inputs as in the case of conventional method. Therefore, we are convinced that the farmers with small holdings and with their own labour will find this method more profitable. Wherever farmers have grown rice with this method of cultivation, neighboring farmers have adopted it without getting direct training as they found it workable in their conditions.

CONSTRAINTS

1. Many small and marginal farmers do not have pairs of bullocks to prepare the land for rice transplanting.

2. Not all can buy the mechanical weeders. Sharing of the available few weeders becomes difficult.

3. Extension support on SRI from Government agencies including KVKs is nil. Village-level workers are absent in most places.

4. Majority of the farmers own less than one hectare of agricultural land. They depend upon other sources of income for total food security, which is still a distant dream. When they work as agricultural labourers, they do not get wages as per Minimum Wages Act. Equal wages cannot be dreamt of. Wages are as per negotiation and vary from season to season and village to village. The fate of landless agricultural labourers is still worse.

5. Rice transplanters presently available are not suitable for SRI.

6. Roller markers are found to be inconvenient, requiring a lot of mental concentration and attention – a perceptional constraint.

7. Green manure and enough farmyard manure are not available in Purulia, Gaya and Nalanda regions. This necessitates use of chemical fertilizer.

8. Service providers and resource persons have to work for more time on extension support services besides working on their own fields.

9. Subsidies on agricultural inputs and machinery such as power tillers with necessary attachments, roller markers, weeders, harvesters, threshers, etc. are either not available or are insufficient. Information services on such aspects are inadequate.

10. As green manuring and application of FYM/vermi-compost and even tank silt are almost nil, soil health may deteriorate over time resulting in gradual reduction in yields, a common constraint to both conventional and SRI methods of paddy cultivation.

11. The practice of flattening plants after harvest for drying in the field itself causes the loss of both quality and quantity of grains. The farmers do it for practical reasons:

    - No space for storing the harvested plants before threshing
    - Time gap between harvesting and threshing
    - Majority of the farmers try to do all operations all by their family or farm hands without engaging labourers, that is to save on money.

12. The West Bengal Government is not favourably inclined towards CSOs/NGOs and their efforts. This hampers scaling-up of SRI in West Bengal.

13. Community threshing and drying floors/platforms are not available in the villages visited.

Recommendations

In the eastern and southern states, a majority of the rice farmers have very small holdings, and a very large percentage of their area is rain-dependent. Since this method of cultivation has given significantly more yield, it should be further taken to other farmers. This will help in meeting their rice needs for the whole year. At present, each farmer with the present practices is able to produce only enough to meet their household requirement of 4-8 months.

Based on our observations of the standing SRI-paddy crops and crops grown with conventional method standing side by side, with the same inputs applied, and from our interaction with farmers in both States, we are convinced that the farmers have been successful in increasing their yield by SRI compared to the conventional method of cultivation. Therefore, we come to the following recommendations:

- To take the advantage of this methodology, it must be put on fast-track
- To keep it on fast-track, timely training and exposure visits by various stakeholders in the system is essential. This can be completed before *kharif* 2008 by taking them in *boro* season where SRI method can be demonstrated being practiced alongside conventional paddy fields.
- Front Line Demonstration in the new areas with the assistance of trained personnel is essential for popularizing the method.
- Timely availability of genetically-pure and healthy seeds is the hallmark of higher productivity.
- Availability of manual/power operated weeders, green manure, vermi-compost, fertilizers, harvesters, and power threshers needs to be assured.
- To take the message to other areas, timely financial help is essential.
- Linkages among the ICAR, state agricultural universities, NGOs/CSOs and other allied institutions are a pre-requisite for large-scale popularization of SRI.

Principles of conservation are integral to SRI – a method of scientific management of water, soil, seed and weed.

Poor women farmers find SRI most suitable and hence gainful.

The following recommendations contribute to food grain security.

- Conservation of rain water under rainfed conditions is essential, ideally on 5% of the rainfed land prepared for ponding runoff water.

- Non-chemical approaches to manuring and pest control need to be given priority.

- Subsidies to be made conditional for promoting the sharing of water from wells and for agricultural equipment to be managed on group ownership basis.

- Women can be trained as trainers. One or two lady service providers are not sufficient. Because of the involvement of SHGs/VOs, the expansion/scaling up of SRI is made easier (Examples: PRADAN's old villages in Purulia district and BRLPS' VOs (federations of SHGs) in Bihar).

- Spacing of seedlings can be reduced from the present 30 cm to 25 cm in West Bengal and Bihar.

- Only high-yielding varieties of rice, but not hybrids and not GM varieties, should be cultivated to ensure seed freedom while following the principle of total seed replacement at least once every three years.

- SRI can be scaled up by integrating SRI use into watershed programmes and also Swarna Jayanthi Gram Swarojgar Yojana, a family-based programme in West Bengal and also Bihar just as SRI is integrated into the rural livelihoods programme in Bihar.

- Direct sowing of seeds at one seed per cross-joint in a 25 cm square grid covering at least 0.33 ha can be tried by PRADAN on an experimental basis.

- Inter-cropping of SRI fields with leguminous and other varieties of fodder can be tried to see the effect on weed growth and paddy yields.

- Village-level workers at the Panchayat level need to be motivated and trained on SRI.

- SRI principles can be adopted on experimental basis in the cultivation of millets, sugarcane, etc.

- Integrate water harvesting (5% of the land held) into SRI fields, with drainage channels emptied into the farm pond.

- INM and IPM with a focus on organics should be integrated into the ICM, that is SRI.

- Custom-hiring centres should be in the hands of SHGs of the landless and marginalized farmers after imparting necessary operating and maintenance skills.

- The office bearers and members of Panchayats and Block-level staff in West Bengal and Bihar need to be trained on SRI.

- Rain-drained soils require replenishment of organic matter that restores/sustains soil productivity.

- Soil testing is essential for determining the dosage of bio-fertilizers, chemical fertilizers, and application of tank silt wherever possible.

- Integrated farming system that fits the family profile needs to be introduced on the basis of house-to-field net planning. New housing, if any should be designed as per the grain storage requirements and other household livelihood activities – space management.

- To save on time, to scale up SRI and most importantly to reduce the drudgery of women, power-driven weeders need to be introduced.

- Mechanization of agriculture on group ownership/service-charge basis in the context of marginalized and small farmers is essential. As land consolidation is not accomplished, poor farmers have to run from one piece of land to the other to undertake timely operations. Mechanization can help them save time and energy. Conventional practices of harvesting and threshing result in considerable loss of grain. Poor farmers cannot afford to engage labourers. Joint families are better off than small nuclear families as far as working hands are concerned.

- There is need for preserving local varieties of paddy which are drought-resistant and require fewer inputs. Local varieties like Sona Dhusri but not high-yielding varieties come to the succor of poor farmers in times of environmental and/or economic stresses. Hybrid varieties are not at all suitable in the context of the resource-poor.

- Landless agricultural labourers also need to be trained on SRI to help them get over resistance to change from conventional practices.

- Linkages among SHGs/VOs, farmers, and autonomous bodies like KVKs, ATMA, universities and line departments are needed for better convergence to facilitate scaling-up of SRI.