Note on SRI research activities and up scaling strategies

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1. Introduction

Rice is an important staple for most Indians. Rice production will need to increase dramatically in the next decades to meet the demands of a growing population, not to mention the existing global food and nutrition deficits. This increase must be accomplished with less land per capita, smaller and less reliable water supplies, less degradation of the environment, and less drain on the resources of smallholder farmers, who constitute the majority of the world's poor. Finding local solutions to food production is essential to eliminating hunger and providing insurance against rising food prices. Since rice production has been growing at an annual rate less than 2% during the past decade, acceleration is obviously needed, and quickly, to avoid a rice crisis by 2020. This is a challenge that needs to be addressed in the Twelfth Five Year Plan now being formulated.

There is limited scope of any further increase in the area under rice cultivation over the present 42 million ha. India needs to increase rice production by about 2.5 million tones a year in order to meet its requirements in 2050 – an almost 92 % increase on its current production of 98 mtonnes. Therefore, much of the desired increase in grain production has to be attained by enhancing the productivity per unit area. Water for agriculture is becoming increasingly scarce, and climate change-induced higher temperatures will increase crops' water requirements, so shortages will become more serious. *Most water is used for agriculture to irrigate crops, especially rice. It takes three to five times more water to grow rice than wheat or corn. As competition for water increases and SRI methods are a promising opportunity to reduce water scarcity*. The recent record shows stagnation in yield growth associated with the current strategy of trying to promote production through introduction of new varieties and increased application of agrochemical inputs (fertilizers, pesticides, etc.). The Green Revolution strategy, which was successful in the 70s and 80s when increases in rice production were 27% and 39% per decade, respectively, has been losing momentum.

2. Opportunities with the System of Rice Intensification

The System of Rice Intensification (SRI) is perhaps the best current example of options available to farmers and nations to promote community-led agricultural growth, while managing soil and water resources more sustainably and even enhancing their future productive capacity.

SRI is a management-based rather than variety-dependent or depending on external inputs. This innovation is known as the System of Rice Intensification (SRI), developed in Madagascar in the 1980s and now used by at least 250,000 farmers in India. SRI differs from Green Revolution approaches in that use of new varieties or agrochemical applications are not necessary. In SRI, concurrent increases in the productivity of land, labor, water and capital are achieved by modifying the way that rice plants, soil, water and nutrients are managed. The ability of these changes in management to evoke more productive plants from practically all varieties, new and old, has been seen in more than 40 countries.

3. a. The elements of SRI include: *transplanting young seedlings*, 8-12 days old and less than 15 days; *reducing plant populations* by as much as 80-90% per m^2; converting paddy soils from anaerobic, flooded status to *mostly aerobic conditions*, by alternate wetting and drying; *active soil aeration*, with mechanical weeders that also control the growth of weeds; and *increased soil organic amendments*, possibly but not necessarily making production fully 'organic.' While some of the practices appear counterintuitive – getting more production from fewer plants, with less water application and with reduced reliance on chemical fertilizers – the effects of each can be explained and justified scientifically (*Paddy and Water Environment*, 9:1, 2011)

b.Salient findings on SRI- Directorate of Rice Research

For the past 5 years (2005 onwards) SRI comparative trials were conducted at DRR and other 25 AICRIP centers across the country for its feasibility and quantification of the benefits of SRI

- In tails of AICRIP centers, SRI performed well and found superior (7- 12% higher grain yields)over Conventional flooded irrigation with reduced inputs but the response is not same in all the situations. (ACRIP reports 2005-2010, Mahender Kumar etal., 2010)
- Differential response of varieties for yield under SRI, however most of the varieties tested found promising in SRI over conventional method. Hybrids and medium duration cultivars showed greater promise under SRI method
- The number of effective tillers /m^2 , panicle length, dry matter and other yield attributes such as grains per panicle are higher in SRI.
- Irrigation water reduced by 25-30 % there by enhanced water productivity in SRI in different seasons.
- SRI method with conjunctive use of organic and inorganic fertlisers found promising initially and organics recorded on par yields with chemical fertilizers after 3-4 seasons

- Long term trails on nutrient management in SRI indicated that there is no depletion of nutrients from soil due to continuous SRI cultivation

Based on the research findings we can say that SRI can be implemented in suitable areas not across the country with reduced seed , water and other inputs. It needs slight modifications in different areas as per local situations to make it wide scale adoption. The use of older seedlings during rabi (2.5 leaf stage nursery) and combined use of organic and inorganic are the some of the recommended modifications for SRI.

c. . Upscaling strategies followed in different states (Approximate area of SRI in different states):

In Tripura (50% of rice area) , Tamilnadu (6.5 lakh ha), A.P. states (1 lakh ha) the SRI has spread in sizable area due to:

- Govt policy and active involvement of Govt organisation
- Large scale demonstrations on SRI (Compact block demonstrations)
- Delineation of SRI suitable areas and Implementation in suitable areas
- Govt incentives to SRI adoption and hands on support for implementation at block level
- Collaborative and concerted efforts of different organizations – SRI consortium (Govt, research organistations and NGO's)
- Lot of publicity and mass media
- Farmers exposure visits to acquaint SRI technology

Status of SRI in India

SRI was introduced in India in 2000 when researchers at the Tamil Nadu Agricultural University (TNAU) initiated experiments involving SRI principles in a collaborative project on growing rice with less water. TNAU results in 2000-02 were followed by evaluations on farmers' fields. The results showed an average increase in grain yield by 1.5 tons/ha in both basins with reduced input requirements, and even 8% reduction in labor needed per hectare. This evaluation provided a basis for officially recommending SRI adoption to farmers in 2004.

Concurrently, in Andhra Pradesh, Acharya N.G. Ranga Agricultural University (ANGRAU), introduced SRI in farmers' fields during *kharif* season 2003.Trials in farmer's fields were conducted in all districts of the state. These results generated nationwide

interest as they showed significant yield increases over conventional irrigated rice cultivation. Data from SRI experiments across India show an increase in grain yield up to 68 % (Table.1).

Table1. Grain yields in SRI recorded in experiments across India

S. No Location	Grain yield (t/ha)		% increase over Conv	Source
	Conv	SRI		
Tamil Nadu Rice Research Institute, TNAU, Aduthurai (2005)	*4.7*	*7.1*	*48.9*	*Rajendran et. al., 2005*
14 Research stations, ANGRAU, Andhra Pradesh (2007)	*4.9*	*5.7*	*16.6*	*Mallikarjuna Reddy et. al.,2007*
Indira Gandhi Agricultural University, Raipur, Chattisgarh (2007)	*4.3*	*5.1*	*17.8*	*Shrikant Chitale et al., 2007*
Agricultural Research Institute, Patna, Bihar(2007)	*3.9*	*6.1*	*55.1*	*Ajaykumar et. at., 2007*
Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puduchery (2007)	*2.2*	*3.7*	*68.3*	*Sridevi and Chellamuthu, 2007*
ICAR complex , Umiam Meghalaya (2007)	*4.7*	*5.2*	*10.2*	*Munde et.al.,2007*
Central Rice Research Institute, Cuttack, Orissa (2006)	*5.6*	*7.0*	*25.0*	*Rao.et al., 2007*
Regional Agricultural Research Station, Shillong, Assam (2007)	*3.1*	*4.5*	*45.2*	*Bora and Dutta, 2007*
Agricultural Research Station, UAS, Kathalagere, Karnataka(2005)	*8.8*	*10.2*	*15.9*	*Jayadeva et.al., 2008*
Main Rice Research Station, AAU, Bawagam, Gujarat	*4.7*	*7.5*	*37.1*	*Chauhan et al., 2008*
Birsa Agricultural University, Ranchi, Jharkhand	*4.3*	*5.0*	*16.3*	*Singh et.al., 2009*

Source: More Rice with Less Water (WWF 2008).

Research Experiences on SRI at DRR and AICRIP centers across India

For the past 5 years SRI comparative trials were conducted at DRR and other 25 AICRIP centers across the country for its feasibility and quantification of the benefits of SRI

Features of SRI:

- Use of young seedlings (10-15 day old).
- Planting single seedling with utmost care at shallow depth at a spacing of 25 x 25 cm.
- Weed management with cono weeder to incorporate emerged weeds.
- Use of more organics along with reduced dose of inorganic fertilizers.
- Intermittent and shallow depth of water upto Panicle Initiation and thin film of water after Panicle Initiation stage to maturity.

Salient findings on SRI

- In most of the AICRIP centers, SRI performed well and found superior over Conventional flooded irrigation
- Different principles studies were also found to influence on grain yield
- Varietal performance was different in SRI however most of the varieties tested found promising in SRI over conventional method. Hybrids and medium duration cultivars were promising
- Total; number of tillers , SPAD values at different growth stages panicle length dry matter and other yield attributes are higher in SRI.
- Root biomass per plant, Microbial biomass carbon was found higher in SRI
- Water quantity for irrigation reduced by 25-30 % there by enhanced water productivity in SRI in different seasons
- Long term trails on nutrient management in SRI indicated that there is no depletion of nutrients from soil due to continuous SRI cultivation

Water productivity as influenced by conventional vs SRI method (Mean of *kharif* and *rabi)*

Parameter	Method	Quantity	Per cent
Water applied (m^3/ha)	Conventional	13055	
	SRI	8906	32.0 (reduction)
Water Productivity (kg/m^3)	Conventional	0.32	
	SRI	0.48	
Unit Water requirement (l/kg	Conventional	3125	

grain production)	SRI	2083	

India's population is projected to reach around 1.59 billion by 2050 there by it becomes the world's most populous country by 2035 itself . SRI method has the immense potential to increase rice production by enhancing productivity level with enormous savings in water and seed resources. The anticipated impact of SRI through various components assuming that about 10% of area (4.0 m ha) is brought under SRI (Annexure 1.)

Impact of SRI adoption in India in 10% of rice area

Component	**Inputs used**		**Total estimate**		**Advantage due to SRI**	
	Conventional	**SRI**	**Conventional**	**SRI**	**Quantity**	**Economic terms**
Seed use	50 kg/ha	5 kg /ha	0.20 m tones	0.02 m tones	0.18 m t	Rs 180 crores
Irrigation water	1490 m^3	920m^3	5960 million m^3	3680 million m^3	2280 million m^3	
Additional area to be brought under irrigation				1.2 m ha		
Additional Production					5.0 m t	Rs. 5000 crores
Production	3.17 t/ha	4.17 t/ha	12.68 m t	16.68 m.t	4.0 0 m.t	Rs.4000 crores
Total Production					9.00 m t	Rs. 9000 crores

***If the SRI is adopted even on just 4 m.ha (10% of the rice area) in India, there would be saving of seed worth 180 crores. The increase in area and production is estimated to be 1.2 m ha and 5.0 m. tones with is equivalent to Rs. 9000 crores. There is also saving of nearly 2280 million m^3 of irreplaceable ground water for future* . This is apart from un accounted benefits such as health, nutrition and overall improvement in the rural economy.**

- Proposed states for adoption (A.P., T.N., Karnataka, M.P., U.P., Bihar, W.B., Tripura, Jharkhand, Punjab, Sikkim, J&K.)

Approximate area of SRI in different states:

- SRI implementation has been a component in NFSM programmes and demonstrations have been conducted in identified districts of NFSM.

- Many NGOs across the country are popularizing, training the rural farmers on SRI.
- SDTT and NABARD are also funding to popularize the SRI in different states.

Spread of SRI method in different states:

SRI INDIA FACTSHEET 2009-10					
S.No	**State**	**Farmers**	**Area in Ha**	**Total partners**	**Districts**
1	Bihar	34358	1938	6	10
2	Orissa	17093	3740	52	17
3	Uttarakhand	9330	352	32	15
4	W Bengal	5863	508	7	10
5	Madhya Pradesh	4648	1203	2	2
6	Gujurat	4000	1240	1	2
7	Chhattisgarh	3993	781	12	10
8	Himachal Pradesh	3782	140	12	6
9	Jharkhand	3042	443	17	17
10	Andhra Pradesh	2354	1590	24	12
11	Maharashtra	2093	185	9	11
12	Assam	951	191	25	17
13	Karnataka	600	NA	1	2
14	Tamilnadu	300	207	2	2
15	Manipur	220	22	11	7
16	Uttar Pradesh	----	20	6	3
	Total	**92627**	**12560**	**217**	**143**

*** The figures are not included the area covered by Dept of Agriculture of different states**

In Tripura (50% of rice area) , Tamilnadu (6.5 lakh ha), A.P. states (1 lakh ha) the SRI has spread in sizable area due to:

- Large scale demonstrations on SRI
- Deleniation of SRI suitable areas and Implementation in suitable areas

- Govt incentives to SRI adoption and hands on support for implementation
- Collaborative and concerted efforts of different organizations
- Farmers exposure visits to acquaint SRI technology

Potential areas identified for SRI adoption:

Both on-farm and on-station evaluations across many states and diverse growing environments have shown clearly that SRI has the potential to improve the yields. By considering the irrigation area by different sources for rice and potential area for SRI cultivation is nearly 11.58 m ha. If rainfed area also considerable for implementing SRI nearly 33% of the area (15.62 m ha) can be converted for SRI cultivation (Annexure .1). However ther is a scope to implement the SRI at least 60% of the potential area i.e 4 mha in India. The potential area for SRI is computed based on the area irrigated by canals, tanks and other sources in different states presented in table and Figures . The potential areas of SRI adoption varied from 0.5 mha to 2.28 m ha in different states states viz., Tamilnadu, Bihar, Orissa, Punjab,West Bengal, Andhrapradesh and UttarPradesh. There is scope for further delieniating SRI suitable areas by taking into different type of soils, drainage and water logging and climatic variations.

Potential of SRI :

- Saving of 30 – 40% irrigation water, as the water requirement is less in SRI
- Saving of 85 % on seed, as the seed requirement is less (5 kg / ha as against 40-50 kg/ ha in Conventional method). This is very critical for hybrid rice cultivation as the cost of hybrid seed is relatively higher. Therefore, growing hybrids under SRI is more profitable
- Saving on chemical fertilizers, pesticides as organic manures / natural biocides application is emphasized.
- Even partial adoption of six recommended SRI practices is known to enhance the yield substantially (10-15 %)
- Crop duration reduced by 7-10 days due to absence of transplanting shock and faster establishment of seedlings
- SRI is most suitable for seed multiplication (Breeder and Foundation) as initial seed requirement is small and rouging is easy due to planting of single seedling and wider spacing .
- Increase in soil microbial activity and improves the soil health
- Seed quality under SRI is reported to be better.
- Providing healthy food and environmental protection due to non use of inorganic fertilizer and pesticides
- More yield with less cost of cultivation and hence more net returns and higher benefit cost ratio

- Overall SRI is one of the best options for sustainable rice production

Focussed Research activities:

- Systematic assessment of the advantages of SRI
- Effect of SRI on the physiology of the rice crop
- Dynamics of the soil biological fertility under SRI
- Standardization the inter-cultivation with weeder and development of the motorized weeders
- Suitable growing ecosystem, season and varieties have to be identified for SRI and popularized.
- Soil water balance studies and water saving in SRI
- Tools for SRI
- Long term effects of SRI
- Pest disease interactions with SRI
- Socio- economic impact of SRI

Target 20% of Rice Area to be converted into SRI in the 12th FYP –

Under a creative partnership among – Government + Research + Civil Society

Strategies for upscaling SRI

- Mission mode project for SRI implementation across the country with specified budget and as consortium mode at various levels (Block, District, State and National)
- Efforts need to be made explore the possibilities of main stream funding to promote irrigation through *in-situ* moisture conservation measures to promote SRI with more farmers in this terrain.
- Water user association has to be strengthened in the SRI prevalent areas.
- Knowledge building of farmers and laborers through training and exposure so that key can learn to play and decide how to use selected techniques of SRI in growing rice successfully.
- Sustained efforts have to be made to encourage the use of organic manure to improve the soil. Promotion of green manuring and composting has to be addressed immediately and provision of subsidies.
- The Farmers' Training Centers, KVKs and NGOs can give training to farmers, farm women, and farm youth which will improve their knowledge and skill associated with SRI.
- Strengthening of extension staff at block level with hands on support
- Policy advocacy in National level so as to facilitate main streaming SRI
- Integrations of farm ponds and SRI with support from NREGS, RKVY especially to focus on rainfed SRI.

Annexure 1.

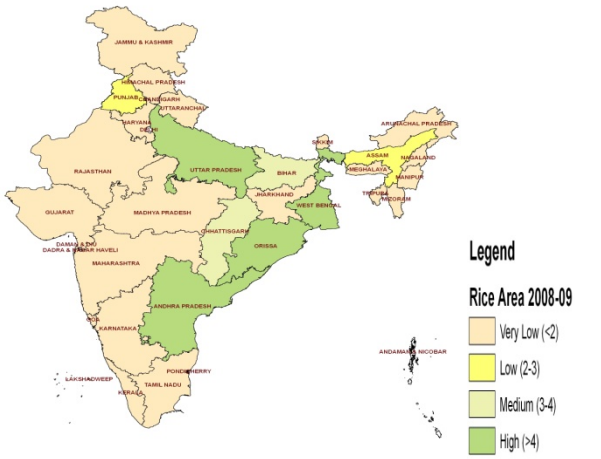


Fig.1Rice Area in different States

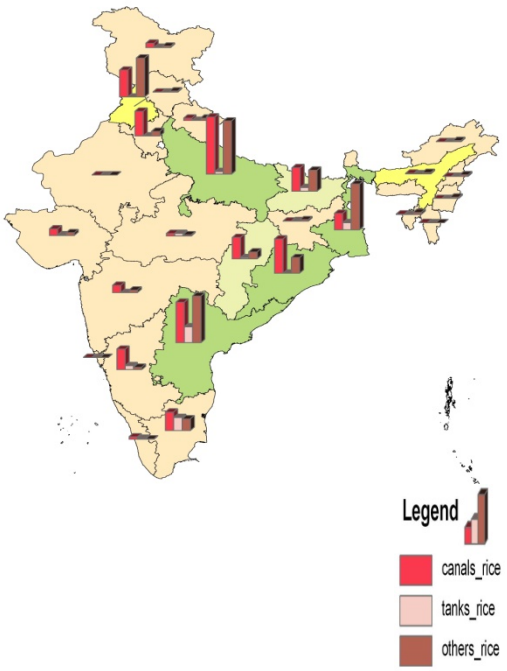
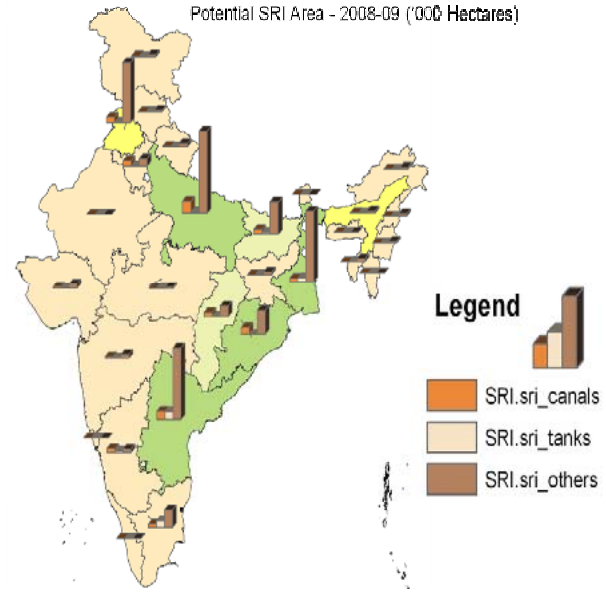
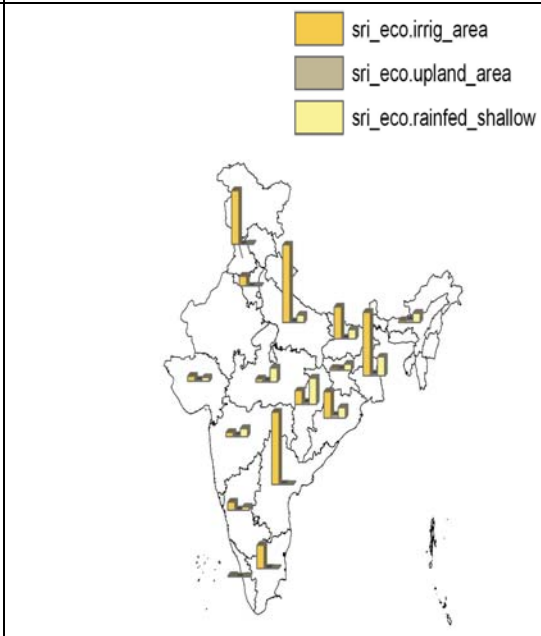


Fig.2Irrigated area of rice with different sources



Potential SRI area in Irrigated rice



Potential SRI area in different ecosystems

Fig.3 Potential SRI area in different states

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