[NATIONAL COLLOQUIUM ON SYSTEM OF CROP INTENSIFICATION (SCI)]

FIELD IMMERSION OF SYSTEM OF CROP INTENSIFICATION (SCI) on 28/02/2011

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NATIONAL COLLOQUIUM ON SYSTEM OF CROP INTENSIFICATION (SCI)

1. Bihar Rural Livelihoods Project (BRLP)

The Bihar Rural Livelihoods Project, locally known as JEEViKA is being implemented by Bihar Rural Livelihoods Promotion Society (BRLPS), an independent Society under the Department of Finance, Government of Bihar. The JEEViKA project is supported by the World Bank and builds on the experiences and lessons emerging from Bihar's efforts at poverty reduction. The objective of the project is to improve livelihoods of the rural poor through social and economic mobilization and enable them to access credit, assets and services such as social safety nets from public and private sector agencies, including commercial banks. The project is being implemented across 55 blocks in 9 districts (Gaya, Nalanda, Muzzafarpur, Madhubani, Khagaria, Purnea, Supaul, Madhepura and Saharsa)

2. Agriculture Context in Bihar

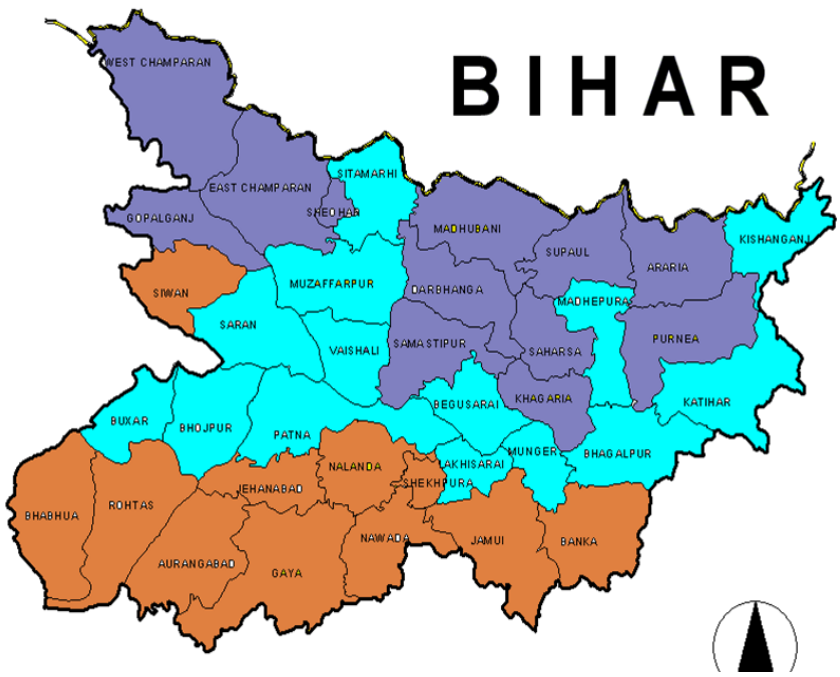
Agriculture is the core of Bihar's economy contributing 35% of state's GDP and employing nearly 75% of the labour force. Given that 88% of the State's poor live in rural areas, growth in agriculture is the key to improving livelihoods and reducing poverty. The key features of the Agriculture sector in Bihar and the opportunities are described in the following sections :

Low Size of Landholdings and Prevalence of Lease farming: In the case of Bihar, 70% of poor households are small and marginal farmers otherwise termed as smallholders across the world. Their average landholding ranges from 0.07 to 0.22 hectare & usually with no irrigation. A significant proportion of households who are landless, either take land on lease or practice sharecropping to undertake agriculture for getting their staple food i.e., paddy. The option of a second crop i.e., wheat or pulses will depend on assured irrigation facility or better residual soil moisture availability, if it is a normal rainfall year. Depending on the family size, the present landholding pattern can only provide food security for 4-5 months. The landless farmers do agriculture on leased land or practice sharecropping.

Input Constraints (Seed, Extension Services, Credit) : Availability of good quality seeds is typically a big constraint faced by the small and marginal farmers in Bihar. The prevalence of fake seeds is rampant. Even in district towns, it is difficult to find well stocked good quality seeds and fertilizer stores. Most of the poor and marginal farmers are using the grains of the previous year to sow their crop (seed replacement rate is nearly 30% in paddy & wheat, 17% pulses, 50% oilseeds & 85% in maize) and most of the existing varieties used are over 15-20 years old. With the inadequate government extension machinery, farmers have no access to knowledge and problem-solving services. Lack of availability of institutional credit for agriculture and poorly developed water and land resources also contribute negatively for the low productivity of agriculture.

Frequent occurrence of Flood and Drought: The state experiences flood and drought very frequently. While North Bihar suffers from floods almost every year, about 33% of the area in the state (mostly South Bihar) receives less than 750 mm of rainfall placing Bihar in the category of chronic drought prone state in India.

FLOOD AND DROUGHT PRONE DISTRICTS IN BIHAR



Flood Prone

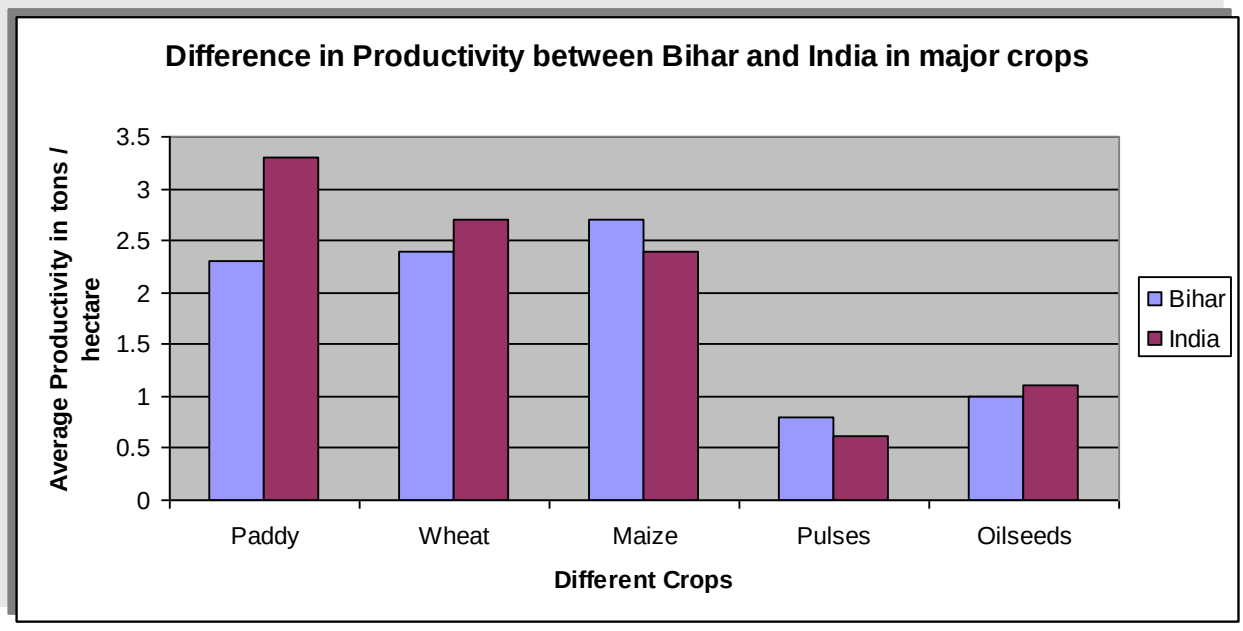
Flood & Drought Prone

Drought Prone

Low Productivities: Bihar has one of lowest agriculture productivities in the country. The average productivity of paddy and wheat, the 2 major crops of the state is lower than National average. The average yield of major crops given in tons / hectare is given below;

	Paddy	Wheat	Maize	Pulses	Oilseeds
Bihar	**2.3**	**2.4**	**2.7**	**0.8**	**1**
India	**3.3**	**2.7**	**2.4**	**0.62**	**1.1**

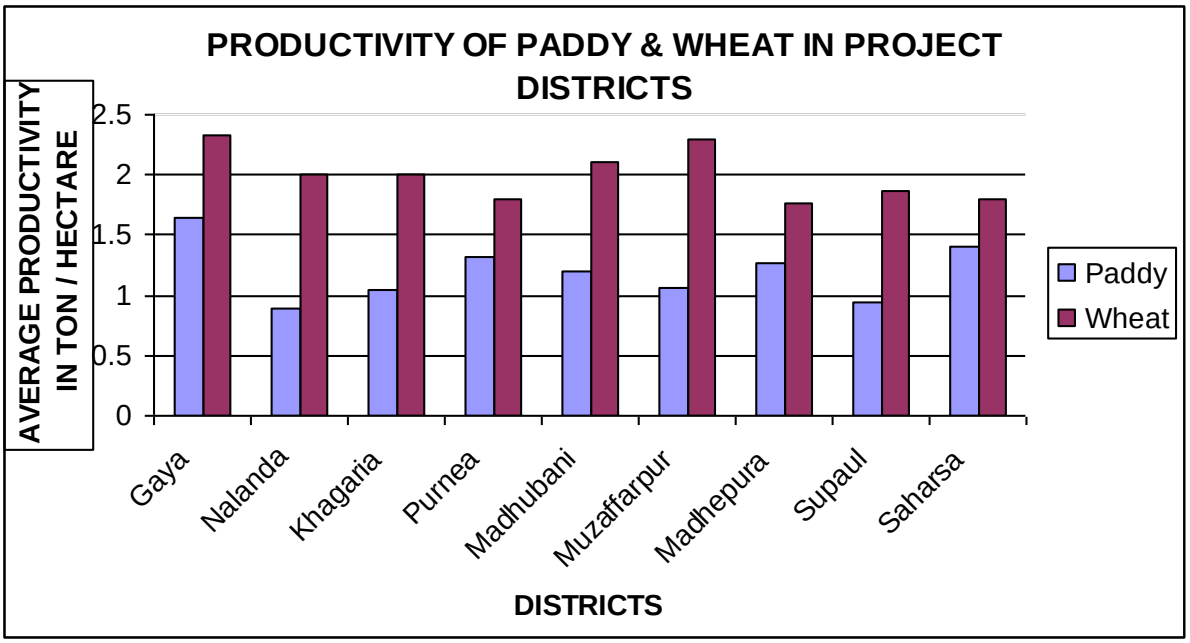
(Data Source : Department of Agriculture, Govt. of Bihar-2010)



The average district wise paddy & wheat productivity in the project districts is given below. The table shows that productivity in these districts is lesser than the state average. Typically the average yield of the smallholders in Paddy and Wheat is even lower than the district average yield.

	Gaya	Nalanda	Khagaria	Purnia	Madhubani	Muzaffarpur	Madhepura	Supaul	Saharsa
Paddy	**1.65**	**0.89**	**1.04**	**1.31**	**1.2**	**1.06**	**1.27**	**0.95**	**1.41**
Wheat	**2.33**	**2**	**2**	**1.8**	**2.1**	**2.3**	**1.76**	**1.87**	**1.79**

(Data Source : Department of Agriculture, Govt. of Bihar-2003)



Opportunities **:** On the other hand Bihar offers a huge opportunity for agriculture. Its Indo-gangetic fertile plain land and the availability of ample water resources offers a huge potential to increase productivity. Concerted efforts towards intensification and diversification of agriculture through the delivery of effective extension services for changing of varieties, inputs supply, farm knowledge services, diversifying into multiple crops, development of irrigation infrastructure, availability of institutional credit and backward and forward linkages with the market can lead to productivity enhancement and increase in per unit realization for the farmers.

3. Rationale for the Intervention

Majority of the poor grow Paddy and Wheat**:** Majority of the SHG households are among the poorest and take up Paddy in the Kharif and Wheat in the Rabi seasons. Thus an intervention touching these 2 crops would have the highest outreach and more specifically among the poor.

Direct impact on Food Security**:** Households retain most of the produce for their own consumption and only the surplus is sold out. Thus the increase in productivity in these two crops would have the twin impact of increase in their food security and increase in incomes.

4. Methodologies : SRI, SWI & SCI in JEEViKA

a. Initiation of System of Rice Intensification (SRI)

System of Rice Intensification (SRI) : Fr. Henri de Laulanie, S.J, first developed SRI methodology in Madagascar in the 1980s. Systems of rice intensification or SRI is a methodology rather than a technology, in which the management of soil, water, plant and nutrients is altered for greater root growth and nurturing microbial diversity resulting in healthier soil and plant conditions. In SRI, practices like seed rate, method of raising of seedlings in nursery, transplantation, control of water in the main field, weeding / hoeing are modified to ensure higher ratios of tillers to mother seedling, increased number of effective tillers per hill, enhanced panicle length and bolder grains, or in short enhanced yield of paddy.

In short, the practice of SRI in comparison with the traditional practice may be depicted as below:

PARTICULARS	CONVENTIONAL	SRI
Seed Treatment	**Not Done**	**Done with salt solution & fungicide**
Seed Rate (Kg / Hectare)	**50 – 60**	**5**
Nursery Area (Sq ft / Hectare)	**10750**	**800**
Age of Seedling for transplantation	**21 – 35**	**8 – 14**
Spacing	**No Spacing**	**25 cm * 25 cm (10′ * 10′)**
Weeding / Hoeing	**No Weeding**	**3 times**
Yield	**2 ton / ha**	**4-6 ton / ha**

Piloting and scaling up of SRI **:** During the preparation phase of the project, it was learnt that the low productivities in paddy and wheat had an adverse impact on the food security of the households. The average paddy yield of small and marginal households belonging to Self Help Groups formed by JEEViKA was ranging from 0.8 to 1.2 tons per hectare, which could only meet 4-5 months of rice consumption of the household. The project thus piloted the System of Rice Intensification (SRI) in 2007 with 128 smallholders belonging to SHG households in 30 hectares of land. It was observed that the average paddy yield was nearly 10 tons per hectare which was significantly higher than the existing productivity. Based on the success of the pilot, the project has scaled up SRI in the subsequent 3 years with 5146, 8367 and 19911 smallholders.

During SRI pilot in 2007, Barti Devi, an SHG member from Gaya had difficulties in convincing her husband Shri Dilu Yadav to undertake SRI. After 4 rounds of heated arguments at home; Barti Devi finally took up paddy cultivation through SRI and got 272 Kgs per Kattha i.e., 18.3 tons per hectare. Today Barti Devi has become a role model for many SHG women and travels across many project villages before the paddy & wheat season to mobilize poor SHG members to cultivate paddy/wheat through SRI. In a public function attended by the Hon'ble CM in 2008, Barti Devi talked about the benefits of SRI and requested the Hon'ble CM to scale up SRI to all the smallholders in Bihar. Her dream came true, when the Chief Minister, Shri Nitish Kumar launched SRI KRANTHI on 27th January, 2011 to scale up SRI in 3.5 lakhs hectare with around 12 Lakh households.

The year wise progress of System of Rice Intensification (SRI) in the project is given below;

Particulars / Years	2007	2008	2009	2010
Nos. of SHG members / smallholders	128	5146	8367	19911
SRI Land in hectare	30	544	786	1412
SRI Yield in tons / hectare	10	7.75	6.5	3.22*
Traditional Paddy Yield in tons / hectare	2.7	2.36	2.02	1.66*
Highest SRI Yield in tons / hectare	18.18	19.3	14.2	6.5
State average Paddy Yield in tons / hectare			2.3	
Climatic conditions		Water stressed condition	Drought	Extreme Drought

*** Data of 74 villages analysed**

b Initiation of System of Wheat Intensification (SWI) in the Project

System of Wheat Intensification (SWI) : SWI involves modifying the practices like seed rate, sowing of seeds at proper spacing, control of water in the main field, weeding / hoeing to ensure higher ratios of tillers to mother seedling, increased number of effective tillers per hill, enhanced panicle length and bolder grains or in short enhanced yield of wheat.

PARTICULARS	CONVENTIONAL	SWI
Seed Treatment	Not Done	Done with Warm water, Cow Urine Jaggery, Vermi-compost & fungicide
Seed Rate (kg / hectare)	100-125	20-30
Sowing	Broadcasting	Line Sowing
Spacing	No Spacing	20 cm * 20 cm (8' * 8')
Weeding / Hoeing	No Weeding	3 times
Yield	1-2 ton / ha	3-4 ton / ha

Piloting and Scaling up of SWI **:** After Paddy; Wheat is the second major staple food crop in Bihar. In 2008 (the 2nd year of SRI) the project felt that, if the yield of wheat can be enhanced through the similar methodologies in wheat then the food security of the smallholders may be ensured. Thus the System of Wheat Intensification (SWI) was piloted with 415 smallholders during Rabi 2008-09 in 16 hectares of land. The average yield was 3.7 tons per hectare against the yield of 1.8 tons per hectare through conventional methods in the same area. Based on the success of the pilot, the project has scaled up SWI in the subsequent 2 years with 25235 and 48521 smallholders in Bihar. The year wise progress of System of Wheat Intensification (SWI) in the project is given below;

Particulars / Years	2008-09	2009-10	2010-11
Nos. of SHG members / smallholders	**415**	**25235**	**48521**
Area in hectares	**16**	**1200**	**2536**
Average SWI Yield in tons / hectare	**3.7**	**4.5**	**Cont.**
Traditional Wheat Yield in tons / hectare	**1.8**	**1.6**	**Cont.**
Highest Yield in tons / hectare	**8.4**	**10.012**	**Cont.**
State average Wheat Yield in tons / hectare		**2.4**	
Climatic conditions	**Normal Rainfall**	**Little shower at the end of rainy season**	**After Extreme Drought**

Date of Sowing : 05/12/2010

Crop Stage on 02/02/2011

Phool Kumari Devi, an SHG member from Muzaffarpur had started SWI with just 2 Katthas (1/12th of an acre) of land and the increase in yield was so high that it enabled her to recover 8 Katthas of land that she had mortgaged for taking a loan. Today she grows wheat through SWI on all her 15 katthas of land.

c System of Crop Intensification (SCI) in Pulses, Oilseeds & Vegetable

System of Crop Intensification (SCI) in Green Gram & Rapeseed : SCI in green gram and rape seed involves lower seed rate, seed grading and treatment, sowing with wider spacing or transplantation of young age seedlings with wider spacing, organic manuring, intercultural operation & proper weeding leading to enhanced yield. During the successful scaling up of SRI and SWI; the project has piloted the application of similar methodologies in different crops such as Green Gram & Rapeseed with around 500 SHG households. The results were very positive, the yields almost doubled for both the crops.

Green Gram Seed Treatment under System of Crop Intensification (SCI)

Harvest stage of Rapeseed grown through System of Crop Intensification (SCI)

The year wise progress of System of Crop Intensification (SCI) in Green Gram & Rapeseed in the project is as follows;

Particulars / Years	2009-10	2010-11
Green Gram		
Nos. of SHG members / smallholders in Green Gram	**490**	**2400**
Area in hectares	**32**	**527**
Average Yield in quintals / acre	**7.5**	**Cont.**
Traditional Green Gram Yield in quintals / acre	**2.5**	**Cont.**
Rapeseed		
Nos. of SHG members / smallholders in Rapeseed	**7**	**425**
Area in acres	**0.48**	**27.96**
Average Yield in quintals / acre	**12.15**	**Cont.**
Traditional Rapeseed Yield in quintals / acre	**6.75**	**Cont.**

System of Crop Intensification (SCI) in Chilli, Tomato & Brinjal **:** The seeds are treated with cow urine, warm water, vermi-compost, jaggery, trichoderma and the germinated or wet seeds are sown in nursery at 2 inches at either side of spacing. Organic environment is made in nurseries and seeds are sown at proper spacing. Compost and soils are treated with trichoderma. Every care is taken to minimize the shock by taking seedlings attached with soils. Then 8-12 days old young seedlings are uprooted carefully and transplanted in main field. Shallow transplanting is done. One feet deep and 0.5 feet diameter pit is made to provide conducive environment for intensification of roots. The farmers should provide favorable environment for the profuse root growth and shoot growth is outcome of attention on roots. Proper irrigation channels are made to facilitate aeration in roots and 2-3 inter cultural operation is done by using SRI-Rabi weeder. The productivity enhancement is around 40-85%.

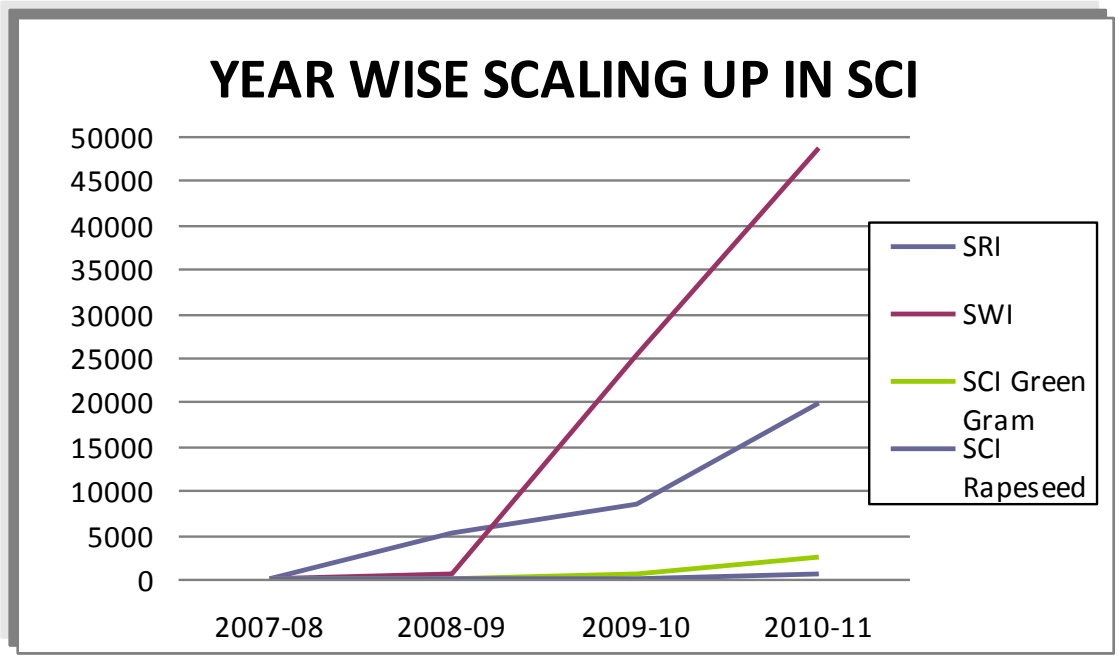
System of Crop Intensification (SCI) in Tomato

System of Crop Intensification (SCI) in Brinjal

The difference between yield of Chilli, Tomato & Brinjal through System of Crop Intensification (SCI) and conventional method is given below;

Vegetable Crops	Unit Description	Nos. of smallholders	Conventional	SCI
Chilli	Kgs / Plant	69	1.5-2	4.5-5
Tomato	Kgs / Plant	168	3-4	12-14
Brinjal	Kgs / Plant	42	5-6	10-12

It is found that in SRI, SWI & SCI; the disease & pest infestations are less, use of agro chemicals are lesser, requires less water, can sustain water stressed condition, more application of organic matter and yield in terms of grain, fodder & firewood are higher.



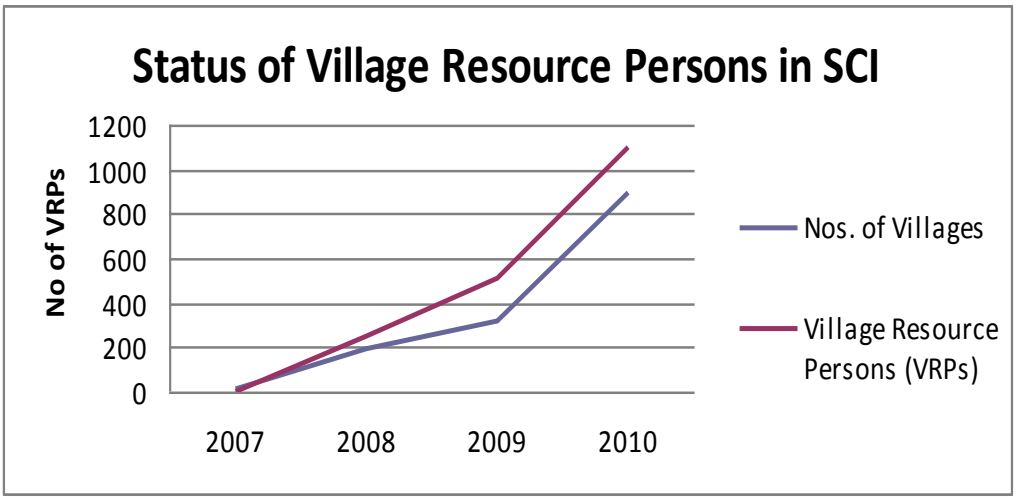
5. *Strategies* :

Community Managed Extension System : One of the key strategies that has played a big role in the scaling up of the intervention has been the use of the community managed extension system. As part of this the Village Organisations (essentially a federation of 8 to 15 Self Help Groups in a village) identifies and appoints a local youth may be a male / female (called the "Village Resource Person") to carry out the extension work for the intervention. The VRPs are given intensive training that includes on-field demonstration. The training module for VRPs was developed and delivered by PRADAN & ASA, the technical support partner agencies. On-the-job technical guidance to the VRPs is provided by Subject Matter Specialists (SMSs) appointed by the support agencies (PRADAN & ASA) or engaged directly by the BRLPS. Each VRP provides services to 30 to 120 farmers (depending on the ability of the VRP to reach-out and influence farmers). VRPs undertake farm/plot-visits to note the progress of the crop and advise the farmers on the field operations. The Village organisations review the work done by the VRPs every month as part of their regular meetings. There is a regular weekly VRP meeting organized to review the progress on quality & quantity of the interventions, updatation of agriculture database, training need assessment of the VRPs for organizing & imparting refresher training to the VRPs. During the yield assessment, few of the plots have been measured by the respective District Magistrates, District Agriculture Officers, officials of Krishi Vigyan Kendras (KVKs) and district Agriculture Technology Management Agencies in presence of the smallholders and VRPs. In the process, the VRPs are also trained to measure the yield scientifically and after which, the VRPs measure all the plots scientifically in a cross verification mechanism. Cross Verification Mechanism means one VRP will assess the yield of the plots of another VRP and vice-versa. This ensures that the VRPs are monitored rigoroulsy right at the village level thereby avoiding the typical problem of information assymetry encountered by public sector extension system.

VRP Register **:** The VRP register is integral to the Community Managed Extension System to have farmerwise data on land, sowing date, intercultural operation dates, plot observations and yield assessment. After the scientific yield assessment by the VRP, the yield data is mentioned in the VRP register and certified by the concerned smallholder.

A recent study on the effectiveness of VRPs notes that 92% of the sampled 300 families were satisfied with the VRPs work and appreciate the hand holding support, timeliness of support, regular monitoring and input supply services provided by/through the VRP. The payment structure of the VRP is based on the deliverables (number of farmers practicing SRI/SWI) and is positively biased towards farmers belonging to scheduled castes and scheduled tribes as well as towards farmers cultivating on leased land or share cropping. In 2010, around 1100 VRPs have been identified by the VOs in 892 villages and trained by technical experts hired by the BRLP. The yearwise VRPs supporting SRI-SWI are as follows;

Year	Nos. of Villages	Nos. of smallholders	Village Resource Persons (VRPs)
2007	**15**	**128**	**3**
2008	**194**	**7753**	**250**
2009	**322**	**25235**	**510**
2010	**892**	**68432**	**1095**



External technical support: A key factor that influenced the success of the SRI and SWI interventions in BRLPS is the involvement of NGOs – PRADAN and ASA – as technical support partners. PRADAN was instrumental in execution of the action research initiative in 2007 that led to the framing of the strategy for scaling up. A recent study comissioned by the BRLPS noted that a village would require about 3-4 years of intervention by the technical support organization to introduce the methodology, cover the entire village, set up systems and withdraw. In tune with this, in the current year, the external technical support agencies have been withdrawn from areas implementing SRI since 2008. The services of these agencies are planned to be utilized in project areas where the interventions are to be newly introduced. The monitoring of the field implementation in the older areas has been mainstreamed and is done by the block level staff. Technical support in these areas is taken from hired individual consultants as and when needed by staff of BRLPS.

Micro-Planning: Micro-planning at SHG level has been exercised as a mechanism to generate demand for SRI/SWI and to standardize the package of inputs used by the farmers. A package of inputs are provided to all SHG members desirous of adopting SRI/SWI. These inputs include quality seed, vermi-compost, fertilizers, etc., which are collectively procured by the Village Organisations with facilitation by the VRP. This input package is costed and the SHG members repay this amount to the VO after the crop season (members not requiring a loan can pay the amount upfront to the VO – individual procurement is not permitted). This micro-planning cycle is repeated every crop season to ensure quality inputs to farmers.

Focus on the poorest: Right from the micro planning stage the focus of the intervention is to reach the poorest who have so far been untouched by the public sector extension system. The VRPs incentive structure is also positively biased towards the poor. These mesaures have ensured that a large percentage i.e, 29% are from Scheduled Caste, 65% are from Backward Caste / Extremely Backward Castes and around 40-50% of leased land SHG members are covered under this programme.

6. Carbon Credit realization from System of Rice Intensification (SRI)

Agriculture releases significant amount of CH_4, N_2O and CO_2 into the atmosphere. These three are the major Green House Gases. In 2005, agriculture accounted for 10-12% of total global anthropogenic GHG emissions. From 1990 to 2005 the GHG emission has increased to 17%. CH_4 is produced when organic materials decompose under anaerobic conditions such as cultivation practices under flooded conditions (Smith et al. 2008). Aerobic soils however, act as an important sink for CH_4 (Awasthi et al. 2005). N_2O is produced as the intermediate product during nitrification and de-nitrification process. Nitrification is the process of aerobic microbial oxidation of ammonia into nitrate whereas denitrification is the process of

reduction of nitrate into gaseous nitrogen (Carlsson-Kanyama & González 2007; Vibol & Towprayoon 2010; Zhou et al. 2010). Production of N_2O is enhanced when available N exceeds plant requirements, especially under wet conditions (Smith et al. 2008).

The traditional paddy cultivation emits more methane and use of excessive nitrogenous fertilizer emits more nitrous oxide to the atmosphere. These two gases i.e., Methane and Nitrous Oxide are few of the major green house gases (GHGs) which causes global warming and resulting into climatic imbalance. Methane is 25 times and Nitrous Oxide is 298 times more powerful than Carbon Dioxide. The entities involved in reducing GHGs emissions are liable to get Carbon Credit, which is a source of revenue.

System of Rice Intensification (SRI) is aerobic paddy cultivation because of its alternate wet and dry method, regular weeding improves aeration resulting into less methane emissions. The emission of CH_4 from SRI soil was found to be 4 times less and N_2O flux from SRI treatment was 5 times less compared to traditional paddy cultivation. SRI practices appear to potentially minimize CH_4 emissions and N_2O emissions. The net GWP (global warming potential) due to combined CH_4 and N_2O emissions were significantly less in paddy cultivation through SRI. This has been adequately proved in many countries such as Sri Lanka, China, Nepal, Vietnam, etc. But the smallholders involved in paddy cultivation through System of Rice Intensification (SRI) have not been compensated with Carbon Credit benefits, who are making the world amenable for ecology to sustain for a longer period. It is envisaged that, systematic research needs to be carried out and reports to be published by the scientific community for rest of the world for developing a carbon credit protocol for SRI, which can be easily compensate with the efforts put up by the smallholders around the world.

7. Key Impacts

- ***Increase in Productivity:*** The System of Rice Intensification (SRI) & System of Wheat Intensification (SWI) intervention have increased the productivity of paddy & wheat by more than 2 times. In the extreme climatic conditions like drought 2010, the assessment of 74 villages data has shown that paddy productivity through SRI resulted in around two times i.e., 3.22 tons / ha than the traditional productivity of paddy i.e., 1.66 tons / ha.

- ***Increase in the Food Security:*** The smallholders involved in System of Rice Intensification (SRI) and System of Wheat Intensification (SWI) have yielded double the productivity in most of the cases. The smallholders, who have carried out these two interventions in more than 5 Katthas of land have achieved year around food security. But there are instances, where the smallholders who undertook it in around 10 Katthas of land have sold their marketable surplus. A recent impact assessment has shown that the intervention has had a positive impact on the food security of the participating families due to the increase in productivity. The number of days in a year that the households have to depend on external purchase has come down as a result of the intervention.

- ***Inclusion of the Marginalized*****:** It was observed that as a result of demonstration of higher yields through the SRI/SWI methodology intervention, landless households have been motivated into taking land on lease to take up SRI/SWI. Around 30% of SHG members have taken land on lease for taking up System of Wheat Intensification (SWI) during this Rabi season.

- ***Village Level Agriculture Scientist*** **:** Around 1100 nos. of Village Resource Persons were developed (out of which around 40% are women) to support the smallholders belonging to the Self Help Groups for undertaking System of Crop Intensification (SCI) in various crops.