Clima Rice Technical Brief 11-2012

System of Rice Intensification (SRI) - An Adaptation Technology for Changing Climate

CLIMARICE: "Sustaining rice production in a changing climate: Testing climate uncertainties and validating selected adaptation techniques in farmers field

June – 2012

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Farmers attempt to develop a different environment for rice under System of Rice Intensification (SRI) method by which the rice plants can exhibit their full potential. Major principles of SRI includes perfect land levelling, lower seed rate, transplanting young seedlings of 12 days old, single seedling / hill with wider spacing (25 x 25 cm), careful water management (applying a minimum of water during vegetative growth and at later stages maintaining only one inch water) and weed management using cono weeder thrice in the vegetative stage.

Researchers and farmers' experience in the Cauvery basin in Tamil Nadu from ClimaRice have shown that yields of rice could be increased considerably (18–27%) with reduced water consumption (22-25%) and less expenditure, just by following SRI method of cultivation. Thus it is beneficial for small and marginal farmers under changing climatic conditions.

In Tamil Nadu, the availability of water is declining with projected water supply-demand of about 21 billion cubic metre in 2025 (Selvarajan *et al.*, 2004). Rice is the staple food and vital for realising local food security of resource poor farmers of Tamil Nadu. The area cultivated with rice is about 2 million ha of which 70 per cent is irrigated. Rice cultivation requires water from 1300 to 2000 mm depending upon the local climatic conditions (Geethalakshmi *et al.*, 2011). Alternatively, Rice needs about 3000 to 5000 liters of water to produce 1 kg of grain. The alarming water crisis and water-intensive nature of rice cultivation are driving the search for modified management method to increase water productivity in rice cultivation. The

System of Rice Intensification (SRI) is an alternative method of rice cultivation that was first developed in Madagascar during 1980's to minimize water usage and increase the productivity.

Key Components of SRI

1. Perfect land leveling
2. Use of organic manures
3. Less seed
4. Square planting
5. Wider spacing
6. Transplanting young seedlings
7. Single seedling / hill
8. Less water
9. Turning back the weeds into the soil

Key cultural practices of SRI

A. Nursery management - Mat Nursery

For SRI method of cultivation mat nursery is highly suitable. Nursery area required for planting one hectre of main field is 100 sq.m. The seed beds have to be nutrient-rich and established as close to the main field as possible. Raised beds with the size of 1x5 sq.m are made and a polythene sheet is spread over the bed.

Mat Nursery after sowing

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

To prepare the mat nursery, wooden frames are placed over the polythene sheet and filled to a height of 4 cm with mixture of native soil (70–80%), decomposed farmyard manure (15-20%), rice husk (5-10%) and powdered DAP 1.5 kg/100 m^2. Around 7.5 kg of seeds is needed for planting one hectare of land under SRI. Sprouted seeds treated with bavistin powder (Carbendazim @ 4 g/kg of seed) are spread uniformly on the soil.

Sprinkle water immediately to soak the bed and then water the bed as and when needed to keep it moist all the time. Protect the nursery from heavy rains for the first 5 DAS and continue watering until 14 DAS.

Watering Mat Nursery

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

Urea solution (0.5%) is sprinkled at 9 DAS, if seedling growth is slow or leaves are yellowing (1.5 kg urea/300 l for 100 m^2 area). Seedlings reach 18-20 cm tall at 14 DAS. Water should be drained 2 days before lifting the seedling-mats.

Mat Nursery in Tanjore

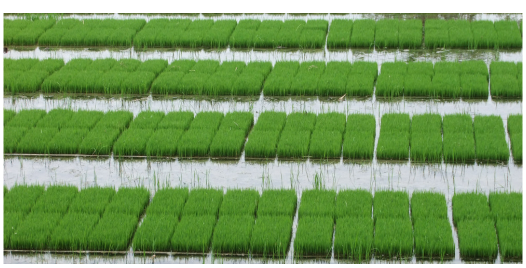

Photo: A. Lakshmanan, TNAU

Advantages of Mat Nursery

1. Reduced nursery area: 100 m^2 to plant 1 ha
2. Robust, young seedlings (18-20 cm tall with 4 leaves) produced within 15 Days After Sowing.
3. Easy transportation of seedling-mats to main field
4. Easy separation of seedlings for transplanting with minimum root damage

B. Main field management

1. Land preparation

Preparation of the main field in SRI is the same as in conventional method. However it is ideal that the field is dry ploughed and puddling by tractor is avoided. Otherwise, the weeder would get stuck and more energy would be needed to run the weeder. Particularly in black soils, the field should be ploughed and kept ready during summer itself.

It is recommended to use organic manures and nutrients, as they are better for promoting the abundance and diversity of microorganisms, starting with beneficial bacteria and fungi in the soil, there by improving production.

Land leveling in Main Field:

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

SRI requires careful leveling and raking, with drainage facilitated by 30 cm wide channels at two-meter intervals across the field. The plots should be small and levelled. For perfect levelling, lazer levelers can be used. If the plot is uneven, water would be stagnating at low points and field dried up at high points and the efficiency of irrigation water is lost.

2. Transplanting

a. Age of the seedling

Seedling-mats of 12 days old should be lifted from the mat nursery and taken to main field for transplanting. Care should be taken to transplant the seedling without experiencing any ‘shock’.

Lifting Seedlings from the mat nursery

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

The seedling should not be damaged either during uprooting or transplanting in the main field. The field should be lightly irrigated either on the same day or the day after transplantation. There should be no standing water while transplanting.

b. Spacing

Wide spacing with square planting is followed in SRI. The row to row distance and within a row plant to plant distance is maintained at 25 x 25 cm with a plant population of 16 per square metre. There are several ways by which to transplant at 25 x 25 cm spacing. Knots are tied at 25 cm interval on a long rope and used as a guide to transplant one row after the other. However, markers are available to help transplanting at 25 x 25 cm spacing. There are markers made out of wood as well as iron. There are bar markers that have to be drawn either way to form a grid and roller markers that would form grids at one go.

The wider spacing allows for sunlight to get through to the plant’s lower leaves and results in a higher level of photosynthetic activity. This, in turn, enhance growth and physiological activity of root system, since they get most of their energy from plant’s lower leaves.

c. Number of seedlings per hill

The seedlings must be transplanted singly with their roots intact, while the seed sac is still attached. They must not be plunged too deep into the soil, but placed at 1-2 cm on the ground at the appropriate point on the planting grid. If there is any doubt regarding the survival of plant then two plants can be transplanted per hill.

3. Nutrient Management

Application of Organic manure including farm-yard manure, green manure, green leaf manure and bio-fertilizers are recommended as basal application under SRI. Top dressing of nitrogenous fertilizers are done based on the colour of the leaf using leaf colour chart. By this way over use of fertilzers are avoided.

Leaf colour chart

Photo: International Rice Research Institute, Phillipines

3. Water management

Rice is not an aquatic plant. It can survive in water but does not thrive under reduced oxygen (hypoxic) levels. Rice plants spend lot of its energy to develop air pockets (aerenchyma tissue) in its roots under continuous inundation.

SRI field in Trichy, Cauvery basin

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

Farmers mainly grow rice under flooded conditions so as to control the weeds. However, the fields are not flooded under SRI method. Irrigation water is provided only to wet the soil. The field should be irrigated again when the soil develops hairline cracks. Depending upon the soil and the environment conditions, the frequency of irrigation has to be decided. After the panicle initiation stage until maturity, one inch of water should be maintained in the field. The water can be removed after 70% of the grains get hardened.

4. Weed management

Weeds would be more in SRI method as there is no standing water. Under no circumstances, chemical herbicides should be used in SRI method. Instead of weeding manually and throwing the weeds outside the plot, there are several advantages of turning the weeds into the soil by using 'weeder'.

Cono weeder in SRI Field

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

Weeding is done on the 10th, 20th and 30th day after transplantation using cono weeder. A day before using the weeder, the field should be lightly irrigated. Weeder should be moved front and back between every two rows.

Weeding in SRI field using conoweeder

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

After the weeding, under no circumstances the water should be drained out of the field. If this water is drained, all the nutrients would be lost from the field. By using the weeder, the soil gets aerated and the roots are exposed to air and also results in profuse growth of diverse soil micro organisms which make nutrients available to the plant. The better root growth in SRI was recorded in field trials conducted in the Climafarmers fields in Nachaloor and Neithaloor villages of Cauvery basin during 2011.

5. Pest and Disease Management

In SRI method normally the chemical pesticides and herbicides are not used. Wider spacing and use of organic manures results in healthy growth of the plants and incidence of the pests and diseases is naturally low. The pests can be easily managed by using some organic products like neem oil (Bio-pesticide).

SRI renders plants more resistance to pests and diseases as the plants receive balanced and complete nutrition by application of organic manure like compost. Field trials conducted in farmer's fields at Nachaloor village of Cauvery basin, Tamil Nadu through ClimaRice project during July-October, 2011, revealed that application of *Pseudomonas fluorescens* @ 5 kg/ hectare is effective in controlling rice blast disease under SRI.

SRI and Greenhouse gas emission (GHG)

Agriculture is one of the major contributors to the production and atmospheric accumulation of methane (CH4), which is produced by soil organisms (methanogens) that live under anaerobic conditions, i.e., in the absence of oxygen. The flooding of rice paddies to grow irrigated rice is one of the major sources of methane within the agricultural sector (Neue, 1993). Even though fewer reports are available on SRI's net impact on the emission of greenhouse gases (GHG) that contribute to global warming, there are reasons to expect that SRI contributes to slowing the accumulation of GHG. This remains to be evaluated thoroughly and precisely. The field experiments conducted under Climarice project during 2011 & 12 suggest that SRI emits less methane (8 mg/m^2/hr) when compared to conventional system (13 mg/ m^2/ hr). Converting rice production from continuously flooded to intermittently flooded soil, or even to mostly aerobic soil conditions, will reduce methane production, and hence SRI can be an eco friendly rice cultivation methodology. We also need to know whether and how much nitrous oxide is produced from SRI fields compared to the methane produced from conventionally flooded fields. Because SRI reduces or eliminates the use of chemical N fertilizers, relying on organic matter as the main source of nitrogen for plant and soil microbial nutrition, there is reason to expect that there will be little if any additional nitrous oxide produced as a by-product of SRI practices. Evaluating this systematically and scientifically should be a priority for all those who are concerned about abating the dynamics that are currently contributing to GHG accumulation and global warming.

Methane Estimation in SRI at Trichy

Photo: Senthilraja, ACRC, TNAU

Performance of Rice under SRI

The results of the field experiment conducted in the farmers field of Cauvery basin with different cultivation methods during Kharif 2011 indicated that under SRI, 22% increase in grain yield and 24.5% water saving compared to transplanted rice. The water productivity was also maximum under SRI method of rice cultivation (0.63 kg/m^3), followed by Alternate Wetting and Dring (AWD) and aerobic rice cultivation. The conventional rice cultivation produced lower grain yield per unit of water (0.36 kg/m^3) used (Geethalakshmi, 2011).

A study was conducted using Soil and water Assessment Tool (SWAT) to examine the influence of change in cultivation methods on the hydrology and rice productivity in Bhavani sub-basin of Cauvery basin in Tamil Nadu (Table 1) (Lakshmanan et. al. 2011).

Table 1. Comparison of rice cultivation systems on hydrology and yield of Rice

Parameters	Method of cultivation			
	TRC	SRI	ARC	AWD
Rainfall (mm)	1284	1284	1284	1284
ET(mm)	1322	1013	832	1085
PET (mm)	2099	2099	2099	2099
No. of irrigations	21	28	19	17
Quantum of water used (mm)	1220	920	740	1020
Saving in irrigation	-	300	480	200

water (mm)				
Yield (Kg/ha)	3032	4109	2401	3282
Difference in yield (%)	-	+ 26	-20.8	+ 8.2

TRC: Transplted Rice; ARD: Aerobic Rice; AWD: Alternate wetting and drying

In SRI system, the field is irrigated frequently but the water used for irrigating the field is only 50% compared to flooded system of cultivation. Hence, there is a saving of 300 mm of water and the yield was 26% more than the conventional flooded system of cultivation.

Farmer holding rice plant produced under SRI and flooded rice cultivation

Photo: T. Ramesh, Assistant professor, TRRI, Aduthurai

Advantages of SRI

a. When young seedlings are transplanted carefully at wider spacing, their roots grow larger on soil that is kept well aerated with abundant and diverse soil microorganisms.
b. Saving on water as wet- dry method is followed (22- 25%)
c. By using the weeder, the first advantage is the control of weeds and also adding organic matter to the soil. This gives the benefit of cultivating a green manure crop.
d. Cost of external inputs gets reduced as chemical fertilizers and pesticides are used minimum
e. Incidence of pests and diseases is low as the soil is allowed to dry intermittently
f. Rice plants develop about 30–80 tillers with big panicles, well-filled spikelet with higher grain weight and the yields are reported to be more by 18-27%.
g. Global warming potential is lesser in SRI method compared to conventional method of rice cultivation

Constraints in adoption of SRI

Though SRI has many adavntages over conventional rice cultivation, the adoption level is not high. Some of the reasons are discussed below:

A. The main obstacles to SRI adoption is mindset and attitude of the farmers who have followed flooded rice for a longer period.
B. An initial barrier is labour-intensity, while the methods are being learned (Moser and Barrett, 2003) especially for taking up planting. Once farmers acquire skill and confidence in the methods, SRI would prove to be labour-neutral or even become labour-saving (Uphoff, 2007). Climafarmers who cultivated rice under SRI in Cauvery basin, from their experience says that SRI is labour neutral once farmers learn the art of single seedling transplanting. However, mindset of the women labourers are not favouring to single seedling under square planting.
C. Non availability of skilled labour for handling very young seeling in square planting under SRI is also a another problem. To certain extent, as an alternative , mechanical transplanting can solve this problem.
D. If the land levelling is not proper, water would be stagnating at low points and field dried up at high points leading to drying up of plants and yield reduction

Mechanical transplanting in the Clima farmers field at Trichy, Cauvery basin

Photo: Babu, ACRC, TNAU

E. SRI recommends use of organic manure to meet the nutritional requirement of the crop. Non-availability of enough quantity of organic manures also is a big concern.
F. One of the important component in SRI is regulation of irrigation water. In the delta region of cauvery basin, cascade method of irrigation is followed and the water flows from one field to another which makes it difficult to regulate the irrigation. The same problem of water control was also experienced by Climafarmers of Tanjore region of Cauvery basin where irrigation and drainage are managed by single channel.
G. During the monsoon season, in the low lying areas, water stagnates and makes it impossible to cultivate rice under SRI method
H. Weeding using cono-weeder are recommended thrice under SRI. Clima-farmers in Trichy and Tanjore region found it difficult to operate the manual cono-weeder. While weeding with the weeder in one acre of crop, a person has to traverse a distance of 16 kilo metres with drudgery. Hence, farm labourers does not prefer to come for weeding operation. Recently, mechanical weeder have been developed, however, it is not yet cost effective.

Experience of the Clima farmers in SRI

In 2010-11 *samba* season, 37 farmers of Natchalur village in Karur District (Cauvery basin) adopted SRI method in 89 acres of land from almost zero area in the previous year. There was significant increase in yield (30.75%) and saving of water (35%) in SRI method as compared to the conventional method of rice cultivation in the village. The yield parameters such as number of productive tillers, number of grains per panicle, filled grains percentage were higher in SRI compared to conventional method.
Some of the specific case studies are presented below:

Mr.Anbalagan, progressive farmer from Natchalur village has adopted SRI in 5 acres under canal irrigation. He raised the mat nursery with 5 kg of seeds per acre and transplanted 14 days old seedling using rope marker. Weeding was done thrice using improved cono weeder on $30^{th,}$ 40^{th} and 50^{th} days after transplanting. Fertilizer was applied as per the soil test report. Application of urea with neem cake in split doses resulted in effective management of pest and diseases. He has recorded grain yield of 6300 Kg/ha under SRI as against 3940 kg/ha under normal method. The initial experience was bitter due to the criticism of the villagers, but at harvest, the neighbouring farmers of the village got convinced by seeing the higher yield.

SRI nursery in Mr.Anbalagan field

Photo: Diraviam, SKVK, Karur

Mr. Kalaiselvan, a progressive farmer from Mudhalaipatti village in Karur District with a total land holding of 3 acres was the first person in the village to adopt the SRI under the technical guidance of ClimaRice Project during 2010-11 and got 5400 kg/ha of grain yield which was 22% higher than the conventional method of cultivation

Mr. Karikalan, a progressive farmer from Keelapatti village of Kulithalai block raised paddy under SRI in 19 acres and got 5890 kg/ha of grain yield, which was 33% higher than the conventional method of paddy cultivation

Mr. Jeganathan, a progressive farmer of Natchalur village, cultivating paddy for more than 25 years adopted SRI in 5 acres. He used 7 kg of seeds per acre and transplanted 17 days old seedling with 25x25 cm spacing using rope marker. He got 5425 kg/ha of grain yield which was 15 % more than the conventional method.

Conclusion

To achieve full potential in paddy:

- A plant should have more number of tillers
- The number of effective tillers should be higher
- Panicle length and number of grains per panicle should be more
- The grain weight should be more
- The roots should have extensive and healthy growth

SRI satisfy all the above requirements and produce more grain yield with lesser water consumption.

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CLIMARICE II Project (2009-2012)

ClimaRice **is** an integrated project that aims to assess the climate variability and its impacts on the water availability and rice production systems in the Cauvery river basin of Tamil Nadu, and Krishna river basin in Andhra Pradesh, India. The overall goal is to contribute to the Regional and National adaption strategies to sustain rice production and ensure food security amidst changing climate. The partners are:

- Bioforsk - Norwegian Institute for Agricultural and Environmental Research
- Tamil Nadu Agricultural University, Coimbatore, India
- International Pacific Research Institute, Hawaii, USA
- International Water Management Institute, Hyderabad

The project is funded by the Ministry of Foreign Affairs, Norway/The Norwegian Embassy, New Delhi.

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