KEYNOTE ADDRESS https://doi.org/10.58297/MLIY2974

Policy Options for Scaling-Up SRI

Vibhu Nayar[1] and Ravichandran VK[2]

[1]Additional Chief Secretary/Executive Director, ITPO, Ministry of Commerce and Industry, Government of India, New Delhi, India.

[2]*Part time Climate Smart Agriculture Specialist, FAO, Tamil Nadu, India.

*Corresponding author email: vkr9999@yahoo.com

Abstract

The challenge of increasing food production, in the context vertical expansion through improved productivity per unit of land area under the situation of adapting to the changing climatic conditions that impose water scarcity and Green House Gases (GHG) emissions from the rice fields. Many research findings showed that SRI method outperforming in terms of yield and reduction in cost of cultivation along with several perceived ecosystem benefits. Finally, the researchers suggest for further promotion and scaling up of the SRI method in suitable regions of India is highly imperative. SRI is knowledge and experience-based method of rice production than input centric technology. The SRI method has been piloted in most of the countries and a section of farmers realized its full or partial potential but they are reluctant to spread their success with their fellow farmers. It is right time to undertake a few studies by the behavioural scientists to nudge this innovative method of SRI among farmers to the niche paddy growing areas. Grain yields reported from field experiments carried out in different parts of India showed yield increases ranging from 9.3% to 68% as compared with conventional practice. The Ministry of Agriculture that included SRI as part of the National Food Security Mission in 133 food-insecure districts. The research wing of SAU should evolve new or modify the available transplanters and weeders for the exclusive mechanization under SRI method. The beneficial effects of SRI like water-saving, use of less inputs and reaping higher benefits by SRI technology should be made aware among farmers through demonstration. The scaling up of SRI needs to be buoyed out by the joint efforts of State Agricultural University Researchers, ministry of Extension personnel's, not for profit organizations with farmers. Upscaling of SRI strategy will help achieve national as well as household food-security. This paper clearly describes the role of every institutional responsibility in reaching the unreached.

Keywords: SRI, Scaling-up, Role of SAU, Department of Agriculture, Yield.

Introduction

India has the world's largest area of rice cultivation area (44 million ha) and is the second-largest rice-producing country after China. Our country will need to produce at least 130 million tons of milled rice per year by 2030 in order to feed the growing population. The current level of production is 124 million tons.

The challenge is not only to increase food production despite the limited scope for expanding cultivated land area and greater constraints on water supply for the agriculture sector, but also at the same time to enable Indian farmers to adapt to changing climatic conditions. These conditions impose water scarcity and more extreme events of flooding, storm damage, extreme temperatures, and pests and diseases without loss of yield. There must also be reductions in the emission of climate-altering greenhouse gases (GHG) from farmers' rice fields.

The System of Rice Intensification (SRI) is a new system to increase food production and security with reduced inputs and lessng with lesser GHG emissions. SRI is neither an improved variety nor a technology. SRI is an amalgamation of Best Management Practices (BMP) relating to seedling age grid planting and to the management of irrigation, weeds, and nutrients. The effectiveness of the changes that SRI introduces into age-old practices is already proven through various research programs and endorsed by the uptake that has started in over 60 countries around the world.

The magnificent transformation can be found, in the roots of crop plants that grow more abundantly and robustly under SRI management, not just for rice crops but in other

crops as well. This has prompted some in India to rename SRI as 'the system of *root* intensification.' Changes occur particularly in the rhizosphere region around the roots, enabling roots to use the nutrients that are inherently available and externally-provided in the soil more efficiently.

In most of the Indian states and in other countries, the performance of SRI has been proved beyond any doubt under farmers' actual conditions to be superior as compared to present practices, based on demonstrations laid through central/state Government initiatives and through various international funding organizations. In addition to raising yields, SRI can reduce farmers' costs of production and their water requirements, with crops that can better withstand the growing stresses of climate change - water shortage and unreliability, storm damage, pests and diseases, and extreme temperatures.

The acceptance and sustainability of SRI is mainly dependent on changes in the behaviour of farmers rather than on increasing in applying of external inputs, making better use of the land, labour, water and seeds that farmers have access to. Under SRI, the synergy of its BM practices exploits more fully the genetic potential of the variety of rice. The scaling up of SRI with other farmers requires better understanding, new knowledge and skills, and a more modern management perspective on the tasks of farming, being willing to innovate and to make decisions based on observable, measurable results.

Despite the additional opportunity that SRI gives to produce more output with less inputs, relying more on natural processes and interactions. SRI also to reduce the generation of greenhouse gases, we find that the adoption and scaling up of SRI by rice farmers in different parts of the world and in India remains lower than warranted by economic and environmental considerations. While SRI falls clearly under the Government's commitment to 'natural farming,' there are yet to be nudging the policy-level initiatives that would scale up SRI as Climate-Smart Agriculture practices in a larger way, making appropriate adaptations to local agroecological circumstances.

Based on the experience gained during the rapid expansion of SRI use under a 'mission mode' approach followed under the World Bank-funded IAMWARM project in Tamil Nadu, where this use expanded from very low levels to 3,70,000 hectares within seven years, I would like to put forward a number of suggestions. This methodology is worth expanding in India and elsewhere because of the multiple benefits that SRI use exhibited on a large scale. A thorough third-party project evaluation like M&E, Independent Evaluation Group (IEG) and Inception Completion Results Review (ICRR) by World Bank reported that:

- **Paddy yield** had been increased by **22%** on average, even without all of the farmers using the recommended methods fully or carefully.
- **Water consumption** was reduced by **24%**,
- **Costs of production** were cut by **16%** on average.
- Farmer's **net economic returns** were increased by **45%** as a result of their producing more with less cost.
- Of economic and environmental interest, **energy consumption** was reduced by **37%**, and
- **Expenditure for labour** was diminished by **17%** on average, contrary to the stereotype that SRI is more labour-intensive.
- The project in Tamil Nadu did not focus on climate effects, so greenhouse gases were not measured, but a concurrent study by Oxford and Indian researchers in the neighbouring state of Andhra Pradesh calculated, doing Life Cycle Analysis, the SRI management reduced **greenhouse gas emissions** were cut by **40%**.

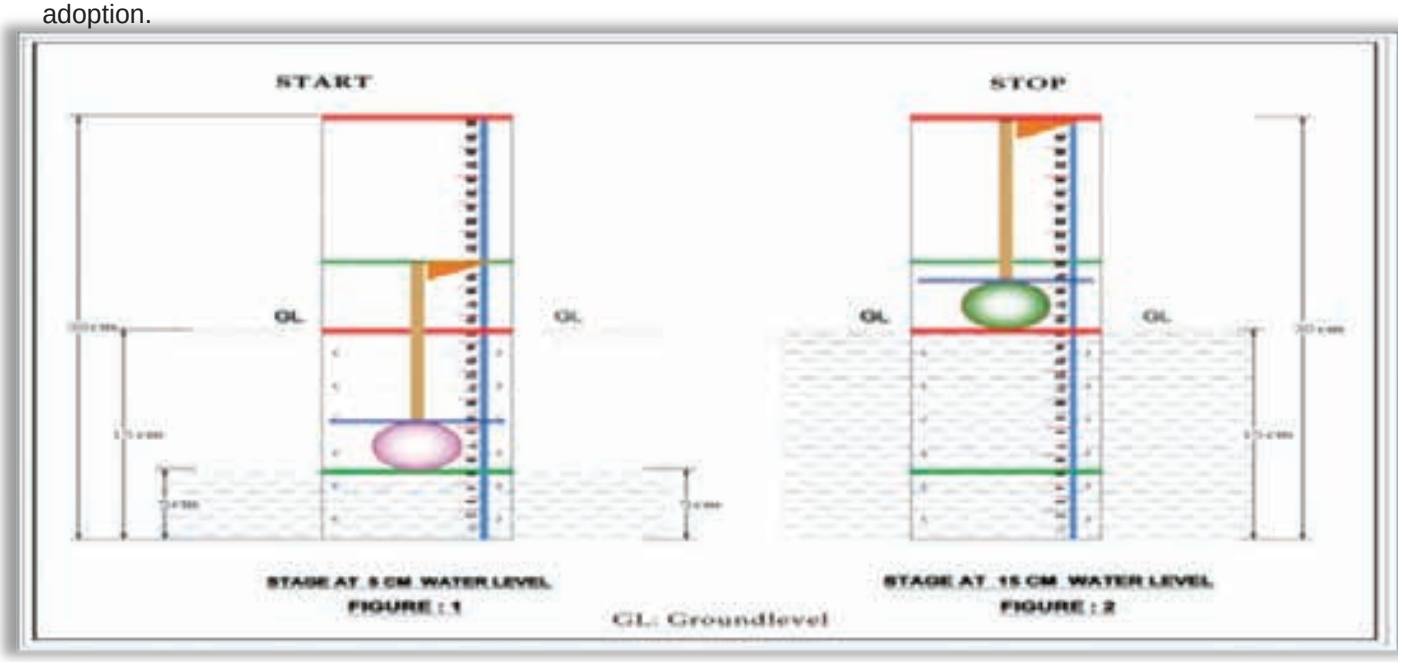
Before going into policy recommendations for the scaling up of SRI, I want to mention some of the constraints that can be identified at the grass root level as affecting the adoption of SRI practices in larger scale.

Constraints to adoption and up-scaling SRI

1. **Changing farmers' perceptions towards SRI:** Planting 10 -15 seedlings per hill is a traditional practice for many decades under conventional rice cultivation. At first, farmers' minds balk at transplanting very young seedlings, even 14 -15 days' old fearing for their survival. Moreover, farmers have a hard time believing that 16 plants per sq. m. can produce more crop than 50 plants, or 75 plants, or 100 plants in that same space. Having wider spacing between plants is perceived as a waste of land area. Farmers' apprehension is not replaced easily by words or even numbers. They need to *see for themselves* that the new practices are beneficial, as probably 20 million farmers in dozens of countries have seen. Persuasion i.e., seeing and believing requires demonstrations rather than lectures or exhortation.
2. **Lack of proper machinery for implementing mechanization:** Even when farmers are willing

to practice SRI, they will face some skilled labour constraints, at least at first. Much of rice production in India right now is quite labour-intensive, and for such farmers, SRI becomes labour-saving, once the methods have been learned, and skill is gained. But both transplanting and weeding are laborious operations, and SRI will become more attractive if there were site suitable transplanters available for planting one or two seedlings, as well as proper implements for inter-row weeding; and laser-levelling to enable farmers to practice alternative wetting and drying (AWD) more efficiently and to save more water, etc. The shortage of skilled labour for grid transplanting at the right time discourages farmers from switching over to this innovative system with confidence. So, there are equipment bottlenecks that need to be addressed as these constrain the practice of SRI on a large-scale adoption.

3. **Supply of irrigation water and power**: As most of the irrigation schemes in the lowland rice areas are partially dependent on drawing ground water using electrical power which is free of cost. Irrigating at the right time is constrained by frequent power cuts in the irrigation areas. This deters farmers from applying AWD (a component of SRI), since they are not sure when the power will come, and for how long it will last. Although SRI requires less total water, farmers need to be confident that the smaller deliveries of water will be *reliable*. The hardware and software of irrigation management need improvement to produce more rice with less water. Installation of Crop Water Assessment Device is a behavioural science-based nudge practice to convince the farmers minds towards water stagnation is not mandatory.



4. **Inadequate extension and climate-change awareness:** The local farmers are generally convinced about its yield increase but lack knowledge of SRI principles and applications, related to its long-run benefits for abating climate change. This reflects weakness in the present extension services and a lack of proper capacity-building. Both training and education are needed to bolster behavioural change.

5. **The unlevel playing field between organic and inorganic soil fertilization:** For decades, Indian farmers have relied heavily on chemical fertilizers, especially nitrogen and phosphorus. These have been heavily subsidized by government, accumulating large fiscal burdens on government. At the same time, the carbon stocks in Indian soils have been depleted, often to less than 1% when levels of 3-5% are desirable. There is no subsidization of organic fertilization of the soil, which would restore higher carbon levels (sequestering carbon in the soil which counters global warming), as well as support better yields and make the use of inorganic soil amendment more productive. Much as the lack of appropriate implements and tools is a constraint on SRI adoption, the lack of such equipment for replenishing the soil's carbon stocks with compost, mulch and other organic materials is a constraint.

Recognizing that there are many benefits to be derived from converting rice and other crop production from current methods that are less productive and costlier, in environmental as well as economic terms, it is important that we give thought to national policy frameworks that can make the transition to more agro ecologically-based food production quicker and smoother.

There are no, or at best weak, national policy frameworks for supporting the dissemination and uptake of water-saving technologies such as SRI in the rice-growing countries of Southeast and South Asia, including India. Although SRI was introduced to India some 20 years ago, there are still some controversial issues raised by farmers, researchers, and policy-makers. These issues should be addressed in open, fact-based discussions, possibly under the auspices of ICAR. Also, SRI and the associated SCI methodologies for other crops like wheat, ragi, sugarcane, mustard, etc. should be considered within the scope of the new national policy for *'nature farming'* which minimizes expenditures and reliance on agrochemical inputs. That is why this international conference has been framed in broader terms than just improving rice production with SRI practices.

SRI's performance in increasing adaptation to climate-change impacts, reducing GHG emissions while increasing yields and food security, makes it more urgent to promote these ideas and practices: The practice of SRI supports the three core principles of *climate-smart agriculture* (CSA), (i) increasing adaptation to climate change (making crop production more resilient), (ii) mitigation of greenhouse gas emissions, and (iii) improving agricultural production and food security.

That SRI qualified as climate-smart agriculture practice has been seen from research results and in-field experience in more than 20 rice-growing countries of Asia, and now extending to Africa and Latin America. Of growing interest is the capacity of SRI practices to reduce the generation and net emission of greenhouse gases, particularly of methane (CH_4), while at the same time increasing crop yield. All countries need to move to more climate-smart agriculture, but for India, this is particularly urgent because of the water shortages already confronted and the silent crisis of soil degradation and soil health that threatens India's future.

Scaling Up SRI : Grain yields reported from ICAR and other field experiments carried out in different parts of India have showed yield increases from SRI ranging from 9% to 68% when compared with conventional current practices. The System of Rice Intensification (SRI) has shown an unprecedented capacity to produce 'more with less'- more crop per drop. The Government has been generally positive in extending its support to the promotion of SRI, starting with the National Food Security Mission and then the National Rural Livelihood Mission, and now with its support for 'nature farming'.

Unfortunately, the process of up-scaling SRI on a massive scale has been relatively slow, owing to multiple constraints in its promotion and the management intensity involved. The integrated nature of SRI also presents multiple challenges in the areas of research, extension, and policy support and there is a need to achieve coherence in these areas. The promotion of SRI in Tamil Nadu is a typical example of convergence of the different organizations in promoting SRI in a big way.

State-level Research Approaches

The tripartite relation that existed among researchers at the state's agricultural university (SAU, in this case the Tamil Nadu Agricultural University, TNAU) with an associated Krishi Vigyan Kendra (KVK) in each district, working with both extension personnel of the state's Department of Agriculture and with farmers was of utmost importance for giving feedback-based fine-tuning and for prioritising location-specific SRI components.

The SRI cannot be compelled to be adopted everywhere on a target-based approach. SRI hot spots/regions or suitable niche areas should be declared by the SAU/KVK based on suitable soils, crop seasons (kharif/rabi), and irrigation sources (surface/groundwater/rainfed). Using GIS mapping, areas suitable for SRI (hot spots) can be demarcated and attention can be paid to popularizing the practice in these priority regions.

The research wing of the SAU should be able to evolve appropriate equipment to reduce labour time and drudgery. Examples would be new transplanters or modification of available existing transplanters so that young seedlings, transplanted just one or two seedlings per hill, can be established in the desired geometric pattern, cutting the labour required for hand transplanting. Multi-row weeders that can cut labour time for SRI because the now-available single-row manual weeder requires walking around 16 km per acre for a one-way pass of weeding. It is indeed timely to develop, test, and promote motorised weeders that can

be manufactured by private industries suited to local field conditions. The motorisation of SRI weeders has begun already in some other countries.

Primarily the SAU/KVK should identify and recommend the most suitable machinery for their State or District, involving farmers as users in the evaluation. Besides organizing a contest for 'best weeder designs' with the design made available to any and all fabricators who want to make weeders. A nice prize can get more innovation than 10x that much money spent on Research projects and contracts.

The owning of mechanised transplanters and motorised weeders by all farmers is not easy financially, hence the state Government should extend subsidies or facilities to encourage groups of farmers to purchase and share the equipment since individual smallholders do not need it for very long at one time, or to encourage entrepreneurs to purchase and operate the equipment, extending custom-hire services based on a service-provider mechanism, which could have contracts for raising nursery, transplanting, and weeding for an economic unit-area cost. This requires some local institutional development, but this can be both cause and effect of SRI's wider spread.

Long-term studies comparing SRI with conventional methods in regard to pest and disease dynamics, soil health and nutrient balance, greenhouse gas emissions so as to mitigate climatic changes should be undertaken to document effects of scaling up in a massive way. As long as innovations that have been adapted and are working well in farmers' fields are not well-documented and shared, they will remain invisible to the agricultural R&D community as well as to policy and decision-makers. Hence, it is imperative to gather and discuss the data on agronomic, economic, and environmental benefits of SRI methodology, and the SAU should take a lead for meetings every six months with stake holders along with extension personnel.

Integration of SRI methodology into farming systems approaches, by combining SRI with other climate-smart and agro-ecological strategies such as conservation farming, agroforestry, rotational cropping, and water-harvesting in rainfed areas will derive more benefit for rural households and the environment. Also, extending SRI principles to other crops such as sugarcane, wheat, ragi, and mustard should be considered and supported in every district by the KVK concerned according to what is most productive and highly suitable.

The collector/administrator who is the inspecting authority for the agricultural programme of his or her area should be made aware about the science that accounts for increases in SRI yield, updated once a year by the SAU concerned in every state, so that the program expands based on sound knowledge and makes further improvements. Imparting training and periodic updating to farmers on the SRI components that are important to their particular region is also essential. This will make them more confident in carrying out follow-up tasks.

Long-term field experimentation: As yields vary across regions as well as with different soils and irrigation sources, long-term field experimentation with different SRI practices is important so that well-supported conclusions can be drawn about their sustainability, and policy measures can be taken for sustaining the food security in every state.

Rural artisan training: It should be possible to service small machines involved in SRI like transplanters and weeders at the farmers' fields quickly for effective functioning. Hence, there should be capacity-building given to rural youths/ITI students in every village by persons with expertise in agricultural engineering. Such skills can create new employment opportunities.

State Extension Approaches

SRI is a knowledge- and experience-based method of rice production rather than an input-centric technology. The extension systems at present are mostly designed for input-driven technologies with a targeted approach where success is evaluated in terms of its demonstrated extent without attention to the

impacted area created through demonstration. During the initial days of introduction of SRI, critical inputs were often given free of cost to enable or induce the farmer to apply certain practices in a timely way, to reap more benefit and to reduce farmers' risk or fear of adoption. It is appropriate now to move away from that approach, not relying on subsidies for SRI but demonstrating the financial and other benefits from its adoption that give farmers incentive to change their practices. Farmers' costs of production, for seeds, fertilizer, and agrochemicals, can be reduced or stopped with SRI, so the amount of capital needed for rice growing is diminished.

In some places, large subsidized demonstrations with 'progressive' farmers were conducted during the introductory phase of the SRI era. Now, developing more efficient and effective methods for scaling up SRI

is crucial. SRI is a very visual subject, where 'seeing' is very important to gain acceptance of the new methods and to change the mindset of farmers. So, a program of compact demonstrations will be important, in large-scale operations under saturation mode covering cluster of farmers or entire village. Farmer Field Schools have been an effective extension methodology, 'learning by doing' and explaining peer to peer learning. As a nudge practice, paddy seed packaging should be available in either 5 or 10 kg to motivate the farmers to adopt seeding at lower rates.

The success of SRI has been fully or at least largely realised by most farmers who have tried this method. Now the extension department officials should encourage smallholder farmers to carry out all the principles of SRI as recommended through compact demonstrations at block level, which will be having more impact rather than just scattered individual demonstrations. Training provided to all the stakeholders, including laborers, will create further impetus for adoption.

Doing it differently: The results indicated that modifying SRI components to suit farmers' preferences results in comparatively higher yields than conventional practices. This was seen from a large study by IWMI-Tata water policy program, published in 2013 in the *Economic and Political Weekly*. A large sample of randomly-selected SRI users in 13 rice-growing states of India were surveyed for comparison with non-SRI users. Full use of the methods produced average yield increase of 13%, but even partial use raised yields over conventional practice. An important finding in the study was that farmers' average cost of production per hectare was decreased by 29% with SRI practices, making an even larger improvement in net income than the improvement in yield.

Encouraging farmers to follow the basic principles of SRI in their own way will be beneficial, with specific practices like age of seedling varying to suits the local conditions. Farmers should not be forced to follow any single defined method. It should be explained to farmers WHY the recommended methods are beneficial for rice crop growth, not just telling them WHAT to do. Knowing why certain changes in practice are recommended will help farmers to make appropriate adaptations. Modified SRI and other improved practices will enable rice farmers to get more production from their available resources, their land, labour, water, seeds, and capital. Similar improvements can be made for wheat, ragi, sugarcane, etc.

Proper Information, Education and Communication (IEC) measures such as distinguishing SRI fields from conventionally-grown fields with a special-coloured flag can attract attention of neighbouring farmers and passers-by. Farmer-to-farmer exchanges through farmer field schools and exposure visits can spread knowledge and information horizontally, and using digital media as tools for propagating success stories within local communities should be effective for upscaling the spread of SRI.

Repeatedly sensitizing the farmers on SRI principles along with the existing challenges and methods to address the same through nudge practices, using print, digital media, and popularising site-specific case studies will be highly helpful for getting understanding and acceptance of various principles of SRI. Also, the extension staff should play crucial roles in facilitating the adoption of SRI concepts through peer-to-peer learning.

Maintain farmer leadership: SRI progress and improvement shall be driven in large part by farmer initiative and innovation. Farmer-to-farmer spread of the new ideas and practices is important, with extension systems working in more farmer-centred ways. SRI has not been and should not become a top-down and rigid methodology, as *adaptation* is more important than *adoption*. This should be a guiding principle for improving and advancing most if not all climate-smart agriculture

National Level

The Twelfth Five Year Plan approach paper highlights the importance of SRI practices as transitions in agriculture that can enhance water and rice productivity. The Department of Agriculture included SRI as part of the National Food Security Mission some years ago, supporting its introduction in 133 food-insecure districts. But promotion was mostly through the supply of weeders and hybrid seeds, operating within the dominant input-supply paradigm of agricultural extension. The approach taken subsequently under the National Rural Livelihood Mission with the Jeevika program in Bihar was more farmer and learning- centred.

Labour training in weeding and transplanting operations would be of much benefit to farmers. Selected young labourers under MGNREGA should be trained in these operations of specialised SRI transplanting for earning extra income. In every village, this training should be imparted, and skilled groups should be developed for giving rapid and expert service.

In recent years, a lot of Farmers Producing Companies have been effective with vibrant membership. Custom-hiring of the machinery required for SRI, available through a Farmers Producing Company, is also becoming more common and should be promoted.

The drivers and principles of SRI effectiveness should be evaluated and incorporated into agricultural development programmes such as the Rashtriya Krishi Vikas Yojana.

The skills of existing staff need to be upgraded and new expertise should be introduced for SRI management at national level, with KVK scientists working in convergence with different organizations for large-scale adoption of SRI.

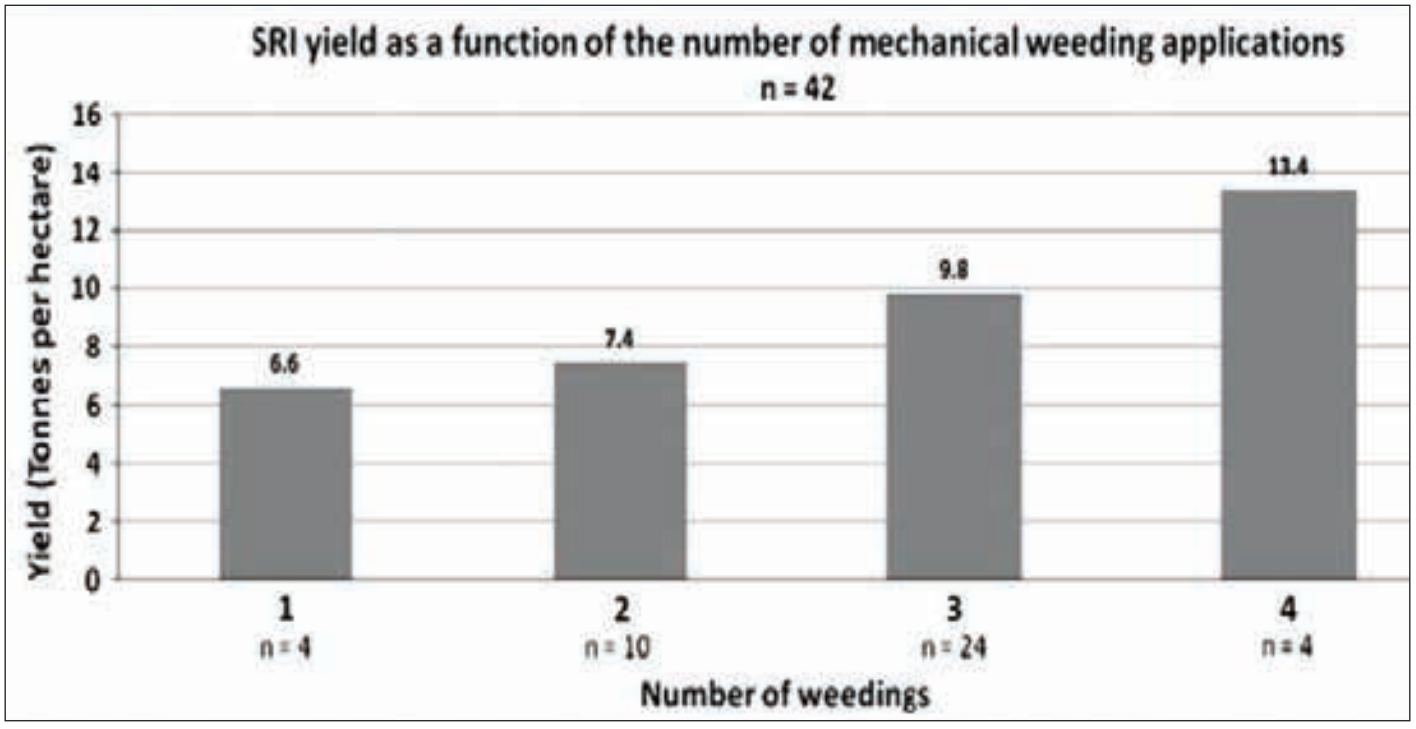
Identifying SRI-efficient zones in each block and demonstrating block-level SRI performance for climate-smart agriculture should show to farmers and other key stakeholders about the merits of these changes for Indian agriculture. Raising awareness through campaigns and training on the principles and applications of SRI and climate change impacts on rice production is also essential.

Some principles of SRI like the planting of young seedlings at shallow depth and raising specialized nurseries need skill and labour, especially in the early stage of adoption. If labourers are trained and experience with SRI transplanting and weeding, this will enhance the crop yield, so one incentive for them to seek training is that it would be justifiable and profitable for farmers to give a higher daily wage in recognition of this skill and the yield enhancement that can follow from best use of SRI practices.

Because farmers in various states of India, e.g., Andhra Pradesh, Bihar, Himachal Pradesh, Tamil Nadu, and Uttarakhand, have been able to market similar gains in the productivity of their wheat, ragi, sugarcane, mustard, pulse and other crops even crops like turmeric, cumin and coriander by adapting these ideas and methods of SRI to other crops, it would be wise for our research institutions and state agricultural universities to do systematic research on these various crops.

The strategy of growing deeper roots and promoting the life in the soil is one that can help our farmers withstand the stresses and strains of climate change, with water constraints and harmful weather. It makes sense for research on other crops through all India national level projects for reaping the benefits of climate-smart agriculture and resource conservation.

The System of Rice Intensification has spread through e-groups, through the exchange of knowledge and experience among actors within and across states, through learning alliances and the like. Making use of modern ICT tools is urgently required for pluralistic extension technology transfer, polygonal skill-enhancement, and primary rural agri-entrepreneurship development.



The 12th Five Year Plan approach paper highlighted the importance of SRI practices in improving the crop productivity. The drivers of SRI adoption should be assessed and incorporated in agricultural development programs such as *Rashtriya Krishi Vikas Yojana* (RKVY). State governments should develop programs and arrangements for smallholder farmers to procure or have access to SRI transplanters and motorized weeders that can save labour and speed up the operations of SRI and SCI practices.

This may also involve subsidies or interest-free loans, but also agri-entrepreneurship for service provision or farmer organisation to undertake group ownership and management. In principle, because SRI methods create gains in productivity for farmers, their adoption should not require subsidization, although some expenditure to get the gains demonstrated and to insure against risk to overcome apprehension is well justified.

International Level

While the principles of SRI are broadly applicable, the specific practices to implement them should be tailored to local conditions and farmers' cropping husbandry techniques, so there should be not be any monolithic presentation or implementation of SRI. In India, we can benefit from learning about the experience with SRI in other countries, and we should share our experience and innovations with others through several Video conferences. The agroecological conditions in India are as diverse as anywhere, and India has been a leader on innovation with SRI thinking, making the most advances with SCI applications. Indian experience should be refined and disseminated by the coordination of the Rice Research Institutes, other ICAR institutions, the Ministry of Agriculture and with the peer farmers.

The SRI 'fire' has been ignited in most of the rice-growing countries around the world, and a large number of farmers have realised its full or partial potential, many of them have undertaken to personally spread knowledge of SRI opportunities to their peers. NGOs like PRADAN and PRAN have trained volunteer farmers to serve as master farmers or as trainers for other farmers' instruction, and surely many participants here could give their own examples of the farmer-to-farmer spread of SRI.

Here is a picture of four farmer-field-school participants in Vietnam who on their own started visiting neighbouring villages to share their experience with others because of their satisfaction with SRI results. And a picture from Cambodia of an elderly farmer who was the first farmer in his country to try out SRI methods. He carried contrasting SRI and conventional rice plants as visual aids, using them to start up discussions of SRI when he walked into other villages.

However, there are probably not so many SRI farmers in India who are spreading information on their successes to their fellow farmers. Providing them with appropriate training materials, videos, T-shirts and embroidered caps could embolden and incentivise them to help change the traditional mindset of other rice farmers.

One simple government action could be provision for the customs-free exchange of SRI transplanters and mechanised weeders among rice-growing countries to contribute to greater global food security and the eradication of hunger.

In some countries, there is a belief that SRI methods are suitable only for organic farming. This preconception should be dispelled. The best results with SRI management often come from organic practices when the other recommended practices are followed, and organic management may be preferred both for the healthiness of the food produced and of the soil. But the other SRI practices also give improved results with some combination, or optimisation, of organic and inorganic nutrients, in what is called Integrated Nutrient Management.

SRI is not only limited to organic production. Such production may be favoured for reasons of both soil health and human health. Perhaps more important, reducing excessive application of nitrogen to the soil increases the emission of greenhouse gases from paddy fields. But SRI was originally developed with the use of chemical fertiliser. So, farmers should make their own decisions. What is important, for all crop production, is to increase the levels of organic matter in our soils as these levels are in many places disastrously low.

Salient successes achieved through SRI and SCI management in various countries should be well-documented and spread throughout the international community. Already there are many hundreds of SRI videos posted on YouTube, Vimeo, and other services, probably over 1,500. We in India can take pride that about half of these have been produced in this country. There is a large body of experience and success in India that can be presented both within and outside the country. There are some particularly interesting experiences that could and should be shared, such as the observation in Southern India that the rat menace is significantly reduced and sometimes even eliminated under SRI field conditions as compared to neighbouring fields with conventional planting. This has been reported also in Sri Lanka.

Perhaps the SRI-Rice centre at Cornell and/or the SRI-2030 centre at Oxford could arrange for regular virtual interaction among scientists and SRI practitioners, biannually or annually, to update knowledge about paddy and other crops under SRI/ SCI/SRI (System of Root Intensification) management. The scientific papers should be published on-line or in regular journals.

Rice is being grown in many different ecosystems around the world, from tropical rainforest areas to the edges of the Sahara Desert in West Africa, and even up to elevations as high as 2,600 meters in Nepal. So, lessons learned within the international SRI community should be shared, especially for adopting and scaling-up the SRI principles for various crops beyond rice.

Policy Support Needed

1. The state-level government support for SRI has been limited to extending subsidies for weeders and markers and putting on field demonstrations. As SRI is more on a behavioural transition than on material innovation, more support should be directed toward the generation and dissemination of knowledge. As the labour needed for weeding is seen as a problem, support could be extended for training and engaging labour during the initial season of adoption.
2. A group/ area-based approach to weeding may be considered rather than an individual farmer-centric subsidy. Labour training in weeding and transplanting operations using small level machineries would be of great relief to farmers.
3. The designs of weeder should be diversified, suitable for different field conditions and differentiated for men and women users, and they should be made amenable to local production. Staggered community nurseries sown at different times at the village level can make available to farmers the required-age seedlings to farmers and reduce labour requirements.
4. State support should be extended to the growing of green manure crops and for production of organic manures such as vermi-compost and bio-fertilizer. It is important for all of agriculture, and not just for SRI, that soil organic matter be raised urgently, to enhance the life in the soil, to make the soil more hospitable for root growth, and to give cropping more resilience against the stresses of climate change.
5. Better control of irrigation in canal and tank systems to be able to deliver smaller but very reliable amounts of water on an agreed-upon schedule will make the

adoption of SRI on a larger scale more feasible. Therefore, irrigation development plans are to be carefully drawn and executed since getting 'more crop per drop' is an imperative for the years ahead.

6. Regulations and enabling laws and policies to address issues and problems of meeting and maintaining water quality standards should be ensured. For the sake of agriculture and for the sake of our people, as we strive to maintain the needed quantities of water, we must also pay attention to safeguarding its quality.

7. Some attention should be given to market development so that farmers who produce rice of superior quality, for which consumers will have a preference and pay a better price, will be appropriately compensated. This would give a big boost to farmer acceptance of SRI methods under pure organic farming which also have social and environmental benefits.

Conclusion

The beneficial effects of SRI suggest that this water-saving technology could and should be up-scaled with some flexible approach. Farmers will only adopt the full components of SRI on a large scale if they are actually benefitted from using the technology. Different from the Green Revolution technology, with SRI farmers should be adapters and promoters, not just adopters.

The interactions among researchers, policy-makers, and stakeholders, including farmers, should be strengthened to increase our science-based knowledge of SRI, enabling the government to develop policy guidelines promoting SRI adoption and, wherever appropriate, up-scaling activities.

These various measures mentioned would help to promote the adoption and up-scaling of SRI at the local level coupled with better governance for improved coordination by both Government and many stakeholders