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Actionable Policy Options for Scaling-Up System of Rice Intensification for Ensuring Higher Productivity, Energy Efficiency and Sustainable Rice Production

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Abstract

Globally, India stands first in rice area and second in rice production. To feed the growing population, rice production has to be increased amid strong competition for limited resources including land. Also, concerns have been raised about yield gaps in rice. The system of rice intensification is one of the strategies to narrow the yield gaps. Rice is the major crop in India, therefore, the identification of an energy-efficient rice cultivation system is important to food security and sustainable intensification (SI). Hence, a comparison was made between conventional and the system of rice intensification (SRI) methods of rice cultivation by conducting two experiments. One field experiment was conducted from 2013 to 2017 at 25 locations across India under the All India Coordinated Rice Improvement Project and another experiment was conducted in 2017 using surveys by collecting data from 262 randomly selected SRI farmers using a personal interview method in the Telangana state of India. The 5-year experimental data revealed that the SRI method of cultivation produced higher rice grain yield (up to 55%) compared to the conventional transplanting method. Survey data revealed that total costs of rice production reduced by 22.71% under SRI. Break even output under SRI was reduced by 58.1%. Adoption of SRI saved total energy inputs by 4350 MJ/ ha. The energy productivities were 0.16 kg/MJ and 0.21 kg/MJ for conventional and SRI methods, respectively. Therefore, for ensuring higher productivity, net returns, energy efficiency and sustainable rice production it is recommended to adopt an environmentally friendly SRI method of crop establishment in the Telangana region of India. Based on the constraints as perceived by the farmers, policy options for scaling up of SRI are suggested.

Keywords: SRI, Scaling-Up, Sustainable Rice Production, Returns, Energy Efficiency

Introduction

Rice is one of the most important staple food crops in the world, representing about 50 percent of the total dietary caloric intake. At the global level, India stands first in rice area with 44 million hectares and second in rice production with 111.52 million tons (Ministry of Agriculture, 2018). Rice production needs to be increased to meet future food requirements amid strong competition for limited resources. The 'Green Revolution' has provided enough food to meet the country's current demand. However, concerns have been raised about sustainable rice production, yield stagnation, and yield gaps. The gaps between the research station and farmer's fields still exist among various rice-growing regions. The yield gaps indicate that the production levels in rice can be increased by bridging the gaps. There are several strategies to bridge the yield gaps and the System of Rice Intensification (SRI) method of rice cultivation is one of the promising approaches for achieving sustainable rice production and increasing the food security of small-scale producers. Rice cultivation is in crisis the world over and India is no exception, with a shrinking production area, fluctuating annual production, stagnating yields, and escalating input costs. The cost of cultivation of rice has consistently been increasing owing to the escalating costs of seeds, fertilizers, and labor. There is a need to grow more rice but with less water and fewer inputs. SRI originated in Madagascar in the early 1980s and the father of this invention is French Priest Henri de Laulanie. He wanted to find ways to enhance the rice productivity of Madagascan farmers who were obtaining rice yields of less than 2 t/ha (Gujja and Thiyagarajan 2009). SRI can increase farmers' rice yields while using less water and lowering production costs (WWF 2007).

Energy use in agricultural production has become more intensive due to the use of fossil fuel, chemical fertilizers, pesticides, machinery, and electricity to provide substantial increases in food production (Nirmala, 2021). Hence, energy efficiency has been crucial for sustainable development in agriculture systems. Efficient use of input energy resources not only saves fossil fuel resources but also provides financial savings (Singh 2004). However, more intensive use has created some important human health and environmental problems (Yilmaz, Akcaoz, and Ozkan 2005). The energy analysis in rice in general and SRI, in particular, is essential because of the direct link between energy and rice yields, and food supplies. Among the different indicators of crop performance, energy analysis is one of importance. Several studies have been conducted on energy analysis of rice in developed countries (Canakci *et al.,* 2005; Cetin and Vardar 2008; Hatirli, Ozkan, and Fert 2005; Jianbo 2006; Kuesters and Lammel 1999; Ozkan, Kurklu, and Akcaoz 2004a; Pishgar-Komleh, Safeedpari, and Rafiee 2011; Tuyet *et al.,* 2017). Energy use and energy efficiency analyses could help in comparing energy use at sectoral and operational levels in rice production. Adoption of SRI can reduce energy use, GHG emissions, and global warming potential (GWP) in rice-growing areas of India. Further, for a cleaner environment, a detailed study of energy efficiency of this technology may add to the suitability for adoption among farmers. Therefore, economically and environmentally sustainable rice establishment methods are needed to replace the conventional methods of rice cultivation in India. Such a method of cultivation must be based on the knowledge of grain yield under different climatic conditions, economics, and energy analysis.

Despite the dispute within the academic community, SRI has been disseminated to farmers in more than 40 countries, most in South and Southeast Asia. Although the exact area of adoption has not been officially reported, there is an estimate that SRI has been adopted on 750,000 ha in India, and 17,000 ha in Indonesia (Uphoff and Kassam 2008). A compilation of results from 11 surveys in 8 countries, including 16,000 SRI farmers, has shown, on average, a 47% yield increase, 40% water savings, 23% lower production costs, and 68% increase in farmer income, compared to conventional rice cultivation (Africare 2010; Sato and Uphoff 2007).

Rice is the major crop in India, therefore, the identification of an energy-efficient rice cultivation system is important to food security and sustainable intensification (SI). Hence, a 5-year study was undertaken at ICAR-IIRR (i) to find a better rice crop establishment method for India by comparing SRI and conventional transplanting methods in terms of grain yield, (ii) to confirm/validate the best crop establishment method through surveys using a personal interview method, and (iii) to provide a detailed study to revalidate a better rice establishment method for higher yield, net returns, energy efficient rice production systems for India. The study was undertaken in the Telangana State of India during 2017-18. A multistage sampling procedure was adopted in getting primary data from farmers.

Economics

Nursery seedlings required for one hecatre under SRI used 5 kg/ha seed as against 75 kg/ha for the conventional method. Significant seed saving can promote seed multiplication rates, purity of seed (single seedling planting), and faster availability and spread of released varieties. It was observed that there was a reduction in costs of all inputs except FYM. The amount spent on FYM was a little high in the case of SRI as compared to the conventional method as more quantities of FYM are recommended for application in the SRI. The amount spent on harvesting was high in SRI, which could be due to more grain yield, which required more time using a hired combine harvester. The results of the study revealed that the total cost of production was US $1084.73 and US$883.92 for the conventional and the SRI methods, respectively, indicating that the adoption of SRI resulted in a reduction in total costs by 22.71%. The Gross returns were US$ 1108.55 and US$ 1295.74, respectively, for conventional and SRI methods (**Table 1**). Higher Gross returns in SRI could be attributed to higher yield (5700 kg/ha) in SRI in comparison with the conventional method of rice production (4880 kg/ha). Higher BCR indicates more profitability with SRI over the conventional method.

Table 1. Comparative economics of rice production under SRI and transplanted methods

Particulars	Conventional method	SRI
Yield (kg/ha)	4880	5700
Gross Returns ($/ha)	1108.55	1295.74
Net Returns ($/ha)	23.82	411.82
BCR	1.02	1.46
Break Even Output (kg/ha)	5751	2409

Energy analysis

The energy productivity (the amount of rice produced per MJ of energy consumed) was calculated as 0.16 kg/MJ and 0.21 kg/MJ for conventional (**Table 2**). Specific energy is an index which shows how much energy was used to produce one unit of disposable product. In this study, the specific energy for each method was calculated as 6.37 MJ/kg and 4.69 MJ/kg, respectively. For producing 1 kg of paddy, 6.37 and 4.67 MJ of energy was spent in the conventional method and in SRI, respectively. This means that each kilogram of paddy produced by the SRI method can save approximately 1.7 MJ compared with the conventional method of rice production.

Table 2: Energy indices in rice production

Item	Unit	Conventional method	SRI
Energy	ratio	4.86	6.6
Energy productivity	kg/MJ	0.16	0.21
Specific energy	MJ/kg	6.37	4.69
Net energy	MJ/ha	119945.27	149673.77
Energy intensiveness	MJ/$	28.66	30.25

The energy intensiveness of rice production for conventional and SRI methods of rice production were 28.66 MJ/$ and 30.25 MJ/$, respectively.

Constraints in adoption of SRI, as perceived by sample farmers

The farmers opined that the skill in transplanting young seedlings was the major constraint in adopting System of Rice Intensification method, followed by difficulty in using conoweeder and nursery management (**Table 3**). Non-availability of organic manure in adequate quantity and unwillingness of labour to do line sowing were the other constraints, as perceived by the selected farmers

Table 3 Constraints perceived by the farmers in SRI method

Sl. No.	Constraint	Mean Score	Garrette Rank
1.	Skill in transplanting young seedlings	73.4	I
2.	Difficulty in using conoweeder	61.6	II
3.	Nursery management	43.3	III
4.	Non-availability of organic manure	41.8	IV
5.	Unwillingness of labour to do line sowing	26.6	V

Policy Options for scaling-up SRI

Although SRI is a proven technology to conserve resources and achieve higher yields, the adoption rate of this technology is slow in India due to the constraints mentioned above. The following suggestions are made for scaling-up SRI in India:

- Policy incentives by the Government play a crucial role in the adoption of any technology. For example, the rice farmers of Tamil Nadu have adopted SRI due to the incentives provided to them. For the promotion of water saving technologies like Direct Seeded Rice (DSR), several state Governments like Karnataka, Andhra Pradesh and Telangana rendered support in the form of cash incentives or subsidies on drum seeder. A similar strategy of providing support may be followed for scaling-up SRI.
- From the various results stated above, it can be concluded that SRI method of rice cultivation has a yield advantage of around 22%. Since the benefit-cost ratio in the SRI method is comparatively more than that of the conventional transplanting method of rice cultivation, it can be inferred that SRI is an economically viable technology and more profitable than the conventional method. Hence, efforts should be made to promote SRI in suitable areas.
- SRI may not suit all the rice growing areas and hence suitable areas may be identified. SRI-suitable areas may be mapped and made accessible to rice farmers.
- SRI is a skill-based technology and hence there is a need to focus on imparting training on SRI to farmers through various extension agencies, in order to double farmer income.
- One of the major constraints in the adoption of SRI was drudgery in using weeder, hence, low cost, user friendly weeders and markers have to be made available to the farmers. The designs of the weeder should be diversified and be made amenable to local production. For large scale adoption of SRI, there is a need for convergence of different organizations working on SRI.
- It is highly imperative to train farm women in different aspects of SRI technology to build their knowledge and skills to ensure widespread adoption of SRI. There is immense scope of harnessing the potential of training of Women's Self-Help Groups (SHG) members to form a SRI task force which could be easily achieved through providing long-term and comprehensive skill based training in the following specific SRI activities.
- Training a cadre of women labourers in every village can help spread SRI and also provide good income for the women.

- Awareness should be generated about SRI through mass media, Krishi Vigyan Kendras, extension departments, etc. SRI offers an opportunity to produce 'Organic Rice', which has significant market potential and paves way for doubling income of the rice farmers.
- Several studies proved that there is a substantial reduction in methane emission in addition, to reductions in the cost of production, higher yields, and saving of irrigation water. Thus, it is imperative to scale-up SRI for reducing water consumption and increasing food production.

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