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A Foreseeable and Desirable Future for the System of Rice Intensification

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Abstract

After some 40 years since when Fr. Henri de Laulanié synthesized the System of Rice Intensification (SRI) methodology, and after more than two decades of experts and practitioners working intensively to disseminate SRI around the world, the time is ripe for a general reflection on what has been done, and especially on how to move forward with the upscaling of SRI methods. This short paper builds on the work carried out by SRI-2030 which, despite being a very young initiative, thanks to the support of the experienced SRI-Rice group from Cornell University, has connected with SRI experts from multiple countries and with various stakeholders of the rice sector.

As the international community recognizes the importance of more sustainable and eco-friendly rice production in terms of food security, less water consumption, and adaptation to and mitigation of climate change, concerted actions should be taken to boost the uptake of SRI, an agroecological practice that tackles all these issues and also improves farmers' livelihoods. However, the diversity within the rice sector and the various context-related barriers to its optimization require diversified strategies. The challenges facing us are global, and a coordinated, collaborative approach is needed. SRI-2030 was established to be a facilitator for the support of synergies among stakeholders in the rice sector with the aim of boosting the upscaling of SRI methods up to 50 million hectares by 2030, to slow the pace of global warming and improve people's well-being.

Keywords: SRI, 2030, Sustainability, Eco-friendly, Collaborative Research, Stakeholders

Introduction

Rice is the staple food for about half of the world's population and employs around 1 billion people, mostly smallholder farmers. However, to do this the rice sector uses 40% of the world's irrigation water and releases 10% of global methane emissions. Given the growing world population, the increased scarcity of water, climate change and the sensitivity of rice to climate stress, the sector must evolve. And it must be quick in making changes because according to current trends, global production of rice is predicted to fall by 15% by 2050, while the world population climbs toward 10 billion (ESG, 2019).

The System of Rice Intensification (SRI) methodology addresses food and nutritional security by enhancing crop yields, water use efficiency, farmers' livelihood (by reducing costs while increasing the outputs), and climate prognosis (by cutting methane emissions). It was selected and recommended by Project Drawdown (Hawken, 2017) as a currently-available and proven technology for reaching net-zero greenhouse gas emissions by 2050. With extensive worldwide research (SRI-Rice, 2022), SRI is well placed to be implemented as a low-cost, high-return course of action for abating global warming and climate change.

SRI principles, appropriately adapted to the ecological and contextual conditions, have been validated in more than 60 countries (Uphoff and Thakur, 2019) and in various and diverse regions of the world: from Mali, on the edge of the Sahara Desert (Styger *et al.,* 2011) to the tropical climate of Panama (Turmel *et al.,* 2011) to Afghanistan's mountainous regions (Thomas and Ramzi, 2011). Due to SRI having been pragmatically assembled and mainly promoted at the grassroot level through a bottom-up approach, with the active participation of farmers, its theory has followed the practice.

SRI has been framed since the very beginning, not as a technology or a commodity whose exchange is mediated by money, but as an 'open system,' based on a set of principles aimed to improve the outputs and sustainability of rice production by using available resources more effectively (Prasad, 2020; Beumer *et al.,* 2022). The dissemination of SRI has been promoted through an open-source approach, and non-proprietary knowledge is shared to allow free access to farmers, researchers, and NGOs to new opportunities (Prasad, 2020).

Since SRI does not rely on external inputs or depend on herbicides or 'miracle' seeds to improve productivity, farmers all around the globe were encouraged to experiment and adapt the practices to their own needs and constraints (Prasad, 2020). SRI farmers have developed their own methods for growing SRI rice, adapting their practices based on its four SRI principles to their own context. Although this is beneficial to farmers who have learned to adapt the practices to suit their agroecological zones, this means that SRI results cannot be generalised or compared easily.

Moreover, this process by-passed commercial interests which therefore did not drive and dominate this agricultural innovation (Prasad, 2020). That the diffusion of SRI did not rely on market mechanisms and forces and came from outside the formal scientific establishment, little support was garnered from established research institutions (Prasad, 2020; Beumer *et al.,* 2022). The lack of support from recognized and respected agricultural institutions in the first phase of SRI dissemination slowed down the process of diffusion as this was left in the hands of few researchers, civil society organisations, and farmers.

Even so, SRI methods have still expanded to reach at least an estimated 10 million farmers on around 7 million hectares (Prasad, 2020). Today, SRI is widely accepted and recognized by the scientific community as a valid set of principles, but its 'open system' and 'open source' features can still cause friction if looked at through the lens of the Green Revolution framework.

As the biggest investment needed to upscale SRI methods is an investment in knowledge, this agroecological approach to rice production represents an opportunity for everyone involved in the rice sector. SRI requires farmers, researchers, the private sector, and policymakers to think outside of their boxes and to find the best way to adapt a fairly simple set of sound, scientifically-proved agronomic principles to their own context of application. The cross-cutting nature of SRI, touching upon a number of global challenges, makes it an attractive component for global initiatives that aim to ensure a livable future for humanity. Moreover, the decades of research and development of SRI methods provide an extensive knowledge base and the current low rate of application makes today a favorable time for investing energy and resources in the upscaling of SRI methods.

Methods

This paper is not based on empirical research, but rather summarizes insights from the work of SRI-2030, and it outlines strategy, hopes and perspectives for the upscaling of SRI methods. The rationale of the paper assumes that SRI methods are an important part of the solution to the many challenges of the rice sector, and that the implementation and promotion is still at the very initial phase. The multiple discussions with stakeholders consulted by SRI-2030 in the past months have offered food for thought and different views that were helpful in drafting this work. However, the opinion of the various stakeholders consulted may differ on how some of the issues are to be approached, on where emphasis for solutions should be put, and on the conclusions drawn. Therefore, even though the paper reflects and summarizes views and ideas of various rice sector stakeholders, responsibility for the paper's content lies entirely with SRI-2030.

Results

Identified challenges and potential approaches

Training and awareness

A lack of training and awareness are, in many cases, the two greatest constraints limiting SRI adoption (Laksana and Damayanti, 2013; Mwidege and Katambara, 2020). The SRI-Rice team from Cornell University visited about 45 countries between 1997 and 2004 and helped establish local networks of SRI experts and practitioners. However, the diffusion of SRI methods has had little direct, in-person promotion, and has been mostly 'remote'. The transfer of knowledge has been almost entirely through 'hard copy' and 'soft copy' transmission, aided by the internet.

SRI methods have been disseminated mostly through civil-society organizations or government-NGO partnerships. Generally, conventional extension services are accustomed with a top-down approach which doesn't fit the participatory processes needed for a well-suited adaptation of SRI principles. Government-NGO partnerships have been proven useful for extension services to successfully upscale SRI, especially when committed local SRI experts have been able to instruct extension service's staff.

For getting an acceleration of SRI use, the most beneficial driver for spreading awareness and skills training would be the systemic promotion of SRI by governments at a state and national level (Barrett *et al.,* 2021; Mwidege and Katambara, 2020), accompanied by effective provision of training from well-trained and well-motivated extension services agencies developing farmers' understanding and application of skills (Laksana and Damayanti, 2013). There is some evidence that access to extension services positively impacts the likelihood of adoption of SRI (Bello *et al.,* 2022).

Farmer field schools (FFS) have been effective mechanisms for SRI farmer training with the knowledge and skills required to practice SRI and water conservation (Kabir and Uphoff, 2007). This methodology increases farmer-to-farmer transfer of knowledge. In the Myanmar case reported by Kabir and Uphoff, there was a five-fold multiplier effect. More contextual research would allow farmers to make adaptations and evaluations of SRI methods and come up with effective practices for their ecosystems. Participatory management by farmers, extension organisations, and research organisations will further increase suitability of practices, and thus increase yields and reduce inputs required.

Integration of SRI with other agroecological practices

A further opportunity to better understand the potential of SRI and expand its implementation is the quantification of the impact on yield and carbon footprint achievable when SRI is combined with other agroecological practices. According to Singh *et al.,* (2021), agroecological practices are mostly analysed in an isolated way, and it is only in the past few years that researchers started focusing on the combination of multiple agroecological approaches. It is through the consideration of a whole package of interlinked practices that a consistent and holistic understanding of farming systems in specific agro-climatic zones can be achieved (ibid). Some studies have been conducted on the combination of SRI and CA (Kassam and Brammer, 2016). As both SRI and CA systems focus on improving ecosystem services, and particularly promoting healthy soils, their combination is considered to further support root development and consequently enhance the cropping systems' performances (ibid). Some other studies have focused on the opportunity to practise intercropping in rice farming under SRI management, resulting in further water savings, increased yield and net income for farmers (Shah *et al.,* 2021). More can be done to integrate agroforestry practices into rice systems by planting trees on fields' borders or even in the fields in large-scale systems. The utilization of biochar and the inoculation of beneficial microbes in combination with SRI methods should be pursued and the reliance on synthetic inputs should be lowered or avoided, as is being pursued in India through Natural Farming programs. The combination of SRI and other agroecological practices deserves further promotion and evaluations across various agro-climatic conditions to better understand the environmental, economic, and social implications (Kassam and Brammer, 2016).

Government Investment and Promotion

The general lack of support from state and national governments has been a major constriction to SRI adoption in several countries. As previously mentioned, the open-source approach and non-proprietary knowledge-sharing that has characterized the dissemination of SRI methods did not rely on market mechanisms and happened outside the formal scientific establishment, therefore compromised the participation of the private sector in spreading SRI. The lack of private sector investment and the fact that other institutions are missing in action reduced governments' support of SRI dissemination.

However, thanks to years of research and field demonstrations confirming the effectiveness of SRI methods in sustainably intensifying rice production, some local and national governments have embraced SRI methods and actively supported their dissemination. Some state governments in India are notable examples of the benefits that can be gained when SRI is accepted by a government. The states of Bihar and Tripura have catapulted SRI adoption through promotion of SRI practices. The number of farmers practising SRI in Bihar rose from less than 1000 in 2005, to over 160,000 by 2007 due to active political support (Verma, 2013).

Therefore, government support has been shown to enable faster dissemination of SRI practices. Also, centralized programs for the upscaling of SRI methods should be better able to integrate cross-cutting research of SRI with newer technologies, such as rice varieties, genetics, mechanisation, or e-agriculture systems, as conducted by leading research institutions therefore helping to move SRI into mainstream appeal. As of today, 10 countries have officially included SRI methods in their Nationally Determined Contributions (NDCs) for reducing methane emissions as a strategy for mitigation of and/or adaptation to climate change. However, intensive advocacy work is still needed as none of the major rice-producing countries have yet included SRI in their NDCs.

Access to Appropriate Equipment

Equipment is an important investment opportunity as the use of machinery rapidly decreases the time and labour required for transplanting and weeding, so it can increase productivity, and also decrease drudgery. Multiple types of weeders and seeders have been developed to suit different environmental and social contexts. However, the quality of the equipment is not always appropriate, and the price is often a barrier for rural farmers. It has been recommended that farmers invest together for purchasing appropriate mechanization for their SRI activities (Sims and Kienzle, 2016). Where this is not possible, government and non-government organisations are alleviating this barrier by providing farmers with partial or whole subsidies for mechanical weeders and other inputs.

Alternatively, many villages have or can mobilize service providers who possess one or more pieces of equipment and rent to small-scale farmers when and as needed, thus the cost of machinery per farmer is reduced. Otherwise, farmer groups can buy their own machinery and share it in turn. As demand for equipment increases, there is an opportunity for job creation as an equipment supplier, or as a service provider. Opportunities for equipment development can be increased with computer-assisted design (CAD) visualisations, open-source file-sharing of ideas, and crowd-sourcing of designs. For example, the US organisation Earth Links works with farmers to develop equipment CAD blueprints that can be shared across the world and used to create cheaper SRI equipment for farmers (Earth Links, Inc., 2022). Since in some areas of the world, rice is cultivated also by large-scale farmers, there is an opportunity to develop appropriate machinery to implement SRI methods on a larger scale and with fully-mechanized operations.

The private sector is the main stakeholder for the development of SRI equipment, but governments and public institutions should create the best conditions for the market to flourish and contribute to the upscale of SRI methods as they ultimately benefit the whole population.

Marketing Channels

Uncertified SRI rice rarely receives a higher price at market than conventionally grown rice, even when grown organically. However, certifications are a high-cost expenditure for smallholder farmers. Support from the government for certification and specialized marketing channels could ease this cost or by subsidising organic fertilisers rather than only inorganic fertilisers as is now the case. This expenditure can be considered as part of a country's NDC, as reducing applications of inorganic nitrogen will reduce nitrous oxide emissions (Skinner *et al.,* 2014), while also increasing carbon sequestration through improved soil health (Ghosh *et al.,* 2012). Furthermore, there are no channels in the international market for the sale of SRI rice to large corporations within countries that import a large quantity of rice, such as the US and Saudi Arabia, which are under pressure to achieve NDCs and reduce GHG emissions.

There should be international market channels with the function of conserving rice biodiversity, enhancing soil quality, and reducing water usage, where SRI certification would justify a higher price, especially if the higher nutritional quality of SRI rice were documented. Alternatively, Tamil Nadu has a Department of Agricultural Marketing that helps farmers to sell agricultural produce through a statal facilitation platform. The Uzhavar Sandhai Scheme was established in 1999 to increase accessibility to market by reducing market costs and supporting farmers who sell their produce directly to consumers to make more income from their production (Agriculture and Farmers Welfare Department, 2021).

Carbon Credits

According to Rajkishore *et al.,* (2015), SRI is among the most effective strategies to enhance carbon sequestration in rice ecosystems. The promotion of mycorrhizal symbiosis in aerobic rice system is, among other considerations, an effective way to improve the ability of soil to sequester carbon as these rhizosphere microorganisms are efficient in converting the CO^2 present in the atmosphere into biomass carbon (Xu *et al.,* 2017).

The adoption of SRI principles also enhances enzyme activities in the rhizosphere, as reported by Rajkishore (2013), which improves carbon sequestration in rice fields (Rajkishore *et al.,* 2015). Watkins *et al.,* (2009) have proposed that carbon credits can boost the adoption of no-till systems for rice farming, which also promotes carbon sequestration, and the same concept could be valid for SRI.

By avoiding flooded conditions, SRI methods drastically reduce methane emissions. However, as far as we know, there are currently no projects rewarding SRI farmers with carbon credits for their contribution in sequestering carbon. Various actors have been working to fill this gap and develop a carbon credit marketplace for rice farmers who sequester carbon and mitigate methane emissions. This could therefore be an opportune time for investments and research on ways and means to enhance the adoption of SRI practices by making it possible through the involvement of SRI farmers in carbon credits schemes.

Conclusion

The global nature of the challenges faced and created by the rice sector requires systemic changes, and we should not be satisfied with small or medium-scale implementation of SRI methods. To meet the challenges of halting and reversing climate change, reducing water consumption, and combating hunger and poverty, there should be policies that are supportive and conducive for farmers, researchers, the private sector, and the civil society as well as government agencies to seriously upscale SRI and introduce innovations in the rice sector.

Appropriate measures should be taken to direct farmers toward the adoption of practices that benefit themselves, the environment, and the whole society. Research that contributes to sustainable intensification of rice production should be supported, and the private sector should be encouraged through economic incentives to back up the transition to a more agroecological rice production. Policies should also incentivise the marketing of quality rice by supporting better prices for more environmentally-friendly rice.

Fortunately, the building-blocks for such reorientation are here. Carbon credits are becoming more and more of an effective method to remunerate environment-friendly activities, and the rice sector should be included in these arrangements as it has a huge potential. Technologies for monitoring GHG emissions and C sequestration from satellites are becoming more and more sophisticated every year. Large players in the private sector and food retailing are realizing the impossibility of continuing with 'business as usual' and are starting to adapt (Sustainable Market Initiative, 2022).

International organizations and donor agencies are supporting national states with grants for the implementation of sustainable agriculture. Official documents for national governments to undertake responsibility for reducing GHG emissions have been signed and are being implemented through Nationally-Determined Contributions (NDCs) (Hong *et al.,* 2021). The world is waiting for more States to join and play their parts in addressing today's and future challenges. India does not mention rice in its NDCs and states that no targets will be made as they do not want to be bound to sector-specific mitigation actions. Being India the second largest emitter of GHGs from the rice sector, an official target for the mitigation of methane from rice paddies would encourage the transition toward a more sustainable rice sector.

SRI-2030, together with SRI-Rice, will play roles in facilitating this transition, helping the multiple actors and stakeholders from all the sectors involved to better communicate and collaborate. But there is little time remaining to reverse our presently disastrous course, for dealing with climate change, water scarcity, hunger and poverty, and the threat of food insecurity. We need a sense of urgency, at all levels of government and society, to undertake actions and policies that will uptake and upscale SRI methods and their extrapolation to other crops through SCI to have a prosperous and sustainable future for people and the environment.

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