LEAD LECTURE https://doi.org/10.58297/HZNE3472

System of Rice Intensification in Indonesia: Research, Adoption and Opportunities

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Abstract

The conventional rice cultivation method is observed to be ineffective in increasing rice production in Indonesia, compounded further by the frequent occurrence of various diseases, pest infestations, and weather uncertainties. The long-term practice of using high agrochemical inputs has adversely affected natural resources such as water, soil, and air. Thus, farming transformation is much needed in order to address the nation's food security. This transformation can be done via the adoption of agroecological practices which rely on biological processes rather than on agrochemicals to maintain soil fertility and protect plant health. The System of Rice Intensification (SRI) is an agroecological method of rice cultivation that relies primarily on creating conditions for healthy plant growth by minimizing inter-plant competition through individual planting and wide spacing, at the same time improving soil structure and functioning by applying organic amendments, facilitating soil-surface aeration during weeding, and managing water to avoid both continuous flooding and water-stressed conditions. This combination of management practices results in better rice growth and yield compared with standard cultivation methods. For this purpose, the impacts of the SRI method on the economic, environmental, and social perspectives were studied. We conclude that the high productivity obtained by the SRI farmers and field trials has proven the suitability of the SRI method for sustainable rice farming in Indonesia. SRI improves the productivity of land, water and increases rice yield by three times higher than the conventional method. SRI is now regarded as a good option to be practiced by farmers in order to bring about a new kind of green revolution that relies upon ecosystem services to increase yield.

Keywords: System of Rice Intensification, Indonesia, microbiome, agroecology

Introduction

Conventional rice farming methods, which rely on the intensive use of chemical inputs introduced by the Green (chemical-inclined) Revolution, deplete agriculture's natural resource base, jeopardizing the future productivity of the land (Pronti and Coccia, 2020). FAO (2011) recommended that cropping systems should be based on low input (fertilizers and water) methods and optimizing ecosystem services to increase yield.

The concept of food sovereignty and agriculture based on agroecology has found attention among researchers and policymakers because this approach has been successful in bringing positive changes in economic, environmental, small farmers, rural communities, and urban populations. Agroecology as a new paradigm in agriculture is focused on the return of the condition of self-reliant local communities, conservation of nature and biodiversity, production of healthy food produced using a low amount of input, and empowerment of rural communities (Altieri and Nicholls, 2020). One of the agroecological practices is the System of Rice Intensification (SRI), which relies on a set of principles of cultivation that has a major impact on the efforts to create sustainable farming towards the realization of a green economy (Doni *et al.,* 2019).

SRI methodology was synthesized in the early 1980s by Henri de Laulanié, S.J. To date, many farmers around the world are using the SRI method to increase rice production. SRI has managed to reduce the use of chemical fertilizers and chemical pesticides, thereby reducing production

costs. Scientists have shown interest in agriculture to understand how SRI can increase rice production up to 3 times more than a non-SRI cultivation technique (Thakur *et al.,* 2016). SRI is touted to be a good option to be practiced by farmers in order to bring about a new kind of green revolution, one that relies upon ecosystem services to increase yield (Thakur *et al.,* 2022).

SRI is a remarkable innovation in the organic farming method that improves the productivity of land, labour, water, and capital investment in paddy cultivation. SRI can be a cost-effective system of labour as well as saving water (25-50 %) and seeds (80-90%), reducing costs (10-20%) and increasing crop yield by at least 25-50%, sometimes 50-100% and there are sometimes even more than 100%. SRI productivity has been proven in 28 countries, from China to Cuba, Peru to the Philippines, Gambia to Zambia, and even Iraq, Iran, and Afghanistan (Uphoff, 2008).

SRI cultivation techniques start with the preparation of the soil to allow the planting of rice seedlings (5-7 days old) planted, one seedling per square measuring (35 x 35) cm. It is recommended that seeds belong to the farmers themselves. The rice field does not have to be flooded with water, restricted to water levels of only two centimeters or less.

SRI was first practiced in Indonesia in 1999. Since then, the interest in using SRI has grown rapidly on the back of government agencies, universities, NGOs, and the private sector. SRI's advantage is in the case of supporting sustainability and sustainable agriculture fields in Indonesia (Uphoff, 2008).

Our previous studies have reported the experimental trials of SRI in Indonesia, such as Java, Sumatra, Bali, Sulawesi, and Kalimantan. For this purpose, the impact of the SRI method on the economic, environmental, and social perspectives was studied.

System of Rice Intensification (SRI) in Indonesia

The basic principles of the SRI methods

The System of Rice Intensification (SRI) is a yield-increasing methodology practiced by probably more than 20 million farmers, with benefits having been demonstrated in over 60 countries (Thakur *et al.,* 2022). SRI methods modify the most common rice-growing practices in a number of ways. The changes include: (1) growing seedlings in nurseries with a minimum of water, a maximum of organic matter, and low plant density; (2) transplanting seedlings into rice fields at a young age, as little as 10-12 days old and no more than 15 days; (3) planting single (rather than multiple) seedlings in hills in a square pattern at a distance of 25-30 cm; this encourages healthy root growth with reduced competition for nutrients and induces profuse tillering and canopy growth; (4) mechanical weeding that eliminates weeds at the same time it aerates the top layer of soil; (5) using organic matter, as much as available, to enhance soil fertility in preference to chemical fertilizers; and (6) intermittent irrigation, alternating wetting, and drying of rice paddies instead of continuous flooding as this favours aerobic over anaerobic microorganisms (Thakur *et al.,* 2016). Fertilizers can be used where there is not sufficient organic matter to meet soil and plant needs, but results are better to the extent that the soil's reserves of organic matter are enhanced. Also, organic and inorganic nutrient sources can be combined (optimized) when the first is limited or the soil has particular deficiencies, but the purpose is to be supporting soil microbial communities, not just the plants.

SRI methods not only increase the production of rice but also the biodiversity in the soil, giving plants greater resistance against pest infestation and, to some extent reducing the uptake of arsenic. SRI also helps to conserve rice biodiversity by giving farmers financial incentives to plant local/indigenous/heirloom varieties. Thousands of these varieties have already become extinct, and most of the surviving varieties face extinction. SRI methods can make producing traditional varieties more profitable by raising their yields while reducing costs of production; these varieties usually command a higher market price because of consumers' tastes and preferences. So even if their yields are not as high as from 'improved' varieties, they can be more remunerative. Furthermore, when SRI methods are used, soil and water quality are improved (Doni *et al.,* 2019).

Growing rice plants with SRI methods enhances their root growth while the roots support the plants' canopy, leaf and tiller growth, and grain filling. These plants have better physiological performance, such as higher rates of photosynthesis that increase the supply of carbohydrates to the roots, which prolongs the roots' longevity and thereby contributes to the grain-filling process (Thakur *et al.,* 2010). Under SRI management, yields are increased by 20–60% or even more (Thakur *et al.,* 2016), while water requirements are reduced by about 25% (Jagannath *et al.,* 2013). According to some research in India, net greenhouse gas emissions, consumptions of groundwater, and fossil energy use are, respectively, lower by 40%, 60%, and 74%

kg^{-1} paddy rice produced compared to standard practices. Farmers' net returns ha^{-1} was increased by as much as 300% (Gathorne-Hardy *et al.,* 2016).

SRI adoption in Indonesia

There are many lessons that Indonesia can learn from the experience of other countries that have been practicing SRI. Expanding SRI is effective in handling three different interested parties, namely (i) the farmers, (ii) the officers, and (iii) the government. Farmers benefit from low seed input, low water usage, more productive panicle, reduction of pest and disease infestation, ability to generate their own seed, high-weight grain, and high-quality seed. On the other hand, the factors that often hinder the farmers from practicing SRI are the long duration needed to cover the land, difficulty in moving the young seedlings, difficulty in controlling the wet and dry needs, absence of organic materials, the requirement of experienced workers and the lack of proper tools.

Thiyagarajan and Gujja (2013) also mentioned that a low understanding of SRI principles and the requirement for detailed attention and monitoring are also among the main causes that contribute to farmers' low interest in SRI. Like the other new farming methods, the farmers may try on this method for a while and then possibly discontinue it for some reason. Therefore, technical support and continuous encouragement for several seasons are needed to change the farmers' ways of managing rice planting.

Conclusion

The high productivity obtained by the SRI farmers and field trials has proven the suitability of the SRI method for sustainable farming in Indonesia. The enhanced soil microbial diversity and activities contribute to the growth of the rice plants and productivity, as attested by the high-yield components under the SRI cultivation method. The agroecosystem also supports the existence of a balance between the pest and non-pest insect populations. The volunteers of farmers to try different cropping methods are the key success of this cultivation method. This augurs well with the good agricultural practice methods in sustainable rice farming.

References

Altieri MA, and Nicholls CI. 2020. Agroecology and the reconstruction of a post-COVID-19 agriculture. *The Journal of Peasant Studies*, *47*(5): 881-898.

Doni F, Mispan MS, Suhaimi NSM, Ishak N, and Uphoff N. 2019. Roles of microbes in supporting sustainable rice production using the system of rice intensification. *Applied Microbiology and Biotechnology*, 103(13): 5131-5142.

FAO. 2011. Save and Grow. https://www.fao.org/3/i2215e/i2215e.pdf

Gathorne-Hardy A, Reddy DN, Venkatanarayana M, and Harriss-White B. 2016. System of Rice Intensification provides environmental and economic gains but at the expense of social sustainability—A multidisciplinary analysis in India. *Agricultural Systems*, 143: 159-168.

Jagannath P, Pullabhotla H, and Uphoff N. 2013. Meta-analysis evaluating water use, water saving, and water productivity in irrigated production of rice with SRI vs. standard management methods. *Taiwan Water Conservancy*, 61(4): 14-49.

Pronti A, and Coccia M. 2020. Agroecological and conventional agricultural systems: Comparative analysis of coffee farms in Brazil for sustainable development. *International Journal Sustainable Development*, *23*(3/4): 223-248.

Thakur AK, Mandal KG, Mohanty RK, and Uphoff N. 2022. How agroecological rice intensification can assist in reaching the Sustainable Development Goals. *International Journal of Agricultural Sustainability*, 20(2): 216-230.

Thakur AK, Rath S, Roychowdhury S, and Uphoff N. 2010. Comparative performance of rice with system of rice intensification (SRI) and conventional management using different plant spacings. *Journal of Agronomy and Crop Science*, 196(2): 146-159.

Thakur AK, Uphoff NT, and Stoop WA. 2016. Scientific Underpinnings of the System of Rice Intensification (SRI): What is known so far? *Advances in Agronomy*, 135: 147-179.

Thiyagarajan TM and Gujja B. 2013. Transforming Rice Production with SRI (System of Rice Intensification) Knowledge and Practice. http://www.agsri.com/images/documents/sri/SRI_Book_Final_Version.pdf (Accessed 12 May 2015).

Uphoff N. 2008. Report on visit to Indonesia. http://sri.ciifad.cornell.edu/countries/indonesia/indoNTUtrep0108.pdf