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System of Rice Intensification (SRI)

संकलन

Deepak Laxman Katgar

M.Sc. Agriculture, Department of Agronomy, Mahatma Jyoti Rao Phoole University, Jaipur Rajasthan- 302019

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important staple food crops in the world, feeding more than half of the global population. In India and many Asian countries, rice is central to food security, rural employment, and agricultural income. However, conventional rice cultivation practices require high water input, higher seed rate, and intensive use of chemical fertilizers and pesticides. These practices often increase production costs and lead to environmental concerns such as soil degradation and methane emission. The System of Rice Intensification (SRI) is an innovative and eco-friendly method of rice cultivation that enhances yield by improving crop management practices. It was developed in Madagascar during the 1980s and later spread to many rice-growing countries. SRI is not a new rice variety but a set of agronomic practices designed to increase productivity by improving plant, soil, water, and nutrient management. The basic philosophy of SRI is to grow healthier plants by providing optimal growing conditions, leading to higher yields with fewer inputs.

2. Principles of System of Rice Intensification (SRI)

The System of Rice Intensification (SRI) is founded on a set of scientifically designed crop management principles that aim to create optimal growing conditions for rice plants. Unlike conventional methods that depend heavily on water and external inputs, SRI focuses on enhancing the natural potential of the rice plant by improving root growth, soil health, and plant spacing. The following principles form the backbone of SRI methodology.

2.1 Use of Young Seedlings

One of the most important principles of SRI is transplanting very young seedlings, generally between 8–14 days old. At this stage, seedlings usually have only two small leaves and are still in their early growth phase. Transplanting young seedlings ensures minimal disturbance to the plant's growth potential. Older seedlings, when transplanted, often experience transplant shock that restricts root development and tillering capacity. In contrast, young seedlings adapt quickly to the main field, establish faster, and develop a more vigorous and extensive root system. Stronger roots allow better absorption of nutrients and water, ultimately contributing to improved plant growth and higher yield.

2.2 Single Seedling per Hill

In conventional rice cultivation, farmers typically transplant three to four seedlings per hill. However, SRI recommends planting only one seedling per hill. This practice reduces intra-plant competition for sunlight, nutrients, water, and space. With less competition, each plant has sufficient resources to grow optimally. As a result, individual plants produce more productive tillers and larger panicles. The root system also spreads more freely in the soil, increasing the plant's resilience and nutrient uptake efficiency. This simple modification significantly enhances plant vigor and yield performance.

Source: https://agritech.tnau.ac.in/

2.3 Wider Spacing

SRI promotes wider spacing, usually 25 × 25 cm or even wider depending on soil fertility and variety. Seedlings are planted in a square pattern to facilitate intercultural operations. Wider spacing allows better penetration of sunlight and improved air circulation within the crop canopy. Adequate spacing reduces the incidence of pests and diseases by lowering humidity around the plants. Moreover, it encourages the development of more tillers per plant and supports stronger root expansion. The square planting pattern also makes mechanical weeding easier and more efficient.

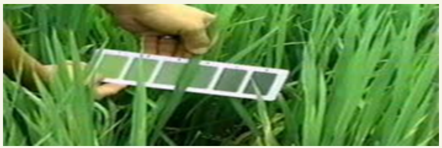
2.4 Intermittent Irrigation

Unlike traditional rice farming that maintains continuous flooding, SRI recommends alternate wetting and drying. Fields are kept moist but not submerged for long periods. Water is applied only when necessary, often when small cracks begin to appear on the soil surface. This practice improves soil aeration and stimulates root growth. Aerobic soil conditions enhance the activity of beneficial microorganisms, which help in nutrient mineralization and availability. Intermittent irrigation can reduce water usage by 30–50 percent, making SRI particularly suitable for regions facing water scarcity. Additionally, it lowers methane emissions associated with flooded paddy fields.

Source: https://www.dreamstime.com/

2.5 Mechanical Weeding and Soil Aeration

Regular mechanical weeding is another essential component of SRI. Tools such as cono weeders or rotary weeders are used at 10–12 day intervals after transplanting. Mechanical weeding not only removes weeds but also incorporates them into the soil as organic matter. The process of weeding disturbs the soil surface, improving aeration and stimulating root growth. Enhanced aeration promotes the proliferation of beneficial soil microorganisms, leading to improved soil fertility and nutrient cycling.



Source: http://www.agritech.tnau.ac.in/

2.6 Organic Nutrient Management

SRI encourages the use of organic inputs such as farmyard manure (FYM), compost, vermicompost, and green manures. Organic nutrient management improves soil structure, enhances water-holding capacity, and increases microbial activity. Healthy soil supports stronger root systems and sustained crop productivity. Although chemical fertilizers may be used when necessary, emphasis is placed on integrated nutrient management to maintain long-term soil health and sustainability.

3. Steps in SRI Cultivation

The successful implementation of the System of Rice Intensification (SRI) depends on careful management at every stage of crop growth. Each step, from nursery preparation to harvesting, plays a crucial role in achieving higher productivity, better resource use efficiency, and improved soil health. The following are the major steps involved in SRI cultivation.

3.1 Nursery Management

Nursery management is the foundation of SRI because the method emphasizes the use of young and healthy seedlings. A raised bed nursery is preferred to ensure proper drainage and aeration. Raised beds prevent water stagnation and promote uniform seedling growth. The seed rate required under SRI is significantly lower, usually about 5–8 kg per hectare, compared to 30–40 kg per hectare in conventional methods. This reduces input costs and encourages careful plant management.

Before sowing, seeds are soaked in water for 8–12 hours and then incubated for 24–36 hours to initiate sprouting. Pre-germinated seeds ensure uniform emergence and better seedling vigor. The nursery soil should be enriched with compost or well-decomposed farmyard manure to support healthy early growth. Seedlings are carefully maintained and protected from pests and diseases. Since seedlings are transplanted at a very young stage (8–14 days old), proper care in the nursery ensures strong and vigorous plants in the main field.

Source: http://www.agritech.tnau.ac.in/

3.2 Main Field Preparation

The main field must be thoroughly prepared to provide favorable conditions for plant growth. Proper leveling is essential to ensure uniform water distribution throughout the field. Uneven land can cause water stagnation in some areas and moisture stress in others, affecting plant performance.

Before puddling, organic manure such as farmyard manure (FYM), compost, or green manure is incorporated into the soil. This improves soil fertility, structure, and microbial activity. Puddling helps in weed control and creates a soft soil layer suitable for transplanting. After leveling, a marker is used to create a square planting pattern, commonly at 25 × 25 cm spacing. The square layout facilitates intercultural operations such as mechanical weeding and ensures equal space for each plant.

3.3 Transplanting

Transplanting is a critical operation in SRI. Seedlings are uprooted carefully from the nursery along with a small amount of soil attached to their roots. This minimizes root damage and transplant shock. Transplanting should be completed within 15–30 minutes after uprooting to maintain seedling vitality. Only one seedling is planted per hill, and it is placed shallowly at a depth of about 1–2 cm. Shallow planting encourages better root growth and tillering. Care must be taken not to bury the seedling too deep, as this may restrict root development and reduce plant vigor.

3.4 Water Management

Water management under SRI differs significantly from conventional rice farming. After transplanting, light irrigation is provided to help seedlings establish. Continuous flooding is strictly avoided. Instead, the field is kept moist but not submerged.

Irrigation is applied when hairline cracks appear on the soil surface, indicating the need for moisture. This alternate wetting and drying practice enhances soil aeration, stimulates root growth, and promotes beneficial microbial activity. Efficient water management under SRI can reduce water use by up to 30–50 percent while maintaining higher yields.

3.5 Weed Management

Weed control is essential in SRI due to wider spacing and non-flooded conditions. The first weeding is usually done 10–12 days after transplanting using a cono weeder or rotary weeder. Subsequent weedings are carried out at intervals of 10–12 days, typically 3–4 times during the crop season. Mechanical weeding not only controls weeds but also aerates the soil. The uprooted weeds are incorporated into the soil, where they decompose and act as green manure, enriching soil fertility.

3.6 Harvesting

The crop is harvested at physiological maturity when grains are fully developed and golden in color. SRI plants generally produce more tillers per plant and larger panicles with well-filled grains. Due to improved root growth and better plant management, yields are often higher than those obtained through conventional cultivation methods. Proper harvesting and post-harvest handling ensure maximum grain recovery and quality. Thus, careful execution of each step in SRI cultivation leads to enhanced productivity, profitability, and sustainability.

4. Advantages of SRI

The System of Rice Intensification (SRI) offers multiple agronomic, economic, and environmental advantages over conventional rice cultivation methods.

4.1 Increased Yield

SRI has the potential to increase grain yield by 20–50% compared to traditional practices. This improvement is mainly due to enhanced root growth, increased tillering, and better grain filling. Wider spacing and single seedling transplantation allow each plant to express its full genetic potential, resulting in stronger plants and larger panicles.

4.2 Water Saving

One of the major benefits of SRI is significant water conservation. By practicing alternate wetting and drying instead of continuous flooding, water requirements can be reduced by 30–50%. This makes SRI particularly suitable for regions facing water scarcity.

4.3 Reduced Seed Rate

SRI requires only 5–8 kg of seed per hectare, which is much lower than conventional methods. This reduction decreases seed costs and encourages careful crop management.

4.4 Improved Root System

Plants grown under SRI develop deeper, healthier, and more extensive root systems. Strong roots enhance nutrient and water absorption, improving overall plant vigor.

4.5 Better Soil Health

Improved soil aeration stimulates beneficial microbial activity, enhancing soil fertility and structure.

4.6 Higher Net Income

Lower input costs combined with higher yields significantly improve farmers' profitability and economic sustainability.

5. Limitations and Challenges

Despite its many advantages, the System of Rice Intensification (SRI) has certain limitations. It requires skilled labor, especially for careful transplanting of young seedlings, which may increase initial labor demand. Timely and repeated mechanical weeding is essential, as fields are not continuously flooded and weeds can grow rapidly. Water management must be closely monitored under alternate wetting and drying conditions to avoid crop stress. Farmers accustomed to conventional methods may find it difficult to adopt new practices at first. Additionally, limited availability of mechanical weeders in some regions can hinder effective implementation. Proper training, awareness programs, and institutional support are necessary to overcome these challenges and ensure successful adoption of SRI.

Parameter	Conventional Method	SRI Method
Seed rate	30–40 kg/ha	5–8 kg/ha
Seedlings per hill	3–4	1
Spacing	15 × 15 cm	25 × 25 cm
Water use	Continuous flooding	Alternate wetting and drying
Root growth	Shallow	Deep and vigorous
Yield	Moderate	Higher

7. Economic Importance

The System of Rice Intensification (SRI) holds significant economic importance for farmers and the agricultural sector as a whole. By increasing productivity with fewer external inputs, SRI enhances farm profitability and resource-use efficiency. One of its major economic advantages is the reduction in input costs. The method requires a much lower seed rate, reduced irrigation water, and limited dependence on chemical fertilizers and pesticides. As a result, the overall cost of cultivation decreases considerably. Higher yields obtained under SRI further improve gross and net returns. Stronger root systems, better tillering, and improved grain filling contribute to enhanced productivity. Since water is a major cost factor in rice cultivation, especially in irrigated regions, the practice of alternate wetting and drying reduces energy and irrigation expenses. Many state governments and agricultural institutions promote SRI as a climate-smart and farmer-friendly technology. Various extension programs, training sessions, and subsidy schemes have been introduced to encourage its adoption. By improving income while conserving resources, SRI supports sustainable agricultural development and strengthens rural livelihoods.

8. Environmental Benefits

SRI offers several environmental advantages that make it a sustainable rice production system. Reduced flooding significantly lowers methane emissions from paddy fields, thereby contributing to climate change mitigation. Methane is a potent greenhouse gas, and minimizing its release is essential for reducing agriculture's environmental footprint. Lower water consumption under SRI helps conserve precious freshwater resources. Improved soil aeration enhances the activity of beneficial soil microorganisms, leading to greater biodiversity within the soil ecosystem. Increased microbial activity improves nutrient cycling and soil structure. Furthermore, the emphasis on organic nutrient management reduces chemical pollution in soil and water bodies. By limiting excessive fertilizer and pesticide use, SRI protects the environment and promotes ecological balance.

9. Future Prospects

The future of SRI is promising, particularly in the context of climate change and resource scarcity. Integration of SRI with organic farming systems can further enhance soil health and environmental sustainability. Mechanization of transplanting and weeding operations will facilitate large-scale adoption, especially in areas facing labor shortages. SRI practices can also be adapted to hybrid and improved rice varieties, increasing their productivity potential. Inclusion of SRI in climate-resilient agriculture programs and government policies will promote wider dissemination. Continuous research, field demonstrations, and farmer training are essential to refine practices and ensure successful adoption across diverse agro-climatic conditions.

CONCLUSION

The System of Rice Intensification (SRI) is a farmer-friendly, sustainable, and resource-efficient method of rice cultivation. By adopting young seedlings, single planting, wider spacing, intermittent irrigation, and mechanical weeding, SRI enhances productivity while conserving water and reducing production costs. SRI offers a promising solution for increasing rice production in a sustainable manner, especially in areas facing water scarcity and rising input costs. It represents a shift from input-intensive agriculture to knowledge-based crop management for long-term agricultural sustainability.