System of Rice Intensification: A Climate-Smart Rice Production Strategy

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Introduction:

Over 80% of Asia's freshwater is used in agriculture; about half of this is for rice irrigation. The SRI method is one of the crucial water-saving techniques that improves water-use efficiency in rice without any significant reduction in grain yield. SRI is a comprehensive agronomic package that:

- Exploits rice plant genetic potential.
- Improves growth environment (both above & below ground).
- Enhances soil health.
- Reduces seed, water, and labour inputs.

Historical background:

SRI methodology was developed by Fr. Henri de Laulanie, S.J., in Madagascar in the early 1980s. Fr. Laulanie spent 34 years (1961–1995) working with Malagasy farmers. In 1983 drought, he observed vigorous root growth in rice plants. Two innovative farmer practices he noticed i.e., transplanting single seedlings and keeping soil moist, not flooded. He added two more practices i.e., square planting pattern with single seedlings and using a rotary hoe in two perpendicular directions. By using 15-day old seedlings and these practices, he saw remarkable plant growth. He named this method as System of Rice Intensification (SRI). It took about two decades for SRI to gain global attention. SRI commonly results in 50–100% yield increase and sometimes even tripling of yield (Yamah, 2002).

Five principles of SRI:

1. Early Transplanting

- SRI promotes transplanting of young seedlings aged 8–15 days (before 4th phyllochron).
- Ideal transplanting stage: third phyllochron, when the plant has two to three leaves.
- Young seedlings result in better root and shoot development with higher uptake of nitrogen (N) and manganese (Mn).

2. Transplanting a Single Seedling per Hill with Wider Spacing

- SRI recommends one seedling per hill with wider spacing.

- Single seedlings produce more crown roots than multiple seedlings.
- Handling of young seedlings:
    - Avoid detaching seed from root.
    - Uproot the young seedling along with seed, root and soil.
    - Minimize time between uprooting and transplanting (15–30 minutes).
    - Keep roots moist before transplanting.
    - Transplant seedlings 1–2 cm deep, laying roots in a horizontal position.

3. Mechanical Weeding

- Weeds are managed with mechanical weeders, such as:
    - Use cono weeder in place of rotary pushed weeder.
- 2–3 weedings during the crop period:
    - First weeding: 10 days after transplanting.
    - Subsequently weedings: 10–20 days interval.

4. Maintaining Moist (Saturated) Soil

- Continuous saturation leads to:
    - More hairy, fine, branched adventitious roots near the surface due to more aeration.
    - Keep the soil moist and aerated.
- SRI encourages intermittent drainage, which:
    - Promotes tap roots and primary roots.
    - Improves soil aeration that leads to better root health.
- SRI supports organic fertilization (compost) over chemical fertilizers.
    - Compost enhances biological activity and improves soil health.

5. Flexibility and Adaptation of SRI

- SRI success depends on local conditions and available resources.
- As it is not always feasible to apply all components of SRI simultaneously, hence farmers should adopt and modify SRI principles to suit their local environments.

Myths and truths of SRI

- ❖ SRI has been criticized as "Voodoo science", based on unconfirmed field observations (UFOs) (Sheehy et al., 2004). High yields claimed under SRI are described by critics as a "consequence of measurement error." In contrast, many studies have shown enhanced rice productivity, water savings and higher economic returns from SRI management.
- ❖ SRI supports resource-use by poor farmers, allowing them to rely more on their own labour and skills. Use fewer costly external inputs, such as chemical fertilizers and certified seeds.
- ❖ Scientific evidence supports that moist soil and Alternate Wetting and Drying (AWD) improve root development, reduce crop lodging, and enhance soil aeration.
- ❖ Environmental Benefits: keeping the soil moist through growing period, reduces the methane emission.

Package of Practices of the System of Rice Intensification

Nursery management

1. **Preparation of the nursery**

- Nursery can be prepared anywhere, garden land/ tray/ plastic sheet.
- Mix well-rotted farmyard manure (FYM) + rice husk + soil in 1: 1: 2 ratio.
- Make raised bed for nursery sowing with the drainage channel.
- Level the seedbed properly.

Fig.1 : Preparation of nursery

2. **Add FYM on the Bed**
   - Spread a thin layer of well decomposed FYM or compost over the seedbed.
3. **Sow the Seeds**
   - Take sprouted seeds and scatter them evenly but not too thick.
   - Use healthy seeds at the rate of 2 kg/ acre
4. **Cover the Seeds**
   - After sowing, add another thin layer of FYM to cover the seeds.
5. **Use Mulch**
   - Cover the seedbed with paddy straw.
   - This helps protect the seeds from sunlight, heavy rain, and birds.
   - It also keeps the bed moist and warm, which helps seeds grow better.
   - During winter protect the nursery with plastic tunnel to avoid delay in germination.

(a)

(b)

Fig.2 (a) & (b) : Covering the seedbed with straw mulch

6. **Watering**
   - Water the nursery gently using a rose can regularly.
   - Drain the excess rain water.
7. **Ready for Transplanting**
   - In 8 to 14 days, the nursery will grow into healthy and strong seedlings, ready to be transplanted.

Fig.3 : 8-15 days old seedling

Land preparation for planting

1. **Ploughing and Puddling**
   - Plough the land well and puddle it just like you do in the traditional method.

Fig.4 : Ploughing & puddling

2. **Level the Field**
   - Make the field perfectly levelled so that water spreads evenly.
   - Make 30 cm wide channels every 2 meters or eight rows across the field.
   - These channels help in draining excess water from the field.
   - Water in the channels helps seepage to keep the soil moist.

Fig.5 : Levelled field conditions

Fig.6 : Drainage channels

3. **Marking for Planting**
   - Use a marker to draw lines in both directions at 25 x 25 cm spacing.
   - Transplant seedlings at the points where the lines cross.

Fig.7 : Square planting

4. **No Standing Water**
    - Make sure there is no standing water in the field when you are transplanting the seedlings.

Transplanting

1. **Careful Removal from Nursery**
    - Gently remove the seedlings from the nursery with the seed, soil, and roots still attached.
    - Be careful not to damage the roots or disturb the soil around them.

Fig.8: Uprooting of seedlings carefully

2. **Planting in the Field**
    - Do not plant too deep i.e. just enough to hold the seedling upright.
    - The roots and attached seeds should not be left exposed at the soil surface.
3. **Quick Transplanting**
    - Transplant the seedlings quickly, preferably within 15 minutes and at most within 30 minutes after removing them.
    - This helps prevent the seedlings from getting shocked.
4. **Keep Seedling Upright**
    - Make sure the tips of the seedlings are not bent or upside down when planting.
5. **Gentle Planting**
    - Do not push the seedling straight down into the soil.
    - Instead, gently slip it into the soil so that the roots spread sideways in the moist soil, close to the surface.

Fig.9: Transplanting of rice in SRI plot

6. **Plant Only One Seedling**
    - Plant only one healthy seedling at a spacing of 25 x 25 cm-
    - This spacing allows the plant to grow better with more sunlight, air, and nutrients.

Fig.10: Crop at early stage

Weeding and Interculture

1. **Use a Rotary Weeder / Cono weeder :**
    - Use a simple mechanical rotary weeder to control weeds and churn the soil.

- Rotate the weeder 2 to 4 times in each weeding session to mix the weeds well into the soil.

Fig. 11: Use of Rotary weeder or Conoweeder

2. Weeding Schedule

- Do the first weeding 10–12 days after transplanting (DAT), when weeds are just starting to grow.
- Do the next weeding every 10-15 days for best results.
- By using cono weeder the weeds get churned into the soil. This helps to improve fertility.
- Before weeding with a cono weeder, apply irrigation for ease of moving weeder in the mud.

3. Benefits of Rotary Weeding

- Improves aeration in the soil, helping roots grow better.
- Reduces weed competition and improves availability of oxygen and nitrogen to the roots.
- Each weeding can add up to 1 ton of green manure per hectare.
- This also increases the soil's microbial activity, making the soil more fertile and healthy.

Water management

1. No Stagnant Water

- Do not let water stand in the field. SRI does not need continuous flooding.

2. Keep Soil Moist

- Irrigate regularly to keep the soil just moist, not flooded.

3. Alternate Wetting and Drying

- Allow the soil to dry slightly between two irrigation events and then wet it again.
- This creates both aerobic (with air) and anaerobic (without air) conditions, which help soil microbes, mobilize more nutrients.

4. Better Root Growth

- The moist condition along with mechanical weeding, increase air in the soil.
- This leads to stronger root growth and better uptake of nutrients by the plants.

Nutrient Management :

- Prefer soil test based fertilizer application for P & K over a blanket dose.
- Apply NPK as per conventional practices. Nitrogen can be applied on the basis of customized leaf colour chart (CLCC) for efficient use.
- For better soil health in poor soil condition, apply nitrogen through organic sources (green manure, FYM, Azolla etc.) and chemical fertilizer (prilled urea) in a 50 : 50 ratio.

- Apply 10 tons/ha of well-rotted FYM or compost, which provides enough nutrients and mix it well with soil while puddling
- Apply $ZnSo_4$ (zinc sulphate) @ 25 kg/ha in zinc deficient soils.

Do's and Don'ts for SRI

Do's

1. **Use Quality Seeds**
   - Select good quality seeds of the variety with 110 to 135 days duration or hybrid.
2. **Choose Suitable Areas**
   - Use SRI mainly in medium land with zero water stagnation or terrace land where water drainage is easy
3. **Transplant Young Seedlings Carefully**
   - Transplant young seedlings with soil and roots intact, placing them shallowly in the field.
4. **Use Organic Manures**
   - Apply as much organic manure (FYM, compost, green manure) as possible to improve soil health, however need based chemical fertilizers can also be applied.
5. **Weed Control and Aeration**
   - Use the cono weeder to control weeds which also helps aerate the soil.
6. **Pest Management**
   - Take care to control pests like leaf folder and nematodes**.**
7. **Water Management**
   - Avoid flooding. Instead, use Alternate Wetting and Drying (AWD) to keep the soil just saturated, not waterlogged.

Don'ts

1. Do not promote SRI in fields that are not properly levelled.
2. Avoid promoting SRI in saline soils.
3. SRI is not suitable for lowlands with uncontrolled water.
4. Avoid using SRI in areas with very high rainfall.

Variations in adopting the principles of SRI:

PRINCIPLE	RECOMMENDED PRACTICE	VARIATIONS
Young seedlings	• 8-14 day-old seedlings, not beyond the 3-leaf stage	• Direct seeding • Conventionally-raised older seedlings
Lower plant density and wider spacing	• Single seedling/ Hill • Square pattern (25x25 cm spacing)	• More than 1 seedling • Wider row spacing for cono weeder operation. • Narrow plant to plant spacing

Keep the soil moist and not continuously flooded	• Irrigate 2cm of water after hairline cracks form on the soil. • No water stress after flowering.	• Flood irrigation
Inter cultivation	• 10-12 DAT (Days After Transplanting : 3-4 times in both directions.	• Single direction use only
More Organic manures	• Cattle manure, green manure and biofertilizers	• Combination of both Chemical and organic sources of nutrients.

Benefits and impact of SRI:

SRI techniques are reported to give rise to three key benefits:

1. SRI often leads to increased rice yields, which directly benefits both small-scale (subsistence) and commercial farming households.
2. SRI methods are known to increase the efficiency of two important inputs:
    - Water (less needed due to alternate wetting and drying)
    - Seed (fewer seeds used but better results)
3. SRI is said to represent a more ecologically sustainable method of rice cultivation, primarily through water conservation but also enhances soil microbial activity and lower methane emissions.

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