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Research Article

Potential of the System of Rice Intensification (Sri) for Cuddalore District

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Abstract

System of Rice Intensification (SRI) paddy was introduced to compensate the grave cost of Traditional paddy cultivation. To decrease the cost of cultivation in Traditional paddy, to increase profits of the farmers in rice cultivation by decreasing the use of fertilizers, pesticides and minimizing water use by scientific water management in the face of labor scarcity, SRI paddy was introduced in Madagascar. In Traditional paddy the spacing of 20x15cms was followed and 20 days seedlings and amount of water was required. Whereas, in SRI paddy cultivation, the wider spacing of 25x25cms was followed and by 8-12 days seedlings and a film of water up to 1” only is maintained. The pest management is done without chemical pesticides in SRI paddy cultivation. The profits attained due to SRI paddy cultivation was higher as compared to Traditional paddy cultivation, therefore, SRI paddy was called as poor farmers’ crop.

Keywords: SRI, production systems, water productivity, Organic manure

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Introduction

Rice commends recognition, as a supreme commodity to mankind, because rice is truly life, culture, a tradition and a means of livelihood to millions. It is an important staple food providing 66-70 per cent body calorie intake to the consumers. Rice is consumed both in urban and rural areas and its consumption is growing due to high-income elasticity of demand. To meet the growing demand, a rapid increase in paddy production is needed. But, there is little scope to increase the area; hence increase in production and productivity with an improvement in efficiency of production act as technological breakthrough to meet the growing demand.

The green revolution of 1960’s was oriented towards high input usage particularly fertilizers, irrigation and plant protection chemicals. As a result of excessive use of these inputs the cost of cultivation has escalated. This is more so in irrigated crops like paddy.

The spectacular increase in production of paddy was restricted to irrigated belts of the country. The slanted distribution of green revolution results and increased costs of cultivation have given alarming signals to the future needs of food security. At this juncture the System of Rice Intensification (“SRI” – Rice cultivation) came into light.SRI; the system of rice intensification is a system of production of rice.SRI is considered to be a disembodied technological breakthrough in paddy cultivation.SRI involves the application of certain management practices, which together provide better growing conditions for rice plants, particularly in the root zone, than those for plants grown under traditional practices. This system seems to be promising to overcome the shortage of water in irrigated rice.

Materials and Methods

An experiment was conducted during the Kharif season of the year 2012-13 at farm in Cuddalore district of TamilNadu state. The plot size of an experiment was 5.0 m x 4.0 m.

Sowing Season

There are two seasons for rice cultivation in India. Rice growing seasons vary in different parts of India, depending upon temperature, rainfall and other climatic conditions.

Table 1 Rice Cropping Calendar in TamilNadu

JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT
					Sowing	Sowing		Harvesting	Harvesting

Kharif – May – June Sowing
Rabi – December- January Sowing
December- January Sowing is most favorable for getting quality seed

Preparation of Nursery and Raising seedlings

Seedlings are raised in special raised bed nurseries prepared by mixing manure and soil in layers and sowing 5 kg of pre-soaked seed in an area of 100 m^2/ha (incubated for 12 hours). As far as possible nurseries are located adjacent to main field to avoid time lag between uprooting and planting this is not more than 30-40 minutes.3 kg of seeds (5 kg / ha) is required to transplant in one acre of land. Seed should be thinly spread to avoid crowding of seedlings. Care should be taken that no two seeds should touch each other. Healthy and pure seeds are used. Soak the seeds for 12 hours in water. There after transfer the treated seeds to a water soaked gunny bag. Leave it for 24 hours. Sprouted seeds are taken to the nursery for sowing. To ensure uniform broadcasting, divide the seed into four part and broadcast thinly over the bed (each part at a time). It is better to broadcast seeds in the evening. Land selected for SRI should be well leveled and should not have water logging condition. When the plot is irrigated the water should spread uniformly across the field. Similarly, whenever needed there should be provision to drain the excess rain water. Farmers must have their own irrigation resources so that they can provide irrigation whenever it is needed. The main field is prepared and leveled with little standing water a day before planting for grid marking. Provision should be made for 30 cm wide channels at 2 meters interval. Perfect leveling is the pre-requisite for proper water management and good crop stand.

Table 2 Basic principles of SRI

Description	SRI	Non-SRI
Seeding Rate (kg/ha)	22	74
Nursery Area	1 Cents /acre	5 Cents /acre
Age of Seedlings	8-12 days (2 leaves)	30 days (5-6 leaves)
Seeding Age at Transplanting (Days)	14	29
Spacing	25 cm × 25cm	15 cm × 10cm
Planting Depth (cm)	1	3
Plants / Hill	3-4	1

Hills /Sq.m	33	16
Weeding	Mechanical	Manual / Chemical
Water Management	Keep soil moist all panicle initiation stage	Continuous irrigation
Nutrient Application	Organic Manure	Chemical Fertilizer

Method of Transplanting

The field should be well puddle and leveled. After leveling the field, a marker can be used to lay out the plot into wider spacing i.e., 25 cm x 25 cm row to row and plant to plant. This can also be done with the help of rope by marking. Young rice seedlings 8 to 12 days old and in some places 14-15 days old seedlings (2-3 leaf stage) is considered to be ideal for transplanting as compared to 25-30 days old seedlings in traditional method of rice cultivation. The seedlings with 2-3 leaves stage have great potential for profuse tillering and root development. It results to achieve maximum yield potential of varieties / hybrids. Care should be taken to prevent any harm to seedlings while pulling them from nursery or at the time of transplanting. A metal sheet is inserted 4-5 inches below the seedbed and seedlings scooped along with soil without any disturbance to their roots. Transplanting of tender seedlings need care to minimize root trauma. The farmers and farm laborers need to be educated on this aspect. Young seedlings are planted shallow horizontally thus establish quickly. Seedlings are transplanted with the help of index finger and thumb and by gently placing them at the intersection of marking. Light irrigation should be given on the next day of the transplanting. With wide spacing each plant gets more space, air and sunlight. As a result each plant gives more tillers. The roots would grow healthy and extensively and take more nutrients. As the plant is strong and healthy the number of tillers would be more. The panicle length, grains and the grains weight also is more.

Nutrient Management

All the farmers expressed that they would prefer to use organic material if available in adequate quantities. Green manure and farm yard manure application will enhance the growth and yield of rice in this system approach. SRI was developed in the 1980s with fertilizer use, and this does enhance yield. But soil that is enriched with compost or manure will usually have better structure so that plant roots can grow more easily and deeply, and soil organic matter supports the growth of microbial populations and greater biodiversity within the soil. Compost releases its nutrients more slowly than chemical fertilizer so plants usually get more benefit. The compost can be made from any biomass (e.g., rice straw, plant trimmings, weeds and other plant material), with some animal manure added if available. We think that SRI soil management practices (no flooding, the use of compost, and rotating-hoe weeding) help increase the populations of micro-organisms in the soil which can produce nitrogen for the plant. They can also assist with phosphorus solubilization. Also there is more oxygen in soil which has more worms, ants, termites, etc., which are less abundant in chemically fertilized soil.

Water Management

As the soil is not flooded the roots of the paddy plant grow healthy, deeply in all directions. The root growth is extensive also due to the wide spacing. As the field is intermittently irrigated and dried, the micro organisms grow well which make nutrients available to the plants. Depending upon the soil and the environment conditions, the frequency of irrigation should be decided. During transplanting the field should be just wet – not inundated. The next irrigation with 1-2 cm of water is taken up one or two days after transplanting (depending on the soil type, season, etc.). Only when this water is completely absorbed, the next irrigation is applied: again 1-2 cm water. This procedure of “wetting and drying” is continued throughout the vegetative stage. “Drying,” means here that the water is completely absorbed and a hairline crack is seen. Carefully field inspection by the farmer is essential to ensure optimum moisture management. 1-2 cm water is maintained in the field as soon as the panicle initiation starts. Standing water of 2 cm is maintained from panicle initiation till 15-20 days before the harvest.

Weed management

Weeds would be more in SRI method as there is no standing water. Under no circumstances, chemical herbicides should be used in SRI method. Instead of weeding manually and throwing the weeds outside the plot, there are several advantages of turning the weeds into the soil by using 'weeder'. Weeding is done on the 10th, 20th, 30th and 40th day after transplantation using cono weeder. A day before using the weeder, the field should be lightly irrigated. Weeder should be moved front and back between every two rows. After the weeding, under no circumstances the water should be drained out of the field. If this water is drained, all the nutrients would be lost from the field. By using the weeder, the soil gets aerated and the roots are exposed to air and also results in profuse growth of diverse soil micro organisms which make nutrients available to the plant.

Results and Discussion

The results obtained during the experiment were analyzed and are discussed with possible reasons and literature support.

Panicle initiation (PI)

The panicle initiation stage begins when the primordial of the panicle is differentiated and becomes visible. If water is limiting, panicle initiation may be delayed. The period of PI was found significantly different among the two different methods of cultivation, CF required the longest period of (72.45DAS), followed by SRI with the shortest period of (66.84DAS).

Table 3 Growth Stage of reproductive phase

S.No	Parameter in (DAS)	SRI	CF
1	Panicle initiation (PI)	66.84	72.45
2	Booting stage	79.54	84.32
3	Heading stage	88.63	92.46
4	Flowering	91.56	98.38
5	Dough stage	98.65	103.54
6	Hard dough stage	110.68	116.37
7	Maturity stage	121	130

Booting stage

This is the stage at which the sheath of the flag leaf shows some swelling and it generally occurs two weeks (12-18 days) after panicle initiation stage. Earlier booting was recorded in SRI method (79.54 DAS) than CF (84.32 DAS).

Flowering

Anthesis or flowering refers to a series of events between the opening and closing of the spikelet, the lasting about 1-2.5 hours. It takes 7-10 days for all the spikelet within the same panicle to complete anthesis; most of the spikelet completes anthesis within 5 days. Hence, it takes about 15-20 days for all the spikelets of a crop to complete anthesis. Appreciably past flowering stage (91.56 DAS) was recorded in SRI method, whereas CF (98.38 DAS) had taken statistically longer duration for flowering.

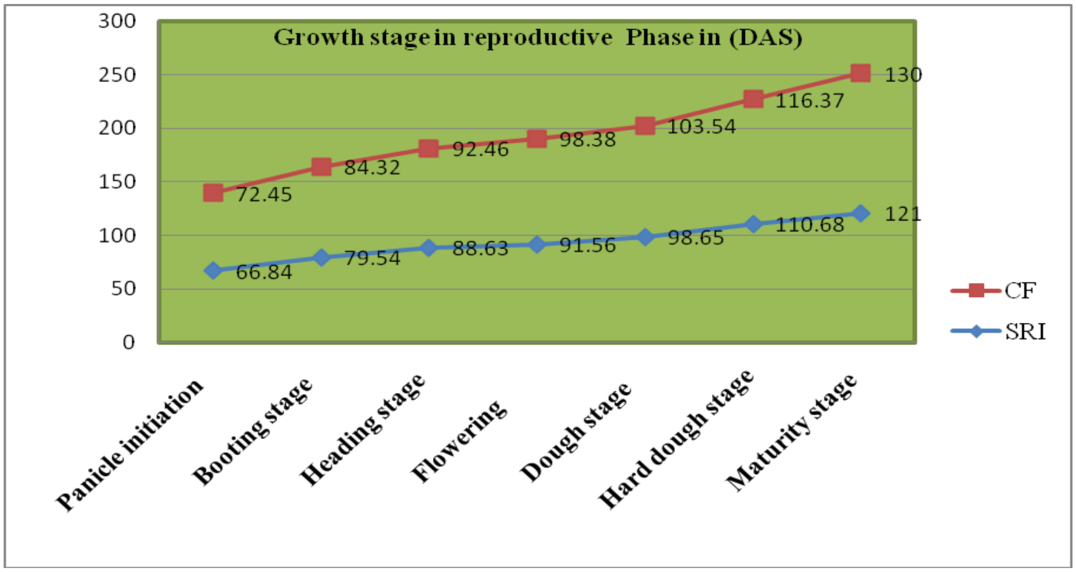

Figure 1 Growth Stage of reproductive phase

Heading stage

Booting stage is followed by the emergence of panicle tip (heading) out of the flag leaf sheath. Generally, heading starts 3 weeks after panicle initiation. The duration for booting stage was considerably longer for CF (103.54 DAS) and the shortest for SRI (98.65DAS).

Dough stage

When ripening advances, milky liquid in grains becomes thicker and finally attains dough stage. Average duration for the soft dough stage was 104 DAS and it varied from 94 DAS to 111 DAS depending up on the different method of crop establishment and varieties. From the analysis, it was observed that soft dough was significantly later in CF (109 DAS), followed by SRI (100 DAS).

The appearance of hard dough stage in the experiment took 105 DAS to 122 DAS

Average duration taken by the rice crop for this stage was 115 DAS.SRI method took notably shorter duration (110.68DAS) and CF (116.37 DAS).

Maturity stage

The grain is said to be matured when grain color in the panicles begins to change from green to yellow. The individual grain is mature, fully developed, and is hard and free from green tint. The mature grain stage is complete when 90-100% of the filled spike lets have turned yellow. At this time, senescence of the upper leaves including the flag leaves is noticeable. The average physiological maturity stage was observed at 128 DAS and varied from 116 DAS to 136 DAS in response to different date of sowing and variety. Statistical analysis of the data recorded at this stage showed that physiological maturity was significantly earlier in SRI (121 DAS) method of crop establishment followed by CF (130DAS).

Biometrical observation of rice

Plant height

The plant height varied from 44.86 cm (35 DAS) to 123.5 cm (95 DAS) and increasing up to 95 DAS. The increment in plant height was prominent (42.33 %) between 35 DAS and 50 DAS, which represents the rapid vegetative growth stage of plant coinciding with the stage of maximum tillering. Plant heights were significantly influenced by method of crop establishment at all observation. Similarly, plant heights of varieties were also significantly different among each other at all dates of observation. At 35 DAS, significantly tall plant height (54.87 cm) was observed in SRI method and significantly short plant height (31.52cm) was observed in CF which could be due to late transplantation in CF and higher competition in nursery bed. In case of 50 DAS significantly tall plant height (72.01 cm) was observed in SRI method and short plant height (59.33 cm) was observed in CF. Significantly tall plant height (92.53 cm) was observed in SRI method in case of 65 DAS and at the same observation short plant height (79.88 cm) was observed in CF.

Figure 2 SRI Plant height

Panicle length

Panicle length was significantly influenced by method of crop establishment as well as varieties. Longer panicle length of SRI method is (26.89 cm). Significantly shorter panicle length was observed in CF method (23.57cm).

Panicle weight

Panicle weight of SRI method (4.176 g) .Significantly lower panicle length was observed in CF method (2.929 g).

Filled grains per panicle

Filled grain per panicle was the highest in SRI method (181.9).Lower number of filled grain was observed in CF method and was (113.7).The longer SRI panicles carried nearly 1.7 times more number of grain compared to panicles obtained from conventional methods. Thus, lower number of filled grains per panicle in CF method might be due to shorter panicle length and higher sterility percentage.

Table 4 Comparison of Parameters between SRI and Conventional Methods

S.No	PARAMETER	SRI	CF
1	Panicle length	26.89	23.57
2	Panicle weight (g)	4.176	2.929
3	Filled grains per panicle	181.9	113.7
4	Grain yield	6.95 mt/ha	4.18 mt/ha^{-1}
5	Straw yield	9.1 t ha^{-1}	6.5 t ha^{-1}
6	Harvest index (HI)	0.41	0.39
7	Water productivity	0.514 (kg/m3)	0.259(kg/m3)

Grain yield

SRI method of crop establishment had produced significantly higher grain yield (6.95 mt/ha) and the lowest yield was under CF method i.e. 4.18 mt/ha.

Straw yield

The straw yield was the highest (9.1 t ha-1) in SRI method which was significantly superior to the straw yield from CF (6.5 mt/ha).

Harvest index (HI)

Harvest index indicates the efficiency of assimilate partition to the parts of economic yield of the rice plants (i.e. panicle). Significantly higher harvest index was obtained in by SRI (0.41), and the lowest was of CF (0.39).

Water productivity of rice

The experiment shows the highest water productivity in SRI methods (0.514 kg/m3), followed by CF (0.259 kg/m3).

Cost of cultivation

The cost of cultivation was calculated for one hectare area from the cost involved in experimental plots.

Table 5 The cultivation cost of SRI and Conventional Farming methods

S.No	Cultivation Practices	Expenditure (per acre) of SRI paddy	Expenditure(per acre) of CF
1.	Seed Rate	Rs60/- for 2kgs	Rs600/- for 30kgs
2.	Nursery management	Rs 168/-	Rs1250/-
3.	Land preparation	Rs 1800/-	Rs1800/-
4.	Transplanting management	Rs 1200/-	Rs2400/-
5.	Fertilizer management	Rs1260/-	Rs3240/-
6.	Weed management	Rs100(weeder rent per day)	Rs2400/-
7.	Pesticide management	Rs120/-	Rs3000/-
8.	Harvesting	Rs2500/-	Rs2500/-
	Total	Rs7208/-	Rs17190/-

Environmental benefits of SRI

SRI methods are not only beneficial for people but also for the natural habitat and biodiversity. Because SRI methods do not require chemical fertilizer, they enable farmers to reduce their fertilizer applications, or eliminate them altogether, producing yields as good or better by use of compost. This can contribute to both better soil and water quality and to improved soil health and human health. Not all farmers are willing to change to fully organic sources of fertilization, but SRI training and experience encourage reduced use of chemical fertilizer. An evaluation of 120 farmers in Tamil Nadu who had used SRI methods for three years, with a doubling of yield, documented that farmers reduced their fertilizer use by 43% and their use of agrochemicals by 80%.

Conclusions

It is conclude that SRI offers three major benefits that have significant climate implications if applied on a large-scale: Reduced demand for water, reduced methane gas emissions, reduced use of chemical fertilizers. In addition, with SRI practices, rice plants have stronger stems and root systems that are more resistant to flooding and storm damage compared to those grown using conventional practices. Perhaps even more important, their deeper root systems make crops more drought-resistant.

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