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A REVIEW :

System of rice intensification a high productive technology

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SUMMARY : The major constraints in rice production are lack of integrated management practices involving land, labour, crop, water and inputs, such as seeds, fertilizers, optimum plant population etc. Increasing the rice productivity by the use of appropriate agronomic management practices become an essential component of rice production technology. The lower average rice yield in India and Tamil Nadu can be attributed to poor soil fertility, improper spacing and nursery management. Intensive research has been initiated to solve the problems related to soil fertility and crop management through co-ordinated net works of research all over the country.

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SRI, Physiology, Yield, Economics

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BACKGROUND AND OBJECTIVES

Rice (*Oryza sativa* L.) is the major source of food for nearly half of the world's population. The cultivation of rice and its productivity is a challenge of coming decades due to potential changes in temperature, precipitation and sea level, as a result of global warming. Geometric growth of population and arithmetic increase in food grain production leave a vast gap in food supply. This gap is further widened due to urbanization and industrialization of fertile lands. In the global scenario, the present population of 6 billion is expected to reach a figure of 9 billion by 2050. The global requirement of rice by 2025 AD would be 800 million tones, which is 26 per cent higher than the present level of production. In India, it is grown over an area of 44.6 million ha (m.ha) with a total production of 87 million tones (m.t) in 2003-2004 amounting to 41.8 per cent of total food grain production (Malik *et al*., 2006). The SRI has its own components *viz.*, transplanting of young seedlings usually 12 to 14 days as single seedling per hill at wider spacing in a square geometry and use of mechanical weeder, need-based fertilizer application and optimum use of water for better growth especially soil aeration (Kumar and Shivay, 2004).Due to wider spacing of 25 x 25 cm, there are more weeds with SRI than conventional cultivation (Jiaguo Zheng *et al*., 2004).

Origin of SRI method of rice cultivation:

The system of rice intensification was developed by Father Henri de Laulanie, a

Jesuit priest in Madagascar in the early 1980s. System of rice intensification is considered as a system rather than a technology. It appears to be a harbinger of post-modern agriculture, a new set of technologies and practices that are based on biological evolutions to the problem of raising agricultural productivity, superseding the engineering, chemical and genetic solutions of 20th century. System of rice intensification raises not just productivity of land but also of water, labour and capital. System of rice intensification is not only a set of practices (young seedlings, wider spacing, less water etc.) but also a set of insights and principles, with a philosophy which can help to reshape the paradigms of agricultural products and its associated sciences (Uphoff, 2006).

Effect of system of rice intensification on growth of rice :

Aziz and Hasan (2000) reported that in SRI practice, the average number of tillers hill^{-1} and effective tillers hill^{-1} were 117 and 103, respectively in Parija variety at Rajshahi, Bangaladesh. The highest number of effective tillers m^{-2} (531) was found with 35 × 35 cm spacing. But with the same spacing the number of effective tillers was 342 m^{-2} in locally intensified farming enterprises trials. On the other hand, in farmers practice the average number of effective tillers m^{-2} was 290 and 393 with 20×20 cm and 20×15 cm, respectively. Saina (2001) reported in SRI practice that fifty tillers per plant were easily obtained, and farmers who had to get over 100 tillers from single tiny seedling. Greater root growth was noticed with SRI plant at 30 cm depth with highest nutrient uptake (Barison, 2002). Root growth and root exudation rate hill^{-1} were significantly higher in SRI plant (Thakur *et al*., 2006). Highest number of tillers hill^{-1} was recorded in SRI with tillering continuing up to 50 DAT (Patel *et al*., 2006). The SRI method performed normal planting in terms of growth attributes, root growth and yield (Zamir Ahmed *et al.*, 2006).

Effect of SRI planting on physiological attributes :

Tao Long Xing and Shaokai (2002) reported that there were lower respiration and the flag leaf photosynthesis rate from filling stage to ripening stage decreased with SRI and stomatal resistance was increased compared to traditional flooded irrigation. Shao-hua *et al*. (2002) reported enhanced root activity during the entire growth period, especially at later growth stages, higher contents of soluble sugars, non protein nitrogen and proline in leaves, higher translocation and conversion rates of stored matter from vegetative organs in plants under SRI. This ultimately enhanced grain filling and spike weight in SRI. In SRI, they observed higher biomass by large individual plants, and dry matter accumulation after heading accounted for 40 per cent of the total dry matter. More than 45 per cent of the material from stem and sheath was contributed to grain yield in SRI. At the same time, SRI facilitated a heavier and deeper root system. Dry weights of stems, leaves, and roots and the total dry weights, leaf area and total root length per hill during the growing period and the tiller number per plant at heading were significantly higher in SRI compared to other treatments.SRI cultivation with 25 x 25 cm spacing was found superior for various physiological parameters such as root growth and LAI (Raghuveer Rao *et al.,* 2006).

Effect on soil microbial activity :

Increased population of bacteria, fungi and actinomycetes were found in young seedlings. This might be due to the fact that larger increased root proliferation with larger canopies led to more photosynthates which reach the soil through root exudation and other forms of rhizodeposition. This supports more diverse and active population of soil organisms (Uphoff, 2006).

Systems of rice intensification on yield attributes and yield of rice

Islam (1999) stated that in the SRI method of plant spacing of 25 cm × 25 cm or 20 cm × 20 cm, yields were about the same (9.5 t ha^{-1} and 9.2 t ha^{-1}, respectively) but with spacing of 30 cm×30 cm, the yield increased upto 10.5 t ha^{-1}. Rajaonarison (2000) conducted an experiment to assess SRI practices during the 2000 minor season on the West Coast of Madagascar and found that SRI practices produced 6.83 t ha^{-1} grain yield where standard practices produced only 2.84 t ha^{-1}. McHugh *et al*. (2002) reported that SRI was associated with a significantly higher grain yield of 6.4 t ha^{-1} compared with 3.4 t ha^{-1} from conventional practices. In SRI plots, grain yields were 6.7 t ha^{-1} for AWD irrigation, 5.9 t ha^{-1} with nonflooded irrigation, and 5.9 t ha^{-1} for continuously flooded rice. The results of the study suggested that, by combining AWD irrigation with SRI cultivation practices, farmers could increase grain yields while reducing irrigation water demand.SRI methods are being used to top up the yields of super high yielding hybrid varieties, with yields as high as 16.5 t ha^{-1} (Yuan, 2002). At Nanjing University of China, rice grain yield of 9.2 to 10.5 t ha^{-1} were obtained using only about half as much irrigation water as usual by adopting system of rice intensification practices (Uphoff *et al.*, 2002). Chowhan (2003) reported that farmers were able to achieve on an average 30 per cent higher production from SRI practice than traditional practice.

The hybrid KRH 2 recorded maximum grain yield of 7.95 t ha^{-1} under SRI system of culture which was superior to the rest of the treatment combinations. In a trial conducted at Almora, a cultivar, Pant Dhan 11 recorded maximum grain yield of 3.38 t ha^{-1} with SRI which was significantly superior to standard transplanting method (DRR, 2004).Balasubramanian and Devaraj (2004) recorded higher grain yield of 7.3 t ha^{-1} and 8.4 t ha^{-1} in SRI during *Kharif* and *Rabi*, respectively, when compared to conventional method of cultivation at Aduthurai, Tamil Nadu. This was mainly because of more number of productive tillers in SRI (545 and 488 m^{-2} in *Kharif* and *Rabi*, respectively).

Rice under SRI practice matured about a fortnight earlier than the conventional *Rabi* crop in time (Rajendran *et al.*, 2006). SRI method resulted in about 43.4 per cent more lateral root activity and 38 per cent more vertical root activity than that of normal method. The yield was higher in SRI system by 11 per cent compared to that of normal method (Surendra Babu *et al.*, 2006). In the on-farm trials conducted in the Warangal district of Andra Pradesh, India, an average yield of 7.6 t ha^{-1} was obtained under SRI method and 5.8 t ha^{-1} under normal transplanting method (Cheralu *et al.*, 2006).

Significantly higher grain and straw yield of 7.8 and 10.6 t ha^{-1}, respectively were recorded under 25 x 25 cm spacing when 5 cm irrigation was applied three days after disappearance compared to conventional method (Singh *et al.*, 2006). Narasimha Reddy *et al*. (2006) observed the better performance of rice hybrid KRH-2 and variety RNR-23064 cultivated under SRI method and reported that there grain yield of 8.9 and 8.5 t ha^{-1}, respectively, as compared to normal cultivation (6.8 and 6.4 t ha^{-1}). Kavitha (2008) observed that SRI with humic acid application produces more number of panicles (456 m^{-2}), filled grains (145 $panicle^{-1}$) and grain yield (10.9 t ha^{-1})

Effect of SRI planting on economics :

There was no significant difference in cost of cultivation between SRI and non-SRI but significant difference was obtained in terms of net returns between SRI (Rs. 27,923 ha^{-1}) and non-SRI (Rs. 9222 ha^{-1}) at Andhra Pradesh during wet season. A net benefit of Rs.18700 ha^{-1} was obtained in SRI (Rajagopalan and Krishnarajan, 1987).SRI methods found to reduce risk. The cost of production under SRI was half the cost of the conventional cultivation (Singh *et al.*, 2006). The combination of young seedlings, single seedling, square planting and cono-weeding registered the highest net return (12,574 ha^{-1}) and BC ratio (1.87) compared to normal practice (Chellamuthu and Sridevi, 2006). Rajendran *et al.* (2006) reported that farmers obtained higher profit by adopting the new SRI method of rice cultivation. The average net profit was Rs. 4795 ha^{-1} for the conventional method and Rs. 16805 ha^{-1} for SRI method. Thus, farmers adopting SRI obtained an additional profit of Rs. 12010 ha^{-1} over conventional method of rice cultivation. The increased profitability under SRI method was achieved by the enhanced productivity.

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