DOI: 10.15740/HAS/AU/9.3/439-444
Agriculture Update
Volume **9** | Issue 3 | August, 2014 | 439-444 |
Visit us : *www.researchjournal.co.in*
e ISSN-0976-6847

A Review

Socio-economic evaluation of system of rice intensification (SRI)

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ARTICLE CHRONICLE :
Received :
29.05.2014;
Accepted :
24.07.2014

SUMMARY : System of rice intensification (SRI) is an alternative method of rice cultivation to economize the use of water and other critical inputs without affecting yield. In recent times, SRI is gaining importance in many countries including India. The present paper is intended to know the socio-economic aspects of SRI. The variable costs were higher in conventional method in comparison with the SRI method because of huge quantity of seeds, fertilisers, plant protection chemicals and animal labour and irrigation charges incurred in conventional method. Socio-economic studies and front line demonstrations (FLDs) during the past 2-3 years have clearly indicated the superiority of SRI as a sustainable method of rice cultivation. Feedback from farmers indicated certain problems which need to be addressed for wider adaptability of SRI. One of the major constraints in adoption of SRI was drudgery in using weeder, hence, low cost, user friendly weeders and markers have to be made available to the farmers. The designs of the weeder should be diversified and be made amenable to local production. For large scale adoption of SRI, there is a need for convergence of different organizations working on SRI.

How to cite this article : Nirmala, B., Kumar, R. Mahender, Waris, Amtul and Muthuraman, P. (2014). Socio-economic evaluation of system of rice intensification (SRI) . *Agric. Update*, **9**(3): 439-444.

KEY WORDS :
System of rice intensification, Socio-economic aspects, SRI, Constraints

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BACKGROUND AND OBJECTIVES

Rice is the staple food crop of India and occupies highest area among all the crops grown in the country (Shobha Rani *et al.*, 2010). Currently India produces rice that is sufficient not only to meet the domestic demands, but also is the largest exporter during 2012 (Mahender Kumar *et al.*, 2013). Increased and sustained production of rice is fundamental to food security in India. The production advance in rice enables self-sufficiency despite increase in population. The total production during 2011-12 was 104 million tones (Agriculture statistics at a glance 2012) which is to be raised considerably to meet the needs of increasing population. There is almost no scope for increasing rice production through an increase in rice area resulting in productivity of rice becoming great concern.

Water is going to be most critical input in the future for agriculture in general and rice in particular. The share of water for agriculture is likely to drastically go down form 90 per cent to less than 60 per cent. Of all the crops, rice uses more than 70 per cent of all irrigation water in India. Also, there is a notion that higher yields in rice come with high investments on seed, irrigation, high doses of fertilizers and more use of pesticides. This practice not only results in higher cost of cultivation but also may not give the desired results in the longer run in a sustainable way.

Contrary to this popular view, SRI method of cultivation produces higher yields with less seed and less water. SRI also emphasizes on the need to shift from chemical fertilizers to organic manures. In overall, SRI method of cultivation can considerably help in attaining the targets with the limited availability of natural resources and there is an urgent need to promote cultivation methods such as system of rice intensification (SRI) in rice to economize the use of water and

other critical inputs without affecting yield. Indian enthusiasm for SRI implies a level of dissatisfaction with conventional approaches to rice intensification and a demand for new methods that can address the perceived problems and challenges of agriculture in the future (Dominic, 2011).

SRI as a method to economize the use of inputs:

SRI gives higher output with lesser input, but it requires very laborious manual work which makes it more suitable for small farms in developing countries that are well endowed with labor but have limited crop land (Yuan, 2002). Initially SRI requires significantly more labor-mainly for preparing land, transplanting young seedlings and weeding, as SRI is a skill based technology, which needs creation of awareness and exposure to adopters in a systematic way. But with experience, this labour requirement would go down. An assessment with the farmers showed that with the adoption of SRI there was a labor reduction of 42 per cent on an average, for preparing land, transplanting young seedlings and weeding (Mahender Kumar *et al.*, 2011).

In case of SRI, the benefits are accrued significantly through use of less input which is revealed in the comparison that is done in terms of input use against the conventional method based on the experiences from Andhra Pradesh. The SRI farmers generally used the less seeds, less chemical fertilizers, less pesticides. SRI is having advantages in terms of reduced seed cost, less chemical inputs but at the same time the total cost is more owing to more use of organic fertilizers, higher weed management and harvesting cost (V and A programme, 2009).

SRI farmers use 5-8 kg per hectare seed in SRI as compared to 40-50 kg per hectare under conventional practices. The average water saving is 37 per cent which varied from 22 per cent to 38 per cent across various farm-size categories in Tamil Nadu (Barah, 2009). The total cost of cultivation per hectare was lower by about 10 per cent in SRI method (Rs.21655) than the conventional method (Rs. 25914). In the SRI method the cost of seeds occupied a meagre amount (0.63%) as compared to the conventional method (6.99%) (Sita Devi and Ponnarasi, 2009). This ensures cultivation of hybrid rice on a large scale, as hybrid rice seed is expensive and requires regular replacement.

Systematic studies conducted at DRR by using digital water meters during wet and dry seasons of 2006 and 10, revealed that water saving in SRI could be up to 25-38 per cent (Mahender Kumar *et al.*, 2011). Total water productivity (after accounting for rainfall) of the SRI was 29 per cent higher compared to conventional method. SRI saved nearly 25 per cent irrigation water without any penalty on yield compared to conventional transplanting (Chowdhary *et al*., 2005). Thiyagarajan *et al.* (2002), reported water saving of 50 per cent over the traditional flooding without any adverse effect on grain yield.

A comparison of costs and returns in SRI and traditional methods of paddy cultivation revealed that there was not much difference in the total cost of cultivation but the variable cost was higher in the traditional method than SRI method. A comparison showed that the higher costs were incurred on land preparation, manures and harvesting in SRI and nursery management, transplanting, intercultivation, plant protection and irrigation in the traditional method. SRI required lesser inputs except manure. This may be because of organic nature of SRI method (Rao, 2011). The per hectare cost of cultivation was slightly higher in SRI method (Rs.33102) when compared to that in traditional method (Rs.31773), may be because of higher application of organic manure (Basavaraj, 2008).

Production cost per kilogram of rice was found to be more than double with the conventional method compared to SRI. The cost of irrigation has been reduced by 43 per cent, expenditure in pesticide was 57 per cent less with SRI compared to conventional method. The cost of nursery preparation was reduced by 32 per cent. Average weeding cost (manual weeding) for SRI was found to be double that of conventional methods and about 25 per cent more for harvesting and threshing (Uprety, 2005). The costs-returns analysis of SRI method revealed that the cost of raising nursery for one hectare main field transplantation was comparatively lower (Rs.954 and Rs. 995) than the conventional method (Rs.3654 and Rs.4503) in *Kharif* and *Rabi* seasons, respectively. However, the cost of cultivation in SRI method was comparatively higher in *Kharif* (Rs.44833) but less in *Rabi* season (Rs.43862) as compared to conventional method (Rs.40627 and Rs.44853 in *Kharif* and *Rabi*, respectively) of rice cultivation (Haldar, 2012).

The variable costs were higher in conventional method with Rs. 30210 per hectare and were lower in SRI method with Rs. 28863 per hectare when compared to SRI method; the variable cost of conventional method of rice cultivation was high because of huge quantity of seeds, fertilisers, plant protection chemicals and animal labour and irrigation charges (Anbarassan, 2010). Minimum seed requirement, low nursery duration and availing subsidy provided by the Department of Agriculture and Cooperation were the most important reasons which influenced the farmers to adopt SRI technique (Anjugam, 2008).

SRI as a yield enhancing technology:

A study was conducted to compare the economics of rice cultivation in five major rice growing states of India, *viz.*, Chattisgarh, Uttarakhand, Punjab, Madhya Pradesh and Tripura, where SRI method of rice cultivation is in vogue. The average results for the above mentioned states are presented in Table 2. The grain yield was 1724 kg/acre for conventional method whereas it was 2466 kg/acre in SRI method of rice cultivation. Even though the total cost of

cultivation was comparatively more in case of SRI, net income was higher in SRI when compared to conventional method of rice cultivation. The benefit cost ratio was also more for SRI method, 2.21 than the conventional method of rice cultivation, 1.94.

Comparison of yields in SRI vs conventional method of rice cultivation is depicted in Table 3. There was a yield advantage of 55 per cent in SRI in Uttarakhand and Punjab states. The yield advantage was 52.5 per cent in case of Andhra Pradesh, 50 per cent for Tripura, 45 per cent for Chhattisgarh and 35 per cent for Madhya Pradesh.

The farm survey conducted in Tamil Nadu has clearly shown that the SRI yield is uniformly high across various farm-size categories. The yield varied from 5 t/ha to 7.5 t/ha under SRI as compared to the reported average of 8.45 t/ha in 2005-06. This implies that small farmers benefit from increase in the yield under SRI (Barah, 2009). The productivity was higher by about 31 per cent in SRI (6.4 t/ha) than the traditional (4.9 t/ha) methods of cultivation (Rao, 2011). The yield obtained with SRI was 5.4 t/ha whereas it was only 3.5 t/ha with the conventional method. The increased grain yield under SRI was mainly attributed to more number of lengthy productive tillers with increased number of filled grains per panicle (Sita Devi and Ponnarasi, 2009). The yield realized in traditional method was 6.07 t/ha, while it was 8.51 t/ha in SRI method. The yield difference was mainly because of more number of productive tillers per m^2 in SRI. The straw yield in traditional and SRI methods was 4.96 tonnes and 5.82 tonnes per hectare (Basavaraj *et al.*, 2008).

Palanisami *et al.* (2013) conducted a study during 2010-11 in 13 states and covered 2234 sample farmers with SRI and non-SRI fields. SRI fields have significantly higher yields. The average yield in SRI parcels in all states was 8.5 quintals per hectare (0.85 tonnes/ha) which is 22 per cent higher than in non SRI fields. Even with the high seed rate and more number of hills per meters square, the yield level (5.23 and 6.39 tonnes/ha) was less in conventional method than that of SRI method (6.47 and 8.31 tonnes/ha) in *Kharif* and *Rabi* season, respectively. This was mainly because of more number of effective tillers per metre square in SRI method that results more yields per unit area (Haldar, 2012). SRI registered 35-48 per cent higher yields than traditional method of rice cultivation at Tamil Nadu Rice Research Institute, Adithurai and Soil and Water Management Research Institute, Tanjavur, (Rajendran *et al*., 2005). SRI adopter got a grain yield of 6.34 tonnes/ha while with conventional flooding recorded lower grain yield of 5.63 tonnes/ha (Raju and Srinivas, 2008). SRI registered a mean grain yield of 5630 kg/ha which was 24 per cent higher than conventional method of rice cultivation (4542 kg/ha) (Veeraputhiran *et al*., 2012). In Tamil Nadu, adoptive research trials on SRI were conducted in Tamiarabarani river basin and the Cauvery delta zone under a state government funded scheme during 2003-04. A 27 per cent yield increase over the conventional method was achieved. The mean grain yield advantage of SRI over standard transplanted method ranged from 7-20 per cent irrespective of soil and locations across the year. This increase in grain yield under SRI could be attributed to profuse tillering, improved soil aeration achieved through the soil disturbance by cono-weeder operation in addition to effect weed separation.

Realizing higher farm level profits with SRI:

Eight hundred and thirty two on-farm demonstrations on system of rice intensification (SRI) were carried out in six hundred hectares of farmers fields in Sivagangai and Madurai districts of Tamil Nadu from 2007-08 to 2010-11 under Tamil Nadu-Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN-IAMWARM) Project. Two methods of rice cultivation *viz.*, SRI and conventional were compared. The results of large scale on-farm demonstrations revealed that adoption of SRI favorably influenced all the yield attributes of rice *viz.*, number of tillers m^{-2} and numbers of grains $panicle^{-1}$. Higher grain yield coupled with substantial water saving to the tune of 24.3 per cent resulted in higher water use efficiency of rice under SRI method. Higher gross income, net income and benefit cost ratio were also associated with SRI than - conventional method of rice cultivation. The cost of cultivation was comparatively lesser in SRI which resulted in an additional net profit of Rs.13,340 ha^{-1} as compared to conventional method of rice cultivation.

SRI method has proven ability to increase rice production by 26 per cent or more depending on the extent of adherence to its basic principles (Barah, 2009). More importantly, SRI saves up to 40 per cent water due to alternate wetting and drying system, which is considered a unique advantage of SRI.

The farmers derive multiple benefits from SRI such as higher yield, less input-cost and high income as compared to non-SRI farms. On the whole, the combined effect of reduction in cost and higher yield has resulted in increase in net return to the extent of over 31 per cent (Barah, 2009).

Net return for SRI was 19,885 ha^{-1} for traditional method and Rs.7,233 ha^{-1} (Rao, 2011). The net returns were higher in SRI (Rs.27009) than the conventional method (Rs.14499) method. The cost of production was almost double in the conventional method of paddy cultivation as the productivity of rice was low in this method. The benefit cost ratio was higher in SRI (2.25) than in conventional method (1.56) (Sita and Ponnarasi, 2009). The net returns realized was much higher in the SRI (Rs.23,593) than in the non-SRI (Rs.9,7200 per hectare. The returns per rupee spent in traditional method were Rs.1.31 against Rs.1.71 in SRI method (Basavaraj *et al.*, 2008).

Net return with SRI was found to be more than double compared to the use of conventional methods. Among the SRI users, 80 per cent of the farmers had net returns of more than Rs. 30,000 per hectare, double the conventional method level of income from rice production. The output/input ratio of SRI was more than double (2.7) compared to conventional methods (1.26-1.41) (Rajendran, 2005). The average gross margin or gross income minus variable costs due to SRI ranged from Rs.6,971 per hectare to Rs.3504. The cost of production per quintal of rice indicates the real profitability of cultivation. Overall, the cost of production of SRI over non-SRI was lower by Rs.178 per quintal (Palanisami *et al*., 2013). The gross return (Rs.64, 036) realized was higher for SRI method compared to conventional method (Rs.49,423) mainly because of higher paddy yield harvested in SRI method (Haldar, 2012). The economic feasibility of both the methods of rice cultivation revealed that the cost of cultivation was comparatively lesser in SRI than that of conventional method. Adoption of SRI was found to result in additional economic benefit over farmer's practice. Adoption of SRI gained an additional net profit of Rs.13,340 ha^{-1} as lesser cost of cultivation coupled with higher gross and net returns under SRI (Veeraputhiran *et al.,* 2012). Anbarassan *et al.* (2010) conducted a study in Salem district of Tamil Nadu and found that the gross income was higher by 25.68 per cent in SRI than the conventional farming, which worked out to be Rs.81455 and Rs. 64818 per hectare, respectively. The net income was also higher by 84.29 per cent in SRI than the conventional farming, with better economic advantage in SRI over conventional method.

Socio-economic studies and front line demonstrations (FLDs) during the past 2-3 years have clearly indicated the superiority of SRI as a sustainable method of rice cultivation. Participant farmers could perceive a unique opportunity in SRI for increasing their income through higher productivity while saving on cost of seed or chemicals or water (Mahender Kumar , 2013).

Perceptions of farm women regarding SRI technology:

Women strongly feel that adoption of SRI in organic ways has led to a reduction in health hazards, as they no longer have to stay for a longer period in fields sprayed with chemical pesticides, which caused skin ailments, headaches, and dizziness earlier. Use of a weeder in SRI has reduced their drudgery compared to the conventional method of rice cultivation with manual weeding. Using a weeder, they no longer have to be in a bent-down posture or to stand the whole day in water for weeding, which made women farmers susceptible to colds, fevers and skin diseases.

SRI adoption has freed them from the tedious job of uprooting rice seedlings from seedbeds and stocking seedlings for several days prior to transplantation. When they stocked the mature seedlings, they had to wipe off mud and brush off small weeds that were pulled out together with the seedlings. SRI has eliminated the stocking procedure by enabling the women to transplant younger seedlings directly onto paddy field. Transplanting fewer seedlings was faster and more manageable. Uprooting fewer and younger seedlings did not tire the women, thus, lightening their task and shortening the time for it. Ploughing and weeding, however, have taken more time. Over all, it, therefore, appears that the women under study became much more entrenched in household domestic work and have increasingly engaged in multiple on-farm livelihoods, as a result of lighter work from the adoption of SRI techniques.

It is highly imperative to train farm women in different aspects of SRI technology to build their knowledge and skills to ensure widespread adoption of SRI. There is immense scope of harnessing the potential of training members of women's self-help groups (SHG) to form a SRI task force which could be easily achieved through providing long-term and comprehensive skill based training in the following specific SRI activities. Training a cadre of women labourers in every village can help spread SRI and also provide good income for the women.

Constraints in adoption of SRI:

The largest and most pervasive constraint for SRI adoption is a subjective one: farmers thinking and willingness to change. Farmers need a certain amount of skill and motivation to use SRI techniques successfully (Uphoff, 2008). There can be a greater labour requirement in SRI which can be a constant deterrent to farmers for changing rice growing practices especially very poor ones who need to invest most or all of the labour in immediate income earning opportunities (Moser and Barrett, 2003). Perceptions of riskiness may constitute a constraint initially, but evaluations have shown them to be incorrect and as SRI use spreads more widely these inhibiting perceptions should become altered (Uphoff, 2007). Alagesan and Budhar (2009) conducted a study to determine the constraints faced by SRI farmers in Krishinagar district of Tamil Nadu in the order of priority as perceived by the respondents, the constraints were lack of skill in handling 15 day old seedlings, shortage of skilled labour for mat nursery preparation, coverage of planting area, labour was poor, importance of cono-weeder not fully appreciated, non-availability of cono-weeder, non-availabilty of leaf color chart and lack of skill in interpreting leaf colour chart/cono-weeder operation.

Drudgery in using cono-weeder was the biggest constraint followed by nursery management and skill in transplanting (Rao, 2011).The respondents in the conventional method reported five main reasons for not adopting the SRI technology. They rank lack of skilled labour as the foremost

reason for not adopting SRI method in their farms. The lack of awareness was ranked second. Nearly, 57 per cent of conventional farmers had expressed that lack of training, experience and extension service were the reasons for their non adoption of SRI (Sita Devi and Ponnarasi, 2009).

The proboability of adoption increases as the literacy level increases and farmers located far away from canal. Difficulties in management practices like water management, inter-cultural operations along with lack of skilled labour and water scarcity especially in *Rabi* season were the major factors constraining the adoption of SRI methods (Haldar, 2012). Feedback from farmers indicated certain problems which need to be addressed for wider adaptability of SRI while appreciating the multiple roles of cono-weeder in SRI, farmers felt the need for mechanized multi-row weeders to reduce drudgery and cover more area per unit time (Mahender Kumar *et al.*, 2013).

The major constraint in SRI adoption was non-availability of skilled labour, difficulty in transportation and transplanting of young seedlings and difficulty in water management (Sain *et al.*, 2008). Chhattisgarh, Madhya Pradesh, Uttarakhand, Punjab, Tripura and Andhra Pradesh.

Conclusion:

From the various results stated above, it can be concluded that SRI method of rice cultivation has yield advantage of around 25 per cent to 55 per cent in various states. Since the benefit cost ratio in SRI method is comparatively more than that of conventional rice cultivation, it can be inferred that SRI is economically viable technology and more profitable than conventional method of rice cultivation. SRI is a skill based technology and hence, there is a need to focus on imparting training on SRI to farmers through various extension agencies. One of the major constraints in adoption of SRI was drudgery in using weeder, hence, low cost, user friendly weeders and markers have to be made available to the farmers. The designs of the weeder should be diversified and be made amenable to local production. For large scale adoption of SRI, there is a need for convergence of different organizations working on SRI.

A few distinctive patterns and models have emerged in recent years, which provide required road map for wider adoption. The lessons learnt from the scenario analysis of these models will be useful for designing effective interventions and strategies for various areas. SRI, which has emerged as an important alternative strategy in water-scare situations, needs carefully designed supportive interventions, including R snd D investments (Thyagarajan, 2004). In developing strong SRI research networks, active participation of the line departments should be assured. Awareness should be generated about SRI through mass media, Krishi Vigyan Kendras, extension departments, etc. Being a low external input technology, SRI offers an opportunity to create a broad, 'SRI organic rice', which has significant market potential.

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