The System of Rice Intensification (SRI) and Food Security among the Poor: Opportunities and Constraints

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Abstract

The Global Triple 'F' Crises (Fuel, Food and Financial) caused the escalation in food prices during last 2 years in the global food market. The crises created detrimental effects in developing countries, including Sri Lanka and her food market, in general, and her food security, in particular.

The objective of this paper is to examine the opportunities and constraints in promoting System of Rice Intensification (SRI) to maintain food security among the poor at the household level in Sri Lanka.

The economics of SRI, and its entailing opportunities and constraints in maintaining food security among the poor in Sri Lanka, were analyzed. The upward productivity shift and eco-friendliness of SRI and the attending saving of scarce water resources and reduction of cost of production, created opportunities for farmers to maintain food security among the poor. The constraints in promoting food security through SRI too, were analyzed. Furthermore, the strategic policy and operational options to promote SRI and maintain food security among the poor in Sri Lanka were proposed.

It is absolutely necessary to promote SRI to enhance a sustainable and eco-friendly food production system and to maintain food security among the poor. It will be a new paradigm shift in the right direction to maintain increased food production and food security in the country.

Introduction

The Global Triple 'F' Crises (Fuel, Food and Financial) struck during the years of 2007 and 2008. They have mainly affected the global economy but have also posed a range of complex challenges and threats for the Sri Lankan economy. One such threat that is of particular relevance, is the threat to Sri Lanka's achievement of the Millennium Development Goals (MDGs) of halving extreme poverty and hunger, which are directly threatening people's right to food. Despite the crises, many other actors in the food industry in developed and other countries managed to increase their speculative benefits, generated through increased prices of food (Oxfam International 2009).

During 2008, we witnessed an unprecedented escalation in global food prices and a reduction in the availability of food and feed stocks. The mounting trend in international food prices accelerated in 2008. U.S. wheat export prices increased from US$375/tonne in January to US$440/tonne in March 2008, and Thai white rice export prices (FOB) increased from US$385/ tonne in January 2008 to US$764.25/tonne in September 2008. Such rises came on top of a 181 % increase in global wheat prices over the 36 months leading up to February 2008, and an 83 % increase in overall global food prices over the same period (World Bank 2008). Oxfam International predicted that the hike in global food prices would propel an additional 119 million people into hunger in 2008, resulting in a total of around 967 million people in hunger worldwide (Oxfam International 2009).

The recent increase in food prices can be attributed to the sharp rise in the demand for food (through consumerism from rapid economic growth in many developing countries, particularly in China and India), which has collided with a decline in supply. The supply decrease has been fuelled by reduced yields owing to climate change and the diversion of farm produce to biofuel production as a substitute for fossil fuels in many developing countries. The resultant food price increase from these forces will directly impact on the food industry and food security of the poor even in Sri Lanka on either side of the threshold of subsistence.

Rice is the staple food product in Sri Lanka. Concerns on availability, accessibility and affordability of rice, at national, regional and household levels are central to any discussion on food security in Sri Lanka. Traditionally, there has been strong government intervention in the rice sector with the majority of Sri Lankan farmers maintaining their livelihood through rice production, processing and marketing (including distribution). Accordingly, growth in the Sri Lankan agricultural sector can be attributed to: investment in technology transfer; research and development (R&D); human capital improvement; maintenance of government extension services; and the development of irrigation infrastructure and road networks to improve access to markets. As a result of this investment, the rice sector has maintained a 96-99 % level of self-sufficiency during the last two decades.

Government institutions (e.g., the Government Agent and its regional administrative system including the Department of Agrarian Development) mainly operate in the delivery of production subsidies (i.e., fertilizer, agricultural credit, irrigated water, extension etc.). In addition, the Paddy Marketing Board, Lak-Sathosa outlets, and island-wide co-operative networks are involved in purchasing paddy at the farm gate, milling/processing, and distributing rice throughout the island, and compete with the private sector to deliver rice stocks to consumers.

In this context, the government has devised and operationalized a range of trade policy-tools (e.g., low tariff, export controls, controlled retail price mechanisms etc.,) and micro-level policy options to safeguard the interest of both farmers and consumers and has managed to maintain food security in the country (Somaratne 2009). Regardless of these interventions, it is likely that for the next few seasons further sharp price hikes and continued volatility will be experienced as a result of unforeseen events inflicted by the global financial crises in the economic environment. Domestically, most private sector paddy millers controlled the supply of rice to the market during the food crisis and maintained their speculative profit-seeking behavior. At the same time it was clear that at the advent of the crisis, government intervention was very weak resulting in diminished stocks of rice and ineffective government food distribution mechanisms. During the crisis in 2007-2008, there were no buffer paddy stocks in government stores island-wide and there were no opportunities to purchase paddy stocks from farmers at the farm gate (Somaratne 2009). Consequently, drastic price increases in various rice varieties at the market were observed during 2007 and 2008 (Table 1).

Table 1. Average annual retail prices (Rs/Kg) of various rice varieties (2006-2008).

Product	2006	2007	% Change (Compared with 2006)	2008	% Change (Compared with 2007)
Varieties of Rice					
Samba – Grade 1	41.90	49.64	18.5	82.33	65.9
Samba – Grade 2	38.66	45.48	17.6	77.77	71.0
Samba – Grade 3	35.78	42.62	19.1	72.60	70.3
Nadu – Grade 1	33.04	42.48	28.6	68.36	60.9
Nadu – Grade 2	30.14	39.34	30.5	65.01	65.3
Raw – Red	31.11	43.35	39.3	66.64	53.7
Raw – White	29.69	38.26	28.9	63.97	66.9

In this respect, Sri Lanka adopted a strategic policy mix and operational options to reduce the price impact and improve food production through initiating supply side interventions to maintain food security in the country. System of Rice Intensification (SRI)[1] is practiced in various parts of Sri Lanka since 2000. In 2002. Oxfam Australia began to promote and open up opportunities among the poor farmers in various districts in Sri Lanka with the objective of facilitating them to maintain their household food security. The SRI network (SRIN) was established in 2007 in collaboration with other INGOs, NGOs, CBOs and other government organizations, which promote environmental- friendly (i.e., free of agro-chemicals, and moving away from using chemical fertilizer), low-cost, high-productive paddy/rice production in the country.

[1] System of Rice Intensification (SRI) emerged in the 1980s as a synthesis of locally advantageous rice production practices encountered in Madagascar by Rev. Father Henri de Laulanie, a Jesuit Priest who had been working there since 1961. But, it is Professor Norman Uphoff from Cornell International Institute for Food and Agriculture, Ithaca, USA, who had brought this method to the notice of outside world in the late 1990s. Today SRI is being adopted in many countries in Asia, Africa and Central America as well as South American countries, and the response from farmers has been overwhelming seeing the benefits of the method, notwithstanding the constraints.

The objective of this paper is to examine the relationship between System of Rice Intensification (SRI)[2] and food security, and to identify opportunities and constraints in promoting SRI paddy production to maintain food security among the poor.

This paper is organized as follows: Section 1 (Introduction) presents a brief introduction of global food crisis and its challenges faced in the Sri Lankan economy. Section 2 (System of Rice Intensification (SRI) and Food Security) explains the relationship between SRI and the food security. Section 3 (Economics of SRI Vs Non-SRI (or Conventional Transplanting) Practices of Growing Paddy) describes the economics of SRI Vs Non-SRI practices of growing paddy. Section 4 (Opportunities in SRI Rice Production) explains the opportunities available in SRI rice production. Section 5 (Constraints in SRI Rice Production and Promotion) discusses the constraints in promoting SRI to maintain food security among the poor in the country. Concluding remarks are included in Section 6 (Concluding Remarks).

System of Rice Intensification (SRI) and Food Security

Rice is the staple food item in more than half the world's population. The demand for rice increases with population increase in the world, and is expected to rise by a further 38 % increase in relation to the demand for rice within the next 30 years, according to the United Nations. Conventional paddy cultivation requires large volumes of water i.e., using the method of flooding. Due to growing scarcity of water in many parts of the globe, farmers are shifting to cultivation of less water-demanding methods and crops. In general, it is obvious that reduction in profitability owing to high input costs, low productivity and low prices of rice are also influencing the seasoned farmers and the younger generation of farmers to withdraw from paddy cultivation process in most parts of Sri Lanka. In this respect, strategic policy and operational options are required to make paddy cultivation more efficient in terms of: a) returns on farmer investments; b) lesser use of water resources; and c) possibility to maintain food security at the household level.

Paddy yield increased by more than 70 % between 1966 and 1999 with the introduction of modern high-yielding varieties, which were accompanied by new management practices such as farm mechanization and the replacement of biological fertilizers by chemical fertilizers along with

[2] SRI includes only six basic and new ideas (or practices) to grow paddy. It is not a technology to use in growing paddy**.** Under SRI, farmers have to follow the six new ideas, such as:

1**.** *Use young seedlings to preserve growth potential (however, DIRECT SEEDING is becoming an option); 2. Avoid trauma to the roots-transplant quickly, shallow, no inversion of root tips that will halt growth;*

3. Give plants wider spacing – one plant per hill and in square pattern to achieve 'edge effect';

4. Keep paddy soil moist but unfolded – mostly Aerobic, not continuously saturated;

5. Actively aerate the soil as much as possible; and

6. Enhance soil organic matter as much as possible.

Practices 1-3 stimulate plant growth; while practices 4-6 enhance the growth and health of roots and soil biota.

the 'Green Revolution' (Frei and Becker 2005). The existing system of paddy production, particularly the 'Green Revolution' technology, is input-intensive and favors capital and technology-rich farmers. Increasing prices of agricultural inputs (e.g., improved seed, chemical fertilizer, agro-chemicals and mechanized farm power) prevent poor farmers from completely adopting modern production technologies. It is clear that the excessive use of chemical fertilizers and agrochemicals (e.g., pesticides, insecticides and herbicides) damages soil biota and contaminates underground water resources, which in turn creates negative environmental and social externalities. In this respect, the system of rice intensification (with its low environmental cost and high yield), will be a sustainable alternative to conventional paddy production to protect the soil biota and safeguard the interest of the society (Uphoff 2002 and Uphoff 2004). Field experiences from some Asian, South American and African countries report that the average rice yield with SRI to be double the current average yield of the conventional practice. Uprety (2004) reports the average rice yield with (phenotype) SRI is 8 tonnes ha^{-1}, whereas the yield is 3 tonnes ha^{-1} under (geno-type) conventional paddy. The evaluation of 167 on-farm trials in Andhra Pradesh, India reports average yield obtained using SRI practices to be 8.1 tonnes ha^{-1}, compared with5.67 tonnes ha^{-1} using conventional practices (Sinha and Talati 2007).

In Sri Lanka, per capita rice consumption was around 100 kg per year. On this basis, if a family includes five members, they need 500 kg per year to maintain their household food security.[3] Accordingly, to be food secure at the household level, the conditions that farmers need to maintain are: availability; affordability (i.e., with income or purchasing power); and accessibility of food.

Economics of SRI versus Non-SRI (or Conventional Transplanting) Practices of Growing Paddy

Results presented in the next section are based on a farm household survey conducted in five districts, namely, Hambantota, Matara, Ampara, Kegalle and Anuradhapura. Data were collected from farmers who have grown irrigated paddy under both SRI and conventional transplanting. Data for the *maha* season 2007/08 were collected from 31 farmers who cultivated paddy with assistance given by Oxfam Australia, Sri Lanka Office. Partial budgeting analysis was considered appropriate to estimate the economic impact because only small relative changes on farm inputs (seed, fertilizer, water) had to be assessed, while all other variables remained the same. Gross margin per hectare of rice cultivated was calculated by subtracting variable costs from gross returns. To assess also the return to labor, the gross margin per man-day was calculated by dividing the gross-margin per hectare by the number of man-days used i.e., of family plus hired labor. Details on household members' participation in rice farming were directly obtained during the farm-based questionnaire survey.

As shown in Table 2, the cost of production of growing paddy under SRI , based on gross margin analysis, was Rs. 91,148 per hectare (Rs. 36,902 per acre), compared to the cost of production (Rs. 101,685 per hectare or Rs 41,168) of paddy grown under conventional

[3] Food security exists when all people, at all times, have physical and economic access to enough safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle.

transplanting (i.e., non-SRI), which was 12 % lower than the non-SRI paddy cultivation. Among the farmers interviewed, the cost of production of SRI paddy was lower due to lower seed rate, non use of agrochemicals, and the low cost of fertilizer. The unit cost of production under SRI was lower by 27%, compared to non-SRI paddy production.

Table 2. Cost of production and the level of land, labor and capital productivity in SRI and non-SRI paddy production in *maha* season 2007/2008.

Components	Unit	SRI	Non-SRI	Difference	% Share
1. Cost of Production:					
Cost of Production(including family labor)	Rs/ha	91,148	101,685	10,537	11.6
Cost of Production (excluding family labor)	Rs/ha	60,026	77,973	17,947	29.9
Cost of Production (including family labor)	Rs/ha	20.00	25.35	-5.35	-26.8
Cost of Production (excluding family labor)	Rs/ha	13.16	19.44	-6.28	-47.7
2. Seed Rate Used	Rs/ha	10	306	-296	-2997.2
3. Land Productivity	Rs/ha	4,560	4,011	549	13.7
4. Farm Income					
Farm gate price (average)	Rs/kg	36	34	2	5.5
Gross farm income	Rs/ha	165,104	137,667	27,437	19.9
Net farm income (level of profit)	Rs/ha	73,956	35,982	37,974	105.5
Gross farm income per unit	Rs/ha	36.21	34.32	1.88	5.5
Net farm income per unit	Rs/kg	16.22	8.97	7.25	80.8
5. Capital Productivity					
Rate of returns on Investment	%	81.1	35.4	45.8	
6. Labor Productivity					
Number of man-days used:					
Including family labor	Md/ha	132	111	21	15.9
Excluding family labor	Md/ha	54	52	2	3.7
Labor productivity	Kgs/md	34.5	36.1	-2	-4.6
Value of labor productivity (Gross)	Rs/md	1,251	1,240	11	0.8
Value of labor productivity (net)	Rs/md	560	273	288	51.3
7. Rate of Availability of Rice –(rate of food security)[a]	[a]No of Persons	34	27	7	20.2
Value of increased net productivity under SRI	Rs/ha	19,879[b]			

Source: SRI On-Farm Survey, Oxfam Australia (2009)

Notes: [a] The mill out turn considered as 75 % for SRI rice and 68 % for non-SRI rice
[b] The value of increased productivity per acre is Rs. 8,048

The land productivity in the SRI was higher than that of the conventional method by 549 kg ha^{-1} (13.7 %). However, this is lower when compared with the potential for land productivity of around 8,000 kgha^{-1} reported in India. The gross and net farm income was estimated by using gross margin analysis under both SRI and non-SRI methods. In particular, farm gate price was higher for SRI paddy by about 6 % owing to the high outturn of paddy with less chalkiness and less rate of broken rice (Table 2). The gross farm income and net farm income (or profitability) was higher in SRI by about 20 and 106 %, respectively, with higher productivity and farm gate prices. Considering all, the rate of return on investment in SRI rice production was about 81 % when compared to the same (35 %) in non-SRI rice production. This indicates the favorable position of SRI farmers to improve capital productivity to invest in the process further.

SRI production process is a labor-intensive production system. The labor productivity was lower by 4.8 % in SRI process than the non-SRI process (Table 2). However, the value of labor productivity was higher in SRI process both in terms of gross and net value of labor productivity, owing to the higher farm gate prices of SRI paddy.

The level of household food security that can be reached was estimated based on the national level per capita rice consumption of 100 kg per year. Accordingly, the number of people who can use the amount of per capita availability of rice at the farm level under both SRI and non-SRI methods were estimated. In that respect, if farmers use the SRI methods, they are in a position to improve their household level food security at a level that is 20.2 % higher compared to non-SRI farmers. The value of increased net productivity (kg/ha) with the SRI method was estimated as Rs 19,879 per hectare (or Rs. 8,048 per acre), which assists either way to maintain food security at the farm level (Table 2).

As shown in Table 3, considering the benefits of SRI paddy production (including the value of straw production used as organic fertilizer) and cost of production, the benefit cost ratio was estimated. The benefit cost ratio on SRI practices was higher than non-SRI practices. The benefit cost ratio for the *maha* season 2007/2008 was lower than the benefit cost ratio for the *yala* 2008 season due to the higher level of land productivity. Evidence from the SRI farms in districts surveyed suggests that SRI is economically attractive and that the productivity of land, capital and labor, increases significantly relative to conventional paddy farming. Furthermore, the net gains on SRI practices in terms of income from paddy, gross returns, net returns and less cost of production were higher for SRI than for non-SRI.

Table 3. Economics of cultivation of paddy under SRI and conventional methods and net gains on SRI.

Component	Unit	Non-SRI Practices	SRI Practices	Net Gains	% Share of Net Games
Income from paddy	Rs/hec	137,677	165,104	27,427	19.9
Income from straw [a]	Rs/hec	1,525	1,112	-413	-27.1
Gross return	Rs/hec	139,202	166,216	27,014	19.4
Cost of cultivation	Rs/hec	101,685	91,148	-10,537	-10.4
Net return	Rs/hec	37,517	75,068	37,551	100.1
B:C Ratio (*maha* 2007/08)		1.4	1.8	0.5	33.2
B:C Ratio (*yala* 2008)[b]		1.5	2.6	1.1	73.3

Source: On-Farm Survey, *Maha* 2007/2008, Oxfam Australia (2009)

Notes: [a] It is assumed that based on nutrient analysis, 30 % of fertilizer requirement per hectare is obtained from straw

[b] Based on provisional data, compiled and analyzed by Oxfam Australia (2009)

Opportunities in SRI Rice Production

In Sri Lanka, the practice of SRI among farmers began in the year 2000 in the Kurunegala District (Namara et al. 2003). Various government organizations, INGOs, NGOs, and CBOs promoted opportunities for farmers to adopt SRI practices/methods to improve productivity and reduce cost and thereby improve food security at the farm level. The SRI network (SRIN) was formed in 2008 as an umbrella organization to facilitate the promotion of SRI.

Technological and Production Aspects

In the Hambantota, Ampara, Matara, Kegalle and Anuradhapura districts, there has been only a partial adoption of standard practices of SRI, and this too mostly among small farmers. All farmers are following the requirement of early transplantation, single seedling per hill and wide spacing of seedlings. Most farmers have followed practices in the management of water, fertilizer, and weeding. The farmers concentrated on preparing drainage channels for water management on SRI, which is crucial to facilitate alternate wetting and drying. Most farmers weeded three times during the season to practice soil aeration to improve soil biota. None of the farmers identified or encountered pest damages during the season. Most farmers managed to reduce cost of production by applying zero level of agro-chemicals and reduced seed rate of about 7.5- 10 kg per acre when compared to the rate of 40-100 kg/ha in conventional practice. The farms where the SRI package was followed in a better manner produced higher yield or output, especially those farms on which weeding was practiced more than twice seasonally, indicating that possibilities exist for many farmers to increase average yield further, and with sustainability. In SRI practices, farmers have the opportunity to select either traditional or high-yielding varieties to grow in order to increase production and thereby improve food security.

It has clearly been shown therefore, that opportunities were opened for farmers to adopt the high productive SRI method of growing paddy, followed by environmental-friendly methods (with zero agro-chemicals use) to maintain sustainable farming systems and generate economic and environmental benefits to maintain long-term food security and sustainability of the system.

Quality Improvement and Food Security

Within the system of SRI, there is an opportunity to harvest 10-14 days early, when farmers use young seedlings. From the farmers' point of view, early harvesting is an additional advantage to obtain higher farm-gate prices. In addition, farmers are able to obtain 100 % filled grain, which gives the highest milling out turn compared to half-filled or three-fourths filled rice produced through the conventional system of growing paddy. Though the volume is the same, the SRI paddy gives the highest weight when compared to conventional paddy, and this factor attracts farmers to move from growing conventional paddy to SRI paddy by improving the quality of rice in order to obtain higher market prices.

Once the 100 % filled grain (paddy) is processed, the keeping quality of rice and the shelf-life of SRI rice can be maintained better than those of the conventional rice. This type of paddy, therefore, gives more opportunities for consumers to maintain the taste and the shelf-life of rice and thereby improve food security. Ultimately, the SRI system will further help us to promote SRI rice among other consumer groups as a niche product to attract them.

There is an opportunity to shift from chemical fertilizer to organic fertilizer through the introduction of SRI methods. In view of existing chemical fertilizer use, SLR 40 billion has been spent on fertilizer subsidies for paddy production in 2008. There is a need therefore, to reduce the cost of fertilizer subsidy. Hence, there is a potential to promote alternative methods like SRI to maintain food security sustainably among the poor in the country. In this respect, the promotion of SRI is one of the strategic options in the right direction in creating opportunities for farmers.

Constraints in SRI Rice Production and Promotion

Thirty-two countries in the world, including India, have already implemented programs to promote SRI practices/methods with the support of government departments of agriculture and the other government organizations. Government organizations in Sri Lanka, however, are still showing a lukewarm attitude to SRI. However, the community-based interventions were initiated by INGOs, NGOs and CBOs. These efforts were later integrated through the SRI network to gain the full potential for promoting SRI methods to improve productivity and maintain food security at the farm level with quality, especially in the southern and eastern regions.

As SRI is a labor-intensive system of paddy production, it is important to develop new methods and technology to minimize or save labor, in particular for weeding through investing in R&D on developing a motorized weeder or through improvement of the mechanized weeder. For these purposes, government patronage is essential to find resources and capacities for conducting research programs. Even in India, now they are at the experimental stage of producing a mechanized weeder, which would be utilized to reduce labor time and cost. Government could collaborate with other organizations and develop initiatives for developing a motorized weeder.

The issues in water management in major irrigated areas can be resolved through the introduction of cultivation plans and using water wisely by introducing paddy with SRI methods in whole *'yaya'* area programs (contagious tracts of rice) to promote SRI. SRI needs less water than conventional paddy cultivation. In India, they have managed to save 40 % of water that is usually required in conventional paddy cultivation through the introduction of SRI methods. At present, they are in the process of shifting from conventional paddy cultivation to SRI to be better prepared to face the challenges in future water use in the light of global warming and climate change.

Concluding Remarks

SRI is not a technology. It is a multi-component 'package' including six basic ideas/practices and methods that can be easily followed to improve productivity, and tonne-produce rice of a higher quality at a lower cost as a pesticide-free product. Farmers tend to focus initially on just one or two of the components, rather than adopting the entire recommended package with the six basic ideas/ practices. There is a considerable diversity in how the individual farmer can adopt and implement the proposed package of SRI. This study shows that SRI adoption has enabled farmers to reduce the cost of production consistently (with low seed rate and no agro-chemicals), enhance the level of productivity, and increase the rate of returns. SRI appears to be a significant alternative with an opportunity for raising paddy yields and managing paddy-based farming generally in resource-scarce regions, and particularly in water-scarce regions. With SRI, the total cost is less while productivity is high, thus it is likely to find acceptance among poor farmers and open up opportunities for them to improve their food security at the household level. Once the productivity is higher, farmers can gain an opportunity to improve food security either through utilizing the increased production or earning additional income by selling the products based on an increased quantity of rice. In this direction, farmers tend to improve food security at the household level either way.

One of the major constraints to the adoption of SRI is the lack of interest shown by the government and its institutions in the promotion of SRI as an alternative method for livelihood development, and to maintain food security. Active involvement of the Department of Agriculture (DOA) is a must to promote SRI as a national level program. Furthermore, the government needs to invest in a R&D program to develop labor-saving devices like motorized weeders to minimize the cost of production.

SRI is still evolving and more experiments are being done in different districts through various INGOs, NGOs and CBOs. These initiatives reveal important issues for research, particularly the lack of scientific basis and data on actual water savings with SRI. It is necessary to develop a study to measure how far SRI methods can be used for water savings to create an efficient and sustainable production process. SRI involves less water application in the process through alternate wetting and drying without flooding, as in conventional paddy farming. Areas for further research include scientific investigation in the use of water under the SRI method, and understanding the opportunities for promotion of SRI as a sustainable process for improving food security in the country, in general, and at the farm level, in particular.

Considering the potential of improving productivity, lowering the cost of production, enhancing environmental friendliness and improving quality of rice, paddy/rice production is approaching a new era to maintain food security through SRI. It is a paradigm shift in the right direction in the agricultural production process in Sri Lanka to increase production, in general, and maintain food security and increased production and farm income at the farm level and to develop a sustainable production process, in particular.

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