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Resource Use Efficiency in SRI Rice Cultivation in Palakkad Plain Agro-ecological Zone of Kerala

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ABSTRACT

The system of Rice Intensification (SRI) method of rice cultivation was introduced to the Palakkad plain agroecological zone of Kerala state as an alternative rice production method to cope with intensified groundwater shortage, long dry spells, and shrinkage in rice cultivation area in the Palakkad plains. The sole aim was to produce more rice with less use of resources. In spite of its advantages, the method gained less popularity among rice farmers. The present study on resource use analysis tried to analyze the input wise use efficiency. The results show that the SRI rice cultivation method provides higher grain yield and net returns compared to the conventional rice cultivation method. The increased net returns realized in the SRI method were constrained by the high cost of cultivation contributed by intercultural, harvesting, and planting operations. From a profitability point of view, the reduction in the cost of cultivation is possible only by using cheap human labour or by indulging more family labor which poses the question of social sustainability. Therefore, the SRI method to be refined with less labor-intensive, technology-oriented, and user-friendly improvements for the continued adoption.

Key words: *Resource use efficiency; System of rice intensification; Agro ecological zones; Kerala.*

Global level climate change effect is intensifying the stresses on various natural systems. The hydrological systems and ground water resources are not an exception. All over the world, water resources are experiencing tremendous extraction pressure. The current situation demands the use of new technologies to increase the water use efficiency in all sectors of economy. *FAO (2017)* reports that the 70 per cent age of global freshwater extraction is by agriculture sector and to meet the future food demand by the growing population, irrigated food production is required to be increased by more than 50 per cent by 2050. As per the current water resource capacity, the amount of water withdrawn by agriculture can be increased only by 10 per cent. Therefore, the option before us is to follow sustainable irrigation methods which result in higher yield.System of Rice Intensification (SRI) is introduced as a water efficient method of rice cultivation which utilises water and soil resources more sustainably and results in productivity enhancement. Even though, the System of Rice Intensification (SRI) claims to enhance rice productionwith reduced water demand, the gains transpire on the expense of inefficient usage of other resources (*Gathorne-Hardy et.al, 2016*). *Hari Krishna (2016)* reported that 62.7 per cent of farmers agreed that SRI technology will improve rice productivity.

Rice is the staple food in Kerala state and constitutes 7.7 per cent age of total cultivation. Palakkad, Alappuzha, Thrissur are major districts involved in rice production. Only 12 per cent of the total state annual requirement is produced domestically, and the remaining being imported from Andhra Pradesh and Karnataka (*Nufaisa et. al 2019*). Rice cultivation in Kerala is proving to be a less remunerative enterprise due to the small holding size, high cost of inputs and unexpected weather events like drought and flood.The analysis of long-term data on rainfall of Kerala indicated that intolerably long dry spells are the normal rather than the exception in all seasons (*Krishnakumar et al. 2009*). The uneven rainfall distribution pattern and lowwater holding capacity of soils, soil moisture stress occurs during summer season (*Surendran et al, 2015*).

Palakkad district of Kerala state is a major rice growing area in the state. The district contributes nearly 40 per cent age of the gross rice production in the state. Drought is a major production constraint limiting rice production in Palakkad (*Durga et al, 2015*). The absence of the Western Ghats for about 45 kms along the eastern boundary of the district has precipitated unique climatic conditionsin the Palakkad district, especially in terms of wind and rainfall patterns, which distinguishes it from the rest of the state. Not only does the area receive a lesser amount of rainfall, but it is also subject to 'continuous dry high velocity winds' funnelled in through the Gap from the neighbouring plains in Tamil Nadu (*Nair et al, 2012*). The National Bureau of Soil Survey and Land Use Planning, Bengaluru under a project co-ordinated by the Kerala State Planning Board in 2012, delineated Kerala into five agro-ecological zones. The classification was based on the parameters such as climate, geomorphology, land use and soil variability. The major rice growing areas in Palakkad district was grouped under the agro-ecological zone namely 'Palakkad Plain' characterised by low rainfall and long dry period. The SRI method of rice cultivation was introduced to this agroecological zone as an alternative to produce more rice with less use of resources such as water, seed, fertilizers, and chemicals. The important attributes which aroused the interest of farmers to gain more knowledge about SRI were high grain and straw yield, lower seed rate, less water requirement and less cost of cultivation. (*Johnson et al.2011*). In spite of many advantages, the SRI still lacks popularity among rice farmers owing to skill required in efficient management of farm resources (*Rama Rao, 2015*). The systematic study on resource use efficiency in SRI rice cultivation will provide the field level picture of input use efficiency and feasibility of continued adoption. In this context, the present study makes an attempt to analyse the input wise use efficacy in SRI rice cultivation method. The study assessed the relative economics of SRI cultivation vis-a vis conventional rice cultivation. A comparison of the operation wise cost structure in those two methods of rice cultivation was also done in this study. Finally, the resource use efficiency in SRI method of rice cultivation is estimated.

METHODOLOGY

The study was conducted in Palakkad Plain agro-ecological zone. Three stage sampling designwas adopted in this study. In first stage, Palakkad Plain agro-ecological zone was purposively selected owing to the characteristics of low rainfall and long dry periods. In second stage, nine villages were randomly selected. During the final stage, 79 farmers each who followed SRI rice cultivation method and conventional rice cultivation is randomly selected. The study is based on the primary data collected from rice farmers by personal interview using a structured pre-tested interview schedule during 2015-16 rabi season. The data on area, details of input use, input price, cultivation practices, cost of cultivation, yield and output price were gathered.

The on-farm resource use efficiency is estimated using Cobb-Douglas production function of the following form for SRI and conventional method of rice cultivationseparately.

$$Y= a_0 S^{a1} OM^{a2} CF^{a3} PPC^{a4} IR^{a5} ML^{a6} HL^{a7} e^{å} \quad ...(1)$$

Where, the dependent variable Y represents the gross returns (Rs./Ha). Among the independent variables, S is the value of seed used per hectare in rupee terms, OM is the value of organic manure used per hectare in rupee terms, CF is the value of chemical fertilizers used per hectare in rupee terms, PPC is the value of plant protection chemicals used per hectare in rupee terms, IRirrigation charges incurredper hectare in rupee terms, ML is the value of machine labour used per hectare in rupee terms, HL is the value of human labour used per hectare in rupee terms, a_0 is the model intercept, a_i is elasticity coefficient and å is the error term.

The Cobb-Douglas production function given in equation (1) was estimated in linear forms by making logarithmic transformation as given below.

$$Ln\,Y = \ln a_0 + \ln a_1 S + \ln a_2 OM + \ln a_3 CF + \ln a_4 PPC + \ln a_5 IR + \ln a_6 ML + \ln a_7 HL + \ln å \quad ...(2)$$

The method of ordinary least square was adopted to estimate the coefficients. The marginal product for x_i^{th} input (MPP_{xi}) were calculated at the geometric mean levels of dependent and the specific independent (input) variables using the estimated regression coefficients.

$$MPP_{xi} = a_{i*} 2/x_i \quad ...(3)$$

Where a_i is the regression coefficient of x_i^{th} independent variable, 2 is the geometric mean of main output and x_i is the geometric mean of xi^{th} input.

The value of marginal product for x_i^{th} input (VMP_{xi}) was calculated using equation (4).

$$VMP_{xi} = MPP_{xi*} P_y \quad ... (4)$$

Where P_y is the price of output.

The resource use efficiency ratio (r) is given by

$$r = VMP / MFC \quad ...(5)$$

Where VMP is the value of marginal product and MFC is the marginal factor cost and is expressed in terms of an additional rupee. If value of *r* is more than unity, it indicates the underutilization of that particular resource and there is further scope for increasing the use of that resource. If the value of *r* is less than one, then the resource is overused in the production. The *r* value equal to one indicates the optimum or efficient use of resource. The value above and below unity implies the inefficient utilization of resource.

Further, cost – return analysis was used to assess the relative economics and structure of input use by value of SRI method and conventional method. To test the equality of two sample means, Welch's two sample t-test is used. The Welch's two sample t-test is a modification of t-test where the number of degrees of freedom is adjusted when the variances are thought not to be equal. The null hypothesis is that the difference between sample means is zero and alternative as the true difference in sample means is not equal to zero. The entire data analysis is done using R× 64 4.0.2 version of software.

RESULTS AND DISCUSSION

Relative economics of SRI and conventional rice cultivation methods : The comparison of grain yield, costs and net returns given in Table1 reveals that yield and net returns values are distinctly more in SRI when compared to conventional rice farming. The results are similar to *Durga (2015)* and (*Shanmugasundaram et al. 2015*) who observed increased yield and net returns in SRI method than conventional rice farming in Palakkad district. As per the test statistic value, the difference is significant at 5 per cent level in case of yield and cost of cultivation. The test statistic reports lower significance for net returns value differences between two groups. These points out the imbalances in proper allocation of resources to ensure a proper remuneration.

Table 1. Relative economics of SRI and conventional rice farming (N=158)

Particulars	SRI	Conventional	t-statistic
Grain yield(kg/ha)	4580	4119	2.3108**
Total cost of cultivation (Rs/ha)	43516	42152	2.0606**
Net returns (Rs/ha)	39578	31886	1.9525*

Note: * and ** denote significance at ten and five per cent level, respectively

Comparison of the operation wise cost structure : On comparing the structure of operation wise cost (Table 2) reveals that the highest share of cost is for intercultivation operation in SRI and harvesting in case of conventional farming. This may be due to high dependence on human labour input.

Table 2. Structure of operation wise cost

Operations	Cost (Rs/ha)		t-
	SRI	Conventional	statistic
Nursery Preparation	831.33 (1.89)	2969.45 (7.01)	-10.571**
Main field Preparation	7165.21 (16.30)	6853.02 (16.18)	0.3096
Planting	7060.72 (16.07)	6564.45 (15.50)	0.2560
Manures & Fertilizer	7588.45 (17.27)	7676.90 (18.12)	-0.0657
Irrigation	989.04 (2.25)	744.37 (1.75)	0.8624
Inter cultivation	10404.02 (23.68)	7448.88 (17.58)	1.9927**
Plant Protection	1905.74 (4.33)	2069.80 (4.88)	-1.1231*
Harvest	7988.08 (18.18)	8023.55 (18.94)	-0.0397
Total	43932.59	42350.42	2.0606**

Note: * and **denote significance at ten and five per cent level, respectively

Data within parenthesis indicate percentages.

The t-test statistic value shows that there exists significant difference in cost incurred for intercultivation, nursery preparation and plant protection. The nursery preparation costs are lower in SRI may be due to less seed requirement for this particular method. Intercultivation cost in SRI is noticeably high as more human labour has to be employed for weeding operations compared to conventional rice farming.

Production function estimates for SRI method of rice cultivation : The significant independent variables and their extent of contribution to the dependent variable gross returns in SRI method is estimated by fitting the Cobb-Douglas production functionto the observations and the results are presented in Table 3. It can be inferred that inputs such as plant protection chemicals, Irrigation, Machine Labour and Human Labour has significant and positive influence on gross returns. *Durga (2015)* in her study on economic analysis of SRI rice cultivation in Palakkad district obtained similar results in case of Irrigation and human labour inputs. Therefore, the SRI method is more labour intensive. The SRI method is skill oriented rather than technology oriented (*Rama Rao, 2011*). The variable Chemical Fertilizers is negatively significant indicating the overuse. The model gave a moderate fit with R^2 value 0.4742.

Table 3. Cobb - douglas production function estimates for SRI method (N=79)

Independent variables	Elasticity coefficient
Seed	-0.08940 (0.1207)
Organic Manure	0.01444 (0.0367)
Chemical Fertilizers	-0.15884* (0.0908)
Plant protection chemicals	0.12804** (0.0431)
Irrigation	0.08391** (0.0248)
Machine Labour	0.05962** (0.0212)
Human Labour	0.34762*** (0.0715)
R^2	0.4742
Adjusted R^2	0.4224

Notes: *, ** and ***denote significance at ten, five and one per cent level, respectively

Figure in parentheses indicate standard error

Resource use efficiency in SRI method of rice cultivation : The estimates of resource use efficiency ratio of significant inputs are given in Table 4. The efficiency ratio of the inputs chemical fertilizers and machine labour is less than unity indicating its inefficient use at farm level. The use of inorganic fertilizers has to be reduced. The inputs plant protection chemicals and Irrigation water have efficiency ratio close to one. Therefore, these inputs are used optimally in the production process. The results are similar to *Barah (2009)* who observed that the water usage in SRI method in Tamil Nadu is more efficient due to its alternate wetting and drying system.The efficiency ratio of the input human labour is more than unity, demonstrating its underuse. The similar results were obtained by *Haldar (2012)* while studying the resource use efficiency in SRI rice cultivation in West Bengal.

CONCLUSION

The SRI rice cultivation method provides higher grain yield and net returns when compared to conventional rice cultivation method. The total cost of cultivation was higher in SRI than conventional farming. The intercultivation operation has the highest share in total cost of cultivation. The results of resource use efficiency analysis shows that the inputs water and plant protection chemicals are used optimally. The increased net returns realised in SRI method were constrained by high cost of cultivation contributed by intercultural, harvesting and planting operations. These operations are highly dependent on human labour input. The resource use efficiency ratio of human labour input points to its underuse and the scope for further use of this input. Moreover, the elasticity coefficient of human labour is highest among significant independent variables which contribute to gross returns. Therefore more production happens with use of more human labour. The portion “which the profitability of SRI farming may be deleted”. From profitability point of view, the reduction in cost of

Table 4. Estimated resource use efficiency (r) in SRI method

Inputs	Production elasticities	VMP	MFC	r(VMP/MFC)	Remarks
Chemical Fertilizers	-0.15884	-3.56	1	-3.56	Overuse
Plant protection chemicals	0.12804	1.03	1	1.03	efficient use
Irrigation	0.08391	1.01	1	1.01	efficient use
Machine Labour	0.05962	0.71	1	0.71	overuse
Human Labour	0.34762	1.19	1	1.19	underuse

cultivation is possible only by using cheap human labour or by indulging more family labour which poses the question of social sustainability. The benefits of reduction in use of inputs like water, plant protection chemicals etc may get outweighed by the costs of social sustainability and environmental sustainability. The social and environmental sustainability analysis isadditionally needed together with the traditional analysis to accurately measure its real efficacy. To ensure continued adoption, less labour intensive, technology oriented, and user-friendly improvements are required to be made in SRI rice cultivation method.

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