

**Working Paper 434**

**Determinants of Farm-Level  
Adoption of System of Rice  
and Wheat Intensification  
in Gaya, Bihar**

**Shikha Pandey  
Parmod Kumar**

ISBN 978-81-7791-290-6

© 2019, Copyright Reserved

The Institute for Social and Economic Change,  
Bangalore

*Institute for Social and Economic Change (ISEC) is engaged in interdisciplinary research in analytical and applied areas of the social sciences, encompassing diverse aspects of development. ISEC works with central, state and local governments as well as international agencies by undertaking systematic studies of resource potential, identifying factors influencing growth and examining measures for reducing poverty. The thrust areas of research include state and local economic policies, issues relating to sociological and demographic transition, environmental issues and fiscal, administrative and political decentralization and governance. It pursues fruitful contacts with other institutions and scholars devoted to social science research through collaborative research programmes, seminars, etc.*

*The Working Paper Series provides an opportunity for ISEC faculty, visiting fellows and PhD scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.*

Working Paper Series Editor: **A V Manjunatha**

# DETERMINANTS OF FARM-LEVEL ADOPTION OF SYSTEM OF RICE AND WHEAT INTENSIFICATION IN GAYA, BIHAR

Shikha Pandey<sup>1</sup> and Parmod Kumar<sup>2</sup>

## *Abstract*

*Around 90 percent of the people in Bihar still live in rural areas and agriculture is one of the main sources of their livelihood, either directly or indirectly. With the size of land holdings declining and decrease in area under agriculture, it has become important to bring in modern technology to help increasing yield per hectare of land by sustaining the natural resources. System of Rice Intensification (SRI)/System of Wheat Intensification (SWI)], is one such technology which is said to increase yield and conserve resources. This paper looks at determinants of farm-level adoption of SRI (SWI) in Gaya district of Bihar using the logistic regression method. The results of the study depict that variables, viz., age, physical productivity and hours of irrigation, were found significant in the adoption of SRI method whereas, hours of irrigation, physical productivity and number of family labour per acre, were found significant for adoption of SWI method of cultivation.*

**Key words:** Paddy, Wheat, System of Rice Intensification, Farm-level adoption and Factors affecting adoption.

## **Introduction**

System of Rice Intensification (SRI) was first introduced in Madagascar in 1983 by Father Henri de Laulanie. It was discovered by him when late rains forced him and his students to prematurely transplant 15-day old seedlings that subsequently tillered and performed well (Bouman, 2012). This method of cultivation has two main attributes, one, planting of 8-12-day old seedling at 25\*25 cm (however, the distance between the seedlings depends on the temperature of the region also) and second, using less water (Laulanie, 2011). The wide spacing between the two plants gives better space, air and sunlight to the plants, helping the roots to grow healthy and absorb more nutrients, which results in more tillers, long panicles and more grain and grain weight. WWF-ICRISAT (2006) report on SRI points out that this method of paddy cultivation requires the transplantation of seedlings when it is in two leaf stage, which helps the seedling to grow healthily and generate more tillers. Also, transplanting of rice seedlings before they are 15 days' old minimizes the transplant shock, resulting in better growth of the plant (Adhikari *et al*, 2010). Under this method the fields are kept un-flooded during the period of vegetative growth, the soil must be only moist and so excess water is drained out. By providing water occasionally the roots are aerated and grow healthy. Once the flowering begins the paddy fields are flooded with 1-3 cm of water during the reproductive period (Uphoff, 1999).

The SRI technique has other complementary attributes, such as, using organic manure instead of chemical fertilisers and turning back the weeds into soil, either manually or using a machine

---

<sup>1</sup> PhD Scholar, Agricultural Development and Rural Transformation Centre, Institute for Social and Economics Change, Bangalore, Email: [shikha@isec.ac.in](mailto:shikha@isec.ac.in) and [shikhapandey2310@gmail.com](mailto:shikhapandey2310@gmail.com)

<sup>2</sup> Professor, Agricultural Development and Rural Transformation Centre, Institute for Social and Economic Change, Bangalore, Email: [pkumar@isec.ac.in](mailto:pkumar@isec.ac.in).

Authors are grateful to Prof. Sunil Nautiyal and Dr. A.V Manjunatha for their valuable comments and suggestions. The authors are also thankful to the anonymous referees for their suggestions and comments. Based on the comments and suggestions the paper has been revised. The usual disclaimer, however, remains.

(weeder). The use of organic fertiliser is not necessary for SRI practice. Using weeder to turn back weed into the field also leads to soil aeration as they get decomposed in the soil and turn into organic matter (WWF-ICRISAT, 2006). The cultivation under SRI is not possible in saline or alkali soils. It also requires levelled plots so that the irrigated water spreads uniformly across the field. The soil has to be fertile.

Some community workers in India and Africa made use of the principles of rice intensification in wheat crop, which gave very enthusiastic results (Khadka and Raut, 2012). This technique of wheat cultivation then came to be known as system of wheat intensification (SWI). It is based on the techniques of SRI. Like SRI, SWI also demands to maintain a plant-to-plant distance varying from 8-20 cm (Khadka and Raut, 2012) leading to enough aeration, moisture, sunlight and nutrient availability resulting in proper root system development from the early stage of the crop growth. It also requires 2-3 times weeding and irrigation for best results.

SRI was first introduced in India in the year 2000 through experiments initiated by researchers at Tamil Nadu Agriculture University. Later, this technology was tested on 200 farmers' fields. The positive results from the experiments led to widespread implementation of this technique in other parts of the country. In Bihar, this technology was first introduced by PRADAN (Professional Assistance for Development Action), a Non-Government Organisation (NGO), in the year 2006 through experiments in a few villages. The increase in yield of paddy led to widespread adoption and promotion of SRI by the Bihar government in 2011. Today, this technology is being promoted in the state through PRAN (Preservation and Proliferation of Rural Resources and Nature), an offshoot of PRADAN.

Agriculture in Bihar has remained stagnant even though it has fertile soil, ample water, which is easily accessible, and a rich peasant tradition (Kishore, 2004). Around 90 percent of the people in Bihar still live in rural areas (Economic Survey, 2016-17) and agriculture is one of the main sources of livelihood for these people, either directly or indirectly. Many people in Bihar are still disguisedly under-employed in agriculture due to lack of industrialisation and poor rural-urban growth linkages (Kumar and Sarkar, 2012) and so agriculture cannot be ignored if the state has to grow. Rice and Wheat are the main cereal crops grown in the state. With the per farmer land size declining and the area under agriculture decreasing, it has become important to bring in modern technology which will help increase the yield per hectare of land by sustaining the natural resources. SRI is one such technology which is said to increase yield and conserve resources like seed and water, hence reducing the cost of cultivation. SRI method of cultivation is scale neutral and can be easily adopted by marginal and small farmers (which comprises of 90 percent of farmers in Bihar).

This paper looks at the determinants of farm-level adoption of SRI (SWI) method of cultivation in Gaya district of Bihar. It analyses factors affecting adoption of this method of cultivation in the study area. After this brief introduction, we look at the available literature on adoption of technology and SRI in the next section, the third section briefs the methodology used to understand the determinants of adoption followed by the results and discussion, after which we present summary and conclusions and lastly policy recommendations.

## Review of Literature

The first part of the review of literature gives the definition of adoption and the ways to measure it. In the second part we discuss some existing work on SRI and SWI, which shows the benefits of using the SRI method of cultivation and factors affecting their adoption.

### Adoption definition

Everett Rogers' 1962 work, 'The diffusion of innovation' is one of the most significant work in understanding how an innovation penetrates a population, it provides a complete structure for understanding individual adoption and collectively diffusion (Straub, 2009). According to Rogers, (1962) adoption of an innovation or technology is "a mental process (an) individual passes from first hearing about the innovation to final adoption" (Feder *et al*, 1985). S/He goes through five stages when evaluating an adoption decision, (1) awareness of the innovation- which is influenced by his/her personal characteristics, socio-economic factors and access to change agents, (2) persuasion- wherein the individual gets enough knowledge about the innovation, (3) decision- whether to adopt or reject the innovation, (4) implementation- when an individual acts on his/her decision and (5) confirmation- wherein the individual reflects on his/her decision and implementation process and re-evaluates whether to continue or discontinue the adoption of the innovation (Straub, 2009).

There are five categories of adopters according to Rogers; (1) Innovators- people who want to be the first to try an innovation, they are venturesome and willing to take risk and are often first to develop a new idea; (2) Early adopters- people to whom the others look up to before adopting a new idea (role models), their role is to decrease the uncertainty of new idea by adopting it; (3) Early majority- people who adopt the new idea just before the average members of the social system, they are an important link between the early adopters and the late adopters; (4) Late majority- people who are sceptical about the idea and will adopt only when majority have adopted it successfully, for them the adoption may be an economic necessity and the answer to increasing network pressure; (5) Laggards- the last people to adopt the innovation and have almost no opinion leadership, these people are traditional in their nature and their unwarranted economic position forces them to be extremely cautious in adopting the innovation (Rogers, 1983).

Feder *et al*/1985 in their paper 'Adoption of agricultural innovation in developing countries: A survey' have said that Rogers' definition of adoption did not distinguish between individual (farm-level) adoption and aggregate adoption. According to them adoption at the individual farm level is defined as "the degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential", and, aggregate adoption is "the aggregate level of use of a specific new technology within a given geographical area or a given population". Further, they say, agriculture technologies introduced are of two types -- divisible (one that come in a package form e.g., the high yielding variety seed, fertiliser and irrigation) and non-divisible (use of a harvester). In the former case, the adoption of the technology/ innovation at the individual farm level for a given period is measured by the percentage area under the new technology or the per hectare quantity of input used where applicable and at aggregate level the similar measure may apply for a region. In case of non-

divisible technology, the adoption at farm level is measured by use/no use of the technology and at aggregate level it is the percentage of farmers using the technology/innovation.

### **SRI and/or SWI**

Takahashi and Barrett (2013), tried to evaluate the socio-economic effect of SRI at the household level using the average treatment effect. The study showed that yield and income per hectare of rice on SRI plots was significantly higher as compared to non-SRI plots by 64 and 107 percent, respectively. The study also depicted that the probability of SRI use increased with better water, labour availability and social networks.

Thiyagarajan (2002) carried out an experiment on SRI adoption in Tamil Nadu. The study concluded that SRI method of cultivation led to an increase in yield of rice provided the farmers strictly followed all the attributes of SRI cultivation, i.e., planting younger seeds one by one at 25\*25 cm, less irrigation, use organic manure and incorporate weeds with soil aeration. They saw a reduction of water usage by 50-56 percentage when paddy is cultivated using SRI in comparison to conventional methods. They also saw that the younger seedlings per hill and 25 hills/m<sup>2</sup> produced yield similar to 3-week-old seedlings, 2-3 per hill and 50 hills/ m<sup>2</sup>. Hence, they concluded that SRI will lead to a reduction in water and seed requirements with an increase in yield of rice.

Barah (2009) evaluated economic and ecological advantages of SRI in relation to the conventional practice in Tamil Nadu. He conducted a detailed farm survey in four districts of Tamil Nadu namely, Tanjore, Coimbatore, Kanchipuram and Ramanathapuram. The districts selected represented distinctive features of irrigation, i.e., Tanjore and Coimbatore had well irrigation, Kanchipuram had canal irrigation and Ramanathapuram was a rainfed district. Among these districts they selected a few SRI and non-SRI farmers to conduct the study. The result of the study showed that farmers under SRI used only 5-8 kg seed in comparison to 40-50 kg seeds under conventional method. The yield under SRI was high; it could increase rice production by 26 percent or more depending on the extent to which a farmer adheres to the basic principles. Also, a saving of up to 40 percent of water was seen under the SRI method due to the alternate drying and wetting system. The study concluded that farmers using SRI are technically and economically more efficient in comparison to the non-SRI farmers.

Palanisami *et al* (2012) investigated the impact of SRI on the yield and income of rice growers in 13 states across India. The states under study were, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu from southern region, Gujarat, Maharashtra and Rajasthan from the western region, Chhattisgarh, Orissa, Uttar Pradesh and West Bengal from the eastern region, Madhya Pradesh from central region and Assam from north-eastern region. Results showed that SRI fields had higher yields (22 percent higher) in comparison to non-SRI fields. The difference in yield depended on various components adopted by the farmers; full adopter of SRI recorded highest difference of yields between SRI and non-SRI practice (31 percent) followed by partial adopters (25 percent) and low adopters (15 percent). They concluded that the selection of different components of SRI for adoption has significant bearing on yield increase. The study also showed that states which had sandy loam to clay loam with ground water or conjunctive irrigation recorded more yield. The main reasons for non-adoption of SRI were, lack of knowledge about SRI, more labour requirement especially for cono-weeder and non-availability of

suitable markers. SRI/modified practices had higher gross margin (Rs. 7,000/ha) and lower production cost (Rs. 178/quintal) compared to non-SRI parcels.

Devi and Ponnarasi (2009) studied the cost and return of paddy in SRI and non-SRI method and the factors influencing the adoption of SRI and the problems in its adoption. Descriptive statistical analysis such as mean, percentage etc., was carried out to compare the typical characteristics of sample farms. Logistic regression model was used to study the adoption of SRI by farmers. The study assumed six attributes of adoption of SRI by a farmer, namely, age, literacy level, farm size, income, number of earners in the family and number of contacts with extension agencies (per month). Result showed total cost of cultivation per hectare was lower by about 10 percent in SRI method than conventional method. There was reduction in seed cost due to less seed requirement, irrigation cost was little, with 40-50 percent saving in water from planting to harvesting in SRI method. However, the cost of human and machine labour was higher in SRI method in comparison to conventional method. But the net and gross returns were higher in SRI in comparison to non-SRI method due to high productivity of paddy under SRI method. Also, the cost of production was low in case of SRI method. Among the six attributes for adoption of SRI by farmers' it was seen that a number of earners in the family influenced the decision of adoption of SRI on a high degree, followed by number of contacts with extension agencies, farm size, income of the farm, literacy level and age.

Adusumilli and Laxmi (2010) compared the performance of SRI and conventional method of paddy cultivation in two mandals (sub-districts) of Mahabubnagar district of Andhra Pradesh. They concluded that SRI farmers in 2009-10 season had an 18 percent yield advantage, with a much higher increase in their net returns per hectare (52 percent) due to the reduction in cost of production. The study found SRI to be not labour-intensive with a 43 percent reduction in labour cost contradicting the conventional belief of SRI was a labour-intensive technology. A marked decrease in water use was seen under SRI method, i.e., the number of irrigation and pumping hours were 52 percent lower in SRI method than conventional method. The estimated saving of about 845 pumping hour $ha^{-1}$  amounted to a saving of 3.151 kwh of electricity, which is currently totally subsidized by the state, amounting to a saving of Rs. 12,607  $ha^{-1}$  given the cost of power subsidy. Hence, they concluded that SRI could be used as a tool to increase rice production and conserve resources like water.

Namara *et al* (2003) probed the determinants of adoption of SRI using logistic regression in two districts namely Ratnapura and Kurunegala in Sri Lanka. According to their report, labour availability, years of schooling, access to training program, farm location and the poverty status of households were the major factors affecting the adoption of SRI method of cultivation in the study area. The households who had a larger family size and greater availability of labour were more likely to adopt SRI method of cultivation concluding that SRI method is labour intensive.

Khadka and Raut (2012) compared yield of wheat from traditional practice with that from SWI in Nepal. Participatory action research was conducted by Mercy Corps Nepal in collaboration with the district agriculture development offices in 16 sites of 3 working districts- 4 sites in Dadeldhura, 8 sites in Baitadi and 4 sites in Doti. They made use of high yielding WK-1204 variety of wheat with three treatments and local practices. The treatments were T1 (seed priming + line sowing), T2 (seed priming + broadcast method), T3 as (without priming + local practice of sowing) and T4 control (local variety +

local practice). The results of the study showed that plant height was same in all cases of treatment, but the number of tillers and length of the spikes differed significantly in case of T1 and T4 and there was a yield difference of 100% increase between T1 and T4. The wheat crops responded positively to seed priming and line sowing. The wheat variety WK-1204 was found to be highly productive compared to the local variety. There was an increase in grain yield after treating the seeds organically before sowing them in the field. The spacing between the plants led to increase in number of tillers per plant, plant height and spike length and number and size of grain resulting in higher grain and biomass yield. The study also concluded that yield of wheat could be increased by 91.33% with the adoption of SWI technology compared to local practice.

Rakib *et al* (2016), in their article, tried to assess the effect of nutrient management and plant spacing on the performance of wheat under SWI and superior yield performance of wheat between SWI and conventional system. The study was conducted from November 2011 to March 2012 at the Agronomy Field Laboratory, Bangladesh Agriculture University. It consisted of three factors; (1) Fertiliser doses, (2) line spacing and (3) plant spacing. A total of 57 plots were under experiment and they made use of high yielding wheat variety BARI GOM 24 (*Prodip*), developed by Bangladesh Agricultural Research Institute. Statistical tools like ANOVA (analysis of variance), computer package MSTATC and Duncan's Multiple Range test (DMRT) were used. The results of the study showed that full recommended fertiliser (RF) dose and closer line spacing increased grain yield by 50.5%. SWI technique was found to increase 18 to 67% grain yield in wheat at farmers' field as compared to the broadcast method. They concluded that better yield attributes and grain yield of wheat was attained only when full recommended fertiliser dose was applied. Closer line and plant spacing ensured better utilisation of soil, water and above ground resources and increased grain yield.

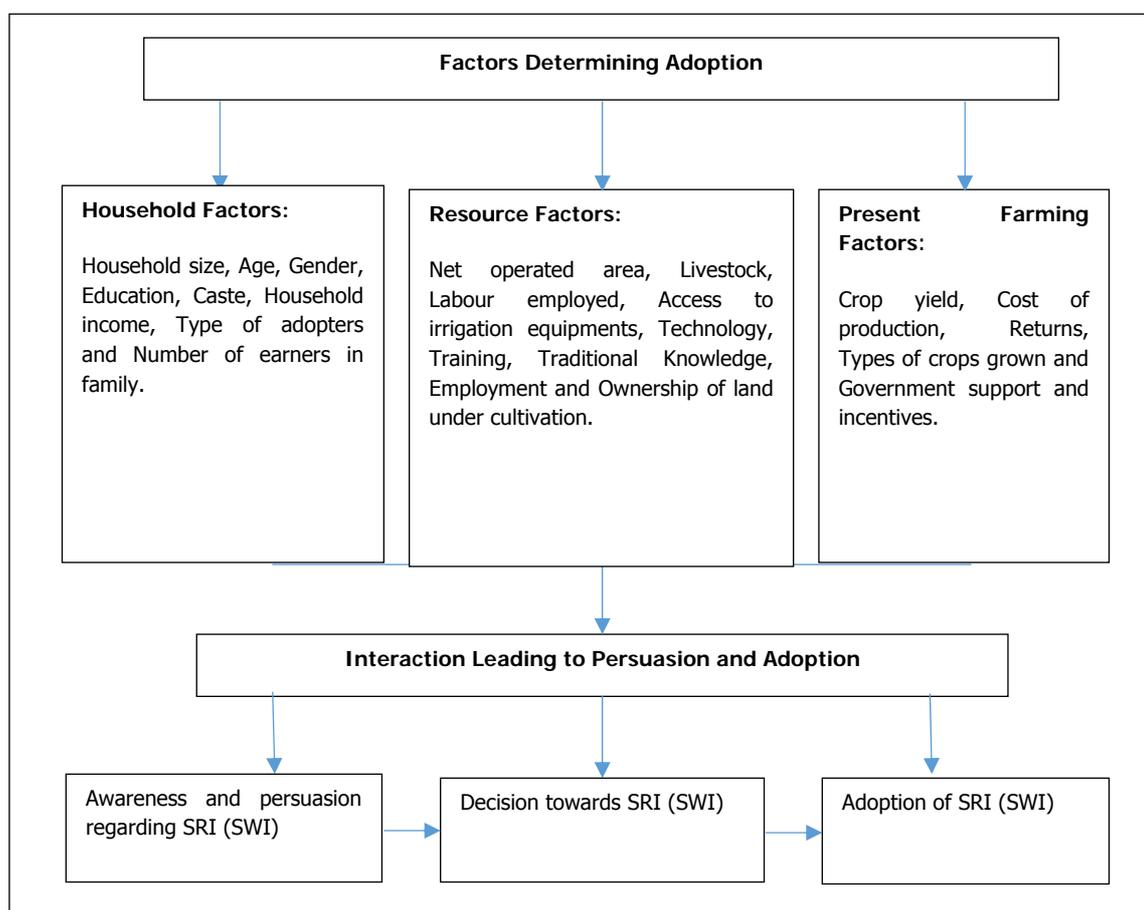
From the above discussion on SRI and SWI it can be clearly seen that most of the studies carried out on SRI and SWI looked at the effect of this method on yield and concluded that both SRI and SWI methods of cultivation lead to enhancement in yield compared to conventional method of cultivation. However, very few studies have pondered on the determinants of adoption of this method of cultivation. In the case of SWI, studies discussed above looked at the experimental results of growing wheat using SWI method and no farm-level studies are available in the literature as it is a very new concept. This paper overcomes such gap and brings in the major factors that affect the adoption of both SRI and SWI at the field level.

## Conceptual Framework

As mentioned above, adoption of a technology in agriculture is of two types, farm-level and aggregate level. By farm-level it means adoption of a technology or method of cultivation by each household under study, whereas at aggregate level one looks at how the adoption has evolved in a region or among a section of the society. Farm-level adoption studies are therefore concerned with the factors affecting adoption decision, either statistically or dynamically, by combining learning and experience (Karki, 2010). In the initial stage, adoption is slow and very few people adopt the technology, but with the spread of information, knowledge and experience by the early adopters it gains momentum.

Figure 1 gives the framework of understanding the factors affecting adoption of SRI (SWI) method of cultivation. In the figure, adoption of SRI (SWI), method of cultivation has been described as the innovation-decision process given by Everett Rogers' 1985 work on diffusion of innovation, according to which farmers go through four stages before adopting an innovation; becoming aware of SRI (SWI) method of cultivation; gaining enough knowledge about SRI (SWI) method of cultivation; deciding to either adopt or not to adopt the SRI (SWI) method of cultivation; and finally implementing the decision taken. In this process, numerous factors affect their decision of adoption and non-adoption of SRI (SWI) method of cultivation in the study area. These factors have been listed under three categories, household factors like household size, income, age of the decision maker, types of crops grown etc.; resource factors like ownership of land under cultivation, irrigation facilities, labour etc.; and present farming status like crop yield, cost of production type of crops grown etc. (see Figure 1).

**Figure 1: Conceptual Framework for SRI (SWI) Adoption**



*Source:* Modified from Karki (2010)

## Methodology

This paper is part of a larger study titled, 'System of rice and wheat intensification for sustainable agricultural development of Bihar'. It consists of data from four villages of Gaya district, namely Patthargatha, Dohari, Gohti and Pathara. These four villages were selected purposively after discussion with the agriculture officials at Gaya district and members of PRAN organisation, who are working in the area to promote the use of SRI technology. From these four villages, a sample of 302 farmers was selected. This sample consists of both adopters and non-adopters of the technology. By adopters, we mean the farmers who are cultivating paddy and wheat using the SRI (SWI) method of cultivation in more than 5 percent land, out of the total land put under paddy and wheat cultivation every season. The reason for keeping the low base of at least 5 percent or more of the cropped area under SRI (SWI) is that both SRI and SWI are new concepts in the study area and the farmers using this technique are still mastering the skills and hence not willing to apply the method for total land area under paddy and wheat cultivation. Compared to SRI, SWI is an even newer concept and the increased demand of labour at the time of sowing, in case of SWI method, forces the farmers to adopt this method in only some portion of the total land under wheat cultivation.

To determine the factors responsible for adoption of SRI (SWI) by the farmers, binary logistic regression is used. The reason for selecting logit model is that the dependent variable is dichotomous in nature and a few independent variables like caste, village, etc., are also dichotomous in nature. So, according to econometric literature logit model is one of the qualitative response models which can be used. The other model which can be used is the probit model, while results of logit and probit models are similar but interpretation of a probit model is difficult (Gujarati and Sangeetha, 2007). Probit model fits better if the variables under question follow normal distribution. In the present case this condition is hard to be satisfied, therefore, we made use of logit model which does not impose such a restriction.

Logistic regression describes the relationship between the dependent variable and the set of independent or explanatory variables. In our present case, the logit model specifies a functional relationship between the probability of adoption of SRI and various explanatory (independent) variables, mentioned below is the functional form of the logistic regression.

$$\text{Log} \left[ \frac{\pi(X)}{1-\pi(X)} \right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + E_t$$

Where  $\pi$  = Probability of adoption of SRI (SWI) method of cultivation represented by percentage of area under SRI (SWI).

$\beta_0$  = Intercept variable.

$\beta_1$ -  $\beta_9$  = Regression coefficients associated with the independent variables.

$X_1$  = Net operated area

$X_2$  = Number of family labour used

$X_3$  = Hours of irrigation

$X_4$  = Main occupation of head of the household being agriculture

$X_5$  = Caste of the respondent

$X_6$  = No. of earners in the household

$X_7$  = Education of the head of the family

$X_8$  = Physical productivity

$X_9$  = Age of the Head of the family

$E_t$  = Error term

**Table 1: List of variables used in the binary logistic model with their direction**

Variables		Description	A priori sign
<b>Dependent variables</b>		<b>1 if household has adopted SRI (SWI); 0 otherwise</b>	
<b>Explanatory variables</b>			
NETOPAC		Net operated area in acres	+
FAMLBAC		No. of family labour used per acre	+
HRIRRIGNAC		Hours of irrigation used per acre	-
MNOCCP		1 if agriculture main occupation; 0 otherwise	+
CASTE	GEN	1 if belongs to GEN category; 0 otherwise	-
	OBC	1 if belongs to OBC category; 0 otherwise	+
	SC	1 if belongs to SC category; 0 otherwise	+
NERHH		No. of earners in a household	+
EDUCALEV	Illiterate (ILLT)	1 if illiterate; 0 otherwise	-
	Upto Secondary (SECED)	1 if studied upto secondary school; 0 otherwise	+
	Above secondary (ABSECED)	1 if studied above secondary school; 0 otherwise	+
PHPRODOC		Output per acre of paddy and wheat	+
AGE		Age of the head of the family	-

## Variables in the Equations

### Dependent Variable (Y):

The Dependent variable for the study is whether a household has adopted the SRI (SWI) method of cultivation or not. The adoption of SRI (SWI) method is measured by the percentage of area under SRI (SWI) out of the total area under Paddy (wheat) respectively. SRI (SWI) adoption was defined as a binary variable and assigned with "1" if the households have cultivated paddy (wheat) using the SRI (SWI) method in more than 5 percent of total land under paddy and wheat cultivation and "0" otherwise. The reason for considering households with more than 5 percent land under SRI (SWI) cultivation as adopters is that around 90 percent of the farmers under study (which is also true for the state as a whole) are marginal farmers, that is, they have less than 2.5 acres of land under cultivation. So, given their small size of landholding different proportion of land is devoted to SRI (SWI). To ensure that at least a bare minimum percentage of area is under SRI (SWI) and given the size of sample we prescribe to have at least 5 percent of crop area under SRI (SWI) to ascribe it as an adopter.

### Independent/Explanatory Variables:

The adoption of SRI (SWI) method of cultivation is influenced by the following socio-economic factors, which have been used as the determinants of adoption in the present study.

**(i) NETOPAC (Net operated area in acre):**

Net operated area measures the total land under cultivation by a household. SRI is a scale neutral method and likely to be adopted by small as well as large farmers. With the increase in area under cultivation the percentage area under SRI (SWI) is expected to increase. Hence, we hypothesise a positive relationship between net area operated and area under SRI, which means higher the area under cultivation, more are the chances for a household to adopt SRI (SWI) method of cultivation.

**(ii) FAMLBAC (Number of family labour used per acre):**

Under this variable we consider the total number of family labour used per acre. SRI (SWI) method of cultivation is a labour-intensive technique (Karki, 2010). Hence, higher the availability of labour, more are the chances of adoption. The households which have more family labour available for agriculture are more likely to adopt SRI (SWI) method of cultivation. Hence, we hypothesise that family labour per acre will have a positive effect on the adoption of SRI (SWI) method of cultivation. Here, family labour is measured as family labour used per acre.

**(iii) HRIRRIGNAC (Hours of irrigation per acre):**

Irrigation is very important for water guzzling crops like paddy and we measure irrigation in terms of hours of irrigation per acre. There are two types of irrigation facilities available in the study area namely, ground water (tubewell) and surface (canal water). Tubewell irrigation is most common, where both electric and diesel tubewells are being used. In the case of canal, very few farmers make use of this source as it is hardly available beyond the rainy season. SRI (SWI) method of cultivation is said to require less water (Barah, 2009, Devi and Ponnarasi, 2009 and Adusimilli and Laxmi, 2010). Hence, we hypothesise that hours of irrigation will have a negative effect on adoption of SRI (SWI) method of cultivation. The farmers are more likely to adopt SRI (SWI) method of cultivation if the access to irrigation is less among the farmers.

**(iv) MNOCCP (Agriculture as the main occupation of the head of the household):**

The households, whose income is mainly dependent on agriculture, will want to experiment with the new method of cultivation if it leads to an increase in yield without increasing the cost of production. So, if for the head of the family, agriculture is the main occupation, he will go for SRI (SWI) adoption. Hence, we hypothesise that agriculture as the main occupation of the head of the household and it will have a positive effect on adoption of SRI (SWI) method of cultivation. The other reason for this hypothesis is availability of more time for agriculture for those households. SRI being labour intensive, it will have positive relationship with availability of labour.

**(v) Caste:**

Caste has been very integral to Indian society. The households belonging to the OBC (other backward caste), especially the Khushwaha community, are agriculturists. The SC (schedule caste) households have mostly been the agricultural labourers, and the general category households belong to the landlord group. This variable is being used to see if caste has any role in the adoption of SRI (SWI) method of cultivation. For the study, we hypothesise that farmers belonging to OBC and SC category

have a positive effect on adoption of SRI (SWI) method of cultivation and GEN will have a negative effect.

**(vi) NOERHH (Number of earners per household):**

This variable includes all the members of the family who contribute towards this economic activity. The risk-taking capacity of those household who have more earning member's increases and they can experiment with the innovative technologies (Karki, 2010). Hence, more the number of earners in the family, the higher are the chances of adoption of new technology by the household. Hence, we hypothesise that number of earners in the family will have a positive effect on adoption of SRI (SWI) method of cultivation.

**(vii) EDUCALEV (Education level):**

Education is another useful tool for adoption of modern technology. If the farmer is more educated, he/she is more likely to adopt new technology. In this study we consider the education of the head of the family and the variable is divided into three categories -- illiterate, up to secondary education and above secondary education. According to Namara *et al* (2003) the years of schooling significantly increased the likelihood of a farmer to adopt SRI method of cultivation. Thus, it has been hypothesised that the level of education will have a positive effect on adoption of SRI (SWI) method of cultivation.

**(viii) PHPRODOC (Physical productivity of the crop):**

The physical productivity of a crop is measured by output per acre or realised yield and it is one of the key factors for adoption of new technology. This is because farmers are attracted to a method of cultivation if it helps them increase the yield per acre without much effect on their cost of cultivation. Many studies have pointed out that SRI method of cultivation leads to an increase in yield (Thiyagarajan, 2002, Adusumilli and Laxmi, 2010 and Palanisami *et al*, 2012). Therefore, we hypothesised output per acre to have a positive impact on adoption of SRI (SWI) technology.

**(ix) AGE (Age of head of the family):**

Age of the head of the family is another important variable that can affect the decision to adopt SRI (SWI) method of cultivation. According to numerous studies on adoption of technology in agriculture, younger farmers are more risk takers and have more information on new practices being used in agriculture (Karki, 2010 and Adesina and Zinnah, 1993). Hence, it is hypothesised that age has a negative effect on adoption of SRI (SWI) method of cultivation.

## **Results and Discussion**

In this section we present results of the logit regression using SPSS package. The discussion is divided into two parts. First, we look at the total number of adopters and non-adopters of SRI and non-SRI and SWI and non-SWI and their household characteristics, followed by the output produced using the two methods and the cost of production. In the second part, we look at factors affecting the adoption of SRI and SWI method of cultivation.

## The First Part

In the case of paddy, there are total number of 288 farmers under study of which 200 (69.44 percent) are adopters and 88 (30.56 percent) are non-adopters of SRI method of cultivation as can be seen from Table 2. Among the adopters 81.50, 15.00 and 3.50 percent belong to marginal, small and medium farmer's category, respectively and among the non-adopters 77.27, 20.45 and 2.27 percent belong to the marginal, small and medium farmer's category, respectively (see Table 2).

**Table 2: Number of SRI Adopters and Non-Adopters**

Type of farmers	Adopters	Non-adopters	Total
Marginal farmers	163 (81.50) [70.56]	68 (77.27) [29.44]	231 (80.21)[100]
Small farmers	30 (15) [62.50]	18 (20.45) [37.50]	48 (16.67) [100]
Medium farmers	7 (3.5) [77.78]	2 (2.27) [22.22]	9 (3.12) [100]
<b>Total</b>	<b>200 (100) [69.44]</b>	<b>88 (100) [30.56]</b>	<b>288 (100) [100]</b>

*Source:* Primary survey

Figures in parentheses (..) are respective percentage of row total and [...] are column total. Table 3 gives the household characteristics of the SRI adopters and non-adopters. On an average, not much area is put under SRI cultivation across class of farmers in comparison to the average area under paddy. The average size of family is similar for both the adopters and non-adopters across marginal, small and medium farmers, that is 7 and 8 for marginal farmers, 9 and 10 for small farmers and 15 and 20 for medium farmers (see Table 3). There is not much difference in caste, education and occupation among the adopters and non-adopters. As can be seen from Table 3, out of total farmers surveyed 53, 43.5 and 3.5 percent belong to the SC, OBC and GEN category respectively among the adopters and 40.91, 52.27 and 6.82 percent belong to SC, OBC and GEN category respectively among the non-adopters.

**Table 3: Household Profile of SRI Adopters and Non-adopters**

Particulars		Marginal farmers		Small farmers		Medium farmers		Total	
		Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter
Avg. area under cultivation (in acres)		0.40	0.94	0.59	2.29	0.63	5.55	0.43	1.32
Avg. no. of family members		7	8	9	10	15	20	8	8
Caste	GEN	2 (28.57) [1.23]	3 (50.00) [4.41]	3 (42.86) [9.68]	3 (50.00) [16.67]	2 (28.57) [33.33]	0 (0.00) [0.00]	7 (100) [3.50]	6 (100) [6.82]
	OBC	61 (70.11) [37.42]	34 (73.91) [50.00]	22 (25.29) [70.97]	10 (21.74) [55.56]	4 (4.60) [66.67]	2 (4.35) [100.00]	87 (100) [43.50]	46 (100) [52.27]
	SC	100 (94.34) [61.35]	31 (86.11) [45.59]	6 (5.66) [19.35]	5 (13.89) [27.78]	0 (0.00) [0.00]	0 (0.00) [0.00]	106 (100) [53.00]	36 (100) [40.91]
	Total	163 (81.50) [100]	68 (77.27) [100]	31 (15.50) [100]	18 (20.45) [100]	6 (3.00) [100]	2 (2.27) [100]	200 (100) [100]	88 (100) [100]
Education	Illiterate	90 (90.00) [55.21]	32 (82.05) [47.06]	10 (10.00) [32.26]	5 (12.82) [27.78]	0 (0.00) [0.00]	2 (5.13) [100.00]	100 (100) [50.00]	39 (100) [44.32]
	Up to Secondary	61 (77.22) [37.42]	26 (72.22) [38.24]	14 (17.72) [45.16]	10 (27.78) [55.56]	4 (5.06) [66.67]	0 (0.00) [0.00]	79 (100) [39.50]	36 (100) [40.91]
	Above secondary	12 (57.14) [7.36]	10 (76.92) [14.71]	7 (33.33) [22.58]	3 (23.08) [16.67]	2 (9.52) [33.33]	0 (0.00) [0.00]	21 (100) [10.50]	13 (100) [14.77]
	Total	163 (81.50) [100]	68 (77.27) [100]	31 (15.50) [100]	18 (20.45) [100]	6 (3.00) [100]	2 (2.27) [100]	200 (100) [100]	88 (100) [100]
Main occupation	Agriculture	115 (78.77) [70.55]	49 (74.24) [72.06]	26 (17.81) [83.87]	15 (22.73) [83.33]	5 (3.42) [83.33]	2 (3.30) [100.00]	146 (100) [73.00]	66 (100) [75.00]
	Dairying	1 (100) [0.61]	1 (100) [1.47]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	1 (100) [0.50]	1 (100) [1.14]
	Govt./ Pvt. Employee	3 (75.00) [1.84]	4 (66.67) [5.88]	0 (0.00) [0.00]	2 (33.33) [11.11]	1 (25.00) [16.67]	0 (0.00) [0.00]	4 (100) [2.00]	6 (100) [6.82]
	self-employed	4 (100) [2.45]	1 (100) [1.47]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	4 (100) [2.00]	1 (100) [1.14]
	Agr. Wage labour	3 (75.00) [1.84]	5 (100) [7.35]	1 (25.00) [3.32]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	4 (100) [2.00]	5 (100) [5.68]
	Non-agri. Wage labour	37 (90.24) [22.70]	8 (88.89) [11.76]	4 (9.76) [12.90]	1 (11.11) [5.56]	0 (0.00) [0.00]	0 (0.00) [0.00]	41 (100) [20.50]	9 (100) [10.23]
	Total	163 (81.50) [100]	68 (77.27) [100]	31 (15.50) [100]	18 (20.45) [100]	6 (3.00) [100]	2 (2.27) [100]	200 (100) [100]	88 (100) [100]

Source: Primary survey

Figures in parentheses ( ) are respective percentage of row total and in [ ] are respective percentage of column total.

As already shown in Table 2, most of the farmers under study belong to the marginal farmers category followed by small and medium farmers. Among the marginal farmers category, most of the farmers fall under SC category, followed by OBC and GEN in the case of adopters and among the non-adopters belonging to marginal farmers category, most of them belong to OBC category followed by SC and GEN. The data related to education of the head of the family shows that among the adopters and non-adopters, 50 percent and 44.32 percent are illiterate, respectively. Among the illiterates, 90 percent belong to the marginal farmer category and 10 percent to small farmer category in the case of

adopters. The education level of marginal farmers among the adopters shows that 55.21 percent are illiterate, 37.42 have studied up to secondary school and only 7.36 percent have studied above secondary school. Similar is the case for non-adopters among marginal farmers. Here, the illiterates comprise 47.06 percent, followed by 38.24 percent for up to secondary education and 14.71 percent have studied above secondary school. This clearly shows that there is not much difference in education of the adopters and non-adopters and our data consists of less educated farmers. For around 71 percent adopters and 72 percent non-adopters among marginal farmers, agriculture is the main occupation followed by non-agriculture wage labour 23 percent and 12 percent, respectively. Similarly, for small farmers also agriculture is the main occupation followed by non-agriculture wage labour (see Table 3).

In the case of wheat, 299 farmers are surveyed of which 92 (30.77 percent) are adopters and 207 (69.23) are non-adopters of SWI method of cultivation (see Table 4). Like the previous case here also most of the farmers among the adopter (83.70 percent) as well as non-adopters (79.23 percent) belong to the marginal farmer category, followed by the small and medium farmer categories. Table 5 below gives the household characteristics of SWI adopters and non-adopters. Like SRI, in this case also there is not much difference in the household characteristics of the adopters and non-adopters. The average area under SWI is 0.26 acres and that under traditional wheat is 1.47 acres. Across different category of farmers, there is not much difference in area under SWI, for example, for marginal farmers the average area under SWI is 0.25 acres, for small farmers it is 0.36 acres and for medium farmers it is 0.28 acres. This clearly shows that even among the adopters not much area is under SWI, this could be due to the labour-intensive nature of this method of cultivation.

**Table 4: Number of Adopters and Non-Adopters of SWI Method of Cultivation**

Type of farmers	Adopters	Non-adopters	Total
Marginal farmers	77 (83.70) [31.95]	164 (79.23) [68.05]	241 (80.60) [100]
Small farmers	13 (14.13) [26.53]	36 (17.39) [73.47]	49 (16.39) [100]
Medium farmers	2 (2.17) [22.22]	7 (3.38) [77.78]	9 (3.01) [100]
<b>Total</b>	<b>92 (100) [30.77]</b>	<b>207 (100) [69.23]</b>	<b>299 (100) [100]</b>

Source: Primary survey

Figures in parentheses are respective percentage of column total

Most of the adopters of SWI methods of cultivation belong to the SC category, i.e., 70 and 46 percent for marginal and small farmers, respectively. In terms of education also there is not much difference as most of the farmers are illiterate, 62 percent for adopters and 48 percent for non-adopters in case of marginal farmers, 38 and 48 percent for small farmers. (see Table 5) showing that most of the farmers under this study are less educated. Agriculture is the main occupation for both the adopters and non-adopter, as can be clearly seen from Table 6 given below, where 79, 84 and 50 percent of the marginal, small and medium adopters and 67, 83 and 100 percent of marginal, small and medium non-adopters respectively. Table 6 shows the yield per acre for both paddy and wheat. The yield for both paddy and wheat is much higher for SRI and SWI method of cultivation vis-à-vis the traditional method. The t-test was run to check if the difference in the yield using the two methods is significant or not and it was found that for marginal and small farmers, the difference in yield of both paddy and wheat was significant at 1 percent level whereas for medium farmers, in case of paddy, it was significant at 5

percent level. This result is consistent with other studies on SRI and SWI, e.g., Makadia *et al* (2015), Takashi and Barrett (2013), Adusumilli and Laxmi (2010), Khadka and Raut (2012) and Rana *et al* (2017). Hence, from the above discussion we can say that SRI and SWI method of cultivation of paddy and wheat does lead to an increase in productivity in comparison to the traditional method of cultivation.

**Table 5: Household Characteristics of SWI Adopters and Non-Adopters**

Particulars		Marginal farmers		Small farmers		Medium farmers		Total	
		Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter
Avg. area under cultivation		0.25	1.06	0.36	2.84	0.28	4.17	0.26	1.47
Avg. no. of family members		7	7	8	9	19	14	8	8
Caste	GEN	0 (0.00) [0.00]	7 (53.85) [4.27]	2 (100.00) [15.38]	4 (30.77) [11.11]	0 (0.00) [0.00]	2 (15.38) [28.57]	2 (100) [2.17]	13 (100) [6.28]
	OBC	23 (76.67) [29.87]	77 (70.64) [46.95]	5 (16.67) [38.46]	27 (24.77) [75.00]	2 (6.67) [100.00]	5 (4.59) [71.43]	30 (100) [32.61]	109 (100) [52.66]
	SC	54 (90.00) [70.13]	80 (94.12) [48.78]	6 (10.00) [46.15]	5 (5.88) [13.89]	0 (0.00) [0.00]	0 (0.00) [0.00]	60 (100) [65.22]	85 (100) [41.06]
	Total	77 (83.70) [100]	164 (79.23) [100]	13 (14.13) [100]	36 (17.39) [100]	2 (2.17) [100]	7 (3.38) [100]	92 (100) [100]	207 (100) [100]
Education	Illiterate	48 (90.57) [62.34]	80 (86.96) [48.78]	5 (9.43) [38.46]	10 (10.87) [27.78]	0 (0.00) [0.00]	2 (2.17) [28.57]	53 (100) [57.61]	92 (100) [44.44]
	Upto Secondary	22 (75.86) [28.57]	69 (75.82) [42.07]	6 (20.69) [46.15]	18 (19.78) [50.00]	1 (3.45) [50.00]	4 (4.40) [57.14]	29 (100) [31.52]	91 (100) [43.96]
	Above secondary	7 (70.00) [9.09]	15 (62.50) [9.15]	2 (20.00) [15.38]	8 (33.33) [22.22]	1 (10.00) [50.00]	1 (4.17) [14.29]	10 (100) [10.87]	24 (100) [11.59]
	Total	77 (83.70) [100]	164 (79.23) [100]	13 (14.13) [100]	36 (17.39) [100]	2 (2.17) [100]	7 (3.38) [100]	92 (100) [100]	207 (100) [100]
Main occupation	Agriculture	61 (83.56) [79.22]	110 (74.83) [67.07]	11 (15.07) [84.62]	30 (20.41) [83.33]	1 (1.37) [50.00]	7 (4.76) [100.00]	73 (100) [79.35]	147 (100) [71.01]
	Dairying	1 (100.00) [1.30]	1 (100.00) [0.61]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	1 (100) [1.09]	1 (100) [0.48]
	Govt./ Pvt. Employee	1 (50.00) [1.30]	7 (77.78) [4.27]	0 (0.00) [0.00]	2 (22.22) [5.56]	1 (50.00) [50.00]	0 (0.00) [0.00]	2 (100) [2.17]	9 (100) [4.35]
	Self-employed	2 (100.00) [2.60]	3 (100.00) [1.83]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	2 (100) [2.17]	3 (100) [1.45]
	Agr. Wage labour	2 (66.67) [2.60]	7 (100.00) [4.27]	1 (33.33) [7.69]	0 (0.00) [0.00]	0 (0.00) [0.00]	0 (0.00) [0.00]	3 (100) [3.26]	7 (100) [3.38]
	Non-agri. Wage labour	10 (90.91) [12.99]	36 (90.00) [21.95]	1 (9.09) [7.69]	4 (10.00) [11.11]	0 (0.00) [0.00]	0 (0.00) [0.00]	11 (100) [11.96]	40 (100) [19.32]
	Total	77 (83.70) [100]	164 (79.23) [100]	13 (14.13) [100]	36 (17.39) [100]	2 (2.17) [100]	7 (3.38) [100]	92 (100) [100]	207 (100) [100]

Source: Primary survey

Figures in parentheses () are respective percentage of row total and in [] are respective percentage of column total.

**Table 6: Per acre Yield of Paddy and Wheat using SRI and Non-SRI and SWI and Non-SWI Method of Cultivation (in kg per acre)**

Type of farmers	SRI (1)	Non-SRI (2)	(1-2)	SWI (3)	Non-SWI (4)	(3-4)
Marginal farmers (0-2.5 acres)	1761	1207	554*	1475	993	482*
Small farmers (2.5-5 acres)	1892	1331	561*	1503	979	524*
Medium farmers (5-10 acres)	1692	1219	473**	1465	1077	388
<b>Total</b>	<b>1779</b>	<b>1233</b>	<b>546*</b>	<b>1479</b>	<b>993</b>	<b>486*</b>

Source: Primary survey

\*Represents 1 percent level of significance

\*\* Represents 5 percent level of significance

Table 7 shows the total value of output produced using the traditional and SRI (SWI) method. The value of output of paddy and wheat produced using the SRI (SWI) method of cultivation is much higher.

**Table 7: Total Value of Output of SRI, Non-SRI, SWI and Non-SWI Paddy and Wheat**

Type of farmers	Total value of output of SRI paddy (in Rs.)	Total value of output of Non-SRI paddy (in Rs.)	Total value of output of SWI wheat (in Rs.)	Total value of output of Non-SWI wheat (in Rs.)
Marginal	27,925.22	19,784.96	25,294.56	17,096.05
Small	30,401.42	22,323.22	25,226.88	16,827.45
Medium	28,010.61	19,978.24	25,379.8	18,541.31
<b>Total</b>	<b>28,299.64</b>	<b>20,308.54</b>	<b>25,286.85</b>	<b>17,098.21</b>

Source: Primary survey

Table 8 gives the cost of cultivation of SRI and non-SRI paddy. Labour is the major cost incurred for both the methods, followed by fertiliser and irrigation although the percentage share of each input differs in the two cases. The share of cost of seed in SRI cultivation is just 1.5 percent whereas in non-SRI it is 5.4 percent. This shows that there is a decrease in use of seed in SRI method of cultivation and the result is consistent with other studies on SRI e.g. Devi and Ponnarasi (2009), Thiyagarajan (2002) and Barah (2009). The share of labour in the total cost has been 60.80 percent for cultivating paddy using SRI method whereas it was only 56.47 percent for cultivation of non-SRI paddy. The cost of irrigation is more for SRI even though the water required is less in their case. This is because the farmers who own tubewell do not pay any electricity charges and hence have almost no cost excepting the maintenance cost which is incurred occasionally (only if the motor is damaged, which is not a regular cost on annual basis) whereas farmers who hire water to irrigate the field incur heavy cost on irrigation and that is included in the irrigation cost over here.

**Table 8: Cost of Cultivation of SRI and Non-SRI Paddy**

Cost of inputs/acre	Marginal farmers		Small Farmers		Medium farmers		Total		
	SRI Paddy	Non-SRI Paddy							
Seed	203.78 (1.53)	659.01 (5.09)	183.27 (1.36)	774.14 (6.67)	186.33 (1.39)	730.85 (5.54)	200.1 (1.50)	684.19 (5.40)	
Manure	585.19 (4.39)	785 (6.06)	961.14 (7.16)	1,524.74 (13.14)	1,800.87 (13.47)	1,445.09 (10.95)	684.13 (5.12)	951.31 (7.51)	
Pesticides & weedicides	73.7 (0.55)	53.89 (0.42)	144.62 (1.08)	26.28 (0.23)	181.58 (1.36)	24.08 (0.18)	88.12 (0.66)	47.56 (0.38)	
Fertiliser	1,525.09 (11.44)	1,457.2 (11.26)	1,494.98 (11.13)	1,516.15 (13.07)	1,714.7 (12.82)	1,365.04 (10.34)	1,527.21 (11.44)	1,467.17 (11.58)	
Irrigation	1,668.64 (12.51)	1,518.96 (11.73)	769.1 (5.73)	188.14 (1.62)	585.71 (4.38)	1,458.11 (11.05)	1,495.81 (11.20)	1,245.36 (9.83)	
Hired machinery	1,198.43 (8.99)	1,149.92 (8.88)	1,490.87 (11.10)	973.59 (8.39)	1,050.77 (7.86)	1,484.53 (11.25)	1,237.13 (9.27)	1,121.46 (8.85)	
Labour	Hired	1,277.29 (9.58)	2,311.23 (17.86)	4,443.85 (33.09)	4,451.08 (38.37)	6,164.77 (46.11)	3,294.37 (24.97)	1,923.34 (14.41)	2,771.27 (21.86)
	Family	6,801.48 (51.01)	5,008.74 (38.70)	3,943.31 (29.36)	2,145.52 (18.50)	1,685.64 (12.61)	3,393.81 (25.72)	6,193.7 (46.40)	4,386.38 (34.61)
	Total	8,078.78 (60.59)	7,319.97 (56.55)	8,387.17 (62.45)	6,596.61 (56.87)	7,850.41 (58.71)	6,681.18 (50.63)	8,117.04 (60.80)	7,157.65 (56.47)
Total	13,333.6 (100)	12,943.95 (100)	13,431.14 (100)	11,599.64 (100)	13,370.37 (100)	13,195.88 (100)	13,349.54 (100)	12,674.7 (100)	

Source: Primary survey

Figures in parentheses are respective percentage of column total

**Table 9: Profit Earned by SRI and Non-SRI Method of Cultivation (in Rs.)**

Particulars	Marginal farmers			Small farmers			Medium farmers			Total farmers		
	SRI paddy (1)	Non-SRI paddy (2)	(1-2)	SRI paddy (3)	Non-SRI paddy (4)	(3-4)	SRI paddy (5)	Non-SRI paddy (6)	(5-6)	SRI paddy (7)	Non-SRI paddy (8)	(7-8)
Revenue	27,925	19,785	8,140*	30,401	22,323	8,078*	28,011	19,978	8,032**	28,300	20,309	7,991*
Cost	13,334	12,944	390	13,431	11,600	1,832	13,370	13,196	174	13,350	12,675	675
Profit	14,592	6,841	7,750*	16,970	10,724	6,247*	14,640	6,782	7,857** *	14,950	7,634	7,316**

Source: Primary Survey

\*Represents 1 percent level of significance

\*\*Represents 5 percent level of significance

\*\*\*Represents 10 percent level of significance

It is clear from Table 9 that farmers cultivating paddy using SRI method are earning more profit although the cost of cultivation is slightly higher for SRI farmers, thereby higher profits are on account of higher yield from SRI method compared to conventional method. In order to see if the difference in revenue, cost of cultivation and profit earned from the two methods was significant, we used t-test. The results of the t-test show that in case of revenue and profit the difference were significant at 1, 5 and 10 percent level (see Table 9). For example, the difference in revenue earned by SRI and Non-SRI method was Rs. 8140 for marginal farmers and was significant at 1 percent level, in case of small and total (aggregate) farmers also, same trend can be seen, but in case of medium farmers the level of significance was 5 percent. Similarly, for difference in profit earned by the two methods of cultivation also we can see that the difference is significant at 1 percent level for marginal and small farmers, 10 percent level for medium farmers and for total farmers it is significant at 5 percent level.

**Table 10: Cost of cultivation of SWI and non-SWI wheat**

Cost of inputs/acre	Marginal farmers		Small Farmers		Medium farmers		Total		
	SWI wheat	Non-SWI wheat							
Seed	322.73 (2.76)	1741 (20.62)	257.96 (2.65)	1627 (22.27)	331.08 (4.56)	1847 (25.66)	313.76 (2.77)	1725 (21.03)	
Manure	444.33 (3.80)	140.09 (1.66)	239.32 (2.46)	151.13 (2.07)	0	0	405.7 (3.59)	137.28 (1.67)	
Pesticides & weedicides	57.86 (0.50)	7.81 (0.09)	16.3 (0.17)	3.55 (0.05)	0	0	50.73 (0.45)	6.81 (0.08)	
Fertiliser	1,476.36 (12.64)	1,511.3 (17.90)	1,584.62 (16.29)	1,480.34 (20.26)	1,540.54 (21.22)	1,567.03 (21.77)	1,493.05 (13.20)	1,507.8 (18.38)	
Irrigation	1,019.47 (8.73)	724.88 (8.59)	629.99 (6.48)	244.89 (3.35)	210.53 (2.90)	421.71 (5.86)	946.85 (8.37)	631.15 (7.69)	
Hired machinery	1,272.48 (10.89)	1,039.1 (12.31)	1,329.03 (13.66)	960.71 (13.15)	202.7 (2.79)	918.34 (12.76)	1,257.22 (11.12)	1,021.38 (12.45)	
Labour	Hired	1,710.08 (14.64)	824.65 (9.77)	2,215.6 (22.78)	2,320.96 (31.76)	3,789.62 (52.21)	1,943.31 (27.00)	1,826.72 (16.15)	1,122.7 (13.69)
	Family	5,376.68 (46.03)	2,452.97 (29.06)	3,455.25 (35.52)	518.58 (7.10)	1,184.21 (16.31)	499.97 (6.95)	5,014.04 (44.34)	2,050.51 (25.00)
	Total	7,086.76 (60.67)	3,277.62 (38.83)	5,670.86 (58.29)	2,839.53 (38.86)	4,973.83 (68.52)	2,443.28 (33.95)	6,840.75 (60.49)	3,173.21 (38.69)
Total	11,679.99 (100)	8,441.8 (100)	9,728.07 (100)	7,307.16 (100)	7,258.68 (100)	7,197.36 (100)	11,308.0 7 (100)	8,202.63 (100)	

Source: Primary Survey

Figures in parentheses are respective percentage of column total

Similarly, for SWI cultivation also, we can say that the yield rate as well as value of output produced is much higher in comparison to non-SWI method. In case of SWI cultivation, labour is the major cost incurred followed by fertiliser and hired machinery. For non-SWI cultivation also, labour is the major cost followed by seed and fertiliser cost (see Table 10). The percentage share of labour cost in SWI method is around 60 percent, but in case of non-SWI method it is only 38 percent. The cost of seed is only 3 percent for SWI method whereas for non-SWI method it is around 22 percent, this shows that there is a marked decline in the use of seed in SWI method. This is mainly because in SWI method

one needs to sow one or two seed at 20-25 cm, but the non-SWI cultivation makes use of broadcasting method at the time of sowing leading to increase in seed requirement. This result is consistent with the results of Kadhka and Raut (2012).

**Table 11: Profit earned using SWI and Non-SWI method of cultivation (in Rs.)**

Particulars	Marginal farmers			Small farmers			Medium farmers			Total farmers		
	SWI wheat (1)	Non-SWI Wheat (2)	(1-2)	SWI wheat (3)	Non-SWI Wheat (4)	(3-4)	SWI wheat (5)	Non-SWI Wheat (6)	(5-6)	SWI wheat (7)	Non-SWI Wheat (8)	(7-8)
Revenue	25295	17096	8198*	25,227	16,827	8,399*	25,380	18,541	6,838	25,287	17,098	8,189*
Cost	11680	8442	3238*	9,728	7,307	2,420*	7,259	7,197	61	11,308	8,203	3,105*
Profit	13615	8654	4960*	15,499	9,520	5,978*	18,121	11,344	6,777	13,979	8,896	5,083*

Source: Primary Survey

\*Represents 1 percent level of significance

Though the cost of cultivation is slightly more in SWI method, the returns earned from SWI method are much more than the non-SWI method due to increase in output (see Table 11). For wheat also, it was checked if the difference in revenue, cost and profit from the two methods were significant. The results of the study show that for marginal and small farmers, the differences for all the three cases (revenue, cost and profit) were significant at 1 percent level. In case of medium farmers, the number of adopters were just two and so it was difficult to calculate the significance test. Considering all the farmers together, the difference was significant at 1 percent level for revenue, cost of cultivation and profit earned (see Table 11). Hence, from the above discussion we can conclude that both SRI and SWI method fetch more profit to farmers as compared to conventional method of cultivation.

## Second Part

After this brief discussion on number of adopters and non-adopters of SRI and SWI and their household characteristics, output and cost of cultivation, let us now look at the results of the logistic regression for both SRI as well as SWI explaining determinants of adoption. Table 12 given below shows the result of the logistic regression. The variable of age was significant at 10 percent level whereas variables of physical productivity and hours of irrigation were significant at 1 percent level. These variables were perfectly predicted in models where Hosmer and Lemeshow chi-square was 0.747 at 8 d.f. and 0.98 level of significance (see Appendix 1). The -2 log likelihood was 47.104, Cox and Snell  $R^2$  was 0.66 and Nagelkerke  $R^2$  was 0.93 and the overall percentage of right prediction was 97.6 percent (see Appendix 2 and 3).

**Table 12: Factors Affecting the Adoption of SRI in the Study Area**

	<b>B</b>	<b>S.E.</b>	<b>Sig.</b>	<b>Exp(B)</b>
GEN(1)	-.967	2.156	.654	.380
OBC(1)	1.443	1.017	.156	4.232
AGE	-.070	.040	.078	.932
NOERHH	.380	.488	.436	1.462
ILLT(1)	.138	1.387	.921	1.148
SECED(1)	.953	1.313	.468	2.595
NETOPAC	-.618	.478	.196	.539
MNOCCP(1)	-1.549	1.017	.127	.212
PHPRODOC	1.157	.256	.000	3.181
FAMLBAC	.035	.024	.146	1.035
HRIRRIGNAC	-1.260	.295	.000	.284
CONSTANT	54.485	14.737	.000	4.595E+23

As hypothesised the variable physical productivity of paddy per acre has a positive and significant effect on adoption of SRI method of cultivation. This means that the increase in output of paddy is one of the main factors for adoption of SRI method of cultivation. Looking at the odds ratio (Exp (B)) value in the table, we can say that, with one-unit increase in output of paddy, the chances of adoption of SRI method of cultivation increases by 3 times. Variables, viz., hours of irrigation and age have a significant effect on the adoption of SRI method of cultivation while their  $\beta$  coefficient is negative. This result clearly indicates that the water requirement for cultivating rice is less in case of SRI method of cultivation and the reduction in cost of irrigation due to decline in requirement of water is one of the main factors affecting the adoption of this method of cultivation. In the case of age, we can say that young farmers are more willing to adopt the new method of cultivation in comparison to the old ones. This result is consistent with other studies on technology adoption, e.g. Arellanes and Lee (2003), Karki (2010) and Thangata and Alavalapati (2003). The reason for this could be that younger farmers are willing to take risk and that they have a longer planning horizons (Thangata and Alavalapati, 2003).

However, the variables, viz., family labour per acre, net operated area, number of earners in the household, agriculture as the main occupation and education did not have a significant effect on adoption of SRI method of cultivation. The reason for non-significance of family labour per acre could be the substitutability of family labour with hired labour, as at the aggregate, total labour use between the SRI and non-SRI was found not significantly different (Table 8). The  $\beta$  coefficient for net operated area (in acres) and main occupation was negative and insignificant. This means that farmers are still sceptical about this method of cultivation and are not willing to put a large portion of land under it. Also, farmers whose main occupation is agriculture, are less willing to go for SRI method of cultivation as it is a new method for them and they are less willing to take risk. The reason for non-significance of education could be that SRI method of cultivation is simple and does not require any formal education

and with little training the farmers can master the skill, also well-educated people are more interested in non-farm employment (Karki, 2010).

**Table 13: Factors affecting the adoption of SWI method of cultivation**

	B	S.E.	Sig.	Exp(B)
NETOPAC	.403	.327	.218	1.496
GEN(1)	1.382	1.916	.471	3.982
OBC(1)	-.815	.867	.347	.443
NERHH	-.308	.421	.464	.735
MNOCCP(1)	-1.586	1.048	.130	.205
ILLT(1)	-.758	1.264	.549	.469
SECED(1)	.559	1.287	.664	1.750
IHRIRRIGNAC	-.669	.194	.001	.512
PHPRODOC	1.795	.374	.000	6.021
FAMLBAC	.163	.038	.000	1.177
AGE	.027	.034	.422	1.027
CONSTANT	-12.931	6.113	.034	.000

The results of the logit model for understanding the factors affecting the adoption of SWI method of cultivation observed mainly three main determinants, namely, hours of irrigation, physical productivity and family labour per acre significant at 1 percent influencing the adoption of SWI method of cultivation (see Table 13). These variables were found significant in the model where Hosmer and Lemeshow chi-square was 1.11 at 8 d.f. and 0.97 level of significance (see Appendix 4). The -2 log likelihood was 54.79, Cox and Snell  $R^2$  was 0.65, Nagelkerke  $R^2$  was 0.92 and overall percentage of right prediction was 95.3 percent (see Appendix 5 and 6).

As hypothesised, output per acre and family labour per acre has a positive and significant effect on SWI method of cultivation. The odds ratio (Exp (B)) for output per acre shows that with one unit increase in output of wheat using SWI method of cultivation its adoption was more likely to increase by six times. Since land is limited, increase in output due to the new method of cultivation without much increase in expense, will attract farmers to adopt SWI method of cultivation. Similarly, for family labour per acre for one unit increase in family labour, the adoption of SWI method was more likely to increase 1.1 times. This is because, SWI requires much more labour in comparison to the traditional broadcasting method of sowing wheat. And, with more family labour being available the cost of production is reduced which is an incentive to adopt SWI method of cultivation. Irrigation per acre here also has a negative sign, which means with increase in requirement of irrigation the rate of adoption will decline. This is because it will increase the cost of cultivation which will demotivate the household to adopt SWI method of cultivation.

The variables, viz., education, number of earners in the family, age, agriculture as the main occupation and caste did not significantly affect the adoption of SWI method of cultivation. Looking at

Table 13 we can say that the  $\beta$  coefficient for main occupation as agriculture and number of earners per household was negative and insignificant. The reason being that SWI method of cultivation is new to the farmers and due to the high amount of labour involved not many people are willing to invest in it as labour is not easily available. With household, which have more members earning outside agriculture, the labour for agriculture declines and hiring labour for SWI increases the cost of cultivation. The introduction of seed drill machine can be a huge incentive for people who are not adopting SWI method as this will not increase their cost of labour and the increased yield from wheat will help them reap good returns. The variable on education also did not have a significant effect, the reason being similar as in the case of SRI. The variable caste also did not have a significant effect on the adoption of SWI method of cultivation as there was not much difference in the caste of adopters and non-adopters as can be seen in Table 5.

### **Summary and Conclusion**

From the above discussion it can be clearly seen that both SRI and SWI method of cultivation lead to around 48-50 percent increase in output of paddy and wheat in comparison to the traditional method. Although the cost of cultivation is slightly high in case of both SRI and SWI methods, the profit earned is higher due to the increase in yield, showing that SRI and SWI methods are beneficial for the farmers, especially for those who have cheap and easy labour available. The variables physical productivity and hours of irrigation per acre have a significant effect on adoption of both SRI and SWI method of cultivation. This means, that one of the main reasons for adoption of SRI and SWI method of cultivation is the increase in yield of paddy and wheat. The variable age was found to be significant for SRI adoption showing that young farmers are ready to take risk by investing in new method of cultivation. The variable family labour per acre was found significant for adoption of SWI method of cultivation, showing the labour-intensive nature of SWI method and with cheap labour available at home the cost of cultivation decreases. The other variables like net operated area, caste, agriculture as main occupation, number of earners in the family and education were found non-significant in both SRI and SWI method. The reason for non-significance of net operated area could be that these methods are still quite new to the farmers and most of them have adopted it in less than 40 percent of the area under paddy and wheat cultivation. For education being non-significant one can say that these methods of cultivation are not much different from the traditional method and does not require any technical knowledge, while with little training the farmers can master the skills required for it.

### **Policy Recommendation**

Since both SRI and SWI methods of cultivation have a potential to increase yield of paddy and wheat, respectively to a great extent, its promotion will be highly beneficial for the farmers. Also, both the methods are scale neutral and with states like Bihar, which have more than 90 percent farmers under the marginal category, it will be highly-beneficial to farmers to adopt this method of cultivation. The government needs to organise proper training programmes for the farmers to demonstrate the technique of crop intensification through extension workers. In order to reduce the use of labour, which

is dear at the time of cropping season, the government needs to introduce low-cost seed drills, which will also reduce the cost of labour and hence the cost of cultivation.

## References

- Adesina, A A and Moses M Zinnah (1993). Technology Characteristics, Farmers' Perceptions and Adoption Decisions: A Tobit Model Application in Sierra Leone. *Agricultural Economics*, 9 (4): 2971-311.
- Arellanes, P and David R Lee (2003). The Determinants of Adoption of Sustainable Agriculture Technologies: Evidence from the Hillsides of Honduras. Proceedings of the 25<sup>th</sup> International Conference of Agricultural Economics (IAAE). Pp 639-699.
- Adusumilli, Ravindra and S BhagyaLaxmi (2010). Potential of the System of Rice Intensification for Systemic Improvement in Rice Production and Water Use: The Case of Andhra Pradesh, India. *Paddy Water Environ.* Technical Report.
- Barah, B C (2009). Economic and Ecological Benefits of System of Rice Intensification (SRI) in Tamil Nadu. *Agricultural Economics Research Review*, 22 (July-December): 2009-214.
- Bouman, Bas (2012). What is the System of Rice Intensification (SRI) and Where is it Going?. <http://irri.org/news-events/hot-topics/system-of-rice-intensification-sri>; April.
- De Laulanie, H (2011). Intensive Rice Farming in Madagascar. English translation of the 1983 publication. *Triculture* 29 (3): 183-87.
- Devi, Sita K and T Ponnarasi (2009). An Economic Analysis of Modern Rice Production Technology and its Adoption Behaviour in Tamil Nadu. *Agricultural Economics Research Review*, 22 (Conference number): 341-47.
- Economic Survey, Govt. of Bihar (2016-17). <http://finance.bih.nic.in/Reports/Economic-Survey-2017-EN.pdf>.
- Feder, G, R Just and D Zilberman (1985). Adoption of Agricultural Innovation in Developing Countries: A Survey. *Economic Development and Cultural Change*, 33 (2): 255-98.
- Gujarati, D N and Sangeetha (2007). *Basic Econometrics*, Fourth Edition. New Delhi: Tata McGraw-Hill Publishing company limited.
- Khadka, Ram Bahadur and Prashant Raut (2012). System of Wheat Intensification (SWI): A Concept on Low Input Technology for Increasing Wheat Yield in Marginal Land. A report for European Union Food Facility project and Safety Nets supporting Agricultural Productivity (SNAP).
- Karki, Sudeep (2010). System of Rice Intensification: An Analysis of Adoption and Potential Environmental Benefits. <https://brage.bibsys.no/xmlui/handle/11250/187733>.
- Kishore, Avinash (2004). Understanding Agrarian Impasse in Bihar. *Economic and Political Weekly*, 39 (31): 3484-91.
- Kumar, Parmod and Sandip Sarkar (2012). *Economic Reforms and Small Farms: Implications for Production, /marketing and Employment*. New Delhi: Academic Foundation.
- Namara, R E, W Parikara and B Randolph (2003). *Prospects for Adopting System of Rice Intensification in Sri Lanka: A Socioeconomic Assessment*. Research report 75. Colombo, Sri Lanka: International Water Management Institute.

- Palanisami, K, K R Karunakaran and Upali Amarasinghe (2012). Impact of System of Rice Intensification (SRI): Analysis of SRI practices in 13 States of India. *Water Policy Research Highlight*. IWMI-TATA Water Policy Program.
- Rakib, R S, Najrul Islam and Md Abdul Kader (2016). Performance of Wheat with System of Wheat Intensification (SWI) using Different Nutrient Management and Plant Spacing. *International Journal of Natural and Social Sciences*, 3 (3): 40-47.
- Rogers Everett, M (1985). *Diffusion of Innovation*. Third edition. The free press, New York. Available at <https://teddykw2.files.wordpress.com/2012/07/everett-m-rogers-diffusion-of-innovations.pdf>. Accessed on 6 June 2018.
- Straub, T Evan (2009). Understanding Technology Adoption: Theory and Future Directions for Informal Learning. *Review of Educational Research*, 79 (2): 625-49.
- Takashi, Kazushi and Christopher B Barrett (2014). The System of Rice Intensification and Its Impact on Household Income and Child Schooling: Evidence from Rural Indonesia. *American Journal of Agricultural Economics*, 96 (1): 269-289.
- Thangata, P H and J R R Alavalapati (1996). *Adoption of Agroforestry Practices in Malawi: A Case Study of Gliricidia Sepium and Maize*. Gainesville: School of Forest and Resources Conservation, University of Florida..
- Thiyagarajan, T M (2002). *Experiments with a Modified System of Rice Intensification in India*. Tamil Nadu Agriculture University. [http://sri.ciifad.cornell.edu/proc1/sri\\_30.pdf](http://sri.ciifad.cornell.edu/proc1/sri_30.pdf).
- Uphoff, N (1999). Agroecological Implications of the System of Rice Intensification (SRI) in Madagascar. *Environment, Development and Sustainability*, 1: 3-4.
- WWF-ICRISAT Project (2006). Realise Full Potential of Paddy Plant: SRI Method of Paddy Cultivation. November, WASSAN publication, Secunderabad, India.

## Appendix

**Appendix 1: Hosmer and Lemeshow test for SRI adoption and non-adoption**

Step	Chi-square	df	Sig.
1	0.747	8	0.98

**Appendix 2: Model summary for determinants of SRI adopters and non-adopters**

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	47.104 <sup>a</sup>	.66	.93

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

**Appendix 3: Classification table with variables for SRI adopters and non-adopters Classification Table<sup>a</sup>**

Observed			Predicted		
			Adopters_and_nonadopters		Percentage Correct
			.00	1.00	
Step 1	Adopters_and_non-adopters	.00	85	3	96.6
		1.00	4	196	98.0
	Overall Percentage				

a. The cut value is .500

**Appendix 4: Hosmer and Lemeshow Test for SWI adopters and non-adopters**

Step	Chi-square	df	Sig.
1	1.105	8	0.97

**Appendix 5: Model summary for determinants of SWI adopters and non-adopters**

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	54.795 <sup>a</sup>	.65	0.92

a. Estimation terminated at iteration number 10 because parameter estimates changed by less than .001.

**Appendix 6: Classification table with variables for SRI adopters and non-adopters Classification Table<sup>a</sup>**

Observed			Predicted		
			Adopter_and_nonadopters		Percentage Correct
			.00	1.00	
Step 1	Adopter_and_non-adopters	.00	200	7	96.6
		1.00	7	85	92.4
	Overall Percentage				

a. The cut value is .500

## Recent Working Papers

- 371 **Migration from North-Eastern Region to Bangalore: Level and Trend Analysis**  
Marchang Reimeingam
- 372 **Analysis of Revealed Comparative Advantage in Export of India's Agricultural Products**  
Subhash Jagdambe
- 373 **Marital Disharmony among Working Couples in Urban India – A Sociological Inquiry**  
Shiju Joseph and Anand Inbanathan
- 374 **MGNREGA Job Sustainability and Poverty in Sikkim**  
Marchang Reimeingam
- 375 **Quantifying the Effect of Non-Tariff Measures and Food Safety Standards on India's Fish and Fishery Products' Exports**  
Veena Renjini K K
- 376 **PPP Infrastructure Finance: An Empirical Evidence from India**  
Nagesha G and K Gayithri
- 377 **Contributory Pension Schemes for the Poor: Issues and Ways Forward**  
D Rajasekhar, Santosh Kesavan and R Manjula
- 378 **Federalism and the Formation of States in India**  
Susant Kumar Naik and V Anil Kumar
- 379 **III-Health Experience of Women: A Gender Perspective**  
Annapuranam Karuppannan
- 380 **The Political Historiography of Modern Gujarat**  
Tannen Neil Lincoln
- 381 **Growth Effects of Economic Globalization: A Cross-Country Analysis**  
Sovna Mohanty
- 382 **Trade Potential of the Fishery Sector: Evidence from India**  
Veena Renjini K K
- 383 **Toilet Access among the Urban Poor – Challenges and Concerns in Bengaluru City Slums**  
S Manasi and N Latha
- 384 **Usage of Land and Labour under Shifting Cultivation in Manipur**  
Marchang Reimeingam
- 385 **State Intervention: A Gift or Threat to India's Sugarcane Sector?**  
Abnave Vikas B and M Devendra Babu
- 386 **Structural Change and Labour Productivity Growth in India: Role of Informal Workers**  
Rosa Abraham
- 387 **Electricity Consumption and Economic Growth in Karnataka**  
Laxmi Rajkumari and K Gayithri
- 388 **Augmenting Small Farmers' Income through Rural Non-farm Sector: Role of Information and Institutions**  
Meenakshi Rajeev and Manojit Bhattacharjee
- 389 **Livelihoods, Conservation and Forest Rights Act in a National Park: An Oxymoron?**  
Subhashree Banerjee and Syed Ajmal Pasha
- 390 **Womanhood Beyond Motherhood: Exploring Experiences of Voluntary Childless Women**  
Chandni Bhambhani and Anand Inbanathan
- 391 **Economic Globalization and Income Inequality: Cross-country Empirical Evidence**  
Sovna Mohanty
- 392 **Cultural Dimension of Women's Health across Social Groups in Chennai**  
Annapuranam K and Anand Inbanathan
- 393 **Earnings and Investment Differentials between Migrants and Natives: A Study of Street Vendors in Bengaluru City**  
Channamma Kambara and Indrajit Bairagya
- 394 **'Caste' Among Muslims: Ethnographic Account from a Karnataka Village**  
Sobin George and Shrinidhi Adiga
- 395 **Is Decentralisation Promoting or Hindering the Effective Implementation of MGNREGS? The Evidence from Karnataka**  
D Rajasekhar, Salim Lakha and R Manjula
- 396 **Efficiency of Indian Fertilizer Firms: A Stochastic Frontier Approach**  
Soumita Khan
- 397 **Politics in the State of Telangana: Identity, Representation and Democracy**  
Anil Kumar Vaddiraju
- 398 **India's Plantation Labour Act - A Critique**  
Malini L Tantri
- 399 **Federalism and the Formation of States in India: Some Evidence from Hyderabad-Karnataka Region and Telangana State**  
Susant Kumar Naik
- 400 **Locating Armed Forces (Special Powers) Act, 1958 in the Federal Structure: An Analysis of Its Application in Manipur and Tripura**  
Rajiv Tewari
- 401 **Performance of Power Sector in Karnataka in the Context of Power Sector Reforms**  
Laxmi Rajkumari and K Gayithri
- 402 **Are Elections to Grama Panchayats Party-less? The Evidence from Karnataka**  
D Rajasekhar, M Devendra Babu and R Manjula
- 403 **Hannah Arendt and Modernity: Revisiting the Work *The Human Condition***  
Anil Kumar Vaddiraju
- 404 **From E-Governance to Digitisation: Some Reflections and Concerns**  
Anil Kumar Vaddiraju and S Manasi
- 405 **Understanding the Disparity in Financial Inclusion across Indian States: A Comprehensive Index for the Period 1984 – 2016**  
Shika Saravanabhavan
- 406 **Gender Relations in the Context of Women's Health in Chennai**  
Annapuranam K and Anand Inbanathan

- 407 **Value of Statistical Life in India: A Hedonic Wage Approach**  
Agamoni Majumder and S Madheswaran
- 408 **World Bank's Reformed Model of Development in Karnataka**  
Amitabha Sarkar
- 409 **Environmental Fiscal Instruments: A Few International Experiences**  
Rajat Verma and K Gayithri
- 410 **An Evaluation of Input-specific Technical Efficiency of Indian Fertilizer Firms**  
Soumita Khan
- 411 **Mapping Institutions for Assessing Groundwater Scenario in West Bengal, India**  
Madhavi Marwah
- 412 **Participation of Rural Households in Farm, Non-Farm and Pluri-Activity: Evidence from India**  
S Subramanian
- 413 **Inequalities in Health Outcomes: Evidence from NSS Data**  
Anushree K N and S Madheswaran
- 414 **Urban Household Enterprises and Lack of Access to Production Loans**  
Shika Saravanabhavan and Meenakshi Rajeev
- 415 **Economic and Social Benefits of SHG-Bank Linkage Programme in Karnataka**  
Meenakshi Rajeev, B P Vani and Veerashekharappa
- 416 **Two Decades of Fiscal Decentralization Reforms In Karnataka: Opportunities, Issues and Challenges**  
M Devendra Babu, Farah Zahir, Rajesh Khanna and Prakash M Philip
- 417 **Karnataka State Budgets - How Far Have They Promoted Inclusiveness?**  
K Gayithri and Vijeth Acharya
- 418 **Caste Discrimination Practices in Rural Karnataka**  
I Maruthi and Pesala Peter
- 419 **Food Security in Brics - Current Status and Issues**  
Malini L Tantri and Kumar Shaurav
- 420 **Impact of Age Structure Transition on Current Account Balance for India: An Empirical Analysis**  
Aneesha Chitgupi
- 421 **Market Value and Capital Structure: A Study of Indian Manufacturing Firms**  
Dhananjaya K and Krishna Raj
- 422 **Inequity in Outpatient Healthcare Use and Utilization of Public Healthcare Facilities: Empirical Evidence from NSS Data**  
Anushree K N and S Madheswaran
- 423 **Role of Worker's Compensation Benefit in Estimating Value of Statistical Life**  
Agamoni Majumder and S Madheswaran
- 424 **Making Every Drop Count – Micro-Level Water Demand Accounting Challenges and Way Forward**  
Chaya Ravishankar, Sunil Nautiyal and S Manasi
- 425 **Conceptualizing Peri-Urban-Rural Landscape Change for Sustainable Management**  
Mrinalini Goswami
- 426 **Social Entrepreneurship: A Business Model for Sustainable Development**  
Neeti Singh and Anand Inbanathan
- 427 **Revenue-Based Business Model to Growth-Based Business Model: A Critical Review of Indian Pharmaceutical Industry**  
P Omkar Nadh
- 428 **Role of Social Entrepreneurship in the Quality of Life of Its Beneficiaries**  
Neeti Singh and Anand Inbanathan
- 429 **Land Alienation in Tripura: A Socio-Historical Analysis**  
Rajiv Tewari
- 430 **The Indian Mining Industry: Present Status, Challenges and the Way Forward**  
Meenakshi Parida and S Madheswaran
- 431 **Impact of Irrigating with Arsenic Contaminated Water on Farmers' Incomes in West Bengal**  
Madhavi Marwah Malhotra
- 432 **Macroeconomic Determinants of Software Services Exports and Impact on External Stabilisation for India: An Empirical Analysis**  
Aneesha Chitgupi
- 433 **Fiscal Dependency of States in India**  
Darshini J S and K Gayithri

Price: ₹ 30.00

ISBN 978-81-7791-290-6



## INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE

(ISEC is an ICSSR Research Institute, Government of India and the Grant-in-Aid Institute, Government of Karnataka)

Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India

Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008

E-mail: manjunath@isec.ac.in; Web: www.isec.ac.in