Research article

Impact Assessment of System of Rice Intensification Adoption - Case from Madagascar -

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Abstract The System of Rice Intensification (SRI) is expected to improve rice yield with minimal impact on harming environment. While many studies have confirmed that the yield increases with adopting SRI by field surveys, the impact of SRI on household income is still debatable because SRI is a labor demanding method and may cause labor redistribution within a household. This study assesses the impact of SRI on the yield, household income, expenditure and caloric consumption in Madagascar, taking into account the endogeneity between farmer's capacity and adapting technologies. The authors collect the data for small-scale rice producing households in Alaotra-Mangoro region on Madagascar central highland in 2014 and 2017 by a face-to-face questionnaire survey. The authors find that the adoption of at least one component of SRI has no significant impact on the rice yield, income, expenditure and caloric consumption of households on average compared with them that adopt none of the SRI components, taking account of the endogeneity of technology adoption. This study applies Propensity Score Matching (PSM) to take account of the endogeneity. Then, comparing mean variables with using fertilizer by using PSM, the authors confirm the positive impact on yield by plot level. However, because households can't adopt both SRI and the use of fertilizers for all plots, no significant difference is observed in household income and expenditure. The findings suggest that a combination of SRI with fertilizer inputs may increase yield significantly, if more farmers in the area start using fertilizers in the future. Provision of technical SRI training alongside sales of fertilizers is crucial. However, it is needed to conduct further research in our study site to explore the impact on the household adopted all four of the SRI components which is more effective, and long-term effects of SRI.

Keywords system of rice intensification (SRI), Madagascar, propensity score matching (PSM), impact assessment, technology adoption, small-scale rice farmers

INTRODUCTION

Sustainable agriculture that reduces environmental load and increases food production has been attracting attention in recent years. System of Rice Intensification (SRI) is one of such a sustainable agriculture that has been drawing attention. This study focuses on the impact brought about by the use of SRI in the Republic of Madagascar, the birthplace of SRI.

Madagascar is in Sub-Saharan Africa where population is growing rapidly, and is a major producer of rice, its staple food. While most of its citizens engage in agricultural activities, the country suffers from low rice productivity and depends on imports for approximately 10% of its consumption. Poverty rate in rural areas is quite high at 78%. Improved rice productivity is considered to be a contributing factor towards poverty reduction in Madagascar.

SRI is a rice cultivation method developed in 1993 by Father Laulanié and is based on his observations of local farming methods as well as his own cultivation experiments (Stoop et al., 2002). SRI is practiced in many countries, particularly developing countries, thanks to dissemination activities led by Norman Uphoff and others.

SRI is not a single package but rather a system that combines principles for transplantation as well as soil and water management, does not require fertilizers and other exogenous inputs, and is expected to promote tillering in rice plants and increase yield. The following four practices are considered to be central principles of SRI in many areas where SRI is practiced (Noltz et al., 2012):

(1) The use of young seedlings: transplanted within 15 days after germination (care must be taken to ensure roots are not damaged), (2) Single seedling transplanting: A single seedling is transplanted per hill, (3) Planting at wider spacing: planting at 20cm × 20 cm spacing, (4) Intermittent irrigation: dry the soil moderately instead of ponding at all times. However, ensure that soil remains moistened.

While income from rice cultivation due to improved productivity is expected to increase, results vary by regions in terms of the impact of SRI on household income of farmers (Berkhout et al., 2015).

In East Timor, impact of SRI is observed with endogeneity of the adoption of agricultural technology taken into account. As a result of taking endogeneity into account, SRI was found to have an effect on the yield increase, but the difference in income between farmers who adopted SRI and farmers who did not was quite small (Noltze et al., 2012). Similarly, a study that considered endogeneity in Indonesia found that SRI increased yield but did not affect the income of farmers. This was because the time previously spent by farmers to earn non-agricultural income was now being spent on the labor required for rice cultivation. (Takahashi and Barret, 2013). Another study found that SRI increases yield in areas without an irrigation facility but does not improve income (Alem, 2015).

The impact of SRI on yield varies by region. On the other hand, improved agricultural productivity affects household budget in various aspects. This includes an increased consumption at home by farmers and consumption of food with higher nutritional value due to improved income (Pandey et al., 2016). In India, one study has found that farmers who adopted SRI are purchasing insurance and consuming food with higher nutritional values (Singh et al., 2017). However, no study has assessed its impact on expenditures and consumption while taking endogeneity into account.

Madagascar is the origin of SRI, and previous studies have attempted to find a correlation between SRI and rice yield as well as identify components of SRI that are crucial in increasing the yield (Barison and Uphoff, 2011; Tsujimoto et al., 2009). Another study has investigated determining factors that leads to the adoption of SRI as well as inhibiting factors (Moser and Barrett, 2003). On-site surveys have shown that SRI is effective in improving yield compared to a conventional farming method (Barrett et al., 2004, Barison and Uphoff, 2011).

While several studies have investigated factors associated with an adoption of SRI and factors that cause an increase in yield, few studies have focused on the impact of adoption of SRI on farmers in Madagascar, and as far as the author is aware, a study on such an impact that takes endogeneity of the technical adoption into account is particularly lacking.

OBJECTIVE

The objective of this study was to estimate the impact of SRI on the improvement of productivity and livelihood of farmers in central highlands of Madagascar. Impact of SRI on the welfare of a household is elucidated through a survey on the household income of farmers as well as their expenditure and food consumption.

METHODOLOGY

Two communes, Ampitatsimo and Ilafy, located in Ambatondrazaka District in the Alaotra-Mangoro Region of Madagascar, were chosen as study sites. Irrigated area by Lake Alaotra is located 240km northeast of the capital Antananarivo at 800m above sea level, and its climate is a tropical highland climate. Rice cultivation and zebu cattle grazing have been practiced in the region since the 19th Century (Yokoyama and Sakurai, 2014). Rice production in Lake Alaotra Region is among the largest in the country and includes District PC15, one of the large-scale irrigated rice cultivation districts from the French colonial era (Fujiki, 2015). Rice cultivation period is long and lasts five to six months, and rice is usually grown once a year.

Fukuda (2015) investigated characteristics of SRI farmers in Ambatondrazaka District. Farmers in this area combined technologies per plot with respect to varieties, transplantation, and SRI. SRI was utilized in combination with the conventional practice. Risk preference also influenced the decision of technologies. Risk-loving husband were more likely to adopt SRI. On the other hand, more risk-aversive wives tended to choose conventional varieties and sort seeds.

Survey on an Introduction of SRI

A team led by Professor Sakurai of the University of Tokyo conducted a survey of Ambatondrazaka District in 2014. Survey method is discussed below (Fukuda, 2015). Ampitatsimo consists of eight villages (fokontany), and Ilafy consists of twelve villages. Average population per village was calculated by dividing the total population of the commune by the number of villages, and four villages were selected from Ampitatsimo and six from Ilafy. 40 rice farmer households were randomly selected from each village (for a total of 400 households), with whom a face-to-face questionnaire survey was conducted. The survey covered a broad range of topics including socioeconomic attributes, income, food expenditures of farmers, the use of inputs at a plot level, adoption of the technology, and yield, and it was conducted twice from May to June in 2014 and again August 2014.

Number of plots managed by farmers totaled 1,337 plots, of which 732 plots were rice paddies where rice was being cultivated. Surveyed farmers also participated in risk experiment in order to measure their risk preference.

335 households and 646 plots were used as survey data after removing missing values and outlier data. Data from farmers who could not respond during the second survey period, farmers whose responses were insufficient, and farmers whose number of cultivated plots increased between the first and second survey periods were removed.

Survey on Knowledge on SRI and Decision on Its Implementation

Additional survey was conducted in December 2017 to clarify the path of SRI dissemination and the state of its implementation. A semi-structured interview was conducted with eighteen farmer households that has partially adopted SRI components, nine households who has not adopted any SRI components from the previous survey. Additionally, the interview was conducted with two agricultural bureau staff at the surveyed district, one head of the irrigation association, and one Japanese specialist staff.

Analysis Framework and Method

Average treatment effect on the treated (ATT) is used to measure the difference of the average between SRI farmers (i.e. treated group) and non-SRI farmers (non-SRI group) (Wooldridge, 2010).

$$ATT = E(yi1|Di = 1) - E(yoi|Di = 1) \quad (1)$$

Where yi1 shows the results for treated group, and *y0i* shows the results for control group. In this study, *y* is defined as the income of an SRI farmer or a yield from an SRI plot. Additionally, *i* is the identification number assigned to each farmer. Technology is adopted when Di=1 and technology is not adopted when *Di*=0. Since *yi1* and *y0i* cannot be measured at the same time against *i-th* farmer, *E(y0i / Di=1)* is replaced with measurable data from a non-SRI farmer. Typically, a difference in farm management capability and motivation is assumed between SRI farmers and non-SRI farmers, and such a difference causes bias in the results. Propensity Score Matching (PSM) is used to address the bias from replacement (Rosenbaum and Rubin, 1983).

PSM assumes that an adoption of SRI is determined by an observable variable. If the adoption is determined by an observable variable, the following equation can be derived.

$$E(y0i|Di = 1, p(xi)) = E(y0i|Di = 0, p(xi)) \tag{2}$$

Where p(xi) shows a probability that SRI is used under observable variable x.

$$Pr\ (Di = 1|xi) \equiv p(xi) \tag{3}$$

PSM requires another assumption. Covariance of SRI farmers and non-SRI farmers need to greatly overlap. In another words, 0<*p(xi)*<1 needs to be satisfied. The following equation is derived from Equation (1).

$$ATT(psm) = E(yi|Di\ 1, p(xi)) - E(y0i|Di = 1, p(xi)) \tag{4}$$

From the above equation, the impact of SRI can be evaluated while taking endogeneity into account. However, in order to minimize the estimation error of PSM, inclusion of every variable associated with SRI adoption is recommended. If a variable that is not observed affects the adoption of SRI, a bias may exist in the ATT result as well. Methods for matching treatment group and control group includes nearest-neighbor matching, stratification matching, radius matching, and kernel matching, among others (Wooldridge, 2010). A matching method that minimizes the pseudo-coefficient of determination and error after estimation was chosen.

Factors that determine SRI adoption were analyzed in order to calculate aforementioned propensity scores. Farmers presumably combine agricultural technologies independently for each plot. Therefore, propensity scores were calculated for each plot. Logistic regression was used to calculate propensity scores.

$$Pr(Y = 1|X1, X2, \dots, Xk) = F(\beta 0 + \beta 1X1 + \cdots + \beta kXk) \tag{5}$$

Where *y* is adoption of the technology (*y*=1: SRI plot, *y*=0: others), *β0* is slices, and *xk* is variable pertaining to adoption.

Hypotheses

This study asks two research questions: "How does SRI technology affect rice yield" and "how does SRI affect farmers?".

A pair of hypotheses are validated. First, fields where SRI is implemented produce greater yields compared to non-SRI fields. Second, an increase in rice yield leads to an increase in rice income, resulting in an overall increase in income for the household of the farmer. Over the course of validating hypotheses, any changes in expenditure and personal caloric consumption are also noted even when the income of farmers who has adopted SRI has not increased.

RESULTS AND DISCUSSION

Results of Introducing SRI

For analysis, an SRI plot is defined as a plot where at least one of the components ((1) Use of young seedlings within 14 days after sowing, (2) Single seedling transplanting, (3) Transplanting by spacing of at least 20cm, (4) Intermittent irrigation) is adopted because farmer adapting all component is very few. A farmer is identified as an SRI farmer if the household practices SRI in at least one of its cultivated plots.

Table 1 The results of a comparison based on whether SRI adaptation by plot level

Variable	SRI ave.	Non-SRI ave.	Total ave.	SRI-Non-SRI diff.
Cultivated area (ha)	0.60	0.75	0.72	-0.15
Dummy for PC15	0.35	0.14	0.18	0.20***
Presence of an irrigation facility	0.58	0.64	0.63	-0.055
Dummy for land ownership	0.64	0.64	0.64	0.0018
Dummy for land fertility	0.10	0.15	0.14	-0.052
Weeding frequency	1.06	0.86	0.89	0.21***
Dummy for transplantation	0.96	0.61	0.67	0.35***
Dummy for the use of commercial varieties	0.71	0.78	0.77	-0.68
Seed usage (kg/ha)	147	158	156	-12
Total chemical fertilizer usage (kg/ha)	1.20	1.17	1.17	0.033
Total organic fertilizer usage (kg/ha)	1,149	734	810	415*
Distance to the plot (min)	24.1	40.5	37.6	-16.4**
Yield (t/ha)	2.91	2.34	2.44	0.57***
Rice productivity per person (kg/person)	19.3	28.5	26.9	-9.23
Revenue from rice (1,000Ar/ha) …A	2,120	1,703	1,777	417***
Fertilizer cost (1,000Ar/ha)	51.6	36.9	39.5	14.7
Pesticide cost (1,000Ar/ha)	6.01	4.25	4.57	1.76*
Herbicide cost (1,000Ar/ha)	6.677	6.675	6.676	0.002
Seeds cost (1,000Ar/ha)	111	103	104	8.32
Land improvement cost (1,000Ar/ha)	61.4	47.6	50.0	13.8
Hired labor cost (1,000Ar/ha)	272	172	190	100***
# non-hired laborers (man-days/ha)	289	190	207	99**
Cost of rice cultivation (1,000Ar/ha) …B	509	371	395	139***
Cost incl. non-hired labor (1,000Ar/ha) …B’	1,379	942	1,019	437***
Income from rice (1,000Ar/ha)… (C = A – B)	1,611	1,333	1,382	278*
Profit from rice (1,000Ar/ha) … (D = A - B’)	742	762	758	-20.2
Observed	112	521	633	

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Table 1 shows the results of a comparison based on whether SRI is adopted or not at a plot level. Significant differences between SRI plots and non-SRI plots were observed for presence of PC15, weeding frequency, transplantation, amount of organic fertilizer used, distance from home to plots, cost of hired labor, and number of labor days worked by non-hired laborers.

Ratio of transplantation is higher among SRI plots since three of the SRI components (excluding intermittent irrigation) are techniques related to transplantation. Intermittent irrigation requires an irrigation facility, and the ratio of intermittent irrigation and the ratio of District PC15 was greater for SRI plots. Weeding work was performed more often in SRI plots due to intermittent irrigation. Greater number of organic fertilizers used in SRI plots was due to recommendations being made towards the use of organic fertilizers at the time of SRI adaptation. Greater hired and non-hired labor in SRI plots was also consistent with previous studies, which confirmed the possibility that SRI is a more labor-intensive farming method.

Yield increased by 0.57 (t/ha) in SRI plots. At the same time, cost incurred by rice cultivation also increased. Based on the market price for Alaotra-Mangoro Region from 2014, price per kg of rice was assumed to be 728 (Ar/kg). Rice income per ha was greater in SRI plots at 10% significance level. Cost of non-hired labor was calculated by assuming the mode of hired labor cost as the employment wage within the area. Significant difference was not observed in profit calculated after including a non-hired labor cost. Significant difference was not observed for rice productivity per person (kg/person), and the adoption of SRI in the area has not improved labor efficiency. Additionally, farmers who adopted SRI were accounted for 23% of the total households, and average yield was 2.32 (t/ha).

Impact of Each Variable on the Adoption of SRI

The impact of each variable on the adoption of SRI at a plot level, calculated by using a logit model which can estimates probability to adapt the SRI. Variables that had a negative impact on the adoption of SRI were cultivated area, number of family members, female family head, distance from home to the field, and the commune in which the farmer lives. Variables that had a positive impact on the adoption of SRI were availability of irrigation, PC15 dummy, number of years of education, number of traders the farmer knows, and knowledge on intermittent irrigation.

Estimated ATT

Table 2 shows the estimated ATT. At a plot level, yield was greater in SRI plots than non-SRI plots and income, but its difference was not significant. Both hired and non-hired labor were greater in SRI plots. In particular, non-hired labor was 113 (man-days/ha), which was significantly larger at 10% significance level and showed a much greater need for labor in SRI plots. No significant differences were observed for other variables, which show that technologies other than adopted SRI (e.g. fertilizer inputs) do not make a difference between SRI and non-SRI plots. At a household level, no significant difference was observed in yield between SRI and non-SRI farmers. Income from rice and income for the entire household were greater among SRI farmers, but no significant differences were observed. Income by means other than labor was the only variable where a significant difference was observed between SRI and non-SRI farmers; SRI farmers were generating a greater amount of income through remittance and land lease. These results indicate that the adoption of SRI has not had an impact on yield and income in the area at a household level.

Table 2 Estimated results by ATT

Plot level		
Variable	ATT result (SRI plots - non-SRI plots)	Standard error
Yield (t/ha)	0.37	-0.32
Cost of rice cultivation (1,000Ar/ha)	29.2	-65
Income from rice (1,000Ar/ha)	243	-153
Profit from rice (1,000Ar/ha)	-95.4	-212
# non-hired laborers (man-days/ha)	113*	-70.0
Hired labor cost (1,000Ar/ha)	44.4	-43
Total chemical fertilizer usage (kg/ha)	-2.05	-2.48
Total organic fertilizer usage (kg/ha)	113	-338
Seed usage (kg/ha)	-9.59	-17.2
Observed	630	-
Household level		
Variable	ATT result (SRI farmers -non-SRI farmers)	Standard error
Average yield for a household (t/ha)	0.39	0.39
Household income (1,000Ar)	601	609
Income per person (1,000Ar/person)	77.8	126
Income from rice cultivation (1,000Ar)	244	472
Income from crops excl. rice (1,000Ar)	-36.9	104
Income from self-employment (1,000Ar)	-14.3	184
Non-agricultural income (1,000Ar)	-1.99	122
Income from livestock (1,000Ar)	101	87
Non-labor income (1,000Ar)	309***	130
Food expenditure (1,000Ar / week)	1.16	2,41
Total expenditure (1,000Ar/ month)	12.4	24,7
Calorie consumption per person (kcal/day)	-30.2	173.3
Observed	325	-

*Note: *** p<0.01, ** p<0.05, * p<0.1*
Plot level uses Kernel matching was used as a matching method. Bandwidth was 0.01, and resampling was iterated 900 times by bootstrap method to obtain a standard error.
Household level uses Radius matching was used as a matching method. Radius was 0.06.
Observed number is different from Table1 because some date is not suitable due to missing parameter.

Knowledge on SRI and Decision on its Implementation

Fig. 1 shows the timing in which farmers became aware of SRI, and shows components regarded as a part of SRI technology in the studied area. While there were some differences in terms of the recognized techniques that constitute SRI, all 27 farmer households interviewed knew about SRI.

Diverse timing in which farmers became aware of SRI and various paths through which SRI disseminated indicate that the word "SRI" itself is widely known in the studied area. However, institutions such as JICA and the local agricultural bureau have also disseminated other technologies, and it is quite possible that farmers confuse these technologies with SRI.

Highest number of farmers that learned about SRI was recorded in 2000, a year in which extension workers of an NGO have disseminated the SRI technology in several communes. Importance of water management was recognized in many households. Many farmers also felt the importance of using relatively innovative technologies, including the use of chemical fertilizers and pesticides and the use of a rotary weeder. While many farmers said that regular planting and row planting are important, only three respondents saw increased spacing between rows (a unique feature of SRI) as important, four saw single seedling transplanting as important, and two saw the use of young seedlings as important.

Results suggest that farmers in this area may be recognizing new technologies also as "SRI", in spite of the fact that they are not a part of the four major components that constitute SRI.

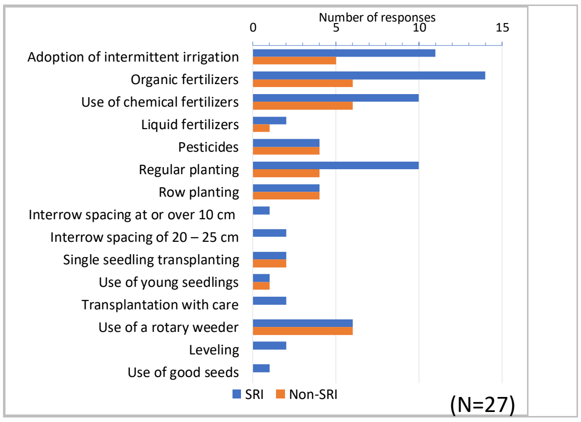

Fig. 1 Component techniques of SRI

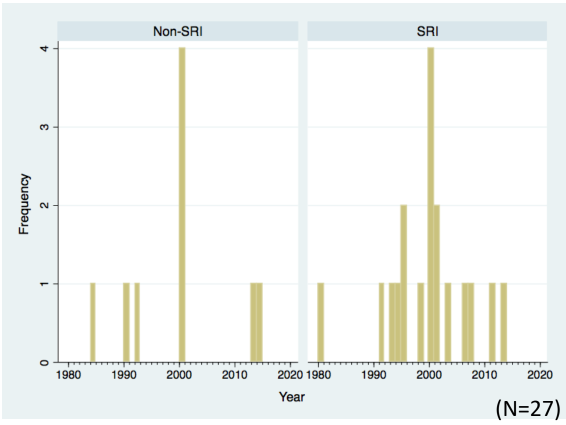

Fig. 2 Period in which farmers know about SRI

Impact of Fertilizer Inputs

Soil fertility in the studied area is low, and phosphorus deficiency is particularly evident (JICA, 2017). For this reason, widening the spacing between seedlings only widens the space and is likely to reduce yield. In the farmer's interview, some farmers indicated that farmers also viewed the relationship between land fertility and seedling spacing as important. Fertilizer inputs itself is assumed to contribute greatly to yield improvement. In addition, if seedlings are planted at wider spacing while fertilizers are applied, merits of SRI such as seed savings and an increase in the number of tillers can be expected.

Therefore, differences in yield and income due to whether fertilizer are applied or not as well as a combination of fertilizer inputs and SRI were verified using data from 2014.

Table 3 shows the results. Estimation after matching shows an increase in average yield due to fertilizer inputs. However, a significant difference in income was not observed due to an increase in fertilizer cost and hired labor cost. When fertilizer inputs were combined with SRI, yield increased by 0.61 (t/ha). While the cost of rice cultivation increased, income per ha also increased due to a significant increase in yield. However, income did not increase when non-hired labor was converted to cost due to an increase in the amount of non-hired labor. At a household level, no significant differences were observed in rice yield and thus income from rice cultivation, and no significant differences were also observed in other incomes.

Table 3 Impact of fertilizer inputs

by plot	Estimation by ATT	
Variable	Fertilizer (Fertilizer = 297)	Fertilizer + SRI (Fertilizer + SRI = 61)
Yield (t/ha)	0.37**	0.61***
Cost of rice cultivation (1,000Ar/ha)	130***	145***
Income from rice (1,000Ar/ha)	138	302**
Profit from rice (1,000Ar/ha)	53.0	66.1
Seed usage (kg/ha)	20.1*	20.1
Cost of hired labor (1,000Ar/ha)	36.7**	86.0***
# non-hired laborers (man-days/ha)	28.4	78.6*
Observed	630	630
per household	Estimation by ATT	
Variable	Fertilizer (Fertilizer = 181)	Fertilizer + SRI (Fertilizer + SRI = 50)
Household income (1,000Ar)	82.6	588
Income per person (1,000Ar/capita)	5.29	136
Income from rice cultivation (1,000Ar)	197	416
Average yield for a household (t/ha)	0.26	0.33
Income from crops excl. rice (1,000Ar)	11.0	34.0
Income from self-employment (1,000Ar)	-123	-112
Non-agricultural income (1,000Ar)	28.9	47.8
Income from livestock (1,000Ar)	0.875	91.1
Non-labor income (1,000Ar)	-31.5	111
Food expenditure (1,000Ar / 1 wk)	-0.361	-0.098
Total expenditure (1,000Ar/ month)	16.9	-16.8
Calorie consumption per person (kcal/day)	17	-37
Observed	325	325

*Note: *** p<0.01, ** p<0.05, * p<0.1*
By plot level uses radius in radius matching for fertilizer use was 0.04, and radius for fertilizer + SRI was 0.01
Per household level uses radius in radius matching for fertilizer use was 0.05, and radius for fertilizer + SRI was 0.06.

As a result, the difference in household income due to fertilizer inputs was not significant. This result was also the same for a case in which the use of fertilizers and SRI were combined. Lack of difference in yield and income at the household level may be due to the fact that the technologies were not being applied across all cultivating plots.

Comparison of average yield difference between years 2016/2017 and 2013/2014 showed a reduction in average yield for 2017 by 0.68 t/ha. This is likely due to a dearth of rainfall in 2016/2017, which led to a poor harvest for the year with a significant reduction in average yield. Weather conditions such as rainfall were not controlled, but they suggested that an increase in yield between 2014 and 2017 was unlikely.

CONCLUSION

This study investigated the impact of SRI on yield and living expense among rice farmers in two communes in Ambatondrazaka District of Madagascar. In the analysis, yield, household income, and expenditure were compared by using data obtained by on-site surveys. PSM was used to account for selection bias and compare average yield between SRI and non-SRI plots, which showed that yield was greater in SRI plots but without a significant difference. Improvement in rice income due to an adoption of SRI was not observed. While the household income was greater for SRI farmers, there were no significant differences between two groups. Differences due to SRI adoption were not observed with regards to a week's worth of food expenditure and expenditure per month by the farmer. Similarly, consumed calories were calculated based on food consumption by farmers, but no difference due to the adoption of SRI was observed.

Interview results from 2017 showed that the term "SRI" is widely known among farmers. However, details of the technology recognized by farmers varied greatly, which implied that SRI is a technology whose name is well-known, but its details are not accurately known.

Considering low soil fertility of the studied area, wider spacing between seedlings may reduce yield. On the other hand, high yield may be achieved by improving soil fertility through fertilizer inputs and adoption of SRI. Survey results from 2014 also confirmed that yield increases when SRI is combined with fertilizer inputs. In this case, cost incurred to cultivate rice increased at a plot level, but income also increased, thereby indicating the importance of combining fertilizer inputs with SRI components. Even in this case however, because households were unable to adopt both SRI and the use of fertilizers for all plots, no significant difference was observed in income from rice cultivation and household income.

In the future, a combination of SRI with fertilizer inputs may increase yield significantly, if more farmers in the area start using fertilizers. Provision of technical SRI training alongside sales of fertilizers is crucial.

Future Research

Among farmers surveyed in this study, only one household adopted all four of the SRI components. In the analysis, farmers who have adopted some of the SRI components were defined as farmers who have adopted SRI. SRI is considered to be most effective when all of the components are adopted (J-SRI, 2011). For this reason, any area nearby the site for this study where SRI is widely practiced may have adopted all components of SRI and thus increased the yield. In addition, comparison per SRI component was not possible due to the sample size, and an identification of component(s) that is important for the study site could not be conducted.

This study did not consider the number of years through which SRI is continually practiced. One study has suggested that farmers who have continued to practice SRI for a number of years are accustomed to the technology and thus able to improve their productivity (Moser and Barrett 2003). An analysis that accounts for the number of continuously practiced years would be important in measuring long-term effects of SRI.

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