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Factors Influencing Adoption of System of Rice Intensification among Smallholder Farmers in Mvomero District, Tanzania

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ABSTRACT: Adoption of the System of Rice Intensification among Smallholder Farmers (SRI) is important due to its extraordinary potential in production and productivity but there are factors which influence its adoption in different places including Tanzania. This research was conducted in Mvomero District, Morogoro, Tanzania to determine the extent of adoption of innovations in paddy production and analyzed factors influencing this adoption. A cross-sectional research design was adopted and 299 respondents were sampled using simple random technique while the Key Informants were sampled purposively. Data were collected using questionnaire and in-depth interviews. Qualitative data were analyzed using content analysis while quantitative data based on the factors influencing adoption of SRI were analyzed using a Two-limit Tobit model. It was found that Marital status, land ownership, availability of paddy markets, knowledge, age and education level had significant influence on adoption of SRI ($p<0.05$). It is concluded farmers' knowledge is an important variable in adoption of SRI and hence enhancement of paddy production and productivity. Extension workers are advised to deliver regular extension programmes to farmers to enable them adopt new paddy innovations including SRI. In this case, farmers will be well-informed about the introduced innovations to their setting.

KEYWORDS: SRI, adoption, innovation, paddy, smallholder farmer.

INTRODUCTION

Adoption of paddy innovations is important to rural farmers. It is the decision by the farmers to accept and make use of paddy innovation which is perceived beneficial towards achieving a sustainable increase in farm productivity and leading to improved well-being of respective farmers (Roggers, 2003). Adoption in this case occurs when there is a continued use of paddy innovations by farmers. The concept of innovation includes an application of advanced idea, method, farm practices and inputs which replace the conventional ones. Scholars define innovation as an idea, farming practice, and or a system that is perceived new by individuals (Rogers, 2003; Leeuwis, 2004).

In this study, SRI is defined as a set of paddy production practices which involves twelve practices namely; selection of seeds using floating-sink method, raising seedlings in nursery, transplanting seedlings of 8-15 days old, uprooting and transplanting within 15-30 minutes, keeping uprooted seedlings in moist conditions, single transplanting, transplanting at shallow depth, spacing at 25cm x 25cm, early and regular weeding, water control by alternate flooding and wetting, application of compost manure and disuse of herbicides.

Adoption of SRI is an important aspect which is anticipated to deliver positive results to the rural paddy farming community. However, a few scholarly studies in Tanzania especially the study area have been conducted in this area. Literature show that, adoption of SRI to paddy growers have the following benefits; yields per hectare increases usually by 50% to 200% or more; water requirements are reduced by 25% - 50%; cost of production is reduced by 8 % - 20%; minimal capital costs make SRI methods more accessible to poor farmers, who do not need to borrow money; the rice plants under SRI have been noted to be more robust against extreme weather events, pests, and diseases due to plant vigour and strength (Katambara *et al*., 2013).

Effort has been undertaken by the government of Tanzania (GoT) to introduce and promote paddy innovations to rural farmers including Mvomero District aiming at improving production, productivity and farmers' wellbeing. Since 2005, GoT introduced paddy innovations to farmers including rice varieties – SARO 5 (TXD 306), IR05N 221 (named *Komboka*, be liberated) and IR03A 262 (named *Tai,* eagle); best agronomic practices - SRI, water-saving irrigation technologies, rice planting techniques, Integrated

Pest Management (IPM), However, the practice shows that paddy farmers do not readily accept innovations immediately. Up to 2015, the GoT through Agricultural Sector Development Strategy (ASDP) phase one and two has been promoting better access and use of agricultural knowledge, technologies, and infrastructure to paddy farmers in 20 irrigation schemes including Mkindo and Dakawa. Similarly, extension agents have been advocating these innovations to ensure that smallholder paddy farmers take in full adoption. Despite the efforts done by the government and extension agents, factors influencing of adoption of SRI in Mvomero District is not yet established. Therefore, this study intended to analyze the factors influencing adoptions of SRI in the area of study.

This study adapts a sociological model of adoption of innovation. The model considers adoption as a learning process and that every person goes through mental steps during that learning process about innovation (Semgalawe *et al*., 1998). The process involves four stages; awareness, evaluation, trial and adoption. In awareness stage, a farmer learns about the new idea; evaluation stage involves comparison of the expected benefits of the innovation with his/her conventional ones, while in trial stage a farmer decides to try an innovation in a small plot/quantity of paddy and then use it on a larger plot/ quantity of paddy. Adoption stage involves complete application (confirmation) or otherwise discards of the innovation.

METHODOLOGY

The study used cross-sectional data to measure the extent of adopt of each innovation and analyse factors influencing adoption of selected innovations among paddy farmers in Mvomero District in Morogoro Region. Two paddy irrigation schemes in the District namely Mkindo and Dakawa were selected. These schemes are the only smallholder schemes where SRI was introduced upon its arrival to Tanzania. Cross-sectional research design was adopted whereby simple random technique was used to obtain 299 respondents from two schemes and estimated by Yamane's formula (Yamane, 1973). Proportionate sampling technique was used to obtain 96 and 203 respondents from Mkindo and Dakawa respectively. The study deployed a mixed methods approach which facilitated the deployment of both qualitative and quantitative methods in data collection. Primary data were gathered using questionnaire and in-depth key informant's interviews (KIIs). Two KIIs were conducted using checklist of questions. Analysis of qualitative data was done through content analysis in which pieces of information from the KIIs were condensed, coded and organized into different themes and compared based on study objective.

The factors influencing adoption of SRI were analyzed using a Two-limit Tobit model. Adoption of SRI was limited between 0 to 12 practices meaning (0) lower limit score and (12) upper limit score. Adoption of SRI involved 12 practices whereby a numerical score of 0 was assigned for non-adoption and 1 was assigned for adoption in each practice. The model used a limited dependent variable whereby the value of the adoption of SRI ranged between 0 and 12 scores. The model was specified as follows:

$Y^* = \beta X_1\ \varepsilon_i$……………………………………………………………………………….(1)

$\varepsilon \sim$ Normal $[0, \sigma 2]$.

Denoting Y_i as the censored observed adoption of SRI practices,

$$Y_i = \begin{cases} 0 & \text{if } Y_i^* \leq 0 \\ Y_i^* = X_i\beta_i + \varepsilon_i & \text{if } 0 < Y_i^* < 12 \\ 12 & \text{if } Y_i^* \geq 12 \end{cases} \quad \text{……………………………………………….(2)}$$

Where:

Y_i = the observed dependent variable, i.e. adoption of SRI, measured in scores upon adopted SRI practices by a farmer ranging from 0-12.

Y_i^* = the latent variable (unobserved for values smaller than 0 and greater than 12).

X_i = is a vector of independent variables (factors influencing adoption and intensity of adoption) which are described in Table 1.

β_i **=** Vector of unknown parameters.

ε_i = error terms that are assumed to be independently and normally distributed with zero mean and a constant variance σ^2, and i=1, 2…n (n is the number of observations).

$X_1 – X_{15}$-= are the predictor variables which are described in Table 1.

The coefficients in Tobit model were farther disaggregated to estimate the expected value of Y_i (Sileshi *et al*., 2012; Mc Donald and Moffit, 1980) as follows:

The change in the probability of adopting SRI practices as an independent variable χ_i changes is:

$$d\Phi(\delta)/d\chi_i = \phi(\delta)\frac{\beta_i}{\sigma} \text{..}(3)$$

The change in intensity of adoption of SRI practices with respect to a change in an explanatory variable among SRI adopters is:

$$\frac{\partial E\left(Y_i / U \rangle Y_i^* \rangle L, X\right)}{\partial X_i} = \beta_i\left(1 + \frac{\delta_L\phi(\delta_L) - \delta_U\phi(\delta_U)}{\Phi(\delta_U) - \Phi(\delta_L)} - \left[\frac{\phi(\delta_L) - \phi(\delta_U)}{\Phi(\delta_U) - \Phi(\delta_L)}\right]^2\right) \text{..................}(4)$$

Where:

χ_i = explanatory variables,

$\Phi(\delta)$ =the cumulative normal distribution

$(\delta) = \frac{\beta_i \chi_i}{\sigma}$ = the Z-scores for the area under normal curve

β_i = vector of Tobit maximum likelihood estimates

$\sigma =$ the standard error of the error term

$$\delta_L = \frac{L - \chi_i\beta}{\sigma}$$

$$\delta_U = \frac{U - \chi_i\beta}{\sigma}$$

L and U are threshold values (L=0 and U=12)

Φ and ϕ are probability density and cumulative density functions of the standard normal distribution, respectively.

Decision-making (DM) and Knowledge were the composite variables that involved procedure in measurement. DM fitted in a two-limit Tobit regression model was determined using scores whereby 3 statements representing DM were assigned scores i.e. 1 =yes and 0=otherwise and decision-making index (DMI) was developed in a range of 0 to 1 for each innovation. The formula was adapted from Meena *et al.* (2012);

$$DMIndex = \frac{TscoreObt}{Maxscore} \text{..}(6)$$

Where:

$TscoreObt =$ Total scores obtained

$Maxscore =$ Maximum expected score

Knowledge as a variable in this study involved farmers' awareness of SRI. It was determined using scores whereby statements were made to represent knowledge for SRI and assigned scores i.e. 1 =yes and 0=otherwise. There were 13 statements representing knowledge for SRI.

Table 1: Variable Definition, Unit of Measurement and Assumed Influence

Variable	Variables definition and unit of measurement	Expected sign
X_1	Sex of the paddy farmer (1 if Male, 0 if Female)	+
X_2	Age of the paddy farmer in years	+/-
X_3	Marital status of the paddy farmer (1 if married , 0 if otherwise)	+
X_4	Education of the paddy farmer in terms of years spent schooling	+/-
X_5	Household size in terms of number of people in the household	+
X_6	Labour availability (1 if available, 0 if Not)	+
X_7	Land ownership (1 if owned, 0 if otherwise)	+
X_8	Farm size for paddy production in hectares	+

X_9	Access to extension advisory (1 if yes received, 0 if not)	+
X_{10}	Access to credit facilities (1 if yes, 0 If Not)	+
X_{11}	Market availability (1 if yes, 0 if Not)	+
X_{12}	Relative advantage for adopting SRI (1 if yes, 0 if otherwise)	+
X_{13}	Total revenue per hectare per production season in 2015 in TZS	+
X_{14}	Decision making (index score in continuous from 0 to 1).	+
X_{15}	Knowledge for SRI (in scores; ranging from 0-13 scores).	+

RESULTS AND DISCUSSION

Factors Influencing Adoption of SRI

The overall results of the two-limit tobit regression indicate that adoption of SRI was influenced by marital status, land ownership, market availability, age of the respondents ($p<0.05$), education level and knowledge of SRI ($p<0.01$) (Table 2).

The results indicates significant association between marital status and adoption of SRI practices at $p<0.05$ significance level (Table 2). The chance of adoption of SRI increased for married farmers as compared to unmarried farmers. Further, it was found out that a probability for the marital status is 2.21 and unconditional expected value is 84.38 (Table 2). This means that the probability a married farmer being an adopter of SRI is greater than for unmarried farmer by 2.21 percent and adoption rate increased by 84.38 percent for all respondents. These results imply that married farmers are better positioned to assist each other compared to unmarried farmers. Given the fact that smallholder farmers in rural areas do not rely on hired labour, spouses help each other in production and domestic activities hence facilitates easy practice of the SRI techniques. This is in agreement with Johnson and Vijayaragavan (2011) observation that adoption of SRI practices requires high labour in case of accomplishing activities related to adoption of SRI practices.

The study also found that the association between adoption of SRI practices and farmers' land ownership was significant ($p<0.05$) (Table 2). The model results similarly indicate that land ownership increased farmers' probability to adopt SRI by 1.48 percent and it increased the rate of adoption of SRI practices by 79.90 percent. This result suggests that farmers with land ownership had higher adoption of SRI than those without ownership by the factor of 1.48 and adoption rate of SRI practices by increased by 79.90 percent. Thus, since land ownership acts as a security which increases farmers' incentives to adopt, it is obvious that land ownership influences adoption decision whereby farmers with land ownership are more likely to adopt SRI practices than those without ownership. In the same manner, Ogutu *et al*. (2015) confirmed that land ownership significantly affects adoption decision of Sustainable Agricultural Intensification technologies (SAI) in multiple ways in Kenya.

Availability of paddy markets is found to be significant determinant factor for the adoption of SRI practices at $p<0.05$ significant level (Table 2) in the study area as expected. Equally, availability of paddy markets increased probability of adopting SRI practices by 1.99 percent and increased the rate of adoption on average by 77.05 percent (Table 2). This result implies that the availability of paddy markets increased the likelihood of farmers to adopt SRI practices. The reason for increased likelihood of farmers to adopt SRI in light with markets availability is the fact that commercial paddy farmers would like to have high production so as to realize profit. Katambara *et al*. (2013) documented that adoption of SRI practices in Mkindo area produces 6.3 tons/ha compared to 3.83 tons/ha when conventional practices are used.

Moreover, farmers' knowledge has an influence on the adoption of SRI practices. It was expected that farmers' knowledge on SRI to be significant and positively associated with adoption of SRI practices. This study result matches with the expectation at $p<0.01$ significant level (Table 2). The results also show that for a unit increase in knowledge of SRI, a probability of adopting SRI increased by 1.19 percent and the rate of adoption increased by 56.67 percent for all respondents. This implies that farmers who were aware and knew how SRI techniques are applied had higher chance to adopt this package of innovations compared to farmers who were not knowledgeable on SRI practices. Similar result on the significant and positive relationship between knowledge and adoption of innovations has been reported by other scholars (Ngwira *et al*., 2014; Sarada and Kumar, 2013; Fita *et al*., 2012). For instance, Sarada and Kumar (2013) observe that as farmers' knowledge increases, the adoption levels of farmers on recommended production practices also increases.

Table 2: Two-limit Tobit Model Estimates for Factors Influencing Adoption of SRI (n=299)

Variable	ß	SE	t-value	Sig.	Probability	Unconditional expected value
Sex (X_1)	.100	.3170	0.31	0.753	.0021	.0977
Age (X_2)	-.022*	.0134	-1.66	0.099	-.0005	-.0217
Marital status (X_3)	.866**	.3740	2.32	0.021	.0221	.8438
Education level (X4)	-.179***	.0579	-3.10	0.002	-.0037	-.1758
Household size (X_5)	-.044	.0716	-0.61	0.542	-.0009	-.0428
Labour availability (X_6)	-.189	.3126	-0.61	0.546	-.0038	-.1854
Land ownership (X_7)	.814**	.3329	2.45	0.015	.0148	.7990
Land size (X_8)	-.075	.1016	-0.74	0.462	-.0015	-.0733
Access to extension advisory (X_9)	-.429	.3495	-1.23	0.221	-.0099	-.4185
Access to credit facilities (X_{10})	.014	.2907	0.05	0.962	.0003	.0136
Market availability (X_{11})	.791 **	.3251	2.43	0.016	.0199	.7705
Perceived relative advantage of SRI (X_{12})	-.004	.3510	-0.01	0.992	-.0001	-.0036
Total revenue per hectare per production season in 2015 (X_{13})	-1.350e-08	8.61e-08	-0.16	0.876	-2.76e-10	-1.32e-08
Decision making power index (X_{14})	-.384	.5923	-0.65	0.517	-.0079	-.3763
Knowledge of SRI (X15)	.579***	.0434	13.34	0.000	.0119	.5667
_cons	2.798	1.0581	2.64	0.009		
Number of obs	299					
LR chi^2 (15)	222.37					
Prob> chi^2	0.000					
Pseudo R^2	0.152					
Log likelihood	-620.9655					

β = Coefficient; SE= Standard error

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% significance levels respectively.

Age was significantly associated with adoption of SRI practices ($p<0.1$) (Table 2). Two-limit Tobit regression results also indicate that for a unit increase in age, a probability of adoption of SRI practices decreased by 0.05 percent and on average decreased the rate of adoption by 2.17 percent for all respondents. In addition, during the focus group discussions it was revealed that age of a farmer has an influence on adoption of SRI practices. A Key Informant at Dakawa scheme emphasized:

"...some practices like transplanting seedlings within 15-30 minutes, keeping uprooted seedlings in moist conditions, single transplanting, careful transplanting at shallow depth and transplanting at spacing of 25cm x 25cm are technical and laborious" (KII One at Dakawa village, 13thJune, 2016).

This means that as age of a farmer increases, the adoption of SRI practices decreases. Thus, the likelihood of a younger farmer to adopt SRI practices is higher than an older farmer. This could be due to the fact some practices within SRI practices are technical which require measurements, timing and intensive care such that they become hectic and cumbersome for old aged farmers to accomplish. The older farmers, unlike younger farmers who have more propensities in learning and adopting innovations, become unable and unwilling to apply SRI techniques. Similarly, Nayak *et al*. (2016); Akinbode and Bamire (2015); Martey *et al*. (2013); Howley *et al*. (2012) reported that age was negatively associated with the adoption of innovations.

Education level of the respondents is an important aspect in the adoption of an innovation. The evidence from the regression analysis shows that education level was significantly associated with the adoption of the SRI practices at $p< 0.01$ significant level (Table 2). The negative sign of the coefficient shows that as the education level increases, the probability of adopting SRI practices decreases. The two-limit tobit model results also indicate that probability of adoption was 0.0037 and unconditional expected value was 0.1758 (Table 2), meaning that an increase in education level decreased farmers' probability to adopt SRI practices by 0.37 percent and adoption rate declined by 17.58 percent for all respondents. This means, farmers with low level of education were more willing to adopt SRI practices than the farmers with high level of education. Farmers with high level of education tend to have off-farm (professional or entrepreneurial) activities and therefore would prefer less tedious and time saving farm techniques. The same is true for Shah *et al.* (2014) and Martey *et al*. (2013) who asserted a negative relationship between education level and adoption of rice innovations in Northern Ghana and Bangladesh respectively. These researchers pointed out that educated farmers deflect their skills to off-farm employment opportunities and are unwilling to adopt farm innovations.

This suggestion is supported by the field observation and KII made during the data collection. A paddy farm of one farmer, a Masters Degree holder, and a researcher in Cholima Agro-Scientific research centre was planted paddy using broadcasting system instead of adopting SRI practices. He gave the following reason for not using SRI practices;
"…*the SRI practices like transplanting at spacing of 25cm x 25cm and transplanting single seedling per hole is laborious and costly to hire labourers for large plots like mine"* (KII Two, 24th May, 2016).

This finding indicates that though a farmer had relatively higher education, he opted for conventional practices than adopting SRI practices. The laborious nature of innovation consumes a lot of time that a farmer could spend for other off-farm activities. Nirmala and Vasantha (2013) had similar observation. They described that non-adoption of SRI practices such as seed treatment, preparation of raised seed bed, application of organic manure, planting single seedling at 25 cm x 25 cm spacing at shallow depth was due to laborious nature of practices.

CONCLUSION AND RECOMMENDATIONS

This study indicates that only farmers' knowledge is an important variable in adoption of each innovation. Therefore, farmers' knowledge to practice SRI is imperative towards increased paddy production and productivity. The land ownership gives a farmer the right and security which is a motivation to adopt innovations. It further revealed that although extension services are crucial in promoting paddy farming, if not well programmed to promote innovations, there is a possibility to constrain adoption of such innovations. Available paddy markets at farm level are an opportunity that motivates farmers to adopt innovations and eventually raise their production and productivity.

Since knowledge was an important aspect in the adoption of innovations, therefore extension officers are advised to educate and train farmers to clearly understand and eventually practice the innovations. In order to avoid negative influence of extension services, extension officers and agricultural interventionists should design farm-level innovations that reflect the paddy production and processing attributes of the potential recipients in the rural farmers' communities.

REFERENCES

1) Akinbode, W. O. and Bamire, A. S. (2015). Determinants of adoption of improved maize varieties in Osun State, Nigeria. *Journal of Agricultural Extension and Rural Development* 7(3): 65 – 72.
2) Fita, L., Trivedi, M. and Tassew, M. (2012). Adoption of improved dairy husbandry practices and its relationship with the socio-economic characteristics of dairy farmers in Ada'a District of Oromia state, Ethiopia. *Wudpecker Journal of Agricultural Research* 4(14): 392 – 395.
3) Howley, P., Donoghue, C. O. and Heanue, K. (2012). Factors affecting farmers' adoption of agricultural innovations: A panel data analysis of the use of artificial insemination among dairy farmers in Ireland. *Journal of Agricultural Science* 4(6): 171 – 179.
4) Katambara, Z., Kahimba, F. C., Mahoo, H. F., Mbungu, W. B., Mhenga, F., Reuben, P., Maugo, M. and Nyarubamba, A. (2013). Adopting the system of rice intensification in Tanzania: A review. *Agricultural Sciences* 4(8): 369 – 375.
5) Leeuwis, C. (2004). *Communication for Rural Innovation: Re-thinking Agricultural Extension.* (3rd Ed.), Blackwell Science Ltd., Oxford, UK. 412pp.
6) Martey, E., Wiredu, A. N., Asante, B. O., Annin, K., Dogbe, W., Attoh, C. and Al-Hassan, R. M. (2013). Factors influencing participation in rice development projects: The case of smallholder rice Farmers in Nothern Ghana. *International Journal of Development and Economic Sustainability* 1(2): 13 – 27.
7) McDonald, J. and Moffit, R. (1980). The use of Tobit Analysis. *Review of Econometrics and Statistics* 62: 318 – 321.
8) Meena, D. K., Ram, H. and Meena, B. S. (2012). Adoption of improved animal husbandry practices by the members and non-members of dairy cooperative societies in Bikaner. *Indian Journal of Dairy Science* 65(4): 356 – 358.
9) Nayak, C., Mahunta, R. and Dash, S. (2016). Economic benefits of system of rice intensification in Kendrapara District of Odisha, *International Journal of Applied and Pure Science and Agriculture* 2(6): 220 – 225.

10) Ngwira, A., Johnsen, F. H., Aune, J. B., Mekuria, M. and Thierfelder, C. (2014). Adoption and extent of conservation agriculture practices among smallholder farmers in Malawi. *Journal of Soil and Water Conservation* 69(2): 107 – 119.
11) Nirmala, K. and Vasantha, R. (2013). Extent of adoption of system of rice intensification cultivation by farmers of Mahabubnagar District of Andhra Pradesh: A critique. *Journal of Research Angrau* 41(4): 79 – 53.
12) Ogutu, W. N., Obare, G. A. and Kassie, M. (2015). *Farm Plot Level Determinants of the Number of Sustainable Agricultural Intensification Practices Adopted in a Maize-Legume Cropping System in Kenya*. Discussion Paper No. 9. Adoption Pathways Project, Nairobi, Kenya. 13pp.
13) Rogers, E. M. (2003). *The Diffusion of Innovations*. (5^{th} Ed.), The Free Press, New York, London, Toronto, Sydney and Singapore. 543pp.
14) Sarada, O. and Kumar, D. G. V. S. (2013). Knowledge and adoption of recommended production technology by cotton farmers, *Journal of Research Angrau* 41(4):54 – 60.
15) Semgalawe, Z. M., Folmer, H. and Heijman, W. J. M. (1998). Household adoption behaviour and Agricultural sustainability in the Northeastern Mountains of Tanzania. The case of soil conservation in the North Pare and West Usambara Mountains. Thesis for Award of PhD Degree at Wageningen Agricultural University, Wageningen, the Netherlands, 189pp.
16) Sileshi, M., Nyikal, R. and Wangia, S. (2012). Factors affecting loan repayment performance of smallholder farmers in East Hararghe, Ethiopia, *Journal of Developing Country Studies* 2(11): 205 – 213.
17) Shah, M. M., Grant, W. J. and Stocklmayer, S. (2014). Adoption of hybrid paddy in Bangladesh: Farm level Experience. *Journal of Agricultural Science* 6(7): 157 – 171.
18) Johnson and Vijayaragavan (2011). Diffusion of System of Rice Intensification (SRI) Across Tamil Nadu and Andhra Pradesh in India. Indian Research Journal of Extension and Education 11 (3): 72-79.
19) Yamane, T. (1973). *Statistics, an Introductory Analysis*. (2^{nd} Ed.), Harper and Row, New York. 1130pp.