DRIVERS OF CERTIFIED RICE SEED USE IN KILOMBERO DISTRICT, TANZANIA

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ABSTRACT: *The main objective of this paper is to assess the drivers of adoption of certified rice seeds among farmers in Kilombero District of Tanzania and as well assess the factors that influences the intensity of adoption of certified rice seeds. The random sampling technique was used to collect data from 130 rice farmers through in-person interview. The data were analyzed using two econometric techniques. Firstly, a binary logit model was used to identify factors influencing adoption of certified rice seeds. Secondly, Tobit regression was used to analyze the determinants of the extent of adoption of certified rice seeds. Empirical findings of this study show that factors such as marital status, access to land, membership of farm association and income from off-farm activities, significantly influenced the adoption of certified rice seeds while the factors that significantly influenced the extent of adoption of certified rice seeds in the study area include education level of the farmers, marital status and the farmer's access to land. From a policy perspective, this study recommends that farmers should be assisted to improve on these factors because adoption of certified rice seed varieties is important for increasing agricultural productivity.*

KEYWORDS: adoption, certified rice seeds, logit, probit, Tanzania

INTRODUCTION

Improving agricultural productivity involves increasing farmers' access to inputs including quality and certified rice seeds. One major factor responsible for low agricultural productivity is the use of poor-quality seeds. The adoption and use of good quality seeds could ensure higher productivity of up to 40% increase (Abebe and Alemu, 2017). For Tanzania, certified rice seeds are rice seeds that have been formally approved by Tanzania Official Seed Certification Institute (TOSCI) as having an acceptable quality in terms of the inherent genetic makeup, the germination rate, the seed health, and as well as the purity of the seed. In line with this national definition, this study refers to certified rice seeds as rice seeds that are produced and distributed by the formal sector and obtained directly by the farmers from approved seed dealers in Tanzania.

Ali *et al.*, (2015) ascertained that the availability of certified seeds as well as access to certified seeds of crop varieties is a key factor in increasing agricultural production and improving welfare. It plays a key role in achieving food and nutritional security. Rice production plays a strategic role in the agricultural development of Tanzania. However, empirical literature from Tanzania such as Mligo and Msuya (2015) show that the supply of quality seeds for many years through formal seed system has not been satisfactory.

There is lack of empirical evidence on the drivers of adoption and extent of adoption of certified rice seeds in Tanzania. This research bridges the gap in literature by assessing the drivers of certified rice adoption and extent of its adoption in Tanzania. In addressing this main objective, this study assessed the economic factors, institutional factors and human specific factors that drives certified rice seed use in the study area. Findings of this study will be very useful in explaining and overcoming some of the bottlenecks to certified seed adoption in Tanzania.

REVIEW OF EMPIRICAL LITERATURE

Anang (2019) examined the effect of adoption of improved rice varieties on productivity of smallholder farmer households in northern Ghana. The study used multi-stage stratified random sampling technique to select 300 households for the survey and modelled adoption using binary probit model. The results showed that adoption of improved rice varieties is influenced by socioeconomic factors such as age, years of formal education, household size, farm mechanization, and farm location.

Factors that influences adoption of improved rice varieties was also examined by Awotide *et al.* (2016). The study which focused on rural Nigeria, used Tobit regression model and found that factors that significantly influenced adoption of improved rice varieties are the level of training, distance to the input shop and membership of farmer-based organization. Another empirical study from Nigeria by Saliu *et al.*, (2016) revealed that household size, farm size and access to extension services significantly influenced the adoption of rice technologies. These findings were based on random sampling of 130 rice farmers and results of marginal effects of the ordered Probit regression.

Mwalongo *et al.*, (2020), assessed factors that determines farmers preferences and adoption of improved groundnut varieties in Tanzania using descriptive statistics and Probit regression model. The study identified that farmer's decision to adopt new varieties is influenced by age, gender, farmer group membership, availability of improved seed and seed cost.

These empirical studies highlights the determinants of adoption and the use of dichotomous choice models such as Logit, Probit and Tobit, either singly or in combination to model the determinants and/or intensities of adoption of improved agricultural technologies including improved rice varieties (Saliu *et al,* 2016; Awotide *et al.*, 2017 Mutanyagwa *et al.* 2018; Abbas and Jiang 2018). Following empirical literature, this study used the Logit model in assessing the factors influencing the adoption of certified rice seeds while the Tobit model is used to assess factors influencing the extent of adoption of certified rice seeds in Kilombero district.

Kilombero District has a high potential for paddy production, more than 80% of the income of the people is obtained from selling paddy or rice (Makingi, and Urasa, 2017). However, yields are low on average about 2 tons per ha mostly due to dependence on rain-fed agriculture, low use of agricultural inputs such as certified seed, fertilizer, poor farm inputs use; for example, use of the hand hoe in land preparation and use of recycled seeds (Sekiya et al. (2020). The above average is

quite low when compared to the 3.1 to 4.3 tons per hectare expected under good management as reported in literature (Makingi, and Urasa, 2017).

Efforts have been made by different institutions to ensure development of seed systems in order to improve adoption of certify seeds by small holder farmers. The efforts include the Ministry of Agriculture with Agricultural Sector Development Programme (ASDP II), a national key document, which emphasizes on increasing agricultural productivity, profitability and farm incomes (URT, 2016). Scholars like Massawe et al. (2020), Sekiya et al. (2020) and Monela (2014) have studied the use of improved rice seeds by smallholder farmers in rice producing area. Improved seed increases yield five times of the recycled seed. However, little has been documented on the drivers of adoption of certified seed in Kilombero. The study answers the question that what are the drivers of adoption of certified seed use in Kilombero.

Research Justification
Rice is among the few crops with long list of certified seed varieties developed and released by the Agricultural Research Institutes (ARIs) in Tanzania, which are strategically, located in the major rice production zones of the country. Nevertheless, only few of them have entered into the seed chain and overwhelming majority farmers still rely on recycled seeds (Sekiya, 2020; Kangile, et al., 2018). It was expected that the introduction of certified rice seeds under formal seed system would greatly increase availability and use of certify rice seed by farmers. However,the availability and use of certified seed have remained low despite of the system being in operationin Tanzania. (TOAM 2015). To the best of my knowledge, there is still inadequate understanding of the reasons for such poor performance. This research therefore examines the drivers of certified seed use in Tanzania. Thus, most of the bottlenecks to certified seed use in Tanzania will be explained. The findings of this study are therefore expected to increase awareness of the entire system of adoption of certified seeds. Moreover, the findings are expected to be used by planners, policy makers and implementers towards the joint goal of improving small holder farmers' lives through emphasizing on certified seeds use.

METHODOLOGY

Data
The data used for this study is obtained through a field survey using structured questionnaires administered in 2019. This study used a multi-stage simple random sampling technique to select the respondents. First, Kilombero district was purposively selected because it is one of the major rice supplying district. The second stage involve the selection of three villages from the district at random. The selected villages are Kisawasawa, Mang'ula and Nkula. Next, the study selected at random forty farmers from each of the selected village, using a proportionate stratified sampling approach based on the village household register.

The study used a semi-structured questionnaire to solicit responses related to household and farm-level characteristics, rice production, access to certified seeds, use of certified seeds, input and output quantities and prices. In order to validate the questionnaires, a pilot testing was done in selected villages and the questionnaire was thereafter revised. The instrument included questions

on the household and farm-level characteristics, rice production practices, seed source, and access to certified seeds. Focus group discussions and key informant interviews was also done in order to supplement the information gathered through the questionnaire.

Theoretical Framework
The adoption decision of a farmer to use improved agricultural technology such as certified rice seed is hypothesized to consist of two mutually exclusive process; (i) the choice to adopt the improved technology (ii) decision on the extent or intensity of use of such improved technology that the farmer adopts (Alene *et al.*, 2000). The outcome of such decision process could be better understood through inferential statistics using the Logit and the Tobit models. The Logit regression model is widely established as an appropriate methodology for estimating the relationship between the likelihood of adoption of improved technology such as certified rice seeds and assessing the various factors determining such likelihood of adoption (Mutanyagwa *et al.* 2018). Likewise, the Tobit model is an empirically established methodology for establishing the relationship between the extent of adoption of improved technology such as certified rice seeds and the covariates affecting such relationship (Alene *et al.*, 2000; Milkias and Abdulahi, 2018).

The Logit model
Theoretically, the Logit model is expressed as;
$$P_i = \frac{e^{\alpha + \beta x}}{1 + e^{\alpha + \beta x}} \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad (1)$$
Where P_i is the probability that the *i*th farmer adopted the improved agricultural technology, e is represents the base of natural logarithms, α is a constant of the equation, β is a vector of unknown parameters, and x is a vector of explanatory variables.
Empirically, to examine the farmers' likelihood of adopting certified rice seeds, the farmers' choice of adoption is regressed on a set of socioeconomic covariates to establish the determinants of adoption of certified rice seeds. The empirical binary logistic model is expressed as follows;
$$P_r(Adopt_i = 1) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots \beta_n x_n \quad . \qquad . \qquad . \qquad . \qquad . \qquad (2)$$
Where $Adopt_i$ is the likelihood that farmer adopts certified rice seeds (1 = Adopt, 0 = otherwise), β_0 is the intercept, β_0 to β_n is the estimates of the parameters, and x_1 to x_n denotes the hypothesized independent variables influencing the likelihood of adoption.

The Tobit model
Theoretically, the Tobit model is expressed as;
data is as specified in equation (24);
$$\gamma_i^* = X_i'\beta_i + \nu_i; \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad (3)$$
$$\gamma_i = \begin{cases} 1 \ if \gamma_i^* > 0 \\ \\ 0 \ otherwise \end{cases} \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad (4)$$
Where γ_{it}^* = latent variable that is non-negative, X_i' is vector of explanatory variables, β_i is vector of unknown parameters, and ν_i is error term.
Empirically, the Tobit model is expressed as;
$$\gamma_i^* = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots \beta_n x_n \qquad . \qquad . \qquad . \qquad . \qquad . \qquad . \qquad (2)$$

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Where γ_i^* represents the total land area under certified rice seeds, β_0 is the intercept, β_0 to β_n is the estimates of the parameters, and x_1 to x_n denotes the hypothesized independent variables influencing the extent of use of certified rice.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Rice Farmers
Table 1 presents a summary of descriptive statistics for the sampled rice farmers. Results of the socioeconomic analysis shows that 11.5% of the respondents were aged between18-24 years while 17.7% were between 25-34 years old, 33.8% were between 35-44 years, 17.7% were aged between 45-54 years, 13.1% were aged between 55-60 years and 6.2% were aged 61 years and above. These findings imply that majority of the respondents fall within the age group of 35-44 years. This suggest that most of the farmers are within the economically active age category. This finding concurs with the findings of Ngailo *et al.*, (2016) who found that many young people are engaged in rice farming in the Southern highlands of Tanzania. Another study by Mutanyagwa *et al.*, (2018) also provided evidence in line with study findings and argues that farmers in their productive age dominates farm production in Tanzania. The findings of this study also show that 50.8% the respondents are male while 49.2% are female. This implies that more male farmers are in the rice farm sector relative to the women farmers.

The educational structure of the respondents shows that 4.6% had no formal education, majority (74.6%) had primary education, 18.5% had attained secondary education, 1.5% had attended college of education and a minority (0.8%) of the respondents are graduates. Furthermore, the findings show that 74.6% of the respondents are married while 15.4% are single. Analysis of the household size show that 74.0% of the respondent's size range between 1-5 persons while 26.0% had household size ranging between 6-10 persons. Moreover, majority (70.0%) of the respondents are members of farm association while 30% do not belong to any farm association.

Table 1: Socioeconomic Characteristics of the Rice Farmers

Variable	Frequency	Percentage
Age of respondents		
18-24	15	11.5
25-34	23	17.7
35-44	44	33.8
45-54	23	17.7
55-60	17	13.1
61 and above	8	6.2
Gender of Respondents		
Female	64	49.2
Male	66	50.8
Education level of Respondent		
No formal education	6	4.6
Primary education	97	74.6
Secondary education	24	18.5
College education	2	1.5
Graduate and above	1	0.8

Marital Status of Respondent		
Married	97	74.6
Single	20	15.4
Divorced	2	1.5
Widow/Widower	5	3.8
Separated	5	3.8
Cohabitating	1	0.8
Household size		
1-5	96	74.0
6-10	34	26.0
Membership of Farm Association		
Yes	91	70
No	39	30

Factors influencing respondents' likelihood of adopting certified rice seed
The socioeconomic factors that determines the likelihood of adoption of certified rice seed among farmers in the study area were identified using the Logit model. The results of estimation of the Logit model on the determinants of adopting the certified rice seeds are presented in Table 2. Overall, the econometric model was significant, with a Chi-square value of 49.38, and is significant at the 1% level, indicating the robustness of the variables included in the model.

The marginal effect for marital status was 0.22 and statistically significantly related to farmers' adoption of certified rice seeds ($p < 0.05$). This implies that being married increases the probability of farmer adoption by 22%. Access to land is also statistically significantly related to farmers' adoption of certified rice seeds ($p < 0.05$). The marginal effect of 0.085 for access to land implies that an increase in the farmer's access to land, increases the probability of farmer adoption of certified rice seeds by 8%.

Moreover, membership in agricultural organization is another factor that significantly influences farmers adoption of certified rice seeds. Given the marginal effect of 0.591, it implies that being a member of an agricultural organization increases the probability of farmer adoption of certified rice seeds by 59%. In line with this study, a study conducted in Nigeria by Onyeneke (2017) revealed that membership of cooperatives positively influenced farmers adoption of improved technologies in rice production. A similar study by Awotide *et al.*, (2016) also ascertained that membership of farmer-based organization significantly influenced the adoption of improved rice variety.

The probability of adoption of certified rice seeds by farmers in the study area is also significantly determined by off-farm income. Results of this study shows that off-farm income have the potential of increasing the probability of adoption of certified rice seeds by about 8% increase.

Table 2: Factors influencing respondents' likelihood of adopting certified rice seed

Variable	Coefficient	Std. Error	z	Marginal effect (dy/dx)
Sex	-0.937	0.773	-1.21	-0.22
Age	0.247	0.282	0.88	0.060
Education level	0.108	0.039	2.75	0.026
Marital status	0.921*	0.525	1.75	0.22
Household size	-0.116	0.845	-0.14	-0.028
Access to land	0.344***	0.152	2.26	0.085
Member in any Agric organization	2.872***	0.932	3.08	0.591
Income from off-farm activities	0.365*	0.192	1.90	0.088
LR Chi2 (8)	49.38			
Prob > chi2	0.000			
Number of observations	112			

Source: Field Data, 2019

Factors influencing respondents' extent of adoption certified rice seeds
Empirical findings of the study which is obtained from the Tobit model is presented in Table 3. The Likelihood Ratio (LR) chi-square is highly significant at 1% (Prob > Chi2 = 0.000) indicating that the Tobit model is appropriate and the explanatory variables jointly contribute to explaining the variations in rice farmers' extent of adoption of certified rice seeds.

Table 3 shows that education level has a positive and significant influence on farmer's extent of adoption of certified rice seeds. This indicates that holding other variables constant, the higher the level of education of the farmers, the higher their extent of adoption of certified rice seeds. Education facilitates farmers access to information needed to make informed decision to use an innovation and practice a new technology such as certified rice seeds. This finding concurs with earlier studies such as Mutanyagwa *et al.* (2018) and Mbavai *et al.* (2019) which shows that education level positively influenced the intensity of adoption and use of certified seeds in Tanzania and Nigeria, respectively.

Moreover, the results show that marital status exhibited a significant positive effect on the intensity of certified rice seed adoption. This suggests that the extent of use of certified rice seeds in the study area increases with households that are married than those that are not married. Another plausible explanation this result is that farming in Tanzania depends largely on human capital (labour), and as such, farmers with spouses are more likely to have larger farm sizes.
The results further show that access to land is one factor that also significantly determined the extent of farmers adoption of certified rice seeds.

Table 3 Factors influencing respondents' extent of adoption certified rice seeds

Variable	Coefficient	Std. Error	t
Sex	0.035	0.463	0.08
Age	0.259	0.180	1.44
Education level	0.458***	0.189	2.42
Marital status	0.444***	0.189	2.35
Household size	0.353	0.564	0.63
Access to land	0.285***	0.079	3.61
Member in any agric organization	0.369	0.476	0.77
Income from off-farm activities	0.136	0.151	0.90
LR Chi2 (8)	23.58		
Prob > chi2	0.001		
Number of observations	68		

CONCLUSION AND POLICY IMPLICATIONS

This paper contributes to existing literature by providing estimates of the determinants of adoption of certified rice seeds and the level of use of certified rice seeds in Kilombero District of Tanzania. The study found that several factors influences the rate of adoption and the level of use of certified rice seeds in the study area. The factors that significantly influenced certified rice seeds adoption include marital status, access to land, membership of farm association and income from off-farm activities. The factors that significantly influenced the level of use of certified rice seeds in the study area include education level of the farmers, marital status and the farmer's access to land. Given that these socioeconomic factors significantly influenced the adoption and use of certified rice seeds in the study area, it is important that proper policy measures that will contribute to the improvement of these factors are put in place. Such policy measures include the provision of more education to farmers and encouraging more farmers to join farm associations. More opportunities should also be created for farmers to earn income from off-farm activities as this will enhance their financial ability to increase their level of use of certified rice seeds.

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