International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 8, Issue 11 -2021

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.11.012

Determinant circumstances for adoption of improved rice variety in Fogera rice production hub of North Western Ethiopia

Misganaw Anteneh Tegegne
Student at University of Bonn, Germany
Correspondence address; *misgieantie@gmail.com*

Abstract

This study was conducted in Fogera plain with the aim of exploring determinants on adoption of improved rice variety among small holder rice producing farmers. Fogera plain is the major rice producing hubs in the country supplying and it is very close to the largest Lake called Lake Tana. The proximity of the Fogera plain to the Lake Tana is an opportunity for rice production as it could get water due to over flow from the lake. Although lots of rice varieties were released in Fogera plain and in the country as well, however, very few of them were adopted by small holder rice producing farmers. This scenarios of production continuous for many years farmers sticking with use of old cultivar called *X.Jigina* though many options of varieties available. *X. Jigna* was the dominant variety in both the supply (seeds) and demand (final consumer) markets in Fogera rice production hub. Hence it was thought that some circumstances might affect for the continuation of this kind of production pattern remained with farmers for long time These factors might be categorized into socioeconomic and institutional aspects in the process of rice production scenarios. Under this survey assessment in Fogera plain, three peasant associations ("*Kebeles*") were selected and a total of 120 rice producing households (40 per Kebele) were taken into account. Primary data were collected from rice producing households and secondary data from various documentations. Logit model was employed for statistical analysis of the data collected under this exploration. Distance to extension agent and remoteness of farmers residence from main road which have transportation access, membership to farmers' organizations such as seed producing cooperatives, total size of land holding were mainly identified as determinants for adoption of improved rice varieties in Fogera plain. The research and development sectors might focus on release of new varieties fitting with the farmers' circumstances. Moreover, strengthening seed cooperatives in the study area is paramount importance to address lack of supply of improved rice seed including remote areas so as address equitable accessibility of the seed for those farmers in far from main accessible areas.

Keywords: Adoption, Fogera plain, improved variety, institutional determinants, socioeconomic determinants, *X.Jigina* cultivar.

1. Introduction

1.1. Rice in Ethiopia

1.1.1. Beginnings of rice production in Ethiopia

In the early 1970s Ethiopia was hit by a severe famine which took the lives of hundreds of thousands of human beings (estimations range from 250,000 to 750,000 people) and countless domestic animals (Kebbede,1988). As a response to this dramatic event and aiming the long term enhancing of food security, North Korean development cooperation efforts introduced rice cultivation in Ethiopia, first in the Fogera and Gambella Plains (Belayineh et al. 2017) . From then on rice cultivation, mostly undertaken by small-scale farmers, has expanded to plains and wetlands. The total potential area for rice production in Ethiopia is estimated to be 30 million hectares, from which X% (5.6 million ha) are considered to be highly suitable (Dawit 2015).New governmental efforts aim the development of commercial rice farming. For instance, around 21% of lands under governmental administration (398,000 ha) have been transferred to local and foreign investors for commercial rice farming purposes.
(Alemu et al. 2011).

1.1.2. Rice varieties in Ethiopia

A limited numbers of rice varieties have been introduced in Ethiopia mainly by the International Rice Research Institute (IRRI) and the Africa Rice Center. The introduced germplasm has been used to develop rice varieties for different agro-ecologies and/or rice ecosystems of the country. However, the introduction and evaluation of new rice germplasm for rainfed, lowland, irrigated, and upland systems is highly needed (Tessema 2011). Since 1998, when the first rice variety was released in the country, 35 improved varieties have been released based on several parameters such as for instance yield performance, early maturity, cold resistance and market preference (MoA, 2011)

1.1.3. Rice in Fogera

Before starting cultivation of rice in Fogera, the district was food aided in 1970-1980s and so far the area was known typically by grazing land, livestock rearing, small-scale crop production using residual moistures, as well as sparsely populated. (Tilahun, *pers. comm.*2018) and (https://www.future-agricultures.org). Rice cultivation started in July 1984 in seasonally flooded plains of Lake Tana (submerged in water every rainy season) as a pilot project entitled "Ethio-Jigna Development Project'' including the agricultural Cooperatives Jigna and Shaga cooperatives including thirty (30) young farmers supported by 9 North Korean agricultural experts. The objective of the pilot project was to establish and promote rice and horticultural crops first in the two cooperatives. The introduction of rice cultivation in the region changed the livelihood of the farmers in the Fogera plain radically. Apart from playing an important role in abating the problem of food-insecurity in the Fogera, rice cultivation increased the revenues of farming households considerably. Fogera has become a densely populated area and non-flooded agricultural production (onions, legumes) crops is flourishing. Nowadays, in local terms, rice farmers from Fogera are considered to be "rich".

2. Hypothesis and Objectives

The hypothesis that various socioeconomic and institutional factors determine adoption of improved rice variety by small holder rice producing farmers in Fogera rice production plain or hub. Hence the study figures out to explore, identify and test those socioeconomic and institutional determinants on adoption status.

2.1. Specific objectives

- To assess socioeconomic and institutional characteristics of rice producing households
- to identify determinant for adoption of improved rice varieties

3. Methodology

3.1. Study site

Fogera is located in Amhara region in the North West of Ethiopia situated between the latitudes 11°57 and 11°59 and the longitudes 37°42 and 37°43and altitudes ranging between 1793 to 1800 meters above sea level. It is categorized as dry savanna according to the FAO AEZ system (FAO,1978). Its mean annual rainfall is 1216 mm ranging from 1103-1336 presenting a dry season (March and April) and a long rainy season (June to September) (Gebey 2012) .

Fogera is one of the 106 districts (local name – Woreda) of the Amhara Regional State, located in the South Gondar Zone. Woreta is the capital of the district and is found 625 km from Addis Ababa and 55 km from the regional capital city, Bahir Dar.

Fogera is bordered by Libo Kemkem district in the North, Dera district in the South, Lake Tana in the West and Farta district in the East. The district is divided into 34 *kebels* (local name for Peasant Association - PA): 29 rural and 5 urban kebeles. The rural population is estimated to be around 220 000 and the number of agricultural households is approximately 44000 (Hagos 2015). The district is dominantly known by rice production besides maize, finger millet, tef, onion, cattle rearing etc.

Farmers largely depend on the long rainy season for crop production and rice cultivation is exclusively undertaken in the period from June to September taking advantage of the flood water coming from two sources: the overflow of water from Lake Tana due to the heavy rains and the contribution of tributary rivers Ereb and Gumara. Rice cultivation is followed by different crops such as onion, tef and other upland crops in the dry season.

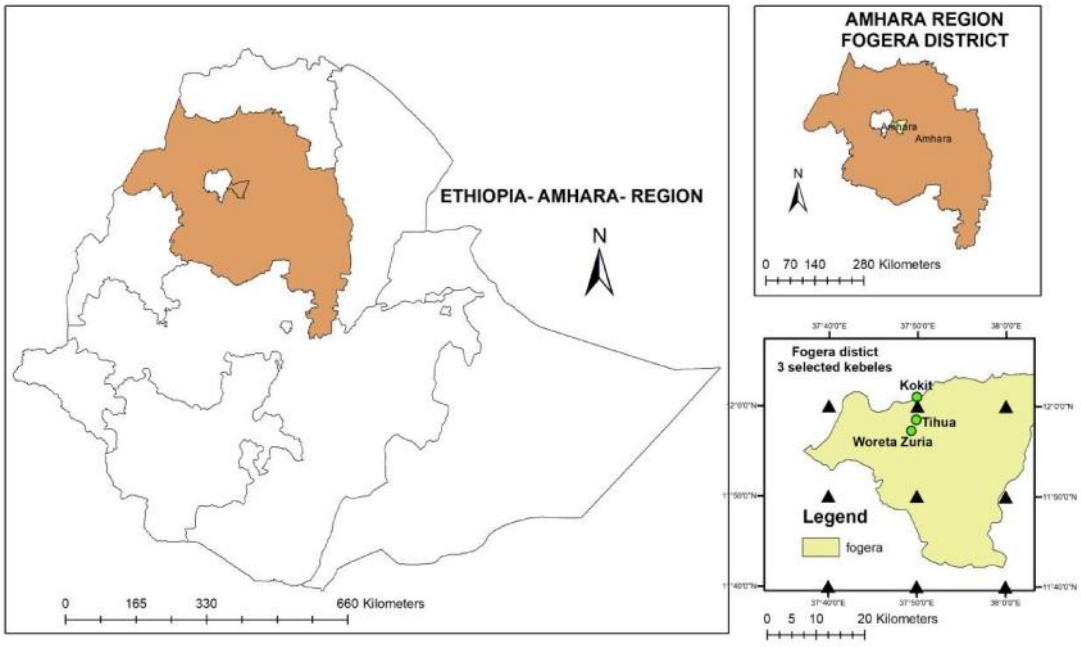

Fig.1. Fogera district with three selected kebeles (study sites)

3.2. Survey design and sampling techniques

The study targeted smallholder rice producing households in the Fogera district, a location with high potential for rice production in the country. Three kebeles (peasant associations) were selected: namely Kokit, Tihua and Woreta Zuria. The selection of these three kebeles was based on their proximity to the main road and accessibility to public transportation services. Thus, it was more time effective for the field work to assess households with relatively good access to roads. An equal sample size of n=40 was determined in each kebele resulting in a total of n=120 respondents in the study area.

3.3. Data collection and data types

In the assessment work both primary and secondary sources of data were considered. Primary data were collected directly from rice producing households by using a structured survey tool, an information acquisition support form (IASF) which was pre-tested before entering into the survey activities. During the survey the IASF was adapted according to the reality of the rice production system in the study area.

Secondary support and validation data were collected from the Fogera research center, the district level agricultural and rural development office, the administrative office of each "kebeles" and from extension workers. Both numeric and categorical data were collected related to socioeconomic and institutional characteristics.

3.4. Statistical analysis framework

Descriptive and central statistics were used for characterization and description of the rice farming households. Inferential statistics were as well applied to test differences between empirical distributions of variables and variable groups. A binary logistic regression model was used to analyze determinant factors on adoption status. The probability of farmers' decision to adopt improved rice variety depends on those socioeconomic and institutional factors.

$$Prob(Y=1) = ln\left(\frac{p}{1-p}\right) = \beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4\dots\dots+\beta_ix_i+U_i$$

Where β_0 is the constant, β_i =i=1,2,3..n is the coefficients of the independent variable, x_i is the vector of independent variable, Ui is the error term with zero mean and constant variance.

4. Results and Discussion

The dataset was divided into two groups based on the varieties farmers used for cultivation. Those farmers used old cultivar called X.Jigina and on the other hand others used improved rice variety. The mean age of farmers using improved variety was 40 years old and those used *X.jigina* cultivar was 41 years old. The result (**t=0.125, p=0.901**) indicates there was no significant mean difference between improved variety and old variety users. The mean distance to extension agent for farmers using improved rice variety was approximately 0.9 km and 2.4 km away from farmers residence for old cultivar users. This revealed that there was significant mean difference between the two groups at 5% level of significance (**t=2.106, p=0.037**). The mean distance to transportation access was 0.41km for improved variety users and 1.1 km for old cultivar users. The result indicates that there was significant and positive mean difference between two groups (**t=2.012, p=0.047**) at 5% level of significance.

The mean distance to market for farmers using *X.jigina* cultivar was 4.33 km away from their home of residence while for farmers in the category of improved rice variety users was 6.3 km far away. There was also significant mean difference at less than 1% level of significance (**t= -2.823, p=0.006**).

The mean years of rice farming experience was approximately 14 years for improved variety users and 13 years for old cultivar users. It shows there was no significant mean variation between the two groups (**t= -0.676, p=0.501**). The mean total size of own land holdings was 1.675 for old cultivar users and 1.16 ha for improved rice users. The result shows that there was significant and negative mean difference between the two groups (**t= -2.314, p=0.022**). The average rice consumption at household level per month in kg was 99 and 82.59 kg for improved variety users and old cultivar users respectively, in this result there was no significant mean difference between the groups (**t=-1.318, p=0.190**). The mean family members involved in agriculture was 4 persons for improved variety users whereas 3 persons for old cultivar users, the result indicates that there was no significant mean difference between the two groups (**t=-0.811, p=0.419**)

Table .1. T- test of continuous variables between adopters and non-adopters

			T-test	
Continuous variables	**non-adopter**	**adopter**	**t-value**	**p-value**
age of HH head (years)	41	40	0.125	0.901
distance to extension agent(km)	2.42	0.90	2.106	0.037**
distance to main road has transport access(km)	1.12	0.41	2.012	0.047**
distance to market input-output (km)	4.33	6.30	-2.823	0.006***
years of rice farming experience(years)	12.6	13.8	-0.676	0.501
total size of own land holdings (ha)	1.162	1.675	-2.314	0.022**
rice home consumption per month (kg)	82.59	99.00	-1.318	0.190
Family member involved in agriculture(no)	3	4	-0.811	0.419

**** ** * 1, 5, 10 % level of significance respectively.*

For categorical variables, method of chi-square test was employed to check if each of the variables has significant relation with adoption of improved rice varities. The variable gender had no significant relation with the status of adoption (x^2 **=0.087**, **p= 0.768**), In other words, gender was independent from status of varietal preference or adoption. In this case we fail to reject the null hypothesis that gender has no any significant relation to adoption. As the result (x^2**=0.082, p=0.774**) shows adoption of rice variety doesn't depend on educational status of farmers From the result of chi-square test (x^2**=9.545, p=0.002**), it could be realized that there was evidence that off farm income was significantly related with adoption at less than 1% level of significance. We could reject the null hypothesis which was stated as off-farm income was independent from status of adoption. Therefore, We accept the alternative hypothesis that off-farm income has statistical relation with adoption of improved rice variety.

Adoption of improved rice variety was significantly dependent on membership to agricultural cooperative almost at 1% level of significance (x^2**=5.779, p=0.016**). Being a member of locally established agricultural cooperatives had significant relation with adoption of improved rice varieties by farmers. The other categorical variable considered in this study was access to media. The result revealed that access to media was independent from status of improved rice variety adoption (x^2**=2.430, p=0.119**).

Regarding participation of farmers in the field day, the result of chi-square test described that participation in farmers' field day was significantly related with adoption of improved rice varieties at less than 1% level of significance (x^2**=8.727, p=0.003**). Generally, there was enough evidence that adoption of varieties by farmers highly and significantly dependent on participation in the farmers' field day. The chi-square result just shows us that participation in the field day had significant relation with the dependent variable, however there was no any evidence if the relation is positive or negative. This would be more explained in the following procedures of statistical analysis using logistic regression model.

Table.2 Chi-square test between adopters and non-adopters on categorical variables

	percentage proportion			
Categorical variables	**adopter**	**non-adopter**	***Chi*-square(x^2)**	***p*-value**
Gender				
male	6.7	76.7	0.087	0.768
female	1.7	15.0		
Education				
literate	3.3	32.5	0.082	0.774
illiterate	5	59.2		
Off farm income				
yes	2.5	4.2	9.545	0.002***
no	5.8	87.5		
Membership to agricultural cooperative				
yes	3.3	69.2	5.779	0.016**
no	5.0	22.5		
Access to radio or tv				
yes	3.3	17.5	2.430	0.119
no	5	74.2		
Participation on field day				
yes	4.2	12.5	8.727	0.003 ***
no	4.2	79.2		

****,**,*, 1, 5, 10 % level of significance respectively*

4.1.1. Factors influencing adoption of rice variety, estimated value of the coefficients and marginal effect (Odd Ratio)

Odds is the ratio of the probability of adopting improved variety and the probability of choosing X.jigina cultivar. Moreover, OR is exponentiated value of the logistic regression coefficient (exp(β)). The explanatory variable (age) was not significantly different from zero and related with the binary dependent variable in the logistic regression model (**p-value = 0.90 > a= 0.05**) at 5% level of significance but it indicates that there was still negative and had non-zero relation with adoption of improved variety with estimated value of the regression coefficient (β_1 = **-0.003**). A unit change in the age of farmers (e.g. when farmer gets older by one year), adoption of improved variety would likely be dropped by 0.3% = (1-0.997(OR))*100 or a factor of 0.997 times. On the other hand, adoption of the variety was greater than by 0.3 % (1/0.997=1.003) relatively for younger farmers. The values of both odds were almost equal in the scenarios of young and old farmers on the decision adoption of the variety.

Distance to extension agent negatively affected adoption of the variety with estimated value of the coefficient (β_2 = **-0.541**) which was statistically significantly different from zero at 10% level of significance (***p-value= 0.069 < a=0.1)***.

Distance to the main road with transport access had also negative relation in the logistic regression model with estimated value of the coefficient (β_3 = **-1.027**). The coefficient of the predictor was statistically significantly different from zero at 10 % level of significance (**p-value= *0.071<a=0.1***). The odds of adopting improved rice variety was lowered by 64.2% (1-0.358)*100 or a factor of 0.358 times when distance to main road would be increased by one unit or one kilo meter from farmers. The values of the confidence interval didn't include one which evidenced that the independent variable was statistically insignificant (CI.95%[0.117, 1.093]).

The number of years of rice farming experience had positive relation in the logistic regression model to adoption of improved rice variety with an estimated value of the parameter (β_4 = **0.040**), however the coefficient value was not statistically significantly different from zero (**p=*0.498>a=0.05***) at 5% level of significance. This insignificancy was also demonstrated and proved as one was involved within the lower and upper value of the confidence intervals (CI.95%.[0.927, 1.170]). An increasing change of the independent variable by one unit would have the odds to influence adoption by 4.1% (OR-1)*100 or a factor of 1.041 times. Additional one year of rice farming experience, would positively and more likely influence adoption of the variety by a factor of 1.041 times.
Total size of own land holdings positively related to adoption in the logistic regression model having estimated value of the regression coefficient (β_5**= 0.872**) and statistically significantly different from zero at less than 5% level of significance (**p-value=*0.031<a=0.05***) which was also proved by the values of the confidence interval in which one was not included(CI.95%.[1.084, 5.275]). This could be expressed, when a hectare of land added to the total size of farmers' own land holdings by one unit , it positively influenced the choice of adoption of improved rice variety by 139.1%(OR(2.391)-1)*100 or a factor of 2.391 times.

Rice consumption in the household per month had related positively to the adoption of rice variety in the model (β_6**= 0.01**) but the coefficient value of the predictor was not statistically significantly different from zero (**p-value = 0.194>a=0.05**). In addition, one was found between the lower and upper values of the confidence interval which is a witness for the predictor to be insignificant (CI.95%.([0.995, 1.026]). One unit change of rice consumption in the household per month (it might be 1 kg or quintal etc.), would change more likely farmers' decision on adoption by 1% (OR(1.010)-1)*100 or higher by a factor of 1.010 times to use improved rice variety. In other words, one additional kilo gram or quintal of rice consumption per month, would more likely increase adoption of rice variety by 1% than those who didn't change their rice consumption in the household.

The other independent variable was the number of family members involved in agriculture, which influenced adoption of improved rice variety positively with an estimated value of the coefficient (β_7**= 0.173)** in the logistic regression model but it was not significantly different from zero (**p-value = 0.419>a=0.05**) at 5% level of significance. One was involved between the lower and upper values of the confidence interval at 95% (CI.[0.782, 1.809]), this indicated the variable was not statistically insignificant at 5% level of significance. There for, a one unit incremental change to the total family size involved in agriculture increased adoption of improved rice

variety by the odds of 18.9% (OR(1.189-1)*100 or more likely higher by a factor of 1.189 times.

Sex was one of the categorical independent variables, it was related positively in the logistic regression model to adoption of improved rice variety with its parameter value of (B_9=0.245), however it was not statistically significantly different from zero (p-value =0.768>a=0.05). This insignificant value was also evidenced that one was included between the values of the confidence interval (CI.95%.([0.250, 6.520)]. The marginal effect or value of odd ratio , when we go across from female which was coded as (0) to male coded (1), male headed households more likely influence farmers' decision to adoption of variety by 27.8% or a factor of 1.278 times.

Membership to agricultural cooperative was positively influencing to adoption of improved variety in the logistic regression model with the value of estimated coefficient (**β_1 = 1.528**) and which was also statistically significantly different from zero at less than 5% level of significance($p_{0.05}$**=0.025<a=0.05**). The odd ratio value indicates farmers who were members of the cooperative had more likely adopt improved variety by 361.1% (OR(4.611)-1)*100 or a factor of 4.611 times than the other farmers who were not members of the agricultural cooperatives.

The model was explained by 42.9% according to NagelKerke result in the model summary (**R^2 = 0.429**). This shows the model fits good with the data. The expected value of the dependent variable would be (β_0= **-1.279**) when all the predictors are equal to zero. Therefore, four variables such as distance to development agent, distance to the main road having access to transportation, total size of own land holding, membership to agricultural cooperative, were included in the binary logistic regression model. Two predictors such total size of own land holdings and membership of the farmers to cooperatives were significant at 5% level of significance and distance to development agent and distance to the main road having access to transportation were remained in the model as its coefficients statistically significantly different from zero at 10% level of significance.

$$Prob(Y=1) = ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 \ldots \beta_i x_i$$

= [-1.279 + 0.872(ownLand) + 1.528(cooperat) - 0.541 (distDevA) -1.027(distTran)]

Table 3..Estimate values of parameters in binary logistic regression and marginal effects).

						95% C.I for Exp(β)	
Explanatory variables	**Coefficient**	**S.E**	**Wald**	**Sig.**	**Exp(β)**	**lower**	**upper**
Age of HH head (years)	-0.003	0.025	0.016	0.900	0.997	0.949	1.047
Distance to development agent(km)	-0.541	0.291	3.305	0.069*	0.582	0.325	1.043
Distance to main road (km)	-1.027	0.569	3.254	0.071*	0.358	0.117	1.093
Years of rice farming experience(years)	0.040	0.059	0.460	0.498	1.041	0.927	1.170
Total size of own land holdings (ha)	0.872	0.404	4.662	0.031**	2.391	1.084	5.275
Rice home consumption per month (kg)	0.010	0.008	1.688	0.194	1.010	0.995	1.026
Family member involved in agriculture(no)	0.173	0.214	0.654	0.419	1.189	0.782	1.809
Gender	0.245	0.832	0.087	0.768	1.278	0.250	6.520
Membership to agricultural cooperative	1.528	0.682	5.016	0.025**	4.611	1.210	17.568
Constant	-1.279	2.752	0.216	0.642	0.278		

****,**,*, 1, 5, 10 % level of significance respectively*

5. Conclusion and Recommendation

In this study, it was realized that new variety had relatively low acceptance by farmers in the Fogera rice production plain. This result indicates for breeders to give focus for variety improvement research activities that meet farmers' circumstances and extension research staffs might to supply alternative seed of improved rice varieties for farmers through strengthening seed producing cooperatives and newly establishing in emerging producing areas too to address shortage of improved seed supply

complained that there was a high shortage of seed supply particularly for recently released rice varieties. As rice is a new crop to the country, it needs a lot of research and development efforts to promote the rice sector and contribute to ensure food security at the regional and national level.

6. References

Alemu, D., Shiratori, K., Seo, T., & Nishikawa, Y (2011). strengthening the responsiveness of agricultural research systems. *Farmer Research Groups*, 185.

Alemu, D. (2015). Rice in Ethiopia: Progress in production increase and success factors. In *6 th CARD General Meeting*(pp. 1-22).

Belayineh et al. (2017): Review On Adoption, Trend, Potential, And Constraints Of Rice Production To Livelihood In Ethiopia.

Gebey, T., Berhe, K., Hoekstra, D., & Alemu, B. (2012). Rice value chain development in Fogera woreda based on the IPMS experience.

Access this Article in Online	
	Website: www.ijarbs.com
Quick Response Code	Subject: Agriculture
DOI:10.22192/ijarbs.2021.08.11.012	

How to cite this article:
Misganaw Anteneh Tegegne. (2021). Determinant circumstances for adoption of improved rice variety in Fogera rice production hub of North Western Ethiopia. Int. J. Adv. Res. Biol. Sci. 8(11): 106-113.
DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.11.012