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Factors that influence the dominance of X-Jigna cultivar under smallholder rice production in Fogera Plain, Northwest Ethiopia

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The aim of this study is to learn more about the status and factors that influence the uptake of improved rice varieties in the Fogera plain, a well-known rice-growing area in Ethiopia. A total of 155 rice-producing households were chosen through a systematic random sampling method. Simple descriptive statistics like mean, frequency, percentage, and standard deviation were utilized to characterize the sample households, while a binary logistic regression model was used to investigate the relevant influencing factors. This study confirms that despite the availability of a number of improved rice varieties assumed to be suitable for the study area, the uptake status of these varieties was found to be very low (16%). The Shaga variety is exempted as it has higher acceptance and compets with the local X Jigna based on different rice traits. According to the logistic regression model results, some variables, such as household heads' age, education level, rice farming experience, land ownership, and road and credit accessibility all contributed significantly to the lower uptake of many improved rice varieties and the dominance of the X Jigna rice cultivar. Hence, based on the findings of this study, providing youth-oriented extension service, implementing farmers' field school, improving road infrastructure, and devising research procedures on variety development that consider farmers' preferences are recommended to have a wider use of rice technological innovation in conjunction with other institutional innovations. These will improve the lives of numerous rice-growing farmers and the national economy.

Key words: *Oryza sativa* L, X Jigna, Shaga, uptake status, Fogera plain, rice-growing farmers.

INTRODUCTION

Rice (*Oryza sativa* L.) probably originated in South-east Asia, but nowadays it is widely grown in other parts of Asia, America and Africa (Khush, 1997). Introduction and cultivation of rice in Ethiopia started in Gambella and Fogera plains through the collaboration works of the Government of Ethiopia (GoE) and North Korean Development Cooperation in response to the great famine in the early 1970s which took the lives of hundreds-thousands of human beings and countless domestic animals (Tadesse, 2020; Tegegne and Mathias,

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2019). From inception to date, rice cultivation endeavors in Ethiopia have shown remarkable progresses in different aspects. According to FAO, taking 2009 as a benchmark, in 2019, from 57,576 ha of land, 170,630 tonnes of rice were produced with a productivity of 2.96 tonnes/ha, representing 20.6, 65.4 and 37% increment in area harvested, volume of produce and yield, respectively within a decade .

The demand for rice consumption in Ethiopia is increasing with rapid population growth, increase in per capita consumption and expansion of urbanization. Despite recorded successes, it does not still satisfy the growing internal market demand of the country (Takele et al., 2017). For instance, the share of domestic rice production of the national demand on 2019 was only 24% and the rest of 76% is covered with import. According to the Ethiopian Revenue and Customs Authority, rice imports grew alarmingly and reached a foreign currency payment of around US$186.2 million in 2019 (Alemu and Thompson, 2020).

Poor performance of the rice seed sector, competition of imported rice with local production in terms of both quality and quantity, poor infrastructure for improving rice production and an under developed marketing system for domestic rice compared to imported rice are the challenges facing smallholder producers dominated rice sector development in Ethiopia (Alemu and Thompson, 2020). Responding to the challenges, Government of Ethiopia (GoE) has given higher attention and considered the commodity as a strategic crop to improve national food security and economic growth of the country. Thus, some of the areas where major interventions are needed in the national GTP plan of the country include the followings: introduction and development of high yielding varieties, multiplication and dissemination of quality and improved seed, use of agricultural inputs including post-harvest machineries, capacity building and follow up to realize farmers' use of recommendations, enhancement of value chain approach for rice production, cluster farming, and motivation of private investors to start commercialized irrigated rice farming (FDRE/NPC,2016).

Accordingly, the National Agricultural Research System (NARS) in collaboration with Coalition for Africa Rice Development (CARD), International Rice Research Institute (IRRI), Africa Rice and other partners has released 39 improved rice varieties used for the three (lowland, upland and irrigated) rice agro-ecologies. It is well noticed that seed technology lays fertile ground for better utilization of other rice related technologies, knowledge and Good Agricultural Practices (GAP) in rice cultivation, despite, availability of seed by itself is not sufficient requirement to be up taken by smallholder rice-growing farmers.

In line with the aforementioned facts, the novel study done by Atnaf et al. (2021) in Fogera plain, pinpointed as uptake status of improved rice was very low. The paper also discussed reasons for the dominance of local X Jigna rice cultivar over improved rice varieties at glimpse. It mainly looks at it from the perspective of traits the variety contained. Again, dealing with technology uptake status by looking at it both from the technology itself and from the producers' socio-economic situations and production area, institutional and infrastructural point gives full picture.

Hence, the motivation of this study is to bring both perspectives and identify factors that directly and indirectly contribute to the lower uptake of many improved rice varieties and the dominance of the X Jigna rice cultivar, mainly from the point of view of the rice variety itself and also from households' socioeconomic characteristics and their access to institutions and infrastructures. Such kind of study has significant contribution in addressing challenges of rice technology up taking process to increase the nation's rice production volume and thereby improving share of the national demand on own production, that directly influences import substitution strategy of GoE and ultimately reduces burden on foreign currency. Therefore, this study intends to have deep insight on how far, why and by what factors the local X Jigna rice cultivar dominates the rice production compared with many improved rice varieties in Fogera plain which is recognized as the leading rice production hub in Ethiopia.

METHODOLOGY

Description of the study area

The South Gonder zone is predominantly recognized for its rice production potential, which approximately covers 70% of the rice grain supply in the country. It has 12 districts and a total population of 2,051,738, of which 1,041,061 are men and 1,010,677 are women and with an area of 14,095.19 km^2. In the zone, the average rural household had 1 ha, which is almost equivalent to the national average (1.01 ha) and greater than the average land holding of the Amhara region, which is about 0.75 ha. Fogera plain is divided into three districts: Fogera, Libo-kemkeme, and Dera. The plain is endowed with favorable temperatures, rainfall amount and distribution, and wider wetlands, and motivates smallholder farmers to participate in rice cultivation. Within the plain, specific study area, Fogera and Libo-kemkeme districts contribute 43% of the national rice grain supply in total, with the shares being 28 and 15%, respectively (Desta et al., 2022; CSA, 2017) (Figure 1).

Sampling procedures and sample size determination

Under South Gonder zone, the two districts namely Fogera and Libo-Kemkeme were selected purposively based on their potential in terms of rice production and coverage. This study used lists of households that produce rice; they were prepared by their respective districts' agricultural offices as sampling frame. After taking the lists of households that produce rice, they were sampled using systematic random sampling technique. To determine the minimum sample size, Yamane's formula (1967) was employed.

$$n = \frac{N}{1 + N(e^2)}$$

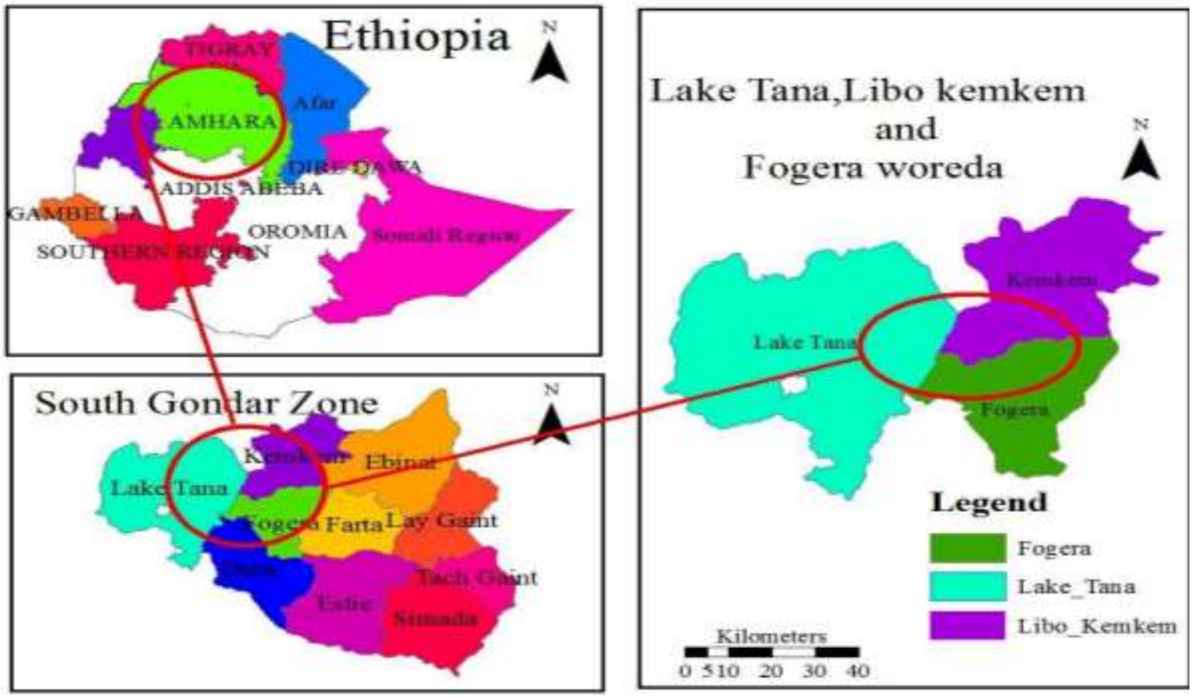

Figure 1. Location map of the study area.
Source: Ethio Geospatial data.

where **n** is sample size, **N** is the number of total rice producing households in the study area and e is the precision level. From 23150 rice producing households, with a precesion level of 0.08 a total of 155 sampled households were drawn using the formula.

Types, sources and methods of data collection

The types of data used were both primary and secondary which were collected directly from sampled rice producer households as well as secondary data sources, respectively. Secondary data include documentations of different organizations such as zonal and district level agricultural offices. Methods used to collect primary data were semi-structure questionnaire-based interview, key informant interview and Focused Group Discussion (FGD). The data from smallholder farmers that produce rice were collected from January 2020 up to February 2020 using semi structured questionnaire. FGD was employed after econometric model analysis on identifying the factors that influence the up -take status of improved rice varieties in May 2020 was done. It was conducted to justify why the significant variables influence the up- take status of the rice varieties based on the opinions of the respondent farmers. The questionnaire was templated with CSPro-software version 7.2 and pre-tested before implementing the actual data collection.

Methods of data analysis

The data analysis was executed using STATA version 15 software. Descriptive statistics including mean, percentage and standard deviation were applied to characterize rice producing households. Inferential statistical tools including independent t-test and Chi-square test were employed to compare means of continuous explanatory variables and to indicate the relationship or interdependency of dummy explanatory variables of variety use category, respectively. The study used binary logistic regression model to identify influencing factors of improved rice varieties use decision. The model is specified as follows:

where Y is a binary outcome and X is an independent variable in modelling px = P (Y = 1|X = x), that is, the probability of success for the covariate value of X = x.

The model was specified as:

$$\text{Logit (px)} = \log(px/1\text{-}px) = b_0 + b_i x_i$$

where log (px/1-px) is the ligit function, b_0 is the intercept, b_i is the vector of parameters to be estimated and x_i is the vector of explanatory variables included in the model.

The main reason for using the logit model is due to the dual decision nature of the dependent variable (rice variety use decision, weather the rice producing farmers were using local X Jigna rice cultivar or improved rice varities). Based on the rice varieties use category, the model is specified as:

$$D_i = 1, \text{ if } D_i^* > 0 \quad (1)$$

$$D_i = 0, \text{ if } D_i^* \leq 0 \quad (2)$$

$$D_i^* = b_i x_i + e_i \quad (3)$$

where e_i is the error term. Because the nature of the dependent variable is dummy, interpreting the model results using the cofficient is not approprtiate. As a result, the logit model results were interpreted using marginal effect or marginal change which shows the change in probability when the predictor or independent variable increases by a certain unit. Accrodingly, the change in probabiliy of using a rice varieties (either improved or local) is from 0 to 1. The respective variable definition and hypotheses are shown in Table 1.

RESULTS AND DISCUSSION

Demographic and socio-economic characteristics of sample households

This section deals with a simple description of the sampled households in relation to their demographic and socio-economics characteristics. Accordingly, as shown in Table 1, average age of the sampled household head was found to be 42 years. It shows that majority of the household heads were found to be in productive age groups in crop cultivation. Majority of the total respondents (92.26%) were male headed. The proportion of the household heads that can read and write was equivalent to those who cannot read and write. The average rice cultivation experience of the household heads was found to be 12 years. It is relatively smaller than the other crops farming experience of the sampled households. This is because rice is newly introduced in the study area as well as Ethiopia. The average household size of the sampled household was found to be 5. It is almost similar to the national rural households' size which is 4.9 persons per household (CSA, 2007).

The average farm land owned by the sampled rice producing households was found to be 0.73 ha; it is relatively very high compared to the national rural land owned size since the region in general and the study area in particular have relatively lower population density compared to many other regions in Ethiopia (Diriba, 2018). In addition to having relatively higher farmland size, the average number of farm plots of the household was found to be 4. Higher number of plot of land might help the sample households to access different rice ecologies suitable for cultivating different rice varieties of the three rice ecosystems (upland rice, lowland rice and irrigated rice). Furthermore, having higher number of plots will be an opportunity for farmers to minimize production and marketing risks via growing different crops. The average annual off farm/non-farm income of the sample households was found to be 1656.13 Birr while the average annual on farm income was found to be 16136.36 Birr. These figures imply that higher portion of the total income is generated from crop production and also make the sampled household to peruse minimum livelihood diversification (Table 2).

Institutional characteristics of sampled households

Concerning the institutional characteristics, as shown in Table 3, more than half of the sampled households (84) are members of agricultural input supplier cooperatives where they fulfil their demands on crop intensification inputs mainly chemical fertilizers and improved crop varieties. Credit, which is one of the most important agricultural inputs, helps smallholder crop producers to access improved seeds, chemical fertilizers and pesticides and labours; it is accessible by almost half (76) of the sampled households. Similarly, more than half (85) of the sampled households have better access to road which could facilitate rice commercialization from both (inputs and output) sides. Moreover, majority of the sampled households (130) have a chance to access extension service delivered by kebele level development agents at least once in a cropping season. In line with this fact, coverage of public based extension services were found to be relatively high, where sampled rice producing households were visited by the development agent and/or district level experts with an average of more than 3 days per cropping season.

Continuous independent variables by variety use decision

Here, attempts were made to address the uptake status of the rice varieties in addition to dealing with the continuous independent variables by up taking decision. Accordingly, 84.5% of the 155 rice-producing household used the indigenous rice cultivar known as X-Jigna, while the remaining 15.5% used improved rice varieties. Despite the fact that NARS has released a number of rice varieties, this result clearly showed that rice producing farmers in the study area still use the local rice cultivar that was introduced three decades ago.

The mean difference of independent variables between the local X Jigna rice cultivar and improved rice varieties use was compared using independent t-test. As shown in Table 4, there is a significant mean difference between the local and improved variety users in age and land owned at 5 and 1% level of significance, respectively. The results showed that households using local cultivar were younger and have large farm land than improved varieties users. The local cultivar has a number of qualities from production, marketing and utilization perspectives. Household heads under younger age group passionately take into consideration these quality parameters for their rice production decision. As X Jigna has major quality of rice variety traits, rice producing farmers dominantly rely on it, even though some farmers involved in the FGD doubt its stable productivity in relation to losing its genetic potential because of the absence of legal institutions who could multiply X Jigna pure seed. Similarly, they indicated that X Jigna is affected by sheath rot disease; however, it has magnificent potential if its seeds are pure specifically in areas where rice has not been grown for so long. Contrary to the assumptions, households using improved rice variety have smaller land size compared to their counterparts. Farmers having smaller land size try to

Table 1. Operational definition of variables.

Variables	Definitions	Type	Exp. Sign
Dependent variable			
Rice variety use	Households that used improved rice variety takes 1 value and 0 for local rice cultivar used	Dummy	
Independent variable			
Age	Age of the household head in completed years	Continuous	+/-
Sex	Sex of the household head (1 for male 0 for female)	Dummy	+
Education level	Education level of the household head (1 for read/write and 0 otherwise)	Dummy	+
Rice cultivation experience	Rice cultivation experience in years	Continuous	+
Household size	Number of persons in the household	Continuous	+/-
Plot number	Number of plots in the household	Continuous	+/-
Cooperative membership	Cooperative membership of the household (1 for members and 0 otherwise)	Dummy	+
Road access	Access to road (1 for yes and 0 otherwise)	Dummy	+
Off farm/non-farm income	Income generated from Off farm/non-farm activities in Birr	Continuous	+
Land owned	Land owned of the household in hectare	Continuous	+
On farm income	Income generated from on farm activities in Birr	Continuous	+
Frequency of extension contact	Frequency of extension contact in number	Continuous	+
Lack of credit access	Lack of credit access (1 for yes and 0 otherwise)	Dummy	-
Price of rice technologies	Affordability of available rice technologies to the household (1 for yes and 0 otherwise)	Dummy	+

Source: Authors

produce surplus volume for own consumption and market merely through improving productivity, which demands using improved rice varieties. An example is Shaga, which is confirmed by the farmers in FGD that it outperforms the dominantly cultivated X Jigna rice cultivar.

Categorical independent variables by variety use decision

Chi square test result indicated, there is no relationship between rice varieties use category and independent categorical variables which are hypothesized to influence the up -take status of rice varieties by the smallholder farmers. They include sex, education level, cooperative membership, road access and lack of credit access (Table 5).

Comparative analysis of X Jigna and Shaga

In comparing the local X Jigna rice cultivar with the promising recently released improved rice variety Shaga, as shown in Table 6, Shaga paddy productivity outperforms X Jigna by at least a ton/ha in both research and farmer fields. Despite the fact that X Jigna's milling recovery percentage was somewhat higher than that of Shaga, the yield in milled equivalent result showed Shaga (3.2 tons/ha) outperformed X Jigna (2.65 tons/ha). Shaga, which outperforms X Jigna in grain yield performance, is competent in biomass output, and, most importantly, complements the current issue of X Jigna being sensitive to rice sheath rot disease, according to participants in the focus group and key informant discussions. Rice sheath rot has become a highly devastating disease, according to a study conducted by Bigirimana et al. (2015) in Rwanda, with production losses ranging from 20 to 85%. Farmers and key informants also stated that since X Jigna has been in the production system for more than three decades, it has demonstrated a propensity to lose its genetic potential.

Rice producers also made comparison between X Jigna and Shaga beyond the level of productivity to the stability of productivity. Accordingly, though Shaga is far better than X Jigna, rice producers also perceived the yield potential of Shaga variety

Table 2. Demographic and socio-economic characteristics.

Variable	Mean/Frequency	St.dev./Percent
Age	42.43	12.46
Sex (Male=1)	143	92.26
Education level (able to read and write=1)	78	50.32
Rice cultivation experience	12.10	5.05
Household size	5.4	2.26
Plot number	4.22	2.205
Annual off and nonfarm income	1656.13	3374.80
Land owned	.73	.44
Annual on farm income	16136.36	11199.06
Price of rice technologies (high=1)	139	89.68

Source: Own Data (2021).

Table 3. Institutional characteristics.

Variable	Mean/Frequency	Std. Dev./Percent
Road access (yes=1)	85	45.16
Lack credit access (yes=1)	76	49.03
Frequency of extension contact	3.23	3.28
Cooperative membership (member=1)	84	54.19

Source: Own Data (2021).

Table 4. The mean comparison of continuous independent variables using chi-square test.

Variable	Local Cultivar Use (n=131)	Improved Variety Use (n=24)	St Err	t value
	Mean 1	Mean 2		
Age	41.53	47.33	2.74	-2.1**
Farm experience rice	12.22	11.50	1.12	0.65
Household size	5.31	5.92	.50	-1.2
Plot number	4.28	3.92	.34	1.05
Frequency of ext. contact	3.27	3.00	.731	0.38
Sqrt off/non-farm income	21.48	10.99	7.89	.19
Land owned	.81	.61	.111	4.05***
Annual on farm income	16099.8	16335.8	3653.67	.92

Source: Own Data (2021).

will deteriorate in a short period of time (will not have stable grain yield for long time) compared to X-Jigna. In addition, the white seed colour of X Jigna cultivar makes it preferable in the market. As shown in Table 7, according to the farmers' response, X Jigna has 12.7% additional value than Shaga sales value. Moreover, currently, income generated from rice biomass sales or using of rice biomass for livestock fattening has become one of the means of income for rice growing farmers. Accordingly, though Shaga has competitive biomass yield with X Jigna, demanding for labour force in trashing deteriorates the quality of biomass thereby hampering the market price value of Shaga biomass compared with X Jigna. According to the farmers' response in FGD, from 1 ha of land covered by Shaga rice variety, farmers could gain an average of 7,700 ETB per year. With similar land size, rice producing farmers could gain an average of 10,400 ETB per year from selling of X Jigna rice biomass.

Furthermore, from consumption point of view (specifically based on softness of its Injera and flour density), Shaga by far outperforms X Jigna. As shown in Table 7, using equal amount of rice flour (100 kg of rice

Table 5. Relationship of categorical variables with dependent variable using chi-square test.

Variable		Local Cultivar/ Variety	Improved Variety	Total	χ^2 test
Sex	Female	10 7.63	2 8.33	12 7.74	0.014
	Male	121 92.37	22 91.67	143 92.26	
Education level	Not read/write	65 49.2	12 50	77 49.63	0.0012
	Read/write	66 50.38	12 50	78 50.32	
Coop membership	No	57 43.51	14 58.33	71 45.81	1.79
	Yes	74 56.49	10 41.67	84 54.19	
Road access	No	75 57.25	10 41.67	85 54.84	1.99
	Yes	56 42.75	14 58.33	70 45.16	
Lack credit access	No	65 49.62	14 58.33	79 50.97	0.62
	Yes	66 50.38	10 41.67	76 49.03	

Source: Own Data (2021).

Table 6. Grain yield and milling recovery based comparative analysis of X Jigna and Shaga.

Rice variety	Yield (ton/ha) (a)		Milling Recovery (%) (b)	a×b (ton)
	Research field	Farmers field		
X-Jigna	3.64	3.5	75.61	2.65
Shaga	4.84	4.5	71.01	3.20

Source: Own Data (2021) and Fogera District Agriculture Office (2021).

flour), Shaga variety has a chance of producing 19% additional number of injera over X Jigna. In comparing X Jigna and Shaga, even though the farmers and key informants explained that Shaga rice variety has all the comprehensive traits, with existing socio-economic, institutional and infrastructural setups, the farmers prefer X Jigna over Shaga. They also believed that using genetically pure X-Jigna seeds will recover its initial higher productivity that could compete with and even exceed the current yield potential of Shaga improved rice variety.

Factors influencing the uptake status of rice varieties by smallholder farmers

Ascertaining factors that impair the uptake status of many improved rice varieties and provide an advantage for the

Table 7. Income and flour density based comparative analysis of X Jigna and Shaga.

Rice variety	Market price of milled rice in ETB/100 kg	Income from rice straw sales in ETB/ha	Number of *Injera*/100 kg of rice
X-Jigna	2350	10400	525
Shaga	2050	7700	642

Source: Own Data (2021).

Table 8. Econometric model result.

Rice varieties use	Coef.	Marginal Effect	St. Err.	t-value
Age	0.118***	0.004	.037	3.17
Education level	1.831**	0.076	.744	2.46
Rice cultivation experience	-0.198**	-0.007	.082	-2.43
Household size	0.23	0.009	.177	1.30
Plot number	-0.295	-0.011	.256	-1.15
Cooperative membership	-0.485	-0.019	.592	-0.82
Road access	1.313*	0.055	.693	1.90
Sqrt off farm/non-farm income	-0.005	-0.000	.008	-0.62
Land owned	-4.897***	-0.185	1.134	-4.32
Annual on farm income	0.00	0.000	0.00	0.80
Sex	0.402	0.013	1.182	0.34
Frequency of extension contact	-0.113	-0.004	.093	-1.22
Lack of credit access	-1.37**	-0.054	.666	-2.06
Price of rice technologies	-1.806	-0.138	1.141	-1.58
	-1.481		1.855	-0.80
Constant				
Number of observations		155		
Chi-square		39.716		
Prob> Chi^2		0.000		

***p<0.01, **p<0.05, *p<0.1.
Source: Own Data (2021).

dominance of X Jigna rice cultivar over many improved rice varieties is estimated using a binary logistic regression model. The Wald Chi square value of 39.716 is statistically significant at 1% significance level (Table 8); it indicates that the selected model was appropriate to address the set objective. From the estimated result, coefficients of the model indicate how a given variable affects the likelihood or probability of an improved rice variety use decision. The result of the model was interpreted using marginal effects. Out of 14 explanatory variables used in the logit model, age, education level, rice cultivation experience, land owned, road access, and lack of credit access were found to be statistically and significantly influencing improved variety use decisions of rice producers. Significant variables are discussed subsequently.

The age of the household head influences households' decision to use improved rice varieties at a 1% significant level. The coefficient indicated an increase in age by one year maximizes the likelihood of using improved rice varieties by 0.4%. However, most of the improved rice varieties released by NARS, with the exception of Shaga, could not outperform the local X Jigna. In the study area, the younger heads of households are practicing market-oriented rice production. They mainly view the merits of rice varieties from the perspective of their relative advantage in the market (having white caryopsis color), not only productivity. In this regard, they are not satisfied with most of the rice varieties recently released. Consequently, younger rice producers still prefer and use the local X Jigna. An analogous finding was also obtained by Udimal et al. (2017).

Education level of the household head is statistically significant at 5% and has a positive influence on households' decision of using improved rice variety. The coefficient indicated an increase in education level by one year increases the probability/likelihood of using improved rice varieties by 7.6%. Household heads with relatively higher education background have a probability of contacting experts at the research centre, agricultural offices and NGOs to access extension materials. This gives them an opportunity to access information as well as seeds of Shaga rice variety, which is recently highly accepted by a number of rice producers. This result is consistent with the findings of Massresha et al. (2021), Feyisa (2020), Amare and Simane (2017), and Afework and Lemma (2015).

Rice cultivation experience is statistically significant at 5% and has a negative influence on households' decision to use improved rice varieties. The coefficient indicated an increase in rice cultivation experience by one year decreases the probability of using the improved rice varieties by 0.7%. The FGD result also confirmed that X Jigna is preferred over the majority of improved rice varieties by experienced household heads as they recognized X Jigna possesses multiple traits at once, which gives multiple advantages. Similar results were reported by Almaz (2008).

Road access is statistically significant at 10% and has a positive influence on households' decision of using improved rice variety. The coefficient indicated that having good road access increases the probability of using improved rice varieties by 5.5%. Household dominantly cultivated X Jigna is located in remote area. Moreover, the recently promoted and highly up taken variety, Shaga is cultivated by household having better road access. Theoretically, access to road is an important factor influencing crop technology up take. When there is access to roads which connect rural farmers with market, they can easily transport what they produce to the market. If the market linkage is increased, this in turn increases the farmers' confidence to produce demand-based commodity for sale through using improved agricultural technology. This result is consistent with the findings of Belay et al. (2022).

Land owned is statistically significant at 1%. The coefficient indicated that an increase in land owned by 1 ha decreases the probability of using the improved rice varieties by 18.5%. It is understandable that expected amount of a given crop for a household is attained in two ways. The first one is through the expansion of farm land while the second one is via improving crop productivity. This study result has shown an inverse relationship between land size and probability of using improved rice variety. It might be that the household having smaller land size was forced to use improved rice varieties like Shaga, which has relatively higher productivity to fulfil small volume of produce derived from having small farm land. A similar finding was obtained by Massresha et al. (2021).

Lack of credit access is statistically significant at 5% and has a positive influence on households' decision of using improved rice variety. The coefficient indicates that having credit access increases the probability of using improved rice varieties by 5.4%. It could be because the recently released Shaga variety is dominantly distributed by formal or semi-formal institutions like unions, cooperatives and farmers groups which require finance; while the highly demanded local X Jigna rice cultivar seeds are dominantly accessed through exchange in non-monetary form. Similar results were reported by Tura et al. (2010).

CONCLUSION AND RECOMMENDATIONS

The result of the study confirms that the uptake status of improved rice varieties by smallholder rice-growing farmers in the Fogera plain was too low. Overwhelmingly, the majority of rice-growing farmers used the local X Jigna rice cultivar, despite the fact that the uptake status of the Shaga rice variety is very progressive and promising. A rice variety that incorporates multiple traits into one was highly preferred by rice-growing farmers. X Jigna rice cultivar is more prefered to many of the improved rice varieties due to its higher and stable grain yield for several decades, white caryopsis color, and higher biomass yield with better palatability and storage suitability. These are the primary reasons for its dominance in the study area. Furthermore, the econometric model analysis results revealed that the age and educational level of the household heads, as well as access to credit and roads have positive contributions to the uptake of improved rice varieties by smallholder farmers; whereas the rice cultivation experience of the household heads and land ownership were found to have negative contributions. Therefore, the followings are recommended to enhance the national rice supply contribution of Fogera plain in implementing the import substitution strategy of the government to attain rice self-sufficiency by 2030: Provision of youth-oriented extension services; educating rice growing farmers with skills needed for seed maintenance; improving road infrastructure, minimizing bureaucracy of credit services delivered by governmental credit and saving institutions; devising and implementing a research procedure, including a Participatory Plant Breeding (PPB) approach that helps farmers to decide to be involved in the technology development processes. These will help to reduce the burden of foreign currency.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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