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Determinants of Rice Production in Amhara Region: Evidence from Fogera District, Ethiopia

Negese Tamirat*

Department of Economics, College of Business and Economics, Jimma University, Oromia, Ethiopia

Abstract

Agriculture has been assumed to be a vital sector for achieving food security and alleviating poverty. Rice is crucial and most cultivated cereal has a good potential to food self-sufficiency and food security. The production of rice is low in the district due to low attention given to the rice production and low agricultural technology adoption decision to rice production. Therefore, this research attempts to evaluate the determinants that affecting rice yield in the district employing cross-sectional field survey data gathered in 2022. A cross-sectional field survey was collected among 384 rice cultivators in the Fogera district, Amhara region. For the data analysis descriptive statistics and binary logit regression model were conducted. The results of binary logit regression presented the rice production was significantly affected by size of family, educational status, available family labor, livestock owned, access to extension, credit use, access to information, distance to nearest market, and distance to nearest road. Among these key underlying determinants educational status, available family labor, livestock owned, access to extension, credit use, and access to information were positively associated with rice production, whereas size of family, distance to nearest market, and distance to nearest road were negatively associated. The results evaluated the role of rice production at farm level due to higher yield and income could translate in to improved food security and grower's welfare. Therefore, concern bodies should give a vital attention to rice production which is a key to enhance rice grower's income.

Keywords: Agriculture • Food security • Rice production • Binary logit • Fogera district • Ethiopia • Grower's welfare

Introduction

Agriculture is a vital sector in the economic policy of many least developed countries. Agricultural enhancement is assumed to be a best strategy to achieve cereal grower's welfare because the sector is seen as a center to the livelihood of cereal growers. Specifically the advancement in agricultural yield improving food for consumption which in turn reduces food insecurity. Therefore, the sector plays very key role in alleviating poverty in many developing countries [1,2]. Consequently, growth in the agriculture is critical to achieving food security creating spill over effects to the other sectors [3]. Agricultural sector is largest sector and basis for reducing the country's food insecurity in the Ethiopia's economy. The sector holds source of livelihood for over 80% of its people, accounts 50%, 90%, 85% and 70% of gross domestic product, export revenue, labor force and raw materials respectively. Consequently, the agriculture has been the key element of the country's agriculture development led industrialization strategy for many years [4]. The sector presented a lower growth rate of 2.3% in 2015/16 [5]. Many factors served as responsible for such a low growth rate such as subsistence and seasonal rain fed, backward technology adoption decision, poor quality agricultural performance, income inequality, and massive population increment. Thus, the country has faced difficulties to meet its optimum demands for food security. Ethiopian government developed methods, techniques, policies, and strategies with high priority for agriculture to derive agricultural productivity and growth to achieve rural food security [6].

In Ethiopia different rice ecosystems such as upland rice, hydro orphic rice, irrigated lowland rice and paddy rice was introduced in the 1970's. The Fogera district rice cultivation was started in 1993. Rice has a great potential to attain food security in Fogera district, Amhara region. In the Fogera district in 1994, 256 rice grower's cultivated rice in an area of 65 ha produced 1,625 quintals of rice. After 5 years 1999, 16,383 rice grower cultivated rice in an area of 6,675.5 ha produced 313,921 quintals of rice. This presents a tremendous enhancement of the rice production in the district. As Fogera district report presents the rice production enhance from time to time due to using the very key rice improvement techniques, methods, strategies, and policies such as high yield varieties, adaptive rice varieties, improved rice technology, community based seed multiplication, pre-scaling up of technology, on farm demos, rice spacing and transplanting, use of high yield variety of seeds,

***Address for Correspondence:** Negese Tamirat, Department of Economics, Jimma University, Oromia, Ethiopia, Tel: 2 15910061222; E-mail: negesefb@gmail.com*

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pesticides and irrigation [7]. The above listed rice yield improvement is a very key to derive high rice yield.

The studies conducted by Bola AA, et al. evaluated determinants of rice production and its impact on grower's welfare in Nigeria, employing cross sectional field survey data among 481 rice growers [8]. Their studies result presented the different factors such as access to media, access to mobile or phone, training, seed, and income affected rice production and yield is positively correlated with welfare of growers. According to the studies of adoption of modern agricultural technology influenced rice production, which in turn affected income of grower in in Ghana using logit model among 300 growers [9]. The findings of logit model presented the rice production significantly affected by plot size, expected return from technology adoption decision, credit use, and access to extension [10]. Developed research on agricultural growth presented that the age, size of family, number of oxen, off-farm activities, educational status, and adoption decision of chemical fertilizers, improved seed varieties, pesticides, and organic minerals are key components to influenced yield of rice growers. According to the studies, evaluated the determinants of rice production and production in turn reduces poverty in Uganda [11]. Developed the studies on the determinants of rice production and its impact on income of female cultivators in Cote d''Ivoire [12]. The results of their studies indicated the rice production influenced by demographic, socio-economic and institutional factors. Examine influential factors of rice supply [13]. As the result of the supply of rice and rice production significantly affected by credit use, access to extension, educational status, and access to information [14]. Evaluated the factors determining rain fed rice production in Adamawa state Nigeria. As their studies rain fed rice production different underlying demographic, socio-economic and institutional factors. Hence, in the study area there is lack of adequate information, knowledge, and limited empirical literature on rice production. Therefore, this study developed to evaluate the determinants of rice production in the Fogera district, Amhara region.

Materials and Methods

Description of the study area

This research was developed in Fogera district, located in the Amhara region of Ethiopia. The total population of the Fogera district 233,529 estimated at, of which 119,010 (51%) is male 114, 510 (49%) is female. The mean yearly rainfall ranges from 1106 mm to 1336 mm. The total area of the district is 117.405 ha, of which 70% flat land, 11% is mountain and hill, 13% is valley bottom. Average land holding is about 1.4 ha with a minimum and maximum of 0.5 ha and 3.0 ha respectively. Fogera district was considered appropriate for the study for many reasons. First, it is one of the districts with high potential of rice production. Second, it is one of the districts where better and advanced technology has been introduced and well under implementation for rice production. There is a strong extension intervention focusing on rice growers. Moreover, newly introduced recommended rice varieties were widely applied in the district. The Fogera district is rich with beautiful diverse natural resource, with capacity to cultivate diverse rice crop.

Types and sources of data

Descriptive statistics and econometric methods were employed for the data analysis. Primary and secondary data were used. Qualitative and quantitative primary data were employed. The primary data collection was included rice grower demographic and socio-economic characteristics and production decision information. To get the required primary data different methodological approaches like questionnaires, key informant interviews, and focus group discussion were employed. To address the objectives of the study open and close-ended questionnaires were prepared. The study was supplemented by secondary data obtained from different published and unpublished documents, extension office, administrative office, relevant literature, website and other relevant organizations. Information obtained from secondary source includes list of rural rice growers and non-growers. Furthermore, interviews were held with key informants. Cross-sectional field survey data was collected in the months between January and June 2022.

Sampling techniques

The sample growers for this research were drawn from rice cultivators. Multi-stage sampling methods were employed to determine sample Kebeles and sample size. To select sample growers from total rice cultivators this study used non-probability and probability sampling procedures. Out of 33 totals rural Kebeles of Fogera district, 16 Kebeles were identified as good potential rice production. In the first stage: six rice grower Kebeles were randomly selected from totals 16 rice growing Kebeles in the district, based on their agro-ecology (Shaga, Tiwa Zakena, Addis Betekrstian, Kidist Hana, Kokit, and Wegetera). In the second and final stage: Total sample size 361 rice growers were selected from each stratum using proportionate sampling procedures. Finally, the sample respondents from six Kebeles would be selected randomly by employing randomly sampling methods. The sample growers were selected based on the formula given ($n=N/1+N\ (e)^2$). The survey was carried out in the months of January and June 2022 [15].

Data analysis

Data analysis has been done after all relevant data have been gathered from the rice cultivator respondents. It was carried out using descriptive statistics and logistic regression model. Descriptive analysis was examining demographic characteristics and socio-economic profiles of the rice growers and performed using indicators such as frequency, averages, percentages, tables, maximum and minimum values, and t-test. Next, the study applied econometric methods to provide a more appropriate and in-depth analysis. To compute the empirical relationship between the dependent variable and independent variables, the research was applied the binary logistic regression model because the dependent variable was rice grower is dummy/binary/take the value 1 if farmers are rice grower and 0 otherwise. A logit model was conducted to evaluate the determinants of rice production [16]. In this study, the logit model is employed for its simplicity and ease of interpretation of the parameter estimates in probability terms. A logit regression model with logistic probability distribution its simplicity calculation and probability lie between 1 and 0. It represents a close approximation to the cumulative normal distribution, a mathematically easily used model

and is easier to work with. Therefore, the probability of rice production:

$$Pi = Z\ (y = \frac{1}{xi}) = \beta_0 + \beta i\ xi \qquad (1)$$

Representation of rice cultivator.

$$Pi = F\ (Z) = \beta_0 + \sum_{i=1}^{n} \beta ixi = \frac{1}{1+e^{-(\beta_0 + \sum \beta ixi)}} \qquad (2)$$

Where Pi is the probability of ith respondent not rice grower, e is the base of natural logarithms (2.718), Xi is the explanatory variables, n is the number of explanatory variables, i= 1, 2, 3 …, n. and β_0 and βi are parameters to be estimated.

$$1\text{-}Pi = \frac{1}{1+e^{-Zi}} = \frac{e^{Z}}{1+e^{Z}}, \text{ where } zi = \beta_0 + \beta i\ xi \qquad (3)$$

If pi-is the probability of rice grower and (1-Pi) is the probability of rice not grower.

$$\text{Thus, } 1\text{- pi} = \frac{1}{1+e^{zi}}, \text{ then } \frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{Zi}} = e^{Zi} \qquad (4)$$

Taking natural logarithm

$$\left(\frac{Pi}{1-Pi}\right) = \left(\frac{1+e^{Z}}{1+e^{Z}}\right) = e^{(\beta_0 + \sum_{i=1}^{n} \beta ixi} \qquad (5)$$

Logit model:

$$Z = \ln\left(\frac{Pi}{1-Pi}\right) = \beta_0 + \beta 1\ x1 + \beta 2\ x2 + \ldots. + \beta n\ Xn \qquad (6)$$

Logit model becomes:

$$Z = \beta_0 + \sum \beta ixi + ui \qquad (7)$$

$$z_i = \beta_0 + \sum_{i=1}^{n} (\beta_i X_i) + U_i$$

Where z_i is a function of explanatory variables (X), β_0 is an intercept, β_1, β_2, β_3..... β_n are the slope of the equation in the model, L_i is a log of the odds ratio is a z_i, X_i is a vector of a relevant characteristic or independent variables and U_i is a disturbance term.

The below listed explanatory variable such as age, sex, size of family, educational status, availability of family labor, livestock holding, land holding, access to extension, distance to extension agent's office, access to credit, access to information, distance to nearest market, and distance to nearest road are expected to affecting the rice production and productivity in the Fogera district in Amhara region (Table 1).

Definition of variable	Nature of variable	Variable definition and measurement	Expected sign
Age (Aghh)	Continuous	In year	-
Sex (Sexhh)	Dummy	If available=1, 0 otherwise)	+/-
Size of family (Fshh)	Continuous	Number of family members	-
Educational status (Eduhh)	Dummy	If 1 literate, 0 otherwise	+
Family labor (Alhh)	Continuous	In number	+
Livestock owned (Lohh)	Continuous	TLU	+
Land holding (Lhhh)	Continuous	Ha	+
Access to extension (Aehh)	Dummy	If have access Yes=1,0 otherwise	+
Distance to extension agent's office (Dea)	Continuous	In working minutes	-
Access to credit (Achh)	Dummy	If having access=1,0 otherwise	+
Access to information (Aihh)	Dummy	If having inf.=1, 0 otherwise	+
Distance to nearest market (Dmhh)	Continuous	In working minutes	-
Distance to nearest road (Drhh)	Continuous	In working minutes	-

Source: Authors hypothesis 2022

Table 1. Explanatory variables definitions.

Results and Discussion

Description of determinants of rice

Depending on responses of rice growers, lack of rice growers' interest, lack of credit access and poor suitability of cultivated land were vital reasons for low yield of rice in the Fogera district. The growers were suggesting the need for responsible bodies to consider credit facility and suitable agricultural technology which is bases for optimizing rice yield. Table 2 presented the description of the major continuous explanatory variables that affected rice production. Accordingly, available family labor, livestock holding, distance to nearest market, and distance to nearest road were determining rice yield in the district. Majority of the rice growers in the district are endowed with sufficient family labor, and owned livestock. Specifically, available family labor, livestock holding, and distance to nearest road were significant at 1% probability level, while distance to nearest market was significant at 5% probability level. This result in line with the result of Afework, M [17].

Variable	Total (N=384)			
	Mean	Min.	Max.	t value
Agehh	50.71	25	87	0.0936
Fshh	6.35	2	13	0.521
Alhh	4.37	1	8	1.8726***
Lohh	2.78	0.5	5.75	2.3414***
Lhhh	1.16	0.25	3.25	0.2354
Dea	2.32	0.5	4.25	0.5468
Dmhh	8.47	4	14	1.8732**
Drhh	3.74	1	11	2.2361***

Source: Computed from own survey data 2022. ***P<0.01, **P<0.05 and *P<0.10.

Table 2. Description of continuous variables.

Table 3 presented the summary of dummy variable that affecting rice production. As the grower's response educational status, access to extension service, access to credit use, and access information were significantly influence rice production. Accordingly, most of the rice growers were literate (207), user of extension service (242), user of credit (193), and having access to information (245). Moreover, educational status, access to extension service, access to credit use were significant at 1% probability level, while access information significant at 5% probability level. The results of this study similar with the study.

Variable	1	0	Total	t – value
Sexhh	268	116	384	0.4358
Eduhh	207	177	384	3.7635***
Aehh	242	142	384	3.8875***
Achh	193	191	384	4.5348***
Aihh	245	139	384	4.3472**

Source: Computed from own survey data 2022. ***P<0.01, **P< 0.05 and *P<0.10.

Table 3. Description of dummy variables.

Econometric results

The analysis model estimates for the determinants of growers of rice production are presented in Table 4. The goodness fit with regard to the predictive efficiency was high with 311 (81%) of the 384 sample rice growers included in the model correctly predicted.

Variables	Robust Coef.	Std. Err.	Odds ratio	Z-value	P>|z|	dF/dx
Aghh	-1. 381	1.273	0.889	-0.38	0.537	-0.004
Sexhh	0.741	0.521	1.782	1.64	0.456	0.187

Fshh	-0.768	0.398	1.534	-2.21	0.014	-0.168**
Eduhh	0.473	0.841	1.136	2.76	0.004	0.192***
Alhh	0.347	0.596	1.987	1.87	0	0.273***
Lohh	0.362	0.335	1.737	2.04	0.037	0.0785**
Lhhh	0.657	0.287	0.763	1.24	0.564	0.072
Aehh	1.007	0.878	1.836	2.02	0.005	0.216***
Dea	-1.724	1.147	1.734	-1.64	0.378	-0.093
Achh	0.476	0.236	1.762	1.53	0.003	0.248***
Aihh	0.735	1.354	1.372	2.51	0.002	0.132***
Dmhh	-0.273	0.125	0.768	-1.76	0.028	-0.153**
Drhh	-2.531	1.548	1.786	-1.45	0.003	-0.247***
Cons.	1.573	1.186	0. 241	1.04		

Source: Computed from own survey data 2019; Number of growers=382; ***, ** and * imply significant level at 1, 5 and 10% respectively

Table 4. Determinants of rice production binary logistic model result.

Accordingly, Table 4 presented that threaten of the nine explanatory variables such as size of family, educational status, available family labor, livestock owned, access to extension, credit use, access to information, distance to nearest market, and distance to nearest road were found to have significant association rice production. Specifically, factors such as educational status, available family labor, and livestock owned, access to extension, credit use, and access to information had all significant positive associations with rice production with marginal effects ranging between 7.85% to 27.3% on average, other things being constant. Therefore, livestock holding, access to information, educational status, and access to extension, credit use, and availability of family labor positively and significantly affects rice production by marginal effects 7.85%, 13.2%, 19.2%, 21.6%, 24.8%, and 27.3% respectively. On the other hand, size of family, distance to nearest market, and distance to nearest road had significant negative association with rice yield with marginal effects ranging between 15.3% to 24.7% on average, ceteris paribus. Hence, size of family, distance to nearest market, and distance to nearest road negatively and significantly affects rice production by marginal effects 16.8%, 15.3%, and 24.7% respectively. Thus, availability of family labor, credit use, access to extension, and educational status were respectively associated with a 27.3%, 24.8%, 21.6%, and 19.2% higher probability of rice production on average, ceteris paribus. Age, sex, land holding, and distance to extension agent's office did not have significant relation with rice production. This finding consistent with findings.

Conclusion

Rice is a very vital cereal crops in alleviating poverty and food insecurity in Ethiopia. This study was aimed to evaluating the determinants of rice production in Fogera district, Amhara region. For the data analysis both primary and secondary sources of the data were used. Descriptive and binary logistic regression models of data analysis were applied. Moreover, the key determinants such as size of family, educational status, available family labor, livestock owned, access to extension, credit use, access to information, distance to nearest market, and distance to nearest road were found to be a vital factor underlying grower's rice production. Rice production is assumed to be a vital in deriving growth in agricultural sector which in turn provide economic growth in Ethiopia. Therefore, concerned bodies should give a crucial attention to rice production which is a key indicator to alleviate poverty and food insecurity.

Recommendations

Given these results, the various and key recommendation on rice production in the study area could emerged. Importantly, the results of the key determinants could serve as crucial input for designing policies and strategies aimed at rice production in the study area. Specifically, education a strong correlation with rice production, to this end, strengthening rice grower's knowledge among cultivators deserves attention for promoting rice production. Enhanced access to extension, credit use, and access to information could also help to achieve improved rice production. To this end, use of extension is needs to consider enhanced rice yield. Extension use and credit use is particularly vital in terms of enhancing rice production, which can, in turn, reduce poverty and food insecurity. Therefore, this study summarizes the rice cultivating supported by better yield enhancing technology could bring better yield. Hence, enhancing rice production should consequently resulting in substantial income, and alleviating poverty.

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