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Full Length Research Paper

Poverty and income inequality in Girar Jarso District of Oromia Regional State, Ethiopia

Dereje Haile* and Haymanot Asfaw

Department of Agricultural Economics, Addis Ababa University, College of Veterinary Medicine and Agriculture, Selale Campus, Fitche, Shewa, Ethiopia.

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The paper examines the status and determinants of poverty and inequality among rural households in Girar Jarso district of Central Ethiopia. To measure the status of poverty and inequality, the study made use of cost of basic need approach, Foster-Greer-Thorbecke indices and Gini coefficient. Based on the survey of 120 households, the logistic model was estimated. A three-stage sampling procedure was applied for selection of respondents. The poverty line is found to be 4315.7 Ethiopian Birr. The incidence of poverty was computed to be 45% with an average poverty gap and squared poverty gap of 18.6 and 9.99%, respectively. The Gini coefficient was calculated to be 0.33. The logit model shed light on the demographic and socioeconomic characteristics of households behind the persistence of poverty. The result revealed that poverty is strongly linked to family size, remittance, farm and non-farm income and receiving food aid. The findings suggest also that livelihood diversification, encouraging flow of remittances, promotion of non-farm activities, besides agricultural intensification, and appropriate target to avoid distortionary effects of food aid will constitute an important strategy to accelerate poverty reduction.

Key words: Poverty, income inequality, determinants, household, Ethiopia.

INTRODUCTION

Achieving sustainable economic growth with a particular focus on eradicating extreme poverty and hunger has become the key development goal for governments around the world, as reflected in the Sustainable Development Goals (World Bank, 2017). The World Bank (2014) also set an ambitious goal of reducing, to no more than 3%, the fraction of the world's population under the canopy of poverty by 2030. However, there are around 1.2 billion people in extreme poverty in the world (World Bank, 2015). Globally, substantial progress has been made in reducing poverty in the past few decades. The share of African population in absolute poverty declined from 56% in 1990 to 43% in 2012 (Beegle, 2016).

Although Ethiopia has long been known as the cradle of humanity, poverty remains dauntingly widespread and pervasive. By any standard, the majority of people in Ethiopia are among the poorest in the world. Ethiopia has achieved a remarkable economic growth on average of

*Corresponding author. E-mail: hailedereje92@yahoo.co.uk

10.6%, in comparison with an average population growth rate of 2.6%; this implies that the average annual per capita income growth rate was 8.4%. However, because of high population growth, the absolute number of the poor has remained unchanged at some 25 million over the past 15 years. Poverty head count has fallen from 45.5% in 1995 to 26.0% in 2012/2013. It is slightly higher in rural areas (30.4%) than in urban areas (25.7%). Many rural Ethiopians cycle around the poverty line, moving in and out of poverty during the course of a year. Income of the rural poor is 7.8% on average; far from the poverty line, while it is 8.0% for the urban poor. The poverty gap was also reduced but not the severity of poverty. The country is registered to be the poorest in Sub-Saharan Africa with a Human Development Index of 0.448 and Multidimensional Poverty Index of 0.564, which gives a rank of 174 out of 188 and second from the last (Niger) (MoFED, 2012; UNDP, 2015; OPHI, 2016).

Ethiopia, as in other countries in the Horn of Africa, is now associated with famine and it has become the iconic poor country (Maxwell, 2007). Over the last several decades, there has been extensive works on analysis of poverty in Ethiopia. The research interest was strengthened with the decision of many countries to adopt the UN Millennium Declaration exerting as much effort as possible to achieve the MDGs. Many researches revealed that poverty experienced in the last several decades results from a number of structural factors; prolonged conflict, adverse geographical condition, vulnerability to shocks, decline in land holding, irregular supply of inputs, poor access to education, fragile food security, limited access to healthcare and lack of infrastructure, weak institutional structures, rapid population growth, failures in credit, land and extreme environmental degradation (Porter, 2015; Jakiel, 2016; Gecho, 2016). An over-reliance on agriculture, poor asset ownership, poor education, and trivial levels of livelihood diversification are all to blame. Besides, the country suffers spells of drought, with resulting famines and such conditions have a strong influence on the living standards of the whole population (World Bank, 2015).

Ending poverty in all its forms everywhere has been an important component of the SDGs setting out goals and targets to be met by the year 2030 (UNDP, 2015). The adoption of a global goal only makes sense if progress can be monitored. Poverty analysis is a natural point of departure. For a country analysis to meet the SDGs, designing a strategy, analyzing the magnitude and investigating the root causes of poverty has a paramount importance. Since poverty reduction is not an instantaneous process, continuous and systematic analysis is very crucial (MoFED, 2012; World Bank, 2017).

A number of studies have been done at micro level to examine the extent and determinants of poverty in rural Ethiopia (Bogale et al., 2005; Dawit et al., 2011; Abebe, 2017; Bogale, 2011; MoFED, 2012; Sharma, 2014). Most of these studies are aimed at assessing the extent of poverty and explain relative changes which occur in the incidence of poverty due to policy changes. The empirical results of these studies reflect the severe poverty level that continues to prevail in rural Ethiopia and poverty has multiple causes that exhibit economic, social and political characteristics. However, what have so far been studied in Ethiopia, much if not all, concentrate on and reflect the national picture. But studies and analysis at an aggregate level do not necessarily reflect the situation at grass root level. Dercon and Krishnan (1998) strongly advised that one should be careful about the implications derived from measurement and factors of poverty at the national level, because it hides many important differences that exist in different locations.

The road coming out of poverty is rarely a smooth one. The dream of ending global poverty by 2030 is a highly aspirational objective, but is not entirely beyond reach with concerted efforts and commitment from individual countries as well as the international development community (World Bank, 2015). In order to combat such incapacitating problem and its exit time considering very scarce resources available to be allocated for the purpose, the poor must be properly identified and an index taking the intensity of poverty suffered by the poor into account needs to be constructed (Bogale, 2011).

Poverty everywhere is a rural phenomenon and it is caused by dynamic factors that need persistent exploration in order to know its causes at a particular time. Most Ethiopians are rural dwellers and subsistence farmers, and the poorest 40% tend to be even more likely to live in rural areas and engage in agriculture (World Bank, 2016). So far analytical works that scrutinize poverty conducted in Girar Jarso is at best scanty. Most researches focus on the determinants of poverty at an aggregate level. Measurement and analysis of poverty at a disaggregated level is a necessary condition to make the poor an agenda by policy makers on that particular area. The outcomes of the analysis should give a clear picture on the situation in order for decision-makers to be able to identify critical areas for intervention (MoFED, 2012; SESRIC, 2015). To eradicate poverty, successive regimes have launched several poverty alleviation programmes to curtail problems of poverty in the country. These programmes have ensured reduction in poverty. However, the pace of poverty reduction over the past decade has been slow. This phenomenon calls for assessment of poverty and as such, the objective of this study is to assess the status of poverty, measure income inequality and identify the major determinants of poverty.

MATERIALS AND METHODS

Study area

Girar Jarso is located in Central Ethiopia 112 km away from Addis Ababa on the way to Bahirdar, with an area of 401.9 km^2. The

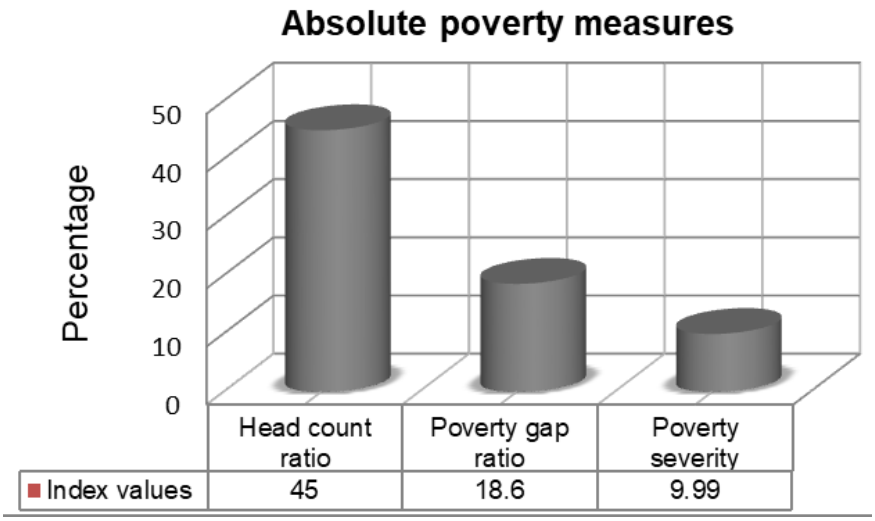

Figure 1. Poverty incidence and severity (Household Survey, 2017).

central highlands have long been considered Ethiopia's most famine-prone areas (Maxwell, 2007). According to Zone Finance and Economic office report of 2004 E.C, the population of the woreda is closed to 76,921 (Male 39,387 and Female 37,534). The average annual temperature ranges from 15 to 18°C, while the average annual rainfall varies between 1200 and 1400 mm. The land holding size on average is estimated to be 3.2 ha. The district is divided into 17 peasant associations with a total of 12,062 farm households (DARDO, 2009) (Figure 1).

Mixed farming is the mainstay of the household economy, intensively carried out by those who have land and livestock. The farming system is rain fed and is characterized by low productivity, low use of farm inputs, traditional farm practices, poor soil fertility, water logging and other related problems. The landless are engaged in sharecropping and other off farm income generating activities like daily laborer. Agricultural products are consumed at home and partly sold to earn cash to meet other household needs, educate children, and contribute to social affairs. The main crops grown include cereals (barley, wheat and teff), pulses (horse bean, chickpea, and lentil), fruits and vegetables (apple, cabbage, kale, onion). Livestock contributes to the subsistence requirement of the population particularly from small ruminants. The major livestock species kept by farmers in the area includes shoats, cattle, donkey, mule and horse. Like elsewhere in the country, the production and productivity of this sub sector is very low.

Sampling procedure

The analysis of poverty in this paper is based on a household survey conducted in Girar Jarso district in Central Ethiopia. The rural household was taken as a basic unit of analysis. The research design followed a multi stage sampling method (systematic and random) at woreda, village and household levels, respectively for selection of desired sample respondents to generate the required primary data. In the first stage, Girar Jarso district was selected purposively from 14 Woredas of the zone based on frequency of shocks like drought or being in famine prone area, food relief program and the subsequent death of cattle during drought season within the central Showa highlands as criteria. In the second stage, four peasant associations, namely, Torbanashe, Addisge, Dire Doyyo and Koticho were selected randomly from a list of peasant associations in the district. In the third stage, sample households were randomly drawn from a complete list of respective peasant association members in conformity with the proportionate to size random sampling procedure. In total, the survey covered 120 households.

Data were collected using both primary and secondary sources. Before conducting the field survey, three enumerators with practical knowledge of the area and well conversant with the culture and language were recruited. The enumerators were diploma holders. However, a detailed discussion was held with them about the interview schedule and they were trained on understanding the questions, interpretation and translation of concepts which improved their confidence and to make amendment in the interview schedule accordingly. To obtain information on poverty, empirical data were collected through structured questionnaires. Discussions with key informants were also held. The enumerators collected the required data under a close supervision of the researcher. The structured questionnaires on demographic, economic and institutional aspects were posed to heads of households. The filled-in interview schedules were thoroughly checked every day on the spot for completeness and for re-interview if problem occurred. Beside the primary data, relevant documents to the study, books, previous working literatures, statistics, and checklists of facts and figures were collected from different government offices of the Woreda. Unpublished materials were also used.

Method of data analysis

After the data collection and retrieval, the data were first sorted out, edited, coded and analyzed using Excel and Statistical Package for Social Sciences (SPSS version 16.0). The research then used descriptive statistics like percentages, means and standard deviations, and inferential statistics like Chi-squares and t-test. The Costs of Basic Needs (CBN) approach, Foster-Greer-Thorbecke (FGT) indices, Gini coefficient, Watts index and econometric model were also employed to address the stated objectives of the study.

Setting poverty line

The first step in measuring poverty is defining an indicator of

welfare such as income or consumption per capita (Khandker, 2009). Consumption expenditure or income has been traditionally used as measure of household poverty. But consumption is typically preferred to income as it better captures long run welfare. It is considered as an adequate measure of household welfare in developing countries as it is better able to capture household's consumption capabilities. Consumption may also better reflect household ability to meet their basic needs. Income is one of the factors that enable consumption, though consumption also reflects a household access to credit and saving at times when their income was too low. Hence consumption is a better measure of household welfare than income (World Bank, 2016). The analysis here is based on the consumption expenditure dataset of the sample households.

There are several approaches to construct the poverty lines. The most popular method of poverty measurement have used the nutritional norm and defined poverty in terms of minimum calorie requirements. The Cost of Basic Needs (CBN) is one of these different approaches, where the total poverty line is constructed as the sum of a food and a non-food poverty line (Greer, 1986; Khandker, 2009). According to Ravallion (2016), three steps in the process of defining absolute poverty lines were used. This includes choosing a welfare indicator, establishing a poverty line and aggregating poverty data. The first step involves specifying a reference level of utility representing a minimum standard of living. The research employs a consumption bundle (2300 Kilo calorie/adult equivalent/day) considered adequate for an adult to lead an average physical life under normal conditions based on estimation of the Ethiopian Nutrition and Health Research Institute (EHNRI, 1997).

Next, consumption expenditure as a money metric threshold between the poor and non-poor associated with the reference utility level was identified. In this case, households were divided into quartiles according to their consumption expenditure per adult equivalent. The choice of reference group was determined on the basis of the commitment the governments want to make in terms of allocating resources to poverty reduction programs. It was reasonable to choose the population belonging to the bottom quartile as a reference group (Kakwani, 2010). The food poverty line is obtained by selecting baskets of food items which are reasonably consumed in a given setting and then calculating which basket yields the specific calorie minimum at the lowest cost under the prevailing prices. The cost of this basket defines the food poverty line.

The food consumption behavior of the reference group accesses to determine average quantities in per adult equivalent of basic food items that makeup the reference food basket. In this case, the basket is made up of the mean consumption levels (purchase, remittance, from aid, and own production) of 13 food items. The calorie value of each food items is established from the food nutrition table of Ethiopian Health and Nutrition Research Institute. The total calorie from consumption of this basket of average quantity per adult by an individual is:

$\sum Q_i$ Kcal = T *, with T ≅ T *. But T *' ≠ T

where T* is the total calorie by individual adult from consuming the average quantities, Q_i is the average quantity per adult of food item 'i 'consumes by individuals, Kcal is the caloric value of the respective food item 'i' consumed by individual adult and T is the recommended calorie of per day per adult.

The average quantity per adult of each food item scales up and down by a constant value so as to provide total of 2300 Kilo calorie/adult equivalent/day before doing any activities. Then, multiply each food after scaling up by the median price and sum up to get a food poverty line. The method of deriving the non-food poverty line is done by choosing some non-food considered essential. However, since there is no absolute standard for minimum non-food requirements similar to that of food that has a standard calorie intake as a basis, constructing the non-food poverty line remains arbitrary (SESRIC, 2015). The non-food needs were obtained by examining the non-food expenditures per adult equivalent per year for households in the lowest income quartile.

Poverty indices

Among the various methods of quantifying poverty, the Foster, Greer and Thorbecke (FGT) formula (Foster, 1984) is the most widely used method. With the help of these indices, the head count, poverty gaps and squared poverty gaps were calculated. The formula has been successful in providing a quantitative description of the spread, depth and severity of poverty in populations. These classes of poverty indices were followed to scrutinize the extent of poverty at the household level. The mathematical expression of the model is specified as:

$$P_\alpha = \int_{i=1}^{z} \left[\frac{Z-x}{Z}\right]^\alpha ; f(x)dx \quad \alpha \geq 0$$

where P_α is the poverty measure, Z is the poverty line, x is the income of households, N is the sample population, q is the number of poor, and α is the poverty aversion parameter or the weight attached to severity of the poor.

The measures are defined for α≥0. For α = 0, P_0 = f (z), the cumulative income distribution at the poverty line Z. In other words, for α = 0, all poor are given equal weight and P_0 equals the head count ratio. If α = 0, Pα, P_0 becomes:

$$P_0 = \int_{i=1}^{z} I\,(x < Z)$$

where I (.) is an indicator function that takes on a value of 1 if the bracketed expression is true and 0 otherwise. So if expenditure x is less than the poverty line (Z), then I (.) equal 1 and the household would be counted as poor. Head count index reflects the proportion of the poor in total population. It literally counts heads, allowing policymakers and researchers to track the most immediate dimension of the human scale of poverty (Morduch, 2005; SESRIC, 2015). The greatest virtues of the headcount index are that it is simple to construct and easy to understand. However, it does not take the intensity of poverty into account, it violates the transfer principle and it does not indicate how poor the poor are, and hence does not change if people below the poverty line become (Khandker, 2009; Ravallion, 2016).

A moderately popular measure of poverty is the poverty gap index, which adds up the extent to which individuals on average fall below the poverty line, and expresses it as a percentage of the poverty line. More specifically, define the poverty gap (G_i) as the poverty line (Z) less actual income (x) for poor individuals; the gap is considered to be zero for everyone else. Using the index function, we have $G_i = [Z - x][x < Z]$.

The index can be normalized by being expressed as percentage shortfall of the average income of the poor from the poverty line (Sen, 1979). If $\alpha = 1$, then the poverty gap index (P_1) may be written as:

$$P_1 = \int_{i=1}^{z} \left[\frac{Z-x}{Z}\right]; f(x)dx \quad \alpha \geq 0$$

The poverty gap is intrinsically meaningful, taking us from counting people to counting shortfalls of income or consumption. It captures the mean aggregate income shortfall relative to the poverty line. However, the income gap ratio is not a good measure of poverty as P_1 is sensitive to the depth of poverty but not to its severity. It is the minimum cost of eliminating poverty, because it shows how much would have to be transferred to the poor to bring their incomes or expenditures up to the poverty line (as a proportion of the poverty line). This measure is an indicator of the potential savings to the poverty alleviation budget from targeting; the smaller the poverty gap index, the greater the potential economies for a poverty alleviation budget from identifying the characteristics of the poor. The poverty gap index violates Dalton's transfer principle (Khandker, 2009; SESRIC, 2015; Ravallion, 2016)

To construct a measure of poverty that takes into account inequality among the poor, many researchers use the squared poverty gap index. This is simply a weighted sum of poverty gaps (as a proportion of the poverty line), where the weights are the proportionate poverty gaps. This measures the mean of the individual poverty gaps raised to a power reflecting society's valuation of different degrees of poverty. Hence, by squaring the poverty gap index, the measure implicitly puts more weight on observations that fell well below the poverty line (SESRIC, 2015; Ravallion, 2016). The measure lacks intuitive appeal, and because it is not easy to interpret it is not used widely (Khandker, 2009). Formally,

$$P_2 = \int_{i=1}^{q} \left[\frac{Z-x}{Z}\right]^2; f(x)dx \quad \alpha \geq 0$$

This depicts severity of poverty by assigning each individual a weight equal to distances from the poverty line. Hence, P_2 takes into account not only the distance separating the poor from the poverty line, but also the inequality among the poor.

Measure of inequality

Income inequality is measure by most widely used technique known as Gini coefficient. In other words, it is the ratio of the area between the Lorenz curve and the diagonal equality line to the total area of the triangle. The Lorenz curve graphically illustrates the relationship between population shares and income shares. The closer the Lorenz curve is to the diagonal, the more equal is the distribution. The Gini coefficient varies between a value of 0 that corresponds to perfect income equality (that is, everyone has the same income) and 1 corresponds to perfect income inequality (that is, one person has all the income, while everyone else has zero income). Gini coefficient satisfies Pigou-Dalton transfer sensitivity, symmetry, mean independence and population size independence criterion (Khandker, 2009; SESRIC, 2015; Ravallion, 2016).

Mathematically,

$$G^P = 1\text{-}\sum[\sigma X_i - \sigma X_{i-1}][\sigma Y_i + \sigma Y_{i-1}]$$

where G^P is Gini coefficient, σX_i is cumulative value for the population up to category i, σY_i is cumulative value for the income up to category i and i is label (for the population or income).

Sen (1976) has proposed an index that sought to combine the effects of the number of poor, the depth of their poverty, and the distribution of poverty within the group. The index is given by

$$P_S = \left[P_o \left[1 - [1 - G^P]\frac{\mu_p}{z}\right]\right]$$

where P_0 is the headcount index, μ_P is the mean income (or expenditure) of the poor, and G^P is the Gini coefficient of inequality among the poor. The Sen Index can also be written as the average of the headcount and poverty gap measures, weighted by the Gini coefficient of the poor, giving:

$$P_S = P_o\, G^P + P_1 \left[1 - G^P\right]$$

where P_S is the Sen's poverty index, P_o is the head count index, P_1 is the poverty gap index and G^P is the Gini coefficient. In value of P_S ranges from 0 (no one is below poverty line) to 1 (no one has any income).

The Watts index according to Ravallion (2016) is a good poverty measure to penalize inequality among the poor and is perhaps the best. It satisfies all the desirable axioms or a poverty measure and is increasingly used in generating the poverty incidence curve. Under the focus axiom, the measure should not vary if the income of the non-poor varies; under the monotonicity axiom, any income gain for the poor should reduce poverty; and under the transfer axiom, inequality-reducing transfers among the poor should reduce poverty (Khandker, 2009). The Watts proportionate poverty gap of person i can defined as ln (Z/X) if the person is poor (X< Z); otherwise, then the gap is zero, of course. Note that this is not the same as the proportionate poverty gap (1– X/Z), which is why we shall call ln (Z/X) the Watts proportionate poverty gap. Now take the mean of these proportionate poverty gaps in the population. If incomes are ordered such that X≤ Z if and only if i < q, q is the number of poor households, then the Watts index is:

$$W = \frac{1}{n}\sum_{i=1}^{q} \ln (Z/X)$$

Descriptive statistics

The descriptive statistical tools like mean and standard deviation were employed for analysis and interpretation of household quantitative characteristics. Besides, inferential statistics such as t-test and Chi-square tests were used for interpretation of data and drawing conclusions.

Specification of the model

To identify the major determinants of poverty, a binary logit model was applied. The dependent variable is binary whereby the sample household were categorized into poor (y = 1) and non-poor (y = 0) on the basis of consumption expenditure. Logistic regression model is commonly recommended as an appropriate probability model in such a situation. The model is mathematically specified as:

$$\prod(x) = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}}$$

Table 1. Definition and notation of variables.

Definitions of variable	Notation	Measurement	Expected sign
Age of household head	AGE	Continuous (number)	+
Education of household head	EDU	Binary (1 if literate, 0 otherwise)	+
Sex of household head	SEX	Binary (if head is male; 0, otherwise)	+
Family size	FAM.SIZ	Continuous (adult equivalent)	+
Dependency ratio	DPR	Continuous (%)	+
Remittances	REMMIT	Continuous (ETB)	-
Farm income	INCOME	Continuous (ETB)	-
Nonfarm income	OFFINC	Continuous (ETB)	-
Size of cultivated land	LAND	Continuous (ha)	-
Livestock ownership	TLU	Continuous (tropical livestock unit)	-
Access to credit	CRDT	Binary (1 if accessible, 0 otherwise)	-
Access to extension services	EXT	Binary (1 if participant, 0 otherwise)	-
Food aid recipients	FOODAID	Binary (1 if received, 0 otherwise)	-

where e is the base of the natural logarithm which is approximately equal to 2.718, X_i is the i^{th} explanatory variable, $\prod$ (x) is the probability that an individual will make a certain choice, where X_i and α and β are regression parameters to be estimated. The probability that a household belongs to the non-poor will be (1-$\prod$ (x)).

$$(1 - \prod(x)) = \frac{1}{1+e^{z_i}}$$

where $Z_i = \alpha + \beta_i X_i$.

Therefore, to get linearity both in variable and in parameters the natural log of the odd ratio should be taken. As p goes from 0 to 1, the logit goes from –α to α, that is, although the probabilities lie between 0 and 1, the logit Z are not so bounded (Gujarati, 1988). The model can be estimated through iterative maximum likelihood procedure. The coefficient of the logit model represents the change in the log of the odds associated with a unit change in explanatory variable.

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots\ldots\ldots + \beta_n X_n + U_i$$

where Z_i is the poverty status of households; X_1, X_2…….. X_n are the explanatory variables; β_0 is intercepted terms; β_1, β_2…….. β_n are the partial regression coefficients of parameters; I is the i^{th} observation; and U_i is the stochastic disturbance or the error term. If the disturbance term is taken in to account, the logit model becomes:

$$Z_i = \alpha + \sum \beta_i X_i + U_i$$

Multicollinearity has been checked before running the model using variance inflation factor (VIF) and contingency coefficients (C). VIF shows how the variance of an estimator is inflated by the presence of multicollinearity (Gujarati, 2004). Each selected continuous variable is regressed on the other, so that the coefficient of determination (R^2) would be constructed. A variable is said to be highly collinear, if R^2 exceeds 0.9 or VIF exceeds 10 (Gujarati, 1995). VIF is expressed as:

$$VIF = \frac{1}{1 - R^2}$$

On the other hand, the contingency coefficients were calculated as follows:

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

where C is the contingency coefficient, χ^2 is Chi-square and N is the total sample size. The values of C range between 0 and 1, zero indicating no association between the variables and values close to 1 indicating a high degree of association, which means high degree of multicollinearity.

Hypothesis

Dependent variable

The dependent variable for this study is household poverty, which is dichotomous. The information to categorize households into two groups was obtained by comparing the total consumption expenditure per adult equivalent per annum to the poverty line. This poverty line was computed based on the amount of calorie requirement (2300 Kcal/adult equivalent/day) plus average expenses needed for non-food items of the lowest income quartile (Table 1).

$$POVHH_i = \begin{cases} 1, Yi < Z \text{ (poor)} \\ 0, Yi \geq Z \text{ (non-poor)} \end{cases}$$

where $POVHH_i$ = household food security status of the i^{th} household, Y_i = Consumption expenditure of households, Z = Poverty line.

It is hypothesized to be a function of the following explanatory variables, selected on the basis of review of literature, past research findings, experts and authors' knowledge of the poverty situation in the area.

Age of household head

It is a continuous variable measured by number of years. As age of household head increases, there is greater tendency to acquire knowledge and experience (Shete, 2010; Dawit et al., 2011; Sharma, 2014). Thus, it is hypothesized that age and poverty are negatively correlated.

Sex of household head

Household head is a person who economically supports or manages a household or for reason of age is considered as head by other members of the household. It is a dummy variable taking a value of 1 if male and 0 otherwise. Households headed by male have more access to agricultural technologies and more security to farmland than female headed ones (Bogale et al., 2005; Shete, 2010; Sharma, 2014). It was hypothesized that male headed households are less likely to be poor than female headed ones.

Education

It is believed to be a necessary condition to equip individuals with the knowledge of how to make a living. Education is a necessary factor for stimulating a country's economic growth as it allows people to be more productive and provides more opportunities for its citizens (Sharma, 2014; Muhammedhussen, 2015; Jakiel, 2016). Literates are eager to get information and use it. Hence, it is supposed that households who have had at least primary education or informal education are the ones to be more likely to benefit from agricultural technologies and thus become non poor.

Family size

It represents the total family size adjusted to adult equivalent. As family size increases, obviously the probability of having economically non active members or children and doddering ages is higher. As family size increases, household resource per head decreases (Dawit et al., 2011; Sharma, 2014; Muhammedhussen, 2015). Hence, it is hypothesized that family size and poverty are positively related.

Dependency ratio

As a continuous variable, it is the ratio between economically inactive (age less than 15 and above 65) with active labor force (age between 15 and 65) with in a household. When a large family size corresponds with the availability of adequate adult labor, it can have a positive effect. A household with high economically non active members shows high dependency ratio and it is more likely to be poor (Bogale et al., 2005; Shete, 2010; Bogale, 2011; Sharma, 2014; Muhammedhussen, 2015). Therefore, it is hypothesized that dependency ratio and poverty are positively associated.

Remittances

Remittances from other sources of finances are an important continuous explanatory variable that can be gauged as one of the indicators of measuring poverty. The values of remittance received are critically important in supporting inclusive growth and reducing poverty through boosting household consumption (UNDP, 2015; Berisso, 2016). Remittance is done as part of their indigenous culture of helping each other. It is expected that having relative economic support from abroad and urban areas within the country has positive impact in reducing the poverty status of households.

Farm income

It is a continuous variable explaining the characteristics of poor and non-poor households. The higher the level of income from farming, the lesser would be the likelihood of household to become poor. Therefore, farm income was hypothesized to be negatively related with household poverty.

Non-farm income

Agricultural production may not be the sole source of income for the rural household. Income earned from non-farm activities is an important continuous explanatory variable that determines household poverty. The success of households in escaping from poverty depends on their ability to get access to non-farm job opportunities. Hence, it was hypothesized that households engaged in non-farm activities are better endowed with additional income and less likely to be poor (Bogale, 2011; Dawit et al., 2011; Babu and Afera, 2013).

Livestock ownership

As a continuous explanatory variable, it represents the livestock number in Tropical Livestock Unit owned per adult equivalent. It is an important variable because households generate some proportion of their income and food items from livestock. The larger the number of Tropical Livestock Unit, the better the level of production and income (Bogale et al., 2005; Dawit et al., 2011; Bogale, 2011; Muhammedhussen, 2015). Therefore, it was hypothesized that households having more number of livestock have less probability to be poor. The livestock ownership is negatively correlated with poverty.

Cultivated land size

It is a continuous variable representing the total landholding of the household measured in hectares. Total cultivated land owned by household is important resource for food production and is negatively associated with poverty status (Bogale et al., 2005; Shete, 2010; Muhammedhussen, 2015). Thus, it is expected that size of cultivated land will have positive impact on reducing poverty.

Access to credit services

Access to credit is a dummy variable with a value 1 if the households received credit, either from formal or informal sources and 0, otherwise. Those households who received the credit wanted to have better possibility to spend on activities they want. They can improve production and productivity by adopting different agricultural technologies. Credit access eases access and use of all production inputs; improved seeds or breed, chemical fertilizer, agrochemicals, feed supplement or livestock medicine (Dawit et al., 2011). It was hypothesized that access to credit affects positively on reducing household poverty.

Access to extension services

It is a dummy variable taking a value of 1 if household has access to extension service and 0 otherwise. The provision of extension services to the farming households directly affects their knowledge, productivity and income; mainly because they have a tendency of using production technologies and learn to practice modern production techniques and are prone to change (Dawit et al., 2011). It was expected to influence household poverty status negatively.

Food aid receiving

It is a dummy variable taking the value 1, if the household receives food aid 0 otherwise. Despite the huge amount of aid received through Productive Safety Net Program, its impact as development resource is inconclusive in both theoretical and empirical evidences (Calfa, 2010). Food aid can increase resources for current consumption; increase and improve the nutritional status of the poor. Thus, by directly alleviating hunger and poverty, food aid is hypothesized to serves as a wage for the poor.

RESULTS AND DISCUSSION

Poverty status

The food poverty line which is calculated from the data available is found to be 3363.11 Ethiopian Birr/adult equivalent/annum (Table 2). The non-food needs were obtained by examining the average non-food expenditures/adult equivalent/year of households in lowest income quartile households. The mean value was 952.6 Ethiopian Birr/adult equivalent/annum. Adding this to the food poverty line gives a total poverty line of 4163.11 Ethiopian Birr/adult equivalent/annum. Compared to other studies at disaggregated level, the poverty line in terms of Ethiopian Birr/adult equivalent/annum of Girar Jarso was found to exceed what Bogale et al. (2005) ranging from 460 to 715 computed for districts of Alemaya, Hitosa and Merhabete in 2005, Babu and Afera (2094) for Gulomekeda, Abebe (2976) for Chencha and Abaya in 2017, Shete (758.27) in 2010, Bogale (1468) for Hararghe highlands in 2011 and still greater than the national average set at 3781 Ethiopian Birr/adult equivalent/annum in 2011 prices (MoFED, 2012).

This poverty line is used to estimate the poverty indices in the study area. Accordingly, the poverty indices calculated using the Foster-Greer-Thorbecke measures were found out to be 0.45, 0.186 and 0.099 for head count, poverty gap and poverty severity, respectively (Figure 2). The resulting poverty estimates show that the percentage of poor people is about 45%, which is more than the regional and national averages (29.3 and 29.6% respectively), Chencha and Abaya (29.8%) (Abebe, 2017), Alemaya and Hitosa (35 and 24%, respectively) (Bogale et al., 2005), and Hararghe highland (35.6%) (Bogale, 2011), but lower than Zeghe peninsula (68.5%) (Shete, 2010) and Gulomekeda (51%) (Babu and Afera, 2013). This indicated that this proportion of households in Girar Jarso woreda live under the canopy of poverty; that is, this share of the population cannot afford to buy a basic basket of goods enabling to get the minimum calorie required (2300 kilo calorie per adult equivalent per day) adjusted for the requirement of non-food items expenditure.

The poverty gap index of 0.186 implies that mean per capita income shortfall of the poor relative to the poverty line was 801.69 Ethiopian Birr/adult equivalent/year. With 3.98 adult equivalents average family size in the area, there was an income shortfall of about 3190.73 Ethiopian Birr per year for a household. Since the district has a total number of 12,062 farm households, it would be 38,486,539.4 Ethiopian Birr per year overall shortfall. It is, therefore, a much more powerful measure than the head count ratio because it takes into account the distribution of the poor below the poverty line and also reflects the per capita cost of eliminating poverty. The poverty gap is less than half of the headcount ratio. In effect, many people are concentrated around the poverty line. The per capita cost of eliminating poverty in the study area was higher than Alemaya, Hitosa and Merhabete computed in 2005 by Bogale et al. (2005) (3.5, 3.52 and 13.5%, respectively), Hararghe highland (9.1%) calculated by Bogale (2011) and still higher than the 7.8% of the poverty line of the national average (MoFED, 2012). But, it is lower than Gulomekeda (15%) computed by Babu and Afera (2013).

Similarly, squared poverty gap in consumption expenditure of 9.99% implies that there is a high degree of inequality among the lowest quartile population. Thus, for 9.99% of the total 120 households, more weight has to be given as they are the poorest of the poor. This result confirms the existence of greater proportion of poorest of the poor households in Girar Jarso than Alemaya, Hitosa and Merhabete (0.74, 0.98 and 3.4%, respectively), Gulomekeda (5.9%), Hararghe highland (3.6%) and national average of 3.1%. But, it was equivalent to what Shete has computed as the poorest of the poor in the Peninsula (18.7%).

Income inequality

The Gini coefficient for countries with highly unequal income distribution typically lies from 0.5 to 0.7 and for countries with relatively equitable income distribution, it is in the order of 0.2 to 0.35 (Todaro and Smith, 2009). Gini coefficient of Girar Jarso is found to be 0.33, more than the national average. It is also not much far from zero, shows existence of equality (Table 3). With a Gini coefficient of 0.30, Ethiopia remains the most egalitarian countries in the world (World Bank, 2016). Generally, Girar Jarso has relatively low inequality in per capita income. It is relatively higher as compared to the Gini coefficient of a study which was done in Hararghe highlands (0.29) (Bogale, 2011).

Table 2. Food consumption of the lowest income quartile and poverty line (Household Survey, 2016).

No.	Food item	Mean Kcal/kg/L	Kcal/AE/Day	Kg/L consumed/Kcal	Mean price/kg/L	Kcal % share	Poverty line in ETB/AE/Year
1	Milk	737	96.83	0.0517	10	4.21	183.96
2	Meat	1970	6.67	0.0034	110	0.29	132.59
3	Teff	3589	1562.85	0.4355	12	67.95	1860.27
4	Wheat	3623	187.22	0.0517	8	8.14	147.17
5	Bean	3514	205.16	0.0584	11	8.92	228.63
6	Sorghum	3805	89.47	0.0235	10	3.89	83.71
7	Vegetable	370	31.05	0.0839	7	1.35	209.13
8	Oil	8964	72.22	0.0081	35	3.14	100.39
9	Sugar	3850	25.53	0.0066	16	1.11	37.77
10	Salt	1780	10.35	0.0058	5	0.45	10.35
11	Coffee	1103	5.52	0.0050	80	0.24	142.53
12	Tea	1190	1.84	0.0015	45	0.08	24.77
13	Pepper	933	5.29	0.0057	100	0.23	201.85
	Total	-	2300	-	-	100.00	3363.11

Table 3. Gini coefficient of Girar Jarso (Household Survey, 2017).

Category	Label (i)	X_i	Y_i	σX_i	σY_i	$\sigma X_i - \sigma X_{i-1}$ (a)	$\sigma Y_i + \sigma Y_{i-1}$ (b)	a×b
Lowest 10%	1	0.1	0.02	0.1	0.02	0.1	0.02	0.00
2nd 10%	2	0.1	0.04	0.2	0.06	0.1	0.08	0.01
3rd 10%	3	0.1	0.05	0.3	0.12	0.1	0.18	0.02
4th 10%	4	0.1	0.07	0.4	0.18	0.1	0.30	0.03
5th 10%	5	0.1	0.08	0.5	0.27	0.1	0.45	0.04
6th 10%	6	0.1	0.09	0.6	0.36	0.1	0.63	0.06
7th 10%	7	0.1	0.11	0.7	0.47	0.1	0.83	0.08
8th 10%	8	0.1	0.13	0.8	0.60	0.1	1.07	0.11
9th 10%	9	0.1	0.16	0.9	0.75	0.1	1.35	0.14
Highest 10%	10	0.1	0.25	1.0	1.00	0.1	1.75	0.18
Total	-	1.0	1.00	-	-	Total = 0.67; G^P = 1- 0.678 = 0.33		

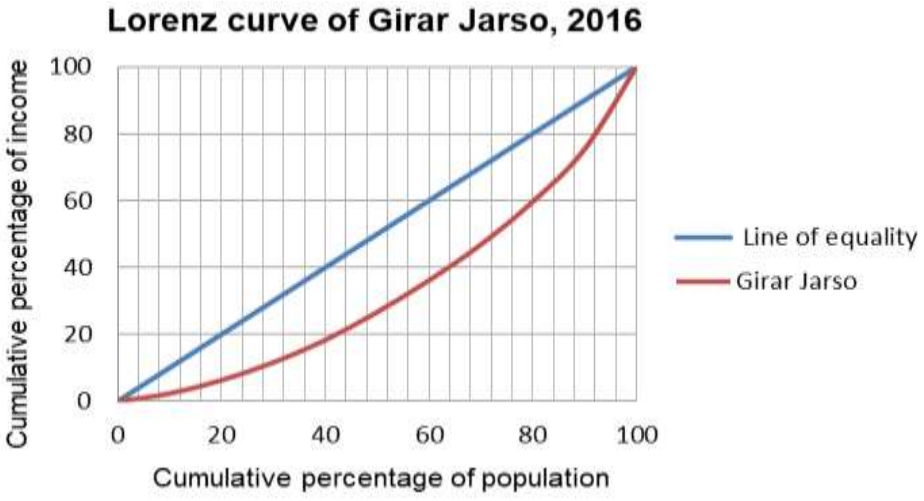

Figure 2. Lorenz curve of Girar Jarso (Household Survey, 2017).

Table 4. Descriptive statistics for continuous variables variables (Household Survey, 2017).

Variable code	Non poor (N = 66)		Poor (N = 54)		Total households (N = 120)		T- value
	Mean	Standard dev.	Mean	Standard dev.	Mean	Standard dev.	
Age of household head	43.63	13.00	42.77	11.21	43.2	12.19	- 0.382
Family size	3.90	1.24	4.08	1.27	3.98	1.25	0.787
Dependency ratio	0.27	0.23	0.34	0.20	0.30	0.22	1.806**
Remittances	8273.4	892.39	2142.6	357.1	554.3	767.14	- 4.705***
Farm income	4303	3104.2	1917.2	1179.9	3229.4	2702.6	- 5.338***
Nonfarm income	2063.8	1596.8	392.05	836.26	1311.5	1549.7	- 6.949***
Cultivated land size	2.72	1.59	1.77	1.09	2.29	1.46	- 3.678***
Livestock owned TLU	2.11	1.29	1.54	1.22	1.85	1.28	- 2.459***

**P < 0.05; ***P < 0.01.

Although inequality remained low, the very poorest might became poorer, posing a challenge to the goal of shared prosperity in Ethiopia. The same source revealed that there was a lower growth rates in consumption observed among the bottom 40%. The highest growth rates were experienced by the fourth decile, but the poorest 10% experienced a decline in consumption. As a result, reductions in poverty rates were not matched by reductions in the depth and severity of poverty. Moreover, when the result is compared to that of Torado's categorization, the income distribution is comparatively equal because the 0.33 is in the rage of equitable distribution. But, it implies the majority of them are equally poor. Sen's poverty value was found to be 0.165.

The Lorenz curve plots the cumulative share of income earned on the y-axis by households ranked from the bottom to the top on the x-axis. In a region with perfect equality, the Lorenz curve would be a perfectly straight 45° line. This Gini ratio gets smaller as the Lorenz moves closer to the diagonal and attains a value of zero when absolute equality is achieved. The Watts index, computed by dividing the poverty line with income, taking logs, and finding the average over the poor is found to be 14.64 (Figure 2).

Descriptive statistics

The descriptive statistics for continuous and discrete variables were presented separately. The continuous variables which are helpful to observe differences among the poor and non-poor households include age of household head, family sizes, dependency ratio remittances, farm income, non-farm income, cultivated land size and number of livestock owned. Family sizes and dependency ratio of the poor were higher than non-poor households. Age of household head, remittances, farm income, non-farm income, cultivated land size and number of livestock owned on the other hand were higher among non-poor households than the poor. Though the family sizes in adult equivalent and dependency ratio of the poor were higher than the non-poor households, this difference was only statistically significant at the 5% significance level for dependency ratio. On the other hand, remittances, total farm income, total off farm income, cultivated land size and number of livestock owned were higher and statistically significant at the 1% significance level among non- poor households compared with the poor households. Though, the age of household head was also higher, it was not statistically significant (Table 4).

Similarly, a chi-square test for the discrete choice variables indicate that greater proportion of poor households were food aid recipients. As shown in Table 5, the only categorical variable which was found to have statistically significant difference between poor and non-poor households at less than 1% level of probability is food aid recipient. However, sex of the household head, education level of the household head, access to credit and access to extension services were found to have statistically insignificant difference between the two groups of households.

Econometric analysis

To determine the explanatory variables that are good predictors of household poverty, the logistic regression model were estimated using Maximum Likelihood Estimation. Prior to the estimation of the model parameters, the variables included in the model were tested for the existence of multicollinearity. The values of VIF and C for continuous and discrete variables did not violate the rule of thumb. As a result, all the 13 explanatory variables were entered into logistic regression analysis. Looking at the results confirms that most of the explanatory variables in the model have the signs that conform to our prior expectations. Among variables fitted into the model, family size, remittance, non-farm income, farm income and food aid recipients

Table 5. Descriptive statistics for discrete variables (Household Survey, 2017).

Variable code		Non poor (N = 66)		Poor (N = 54)		Chi square
		No.	%	No.	%	
Sex of household head	Male	57	86.3	43	79.6	0.970
	Female	9	13.6	11	20.4	
Education level of HH head	Literate	34	54.8	28	45.2	0.001
	Illiterate	32	55.2	26	44.8	
Access to credit	Yes	14	21.2	7	13.0	1.400
	No	52	78.8	47	87.0	
Access to extension services	Yes	47	71.2	36	66.7	0.288
	No	19	28.8	18	33.3	
Food aid recipients	Yes	24	38.1	39	61.9	15.31***
	No	42	73.7	15	26.3	

***P < 0.01.

Table 6. Determinants of poverty in Girar Jarso District (Household Survey, 2017).

Variable	Coeff. (B)	S.E.	Wald	Sig.	Odds ratio
Age of household head	0.018	0.079	0.051	0.822	1.018
Sex of household head	-2.247	1.604	1.963	0.161	0.106
Family size	-1.984**	0.780	6.475	0.011	0.137
Dependency ratio	2.583	2.831	0.833	0.361	13.24
Education of household head	-0.675	0.937	0.519	0.471	0.509
Remittances	-0.004***	0.001	10.751	0.001	0.996
Size of cultivated land	-0.361	0.666	0.294	0.588	0.697
Livestock ownership in TLU	-0.033	0.310	0.011	0.915	0.967
Farm income	-0.002***	0.001	11.113	0.001	0.995
Nonfarm income	-0.002***	0.001	7.088	0.008	0.998
Access to extension services	-0.198	1.065	0.035	0.853	0.820
Food aid recipients	3.901***	1.495	6.812	0.009	49.45
Access to credit	-1.771	1.561	1.287	0.257	0.170
Pearson's chi-square = 37.212	Specificity = 92.4				
-2 Log likelihood = 126.334***	Sensitivity = 94.3				
Total sample = 120	Count R^2 = 93.3				

**P < 0.05; ***P < 0.01.

were found to be significant in determining household poverty with up to 1% level of probability (Table 5).

The goodness-of-fit measures validate that the model fits the data well. The likelihood ratio test statistics exceeds the Chi-square critical value with 13 degree of freedom at less than 1% level of significance, indicating that the hypothesis that all coefficients except the intercept are equal to zero is rejected. The count R^2 result shows the percent correctly predicted sample is 93.3%. The sensitivity, correctly predicted poor is 92.4% and that of specificity, correctly predicted non-poor is 94.3%. The effect of the significant explanatory variables on poverty in the study area is discussed hereunder (Table 6).

The estimated parameter, contrary to the earlier proposition revealed that family size has a negative significant (at p<5%) influence on household poverty. A unit increase in family size, ceteris paribus, leads the odds ratio of falling into poverty by a factor of 0.137. Family size as a covariate, negatively correlated with poverty is inconsistent with the findings of Bogale (2011)

and Abebe (2017). The possible justification for this is existence of large number of economically active than non-active members of the community implying that there is a better demographic dividend. Recognizing that demographics have a dual impact on poverty raises the question of whether high fertility is an obstacle to poverty reduction or not. According to Bogale and Korf (2009), family size may have an ambiguous role in poverty status of rural households depending on the relative strength of size economies in consumption as against the diminishing return to scale.

As can be hypothesized, the coefficient of remittance is found to be negative, implying that the more households get remittance, the higher will be the tendency to be non-poor (at $p < 5\%$). Interpretation of the odds ratio also indicated that probability of households in being poor decreases by a factor of 0.998 as households obtain one more unit of income from remittance. The possible reason here is that the society got a strong social network in which they send money to one another and an increase in number of educated household members' migrants. Remittance is done in the area as part of their indigenous culture of helping each other deeds as community has a strong social cohesion.

As expected, the model reveals that farm income shows a negative and significant effect on poverty (at $p < 1\%$). The negative sign indicates that when farm income earnings increases by one Ethiopian Birr, the likelihood of being non-poor, ceteris paribus, and increases by a factor of 0.995. The possible explanation is that those households who have sufficient access to farm income from sale of crop and livestock and their byproducts are more likely to be non-poor than those who do not earn enough farm income. Those households with more annual farm income have greater resilience or lower vulnerability to poverty. Majority of income earned goes to food expenditure improving accessibility of enough food and non-food expenditure. This result conforms to the findings of other studies (Abebe, 2017).

Consistent with the earlier proposition, the model also reveals the important role of non-farm income in contributing to household poverty (at $p<1\%$). The odds ratio indicates that, other things being constant, the probability of the household to be poor decreases by a factor of 0.008 as the household earned one more unit of money from non-farm income. In this regard, households engaged in non-farm activities are better endowed with adequate income to purchase farm inputs and fulfill family needs and thus, get out of poverty. Additional income received from such activities to be one of coping mechanisms that could serve as a hedge against the future poverty. The higher income diversification implies the lower chances of being trapped in poverty. This negative and significant effect of non-farm income on poverty status was also confirmed by many researchers (Dawit et al., 2011; Babu and Afera, 2013; Megersa, 2015; Muhammedhussen, 2015).

Although we hypothesized that food aid recipients have higher tendency to be non-poor, the model output revealed that it has positive association with household poverty (at $p < 1\%$). Receiving food aid increases the likelihood of being poor by a factor of 49.45. The study area is known to be drought prone and many households have been receiving food aid. Thus, the possible explanation for the unexpected output might be due to the existence of targeting inefficiency, dependency syndrome with repeated food aid for vulnerable households and disincentive effects. If food aid is not delivered in a timely manner, it could aggravate the cyclicality of prices associated with the harvesting and lean seasons due to inadequate storage. The most difficult issue has to do with the disincentive effects of food aid. The study further found that some households in the area even deplete their livestock resources in order to become poor and qualify for food aid. There is no statistically significant difference between the percentages of poor and non-poor participants in the programmes, and the socio-political connections of household apparently influence the likelihood of household participation (Calfa, 2010).

CONCLUSION AND RECOMMENDATIONS

The empirical results of this study reflect incidence, depth and severity of poverty are rampant on the surveyed households and continues to prevail in rural Ethiopia, as is also documented in other research studies cited earlier. The results from analysis of poverty show that it is hard to exit poverty once a household falls into it. This calls for urgent interventions aimed at curbing the fate of the poor. The logit model indicated several interesting results. As poverty is complex and multidimensional and cannot be captured by a single indicator, its reduction efforts have to be multi-targeted. The various factors affecting the probability of falling into poverty gives a framework upon which poverty alleviation strategies may be implemented. In designing poverty alleviation projects, resources will be used more effectively if the most-needy groups can be better targeted. For this reason, the possible areas of intervention that emanate from results of this study are presented hereunder.

Large family size is found to be a significant major factor that makes households less vulnerable to poverty. Consistent with the advocates of population as a positive factor, this finding recommends that in the form of human capital (equipped with variety of skills), population is a great asset, and an appropriate investment in the form of education and health care may bring high returns.

Activities that lead to a boost in agricultural production are crucial to meet the food demand. Agricultural growth was particularly potent in bringing down poverty. Expansion of agriculture only has less satisfying possibilities and due to the recurrence of drought. The

implications is that government and non-government organizations in the area are supposed to promote non-farm employment schemes especially for those who have little or no land that could enable households get diversified income sources. Since a substantial portion of labor supplied in the rural labor markets is a result of economic distress, the promotion of non-farm employment is likely to reduce distress in the wage labor markets. This will have greater impact in improving the state of poverty. Hence, promotion of non-farm activities, besides agricultural intensification, will constitute an important strategy to accelerate poverty reduction in rural areas.

Remittances receiving households are better off in terms of total income, assets and as well as nutritional status as it is actually spent on food consumption. The positive impact of remittances on food consumption makes it imperative to include it as an important component of food security programmes in developing countries. Besides, policies that aim at encouraging the flow remittances will exert a positive effect on reducing poverty.

Food aid is found to have an unintended disincentive effect on rural households as the flows appear typically too unpredictable and small in volume to alter recipient behavior through the insurance effect. The disincentive effects of food aid on supply of labor appear minimal when it is appropriately targeted to intended recipients. When one encounters an apparent labor disincentive problem, this typically signals poor targeting as the root problem. Targeting is an essential instrument to achieve a better impact of poverty alleviation measures. The distribution of food aid has to be done by targeting the poorest members of the population.

This study has attempted to come up with an analysis of rural poverty in a defined scope; however, a lot remains to be unanswered. To provide basic information on rural poverty, the social, political and environmental dimensions that make the rural poor more vulnerable to poverty demands further research. Besides, it is also needed to examine the potential disincentive effects of food aid in targeting errors.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Gender analysis of micro-loan sizes accessed by small-scale agro-entrepreneurs in the Niger Delta region of Nigeria

Ugwuja V. C.[1*] and Nweze N. J.[2]

[1]Department of Agricultural Economics and Extension, University of Port Harcourt, Port Harcourt, River State, Nigeria.
[2]Department of Agricultural Economics, University of Nigeria, Nsukka, Enugu State, Nigeria.

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Available statistics confirmed that men have access to credit more than women in Nigeria because men have assets which serve as collateral for accessing credit. Credit is essential to farmers, especially the small-scale farmers who have limited capital for their production but constitute the greatest force in food production in many developing countries. The study was carried out to investigate micro-loan sizes accessed by male and female small-scale agro-entrepreneurs in the Niger Delta region of Nigeria on a comparative basis. Multi-stage sampling technique was used to collect data from 373 respondents who were either client of formal, semiformal or informal microcredit institutions. Z-test results revealed that loan sizes accessed from formal source showed that there was no significant difference between the mean amount accessed by men and women borrowers. Also for the informal micro-credit, there was no significant difference ($p>0.50$) between the mean amount of loan accessed by male and female agro-entrepreneur borrowers. The result of the semiformal loans showed that there was a significant difference ($p<0.05$) between the mean amount of loan, accessed by male and female borrowers. The study recommends that micro-credit schemes which are the major strategy for formal financial inclusion in Nigeria have really impacted positively on women's loan sizes, and should be sustained to close the gap existing between men and women in accessing microcredit.

Key words: Gender, micro-credit, male agro-entrepreneurs, female agro-entrepreneurs, loan size, formal and informal sources, borrowers.

INTRODUCTION

The term gender encompasses the economic, political and socio-cultural attributes, constraints and opportunities associated with being male or female (USAID, 2003). According to World Bank (2005), gender analysis is a tool for examining the differences between the roles that women and men play, the different levels of power they hold, their differing needs, constraints and opportunities and the impact of these differences on their

*Corresponding author. E-mail: vivian.ugwuja@uniport.edu.ng. Tel: +2348037747971.

lives. A gender assessment which focused on a specific issue or sector is a cost-effective tool aimed at improving project performance and meeting poor people's needs (World Bank, 2005).

One important sector worth focusing upon is agriculture due to its roles in hunger and poverty alleviation as well as the creation of job opportunities. Women are crucial in the translation of the products of a vibrant agricultural sector into food and nutritional security for their households. They are often farmers who cultivate food crops and produce commercial crops, alongside the men in their households who provide income. The Food and Agriculture Organization (FAO) estimates that women produce over 50% of all food grown worldwide and in sub-Saharan Africa women grow 80 to 90% of the food (FAO, 2009). In sub-Saharan Africa, when women obtain the same farm inputs as average male farmers, they increase their yields for maize, beans and cowpeas by 22%.

The omission of gender variables in agricultural policies and interventions represent more than opportunity cost, considering the huge loss in economic growth (IFPRI, 2009). Services are more efficient and equitable when targeted at the different needs of men and women. World Bank (2008) also suggests how high the costs of neglecting gender issues have been in terms of missed opportunities, to raise agricultural productivity and income. These are opportunity costs that least developed countries can scarcely afford.

There are strong indications that investment in agriculture, food and nutrition security will not be achieved while gender disparities persist (IFPRI, 2009). These disparities seriously undermine the potential of women as drivers of agricultural growth, considering the population of women engaged in farming.

In recent years, there has been an increasing emphasis on establishing an inclusive financial sector, which will support the whole diversity of financial institutions that can provide pro-poor development (World Bank, 2008). In Nigeria, successive governments have implemented various agricultural and rural credit schemes, as a means to address perceived shortage of rural credit, stimulate rural employment and productivity. Under these schemes, institutional resources, programmes and government energies were devoted through parastatals to implement supply-led financial development strategies by, channeling of government supplied funds to rural entrepreneurs and small farmers (Iganiga, 2008).These schemes usually dispense loans in small amounts.

Microfinance involves the provision of financial services to the poor and the low-income segment of the society. Worldwide, microfinance has been identified as a potent instrument for promoting financial inclusion and consequently, poverty alleviation. A microfinance loan is granted to the operators of micro-enterprises, such as peasant farmers, artisans, fishermen, youths, women and non-salaried workers in the formal and informal sectors. The loans are usually unsecured but typically granted on the basis of the applicant's character, joint and several guarantees of one or more persons. The maximum principal amount of microloan is ₦500,000 (CBN, 2013).

Over the past four decades, the issues confronting the Niger Delta region of Nigeria have caused increasing national and international concerns. The region produces immense oil wealth and has become the engine of Nigeria’s economy, but also presents a paradox because these vast revenues have barely touched the Niger Delta’s own pervasive local poverty. Today, there are formidable challenges to sustainable human development in the region. The manifestations of these challenges include the conflicts over resources among communities and between communities and oil companies (UNDP, 2006).

Microcredit sources are of three types in Nigeria namely ; (1) the informal rural financial markets which consist of unregistered money lenders , non-institutional sources and unorganized sources, which operates largely outside the banking system and are majorly unregulated, and more loosely, monitored than formal sources (2) semi-formal financial institutions which are unregulated but legal financial entities operating in the semi-formal financial sector can be divided into membership-based Self-Help Organizations (SHOs) and outside assistance-based Non-Governmental Organizations (NGOs). SHOs are indigenous private institutions which finance activities in poor communities with funds mobilized in the community itself. Examples of membership-based SHOs are credit unions loan and savings cooperatives and associations. Generally, SHOs are fully engaged in financial intermediation by raising member deposits and transforming them into member loans, (3) Formal financial institutions which are registered with government organization are regulated by the central bank. These are commercial banks, merchant banks, development banks, savings banks, specialized financial institutions, insurance companies and capital markets.

There is overwhelming evidence that, development must address the needs and priorities of both women and men in order to be successful. World Bank (2012) development report asserted that, greater gender equality can enhance productivity, improve development outcomes for the next generation, and make institutions more representative. Oboh and Kushwaha (2009) in their work reported that being male is associated with the probability of accessing larger loan sizes from Nigerian Agricultural, Cooperative and Rural Development Bank (NACRDB), which is a formal source of micro-credit. Findings from (Odoh et al., 2009) also showed that gender as an explanatory variable was statistically significant having a strong effect on the amount of loan obtained from formal, semi-formal and informal sources among smallholder cassava farmers in Ebonyi State, Nigeria. This shows that, the probability of male farmers receiving a high amount of loan from these credit sources

was high. Sanusi (2012) also reported that access to finance is often cited as one of the major factors impeding the growth of women-owned businesses in developing countries.

It is therefore unclear whether loan sizes to women are smaller than those granted to men. This is pertinent to develop a study that would investigate the various aspects of financial exclusion especially against women involved in agriculture.

Objectives of the study

Specifically, the study was designed to:

(1) Describe by gender, the socio-economic characteristics of the agro-entrepreneurs in the Niger Delta region of Nigeria.
(2) Compare loan sizes accessed from formal, semiformal and informal micro-credit sources among male and female agro-entrepreneurs in the study area.

Hypothesis of the study

There is no significant difference by gender in loan sizes accessed from informal, formal and semi-formal micro-credit sources by agro-entrepreneurs in the study area.

MATERIALS AND METHODS

The study area was Niger Delta. Niger Delta is located in the southern part of Nigeria and bordered to the South by the Atlantic Ocean and to the East by Cameroun. The area is the 3rd largest wetland in the world and has a population of 31.2 million people according to 2006 census (Ministry of Niger Delta Affairs, 2011). It consists of nine states namely, Abia State, Bayelsa State, Akwa-Ibom State, Cross-Rivers State, Delta state, Edo state, Imo state, Ondo state and Rivers state.

Multi-stage sampling technique was used to select respondents in the study area. In stage one, four states were randomly selected out of the nine states of the Niger Delta. These states were Abia, Delta, Bayelsa and Rivers. Stage two was a purposive selection of two LGAs from each state based on a high concentration of economic activities, which are agro-based, making a total of eight LGAs.

Furthermore, there was a purposive selection of agro-entrepreneurs from the list of clients, starting from the three sources of micro-credit. 8 male and 8 female agro-entrepreneurs were selected from each stratum of semi-formal, informal and formal sources from each LGA, making a total of 48 respondents from every LGA. This gave a sample size of 384 respondents. Out of the 384 copies of questionnaire administered to respondents, only 373 of them were successfully completed and used for analysis.

Generally, data were analyzed using these major approaches namely; descriptive statistics such as percentages, frequencies and arithmetic mean, and inferential statistics such as Z-test.

Z-test model

Objective 2 was achieved using Z-test. The analysis was done separately for each credit source comparing male and female agro-entrepreneurs' loan sizes. The Z–statistic is mathematically specified as:

$$Z = \frac{\overline{X} - \overline{Y}}{\sqrt{\frac{S^2_X}{n_y} + \frac{S^2_Y}{n_x}}}$$

Where, Z = The value by which the statistical significance of the mean difference would be judged X = Mean amount of loan obtained by female agro-entrepreneurs from informal/formal/semi-formal sources. $\bar{Y}$ = Mean amount of loan obtained by male agro-entrepreneurs from informal/formal /semi-formal sources. S^2_X = Variance of mean amount of loan obtained by female agro-entrepreneurs from informal /formal /semi-formal sources. S^2_y = Variance of mean amount of loan obtained by male agro-entrepreneurs from informal/formal /semi-formal sources; n_x = Sample size of female agro-entrepreneurs, and n_y = Sample size of male agro-entrepreneurs

RESULTS AND DISCUSSION

Socio-economic characteristics of male and female agro-entrepreneurs in the Niger Delta region of Nigeria

Table 1 shows the breakdown of the socioeconomic characteristics of the respondents by gender. From the table, it could be observed that majority of the women (75.8%) agro-entrepreneurs and male (74.3%) agro-entrepreneurs were married. The result of this study agrees with the findings of Oladeebo and Oladeebo (2008), who reported that 83.3% of farmers were married in Ogbomoso agricultural zone of Oyo state.

Analysis of age of the agro-entrepreneurs showed that the mean age for women was 37.76 years while that of men was 41.66 years. This is in agreement with Adeolu and Taiwo (2004) on micro-financing as a poverty alleviation measure, where the majority (70%) of the farmers was within the age bracket of 30 to 50 years. This implies that, agro-entrepreneurs were still in their middle active age and thus improve their production by making efficient use of the loans.

These result of the household size showed that, majority (50.3%) of the men had 5 to 8 people living in their household while 61.0% of the women respondents had 5 to 8 people living in their household. This result conforms to the findings of Obamiro et al. (2003), who reported that the average number of people in a farm household was seven with majority men (64.9%) and women (53.3%) having secondary education. The result suggests that most of the agro-entrepreneurs in the Niger Delta could read and write. It also conforms to the findings of Ugwuja and Ndubuisi (2012), who reported that majority of farmers in Obio/Akpor Local Government Area of Rivers State attended secondary school

Table 1. Socio-economic characteristics of male and female agro-entrepreneurs (n=373).

Variable	Male			Female		
	Frequency	Percentage	Mean	Frequency	Percentage	Mean
Marital status			-			-
Married	142	74.3	-	138	75.8	-
Single	49	25.7	-	44	24.2	-
Age (years)						
21 - 30	22	11.5	41.66	46	25.3	37.76
31 - 40	70	36.6	-	66	36.3	-
41 - 50	72	37.7	-	58	31.9	-
51 - 60	25	13.1	-	12	6.6	-
61 - 70	2	1.0	-	0	0.0	-
Household size (No)			5.01			5.38
1 - 4	85	44.5	-	63	34.6	-
5 - 8	96	50.3	-	111	61.0	-
9 - 12	10	5.2	-	8	4.4	-
Educational status						
no formal	9	4.7	-	4	2.2	-
Primary	2	1.0	-	6	3.3	-
Secondary	124	64.9	-	97	53.3	-
Tertiary	56	29.3	-	75	41.2	-
Business experience (years)						
1 -10	86	45.0	14	98	53.8	12.14
11 - 20	65	34.0	-	60	33.0	-
21 - 30	29	15.2	-	21	11.5	-
31 - 40	9	4.7	-	3	1.6	-
41 - 50	2	1.0	-	0	0.0	-
Farming status						
Full-time	80	41.9	-	99	54.4	-
Part-time	111	58.1	-	83	45.5	-
Loan size (₦)						
50,000 - 150,000	50	26.2	263,979.06	76	41.8	216,703.30
151,000 - 250,000	58	30.4	-	53	29.1	-
251,000 - 500,000	83	43.4	-	53	29.1	-
Interest rate (%)						
0 - 10	154	80.6	10.24	152	83.5	9.66
11 - 20	15	7.9	-	12	6.6	-
21 - 30	22	11.5	-	18	9.9	-
Repayment period (years)						
0.1 - 0.5	19	9.9	1.08	12	6.6	1.03
0.6 - 1.0	142	74.3	-	150	82.4	-
1.1 - 1.5	5	2.6	-	2	1.1	-
1.6 - 2.0	23	12.0	-	18	9.9	-
2.1 - 2.5	0	0.0	-	0	0.0	-
2.6 - 3.0	2	1.0	-	0	0.0	-

Table 1. Contd.

Borrowing experience (years)						
0	36	18.8	3.05	47	25.8	2.51
1 - 5	73	38.2	-	82	45.1	-
6 - 10	60	31.4	-	43	23.1	-
11 years and above	22	11.5	-	10	5.5	-
Enterprise type						
Crop farming	34	17.8	-	24	13.2	-
Livestock farming	47	24.6	-	6	3.3	-
Fish farming	31	16.2	-	10	5.5	-
Agro-Processing	16	8.4	-	3	1.6	-
Agric-produce marketing	56	29.3	-	139	76.4	-
Agric -service provision	7	3.7	-	0	0.0	-
Location						
Urban	60	31.4	-	62	34.1	-
Rural	131	68.6	-	120	65.9	-
Distance to the source of loan (km)						
≤5	163	85.3	3.28	158	86.8	3.25
6 - 10	15	7.9	-	9	4.9	-
11 - 15	6	3.1	-	9	4.9	-
16 - 20	6	3.1	-	5	2.7	-
21 - 25	0	0.0	-	0	0.0	-
26 - 30	1	0.5	-	1	0.5	-
Savings(Naira)/year						
≤50,000	83	43.5	-	92	50.5	-
51,000 - 100,000	68	35.6	-	66	36.5	-
101,000 - 150,000	28	14.7	-	21	11.5	-
151,000 - 200,000	10	5.2	-	3	1.6	-
201,000 - 250,000	1	0.5	-	0	0.0	-
251,000 - 500,000	1	0.5	-	0	0.0	-
Income (Naira)/year						
≤500,000	51	26.7	-	84	46.2	-
501,000 - 1,000,000	79	41.4	-	58	31.9	-
1,001,000 - 1,500,000	49	25.7	-	37	20.3	-
1,501,000 - 2,000,000	9	4.7	-	3	1.6	-
2,001,000 - 2,500,000	2	1	-	-	-	-
2,501,000-3,000,000	1	0.5	-	-	-	-

Source: Field survey, 2014.

education. Farmers with this level of education would likely have high managerial ability which will enhance farm productivity.

Majority (79.0%) of the men and the women (88.8%) were found to have business experience of 20 years and below. On the average, male agro-entrepreneurs in the study area had business experience of 14 years and female agro-entrepreneurs had a business experience of 12.14 years. This implies that men had more business experience than women. Majority (54.4%) of the women were full-time agro-entrepreneurs while the men (58.1%) were part-time agro-entrepreneurs. This implies that most of the men had other sources of income outside agribusiness while women rely solely on agribusiness for their livelihood.

The result of the loan size showed that majority

(56.6%) of the men accessed N250,000.00 and below while the women (60.9%) also accessed N250,000.00 and below. On the average men accessed ₦263,979.06 while women accessed ₦216,703.30. This implies that numerically men accessed more loan sizes than the women. Analysis of the interest rate showed that most (80.6%) of the men paid interest rate of 10% and below while the women (83.3%) also paid interest rate of 10% and below. This implies that most of the microfinance institution complies with the CBN guidelines of dispensing loan with single digit interest rate. On the average, men paid higher interest of 10.29% for loan accessed than the women (9.66%).

The result of the repayment period showed that, majority of men (74.3%) and women (82.4%) were repaid within the period of 0.6 to 1year. This suggests that most of the micro-loans have short maturity period, which may not favour some agribusiness enterprises that take time to mature. Also, analysis of the borrowing experience showed that majority (45.1%) of the women borrowed within a period of 1 to 5 years while 38.2% of men, also borrowed within the same period. This implies that the borrowing experience for both men and women in the study area was short. The findings from the results also indicated that majority (74.6%) of the women were agricultural produce marketers. About 13.2% of the women were crop farmers, while 5.5% of them were fish farmers. Majority (29.3%) of the men were agricultural produce marketers while 24.6% of the male agro-entrepreneurs were livestock farmers with 68.6% of men and 65.9% of the women residing in the rural area of the Niger Delta region. Male agro-entrepreneurs travelled on the average of 3.28 km to the source of their loan while women travelled on the average of 3.25 km to obtain their loan.

The result of savings showed that majority (43.5%) of the men saved below ₦50,000, while on the average men saved ₦69,697.17. Most (50.5%) of the women also saved below ₦50,000 while on the average, they saved ₦59,851.71. This suggests that men saved more than the women. Analysis of the income showed that many (41.4%) of the male agro-entrepreneurs had income between ₦501,000 to 1,000,000 per year. The average income per year for men was ₦824,996.55. Majority (46.2%) of the women had income below ₦500,000.00 per year while on the average they had income of ₦645,799.69 per year. This result implies that men had more income than the women.

Loan size differentials accessed in formal, semiformal and informal micro-credit sources by male and female agro-entrepreneurs in the Niger Delta region

In Table 2, the different mean loan sizes accessed from the various sources of micro-credit by both female and male agro-entrepreneurs in the study are presented. It would be seen from the Table that in the formal source, while female borrowers accessed mean loan sizes of two hundred and forty-three thousand four hundred and forty-two naira, sixty-two kobo (₦243,442.62), their male counterparts accessed a mean sum of two hundred and eighty-eight thousand naira (₦288,000.00). The test for significant difference between these loan sizes indicate a t-value of 1.792 ($p<0.073$), which implies that there was no significant difference between the loan sizes accessed by gender in the formal micro-credit source in the study.

From the same Table 2 in the informal source, while female borrowers accessed mean loan sizes of two hundred and nine thousand eight hundred and forty-one naira, twenty-seven kobo only (₦209,841.27), their male counterparts were able to access a mean sum of two hundred and forty-four thousand sixty-two naira ,fifty kobo only (₦244,062.50). The hypothesized mean difference of zero between the two groups, male and females was accepted here since the t- value of 1.098 is not significant at alpha level of 0.05. Therefore it is concluded that, there is no significant difference between the amount of loans sourced by informal female and male agro-entrepreneur borrowers in the study area.

In the semiformal source of micro-credit as indicated in Table 2, it was shown that while female agro-entrepreneurs accessed a mean micro-credit of one hundred and ninety-six thousand and thirty-four naira forty-eight kobo (₦196034.48), the males accessed a mean micro-credit sum of two hundred and fifty-nine thousand three hundred and fifty-four naira eighty-four kobo only (₦259354.84). The t-value of 2.392 is significant at 5%, which means that there is a significant difference between the amount of loan accessed by male and female agro-entrepreneurs through the semi-formal source of credit.

Even though in some categories especially in the informal sector, there was no difference between male and female agro-entrepreneurs in loan sizes accessed, with the formal sectors showing a weak difference ($p<0.10$) between male and female agro-entrepreneurs and the semi-formal sector showing a highly significant difference in loan size, accessed in favour of male agro-entrepreneurs. The findings however, disagreed with the findings of (Oboh and Kushwaha, 2009) who reported that, male beneficiaries tend to approved higher volume of loan than their female counterpart in formal microcredit scheme.

The outcome in this particular study should not be surprising, since so many micro-credit schemes favour women more these days due to their high level of loan repayment that is being exhibited by the women. However, 60% of the Micro, Small and Medium Enterprises Development Fund, a scheme under Central Bank of Nigeria is dedicated in supporting women businesses (CBN, 2014). Thus, the gender gap that existed before is now closing up. It was therefore normal

Table 2. Z-test results for loan sizes accessed from formal, informal and semi-formal micro-credit sources among female and male agro-entrepreneurs (n=373).

Gender	Formal credit					Informal credit					Semi-formal credit				
	N	Mean (N)	Mean Diff.	t-ratio	p-val	N	Mean (N)	Mean Diff.	t-ratio	p-val	N	Mean (N)	Mean Diff.	t-ratio	p-val
Male	65	288000.00	44557.38	1.79	0.073	64	244062.50	34221.23	1.47	0.274	62	259354.84	63320.36	2.392**	0.018
Female	61	243442.62	-	-	-	63	209841.27	-	-	-	58	196034.48	-	-	-

** Statistical significance at 0.05 levels; Source: Field survey, 2014.

to discover that, loan sizes across gender in the formal microcredit do not vary significantly.

Conclusion

Credit is essential to farmers, especially in small-scale farmers who have limited capital for their production but, constitute the greatest force in food production in many developing countries. It is recognized that across all socio-economic groups, men are advantaged more than women in access to credit; this is always attributed to men having more assets than women, which serve as security for borrowing loans.

Microcredit schemes which are the major strategy for financial inclusion in Nigeria have really impacted positively on women's access to micro-loans. This type of scheme does not use capital assets as collaterals but, depends more on collateral substitutes such as group guarantees or compulsory savings, access to repeat or larger loans based on repayment performance, streamlined loan disbursement and monitoring. This was evidenced in this study as women almost accessed the same amount of loan as men in the formal credit.

Men accessed larger loans in semiformal microcredit; this could be attributed to men's cooperative societies contributing more money for their share capital, thus resulting in a large amount of credit. The study recommends that micro-credit schemes which are the major strategy for formal financial inclusion in Nigeria have really impacted positively on women's loan sizes, and should be sustained to close the gap existing between men and women in access to microcredit.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Contribution of adoption of motorized water pump on the household farm income of smallholder farmers: Evidence from Lake Abaya and Chamo Basins of Gamo Gofa Zone, Southern Ethiopia

Agidew Abebe* and Amanuel Shewa

Department of Rural Development and Agricultural Extension, College of Agricultural Science, Arba Minch University, Arba Minch, Ethiopia.

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This study aims to analyze effects of adoption of motorized water pump on household farm income of smallholder farmers in Mirab Abaya and Arba Minch Zuria Woreda. The total sample size (n=196) was purposively selected from two Woredas and five Kebeles. Descriptive analysis, inferential analysis and Heckman two-stage mode were employed for data analysis. The ordinary least squares (OLS) model result revealed that among the 12 explanatory variables included in the model, four had significant effect on the household annual gross farm income. A unit increase in irrigated land of a household increases annual gross farm income of the households by Birr 6620.9 at 5% significance level. Adoption of motorized water pump has a positive effect on household annual gross farm income. The annual gross farm income of adopter households was higher by Birr 18555.35 than non-adopter households. Market distance and market information is found to influence income and hence well-being, significantly. The results indicated that a 1 km increase in distance of commodity supply market decreases annual gross farm income of farm households by Birr 3992.8 at 1% significance level. Male household heads had obtained significantly higher income compared to female household heads.

Key words: Water pump, farm income, T-test, Chi-square, ordinary least squares (OLS), Heckman two-stage.

INTRODUCTION

The current government has undertaken various activities to expand irrigation in the country. The country's Agricultural Development Led Industrialization (ADLI) strategy considers irrigation development as a key input for sustainable agricultural development. Thus, irrigation development, particularly small-scale irrigation is planned to be accelerated. Ethiopia is believed to have the potential of 3.7 million hectares of land that can be developed for irrigation through pump, gravity, pressure, water harvesting, and other mechanisms (MoFED, 2010).

*Corresponding author. E-mail: agidew.abebe@gmail.com.

The evidence from the survey conducted at Central Tigray by Kinfe Asayehegn showed that the ratio of mean income of irrigation users to non-users exceeds by 37.03%. This study also showed that family labor at adult equivalent, irrigable land size, access to irrigation, livestock holding and access to credit are found to have a positive and significant association with household income. The results further indicate one unit increase in the active labor force of an average household would raise the total income of the household by ETB 3987.14. To this end, keeping other variables constant at their respective mean values, a unit increase in irrigable land of a household increases total income by ETB 23,327.8. In other words, irrigation user households with one hectare irrigable land are better-off in well-being by ETB 23,327.8 than non-user households (Kinfe, 2012).

The study conducted at Hare irrigation project of Arba Minch Zuria Woreda showed that crop production with animal husbandry is the main farming system in the Hare irrigation system. The main crops grown in the project area are banana, cotton, sweet potato, maize, mango, and avocado. The average size of landholdings in the scheme is 0.8 ha. Crop yields differ from district to district in the schemes due to differences in access to irrigation water, soil type, irrigation and crop management. Chano Chalba enjoys the highest average yield with regard to banana (219 q/ha) followed by Chano Dorga (153 q/ha) and the smallest productivity is at Kolla Shara (144 q/ha). Crop productivity varies from 7 to 22 q/ha for Cotton and 22 to 29 q/ha for maize in the irrigation schemes. The nearby marketing center for local consumption was Arba Minch town. As the area is now known for its banana production, farmers are selling their products at reasonable prices and they are good at bargaining prices. Some farmers even started to get involved in the other sectors such as transport, by owning vehicles like minibuses and trucks, from the benefits they gained from their irrigated farms (Girma and Awulachew, 2007).

Statement of the problem

In Ethiopia out of the total potential, about 10 to 12% of this potential is put under irrigated agriculture (both traditional and modern irrigation systems). The major limitations that constrained the development of the irrigation sub-sector are: (i) predominantly based on traditional farming systems, (ii) inadequate improved agricultural inputs, (iii) limited access to improved irrigation technologies, (iv) inadequate trained human power, (v) inadequate extension services and capital, (vi) absence of appropriate institutions at different levels responsible for the promotion, planning and development of irrigated agriculture, and (vii) inadequate information system on agricultural water management and irrigation development (MoA, 2011).

The study area lacks in depth studies on analyzing the effects of the adoption of motorized water pump on the household farm income of small holder farmers. Therefore, this study was initiated to analyze the effects of the adoption of motorized water pump on the household annual gross farm income of small holder farmers.

RESEARCH METHODOLOGY

In this study, a multi-stage sampling procedure was employed for the selection of Woreda, sample Kebeles and respondent households. In the first stage, the two Woredas were selected purposively as they were located at the basins of Lake Abaya and Chamo. Moreover, there is better use of motorized water pump and irrigation practice in the study area that gives opportunity to local government in developing modern irrigation schemes; and accessible and availability of enough information about the practice.

In the second stage, five Kebeles (three from Mirab Abaya and two from Arba Minch Zuria Woreda) purposively selected because of farmers living in these Kebeles have well used and adopted motorized water pump. In the third stage, the total households residing in the five Kebeles were stratified into two strata: adopter and non-adopter households. The population frame in the selected Kebeles and the lists of adopter households in those Kebeles were obtained from Kebele Administration Offices. Accordingly, Ali (2003) and Glenn (2013) recommended that the total sample size was determined using published table. This table was designed exactly in the same way that the internet calculators are. Based on this criteria, for this study, the total sample size for the population size of 4492 with ±7% precision levels, 95% confidence level and P=0.5 (variability) is equal to 196.

In this study, all adopters (83) from five sample Kebeles were included purposively due to their small size. However, the total sample sizes for non-adopter (113) from sample Kebeles were determined via probability proportionate to size procedure through the following formula:

$$Pi = Ni/N$$

where Pi is the proportion of the population included in stratum i, Ni is the number of elements (total sample size), and N is the total number of the population.

Therefore, the number of sample households from five sample Kebeles for two strata are shown in Table 1.

This determined sample size of non-adopter respondents was selected from the population frame of non-adopter households of the respective Kebele through systematic probability sampling (list sampling) technique (Kothari, 2004). In this study, both primary and secondary data sources were employed. Primary data were obtained from primary data sources (respondents' household and focus group discussions). Important variables on physical, demographic, economic, social and institutional aspect were collected. Depending on the objective of the study and nature of data available, descriptive analysis (mean), inferential analysis (chi-square and t-test) and econometric model (Heckman two-stage selection model) were used to analyze the effects of the adoption of motorized water pump on household annual gross farm income.

RESULTS AND DISCUSSION

Major crops grown by motorized water pump

The results obtained from focus group discussion, key

Table 1. Sample Kebeles and number of sample households for two strata from each Kebele.

Sample Woredas	Sample Kebeles	Non-adopter households		Adopter households		Total sample household
		Total HH	Sample HH	Total HH	Sample HH	
Arba Minch Zuria	Kanchama	1325	34	20	20	54
	Elgo	1123	29	22	22	51
Mirab Abaya	Fura	485	13	11	11	24
	Alge	517	14	9	9	23
	Yayke	876	23	21	21	44
Total		4326	113	83	83	196

Source: Field Survey (2017).

(a) Cabbage farm (b) Tomato farm

Figure 1. Some dominant vegetables grown in the study area through motorized water pump by the small holder farmers.

informant interview and respondents' household revealed that in the study area farmers engaged in both rain-fed and rain-fed + irrigated agriculture (traditional river diversion, concrete canal river diversion and lifting through motorized water pump) and grown different types of annual and perennial crops with the help of rain fall and supplementary irrigation.

The major crops grown by irrigation through motorized water pump in the study area are: industrial crop (tobacco) and dominant vegetables (cabbage, tomato, onion and pepper). Figure 1a and b shows some of dominant vegetables grown in the study area through motorized water pump by the small holder farmers.

Descriptive and inferential statistics result of explanatory variables

The chi-square result in Table 2 shows that adoption of motorized water pump, sex and education level of respondents had significant relationship with the household farm income at 1% significance level, while use of credit had significant relationship with the household farm income at 10% significance level. Therefore, maleness of household head, increase in education level and use of credit have its own effect on the household farm income.

The t-value result also shows that the motorized water

Table 2. Descriptive and inferential statistics result of explanatory variables.

Variable	Mean		χ^2 and t-value	p-value
	Adopter (N=83)	Non-adopter (N=113)		
Adoption of MWP	-	-	153.5***	0.000
Sex of respondents'.	-	-	110.47***	0.006
Age of respondents'	42.8	45.9	-2.68***	0.008
Household labor in AE	4.36	3.16	5.47***	0.000
Education level of respondents'	-	-	19.98***	0.000
Land holding size	1.4	1.39	0.454	0.65
Irrigable land size	1.18	0.002	30.59***	0.000
Livestock holding in TLU	3.86	3.78	0.342	0.733
Use of credit from institution last year	-	-	87.78*	0.087
Contact with DAs per month.	1.77	1.47	2.76***	0.006
Farm distance from water source	0.77	1.4	-8.79***	0.000
Market distance	0.799	0.791	0.106	0.915

*** Significance at 1% level.
Source: Field Survey (2017).

pump adopter households had significantly less mean age and farm distance from water source than non-adopter households. On the other hand, the motorized water pump adopter households had significantly exceeded in the mean of household labor in AE irrigated land size and contact with DAs per month than non-adopter households.

Heckman two stage model estimates for the effect of motorized water pump on household annual gross farm income

Here, the discussion focused on the second stage of Heckman model, which describes the effect of adoption of motorized water pump on household annual gross farm income.

The second stage of Heckman's procedure also referred to as the outcome or selection equation uses Ordinary Least Square (OLS) for analyzing household annual gross farm income. The likelihood function of the two-step Heckman model was significant showing a strong explanatory power. Also, the coefficient of the Inverse Mills Ratio (IMR) was significant ($P<0.01$) providing evidence for the presence of self-selection and hence justifying the use of Heckman's two-stage procedure.

Irrigated land

This is a key asset of rural farm household and a unit increase in irrigated land of a household increases annual gross farm income of the households by Birr 6620.9 at 5% significance level. In other words, motorized water pump adopter households with one-hectare irrigated land are better off in their income by Birr 6620.9 than non-adopter households. Access to irrigated land by allowing households to use family labor and other farm resources more intensively makes households more productive and hence better off.

Adoption of motorized water pump

This has a positive effect on household annual gross farm income. This evidenced as, keeping other things constant, the annual gross farm income of adopter households was higher by Birr 18555.35 than households who do not participate in adoption of motorized water pump. The use of irrigation technology allows farm households to use farm resource in a more productive way. It enables the production of vegetables and cereal crops twice and sometimes three times a year and it helps to improve livestock productivity by providing feed during the dry seasons and minimizing the cost of paying for fodder.

Therefore, participation in adoption motorized water pump for irrigation enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption.

Market distance

Access to market and market information is found to influence income and hence well-being, significantly. The results indicated that a 1 km increase in distance of commodity supply market decreases the annual gross farm income of farm households by Birr 3992.8 at 1% significance level. Households having less access to

Table 3. Ordinary Least Square estimation of model variables.

Model	Coefficient	t-value	P-value
(Constant)	3216.255	0.418	0.677
Age of respondent	68.518	0.735	0.463
Education level of respondent	447.464	0.449	0.654
Household labor	275.538	0.571	0.569
Land holding size	-222.122	-0.067	0.946
Irrigated land size	6620.968**	-2.441	0.016
Adoption of MWP	18555.352***	4.998	0.000
Farm distance from water source	-150.300	-0.092	0.927
Livestock holding in TLU	141.375	-0.296	0.767
use of credit from institution	946.036	-0.333	0.739
Contact with DAs per month	771.602	0.806	0.422
Market distance	-3992.815***	2.669	0.008
Sex of respondent	7486.572***	-2.632	0.009
Dependent variable=annual gross farm income mean=9541.7birr			
Number of observation=196			
Adjusted R^2 =0.269			
R^2=0.317			
Prov. value=0.000			

** , ***, significance at 5 and 1% level, respectively.
Source: Field Survey (2017).

market and information negatively influence farm income than households having better access to market and market information. Market information helps farm households to market perishable farm products at the right time without loss of quality and quantity. Access to market information would also play a key role by providing accurate information on the demand and supply of farm inputs and outputs.

Sex of the household head

Male household heads have higher income compared to female household heads because of better labor inputs used in male-headed households than the female headed ones. In addition, females of the study area have triple burden (production, reproductive and child care), and also they have less access to information about the technology, then due to the case of sex difference of household head has influence in the level of income of households.

Moreover, it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the adoption of technologies as early as possible and their income is higher than their counterpart. The study result revealed that this variable is statistically significant at 1% significance level and the coefficient of this variable also shows keeping all other variables constant, on annual gross farm income of those male headed households exceeded by birr 7486.57 compared to those households headed by female. This finding agreed with that of Agerie (2013) (Table 3).

CONCLUSION AND RECOMMENDATION

The study has explored the potential factors that affect the household annual gross farm income in the study area.

Irrigated land is a key asset of rural farm household and it had significant effect on the household annual gross farm income at 5% significance level. Access to irrigated land by allowing households to use family labor and other farm resources more intensively makes households more productive and hence better off. Therefore, it should be better to give attention by the concerned bodies on the different irrigation technologies to create access to their irrigation water.

The participation in adoption motorized water pump for irrigation enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption. Therefore, the GOs and NGOs should focus their attention in provision of credit to farmers in extended repayment period; it may improve their initial capital to adopt the technology.

Access to market and market information is crucial for

the farmers to improve production practices, to diversify their farm income, to sale their crops at an appropriate time, etc., which enable them to have better capital as well as better household asset. Therefore, the concerned bodies should focus their attention on provision of information about supply and demand market and creation of market accesses.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Technical efficiency of irrigated rice seed farmers in Koussin-Lélé, Benin Republic

Afio ZANNOU, Sylvain KPENAVOUN CHOGOU*, Idelphonse O. SALIOU and Gautier BIAOU

Faculty of Agronomic Sciences, University of Abomey-Calavi, Republic of Benin, 01 B.P. 526 Cotonou, Benin.

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Seed is one of the key inputs for rice production. The quantity of rice seeds produced is largely below the demand expressed by rice producers in Benin. In recent years, several projects have been implemented to promote this activity. A one stage stochastic frontier production which incorporates a model for the technical inefficiency effects was applied on a whole population of 141 farmers identified in the irrigated site of Koussin-Lélé, Benin. The result showed that the technical efficiency ranged from 69% and 99% with the mean of 92%. The most efficient producers had the best yields, 5,096 kg/ha comparable to the experimental potential yields estimated at 4,800 to 5,000 kg/ha in a controlled peasant environment. Farmers who exercise the multiplication of rice seeds as their main activity educated producers and those who are often in contact with agricultural advisers are the most technically efficient. Therefore, the current institutional environment is favorable to rice seed farmers in the study area. The undertaken actions implemented in recent years must be continued and strengthened. The content of the extension should also be focused on appropriate techniques of fertilization and/or restoration of soil fertility to prevent the misuse of mineral fertilizers. Special attention should be given to the producers in the village, Lélé, to help them improve their technical efficiency.

Key words: Rice seed, technical efficiency, irrigated perimeter, Koussin-Lélé, Benin.

INTRODUCTION

Benin has a significant natural resource potential for rice production, with 322900 ha of irrigable land, including 117000 ha of floodplains and 205900 ha of lowland (MAEP, 2011). Thus, rice production is developed throughout Benin territory. Rice can be grown on five of the country's seven agricultural development poles. The lowlands and the valleys of the rivers constitute areas of rice production. However, rainfed rice can be practiced wherever rainfed crops of maize, cowpea and cassava are possible. Thus, rainfed upland rice, irrigated rice, strict rainfed rice and mangrove rice crops are distinguished (FAO, 1997). Rice cultivation is mainly practiced by smallholders. According to MAEP (2014), in terms of production volume, rice has emerged as the third cereal crop (9%) following maize (77%) and sorghum (11%). While national production in the 1980s

*Corresponding author. E-mail: kpenavoun@gmail.com.

was low and hardly exceeded 9000 tons of paddy rice per year, there has been some improvement in recent years. Indeed, since 1990, production is constantly increasing. According to MAEP (2014), it increased from 10940 tons of paddy rice in 1990 to 16498 tons in 1995, 48607 tons in 2000, 124975 tons in 2010 and 234145 tons in 2015, with an average annual growth rate of 12.4% over the past ten years. The national production of husked rice can therefore be estimated at 140000 tons in 2015. The total quantity of rice consumed each year is increasing. From 69,206 tons in 2003 to about 110,800 tons in 2010, to at least 275,000 tons in 2015, with an estimated annual consumption of 25 kg per capita (Gandonou et al., 2010). Thus, Benin remains structurally deficient in rice (ONASA, 2015) and the deficit can only be filled by imports which have increased from 96,500 tons in 2000 to 1,390,340 tons in 2013 (INSAE, 2014).

Several projects or programs have been implemented to promote rice production. Also, several technological packages such as improved varieties of rice have been developed and made available to producers. A framework or platform for dialogue between actors in the sector has been created. Two large rice mills are built in Malanville and Glazoué to ease the processing of paddy and putting consumable rice on the market. Access to fertilizers and to certified seeds to rice producers was subsidized. Indeed, the availability and accessibility of producers to quality seeds is the first of the eight strategic axes defined in the SNDR (MAEP, 2011).

In spite of the noted potentialities, rice production faces several constraints, such as difficulties in accessing specific inputs, lack of adequate credit for rice production, low level of professionalization, lack of materials and work equipment, and climate change. After the diagnostic analysis of the situation, the Government of Benin developed and adopted in November 2011, the National Rice Development Strategy (SNDR).

Production and productivity cannot be improved without timely access to quality seeds. They can contribute about 30 to 40% of crop productivity (Kpedzroku and Didjeira, 2008; Dembélé, 2011). From this point of view, it is necessary that particular attention be given to the production of seeds, especially since it is planned to increase rice production by at least 385,000 tons of white rice, that is, 600,000 tons of paddy by 2018. This objective will be achieved with the production and distribution of 8300 tons of rice quality seed (MAEP, 2011). But by 2014, only 2099 tons of seeds are produced on 1523 ha of land. In addition, there has been a downward trend in seed yields in recent years. The yields for 2011-2012, 2012-2013 and 2013-2014 are respectively 2.7, 2.4 and 1.4 tons/ha (Konnon et al., 2014). Efforts must therefore be made to achieve the objectives set.

Under these conditions, it is essential to assess the capacity of the rice seed production system in order to better produce through the implementation of all inputs of production. Indeed, the increase in production does not necessarily require an overall increase in productive resources, but may also stem from a change in the way in which existing resources are managed. As such, concerns about efficiency are one of the main subjects of the economy of production. At the microeconomic level, measuring farm efficiency does not only provide a better understanding of productivity analyzes, but also the effects of market regulation policies on farms. However, at the macroeconomic level, these same levels of individual efficiency are conditions for social or collective efficiency (Piot-Lepetit, 1996). Therefore, it is necessary to study the imperatives of efficient use of productive resources (Nishimizu and Page, 1982).

Prior to the implementation of the SNDR, several studies have been carried out on the consumption of rice in Benin and have yielded many useful results. After the implementation of the SNDR, few studies have been carried out on the technical efficiency of rice producers in Benin in general, and on rice seed producers in particular in which IR 841 perfumed rice is the most popular variety of Beninese consumers (Konnon et al., 2014).

Therefore, this article aims at investigating the technical efficiency and its determinants for rice seed farmers in the partially irrigated area of Koussin-Lélé in Covè, southern Benin.

METHODOLOGY

Population and data collection

The data used in this study were collected in the irrigated area of Koussin-Lélé in the district Covè in Benin. This perimeter covers an area of 106 ha divided into two blocks (villages) separated by 4 km: Koussin (54.7 ha) and Lélé (51.3 ha). So, it is possible to distinguish the farmers from each village (Koussin or Lélé). On this perimeter, there were 141 farmers; all of them belong to 11 groups: 5 groups of men and 1 women group in Lélé; 4 groups of men and 1 group of women in Koussin. All these groups are members of the Union of Groups of Rice Farmers of Koussin-Lélé (UGPR-KL). All producers in the area are seed farmers who produce only the IR 841 rice variety. All of them were surveyed and the production data collected relate to those of the first cycle of the 2014-2015 rice season. Data were collected primarily through structured questionnaire. These data were supplemented by documentation and observations made in the field.

Data analysis

Technical efficiency analysis

Discussions on the concept of efficiency in production date back to the work of Farrell (1957), which included those of Debreu (1951) and Koopmans (1951). According to Farrell (1957), technical efficiency is achieved when, for a given level of production, it is impossible to obtain a larger quantity produced with the same quantities of inputs. In other words, it is the capacity of the firm to situate itself on the frontier of production possibilities, called frontier production function (Kpenavoun et al., 2017). There are a variety of theoretical approaches developed to measure the technical efficiency of farmers.

Most of the studies, investigating the influence of factors which explain the differences in technical efficiencies of farmers use a two-stage approach. The first stage involves the estimation of a stochastic frontier production function and the prediction of farm-level technical inefficiency or technical efficiencies. In the second stage, these predicted technical inefficiency or technical efficiencies are related to farmer or farm specific factors using ordinary least square (OLS) regression. This approach appears to have been first used by Kalirajan (1981) and has since been used by a large number of agricultural economists. Kumbhakar et al. (1991), Reifschneider and Stevenson (1991) and Huang and Lui (1994) specify stochastic frontiers and models for the technical inefficiency effects and simultaneously estimated all the parameters involved, given appropriate distributional assumptions associated with cross-sectional data on the sample firms. Battese and Coelli (1995) proposes a model for technical inefficiency effects in a stochastic frontier production function for panel data.

This one-stage approach is less objectionable from a statistically point of view and is expected to lead to more efficient inference with respect to the parameters involved (Coelli and Battese, 1996). This is this one stage approach used in this study.

The stochastic frontier production function, initially and independently proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977), is the approach used in this study. It is the most suitable method for African farms characterized by a failure of agricultural markets. The formulation is as follows:

$$Y = f(x,\beta)e^{V_i - U_i} \quad \text{with } i = 1,2,...n \text{ (n = sample size)} \qquad (1)$$

The variable Y_i denotes the output of the firm i; the variables X denote the quantities of each of the inputs used to produce Y_i; β is the vector of the parameters associated with X to be estimated. The error term is split into two parts V_i and U_i. The random term V_i is associated with random factors that are not under the farmer's control such as economic environment, climate, floods, devastating bird invasions, measurement errors and any other statistical by hypothesis, V_i is a symmetric error term which is assumed to be independently and identically distributed (iid) having normal distribution (0, σ_v^2) errors. U_i represents the random variable reflecting the technical inefficiency, in terms of production of the farm i, U_i is defined with an asymmetric distribution and assumed to be independent of V_i. U_i is the non-negative truncation (at zero) of the normal distribution with mean μ_i and variance σ_u^2.

Technical efficiency index (EFFICIENCY) of a rice seed farmer is defined as the ratio of the observed output to the frontier output which could be produced by a fully-efficient farmer, in which the inefficiency effect is zero. So, this technical efficiency is given by the following formula:

$$EFFICACITE_i = e^{-Ui} \qquad (2)$$

where

$$\text{EFFICACITE}_i = \frac{f(X;\beta)e^{V_i - U_i}}{f(X;\beta)e^{V_i}} = \frac{Y_i}{f(X;\beta)e^{V_i}} \qquad (3)$$

The interpretation of the results is based on the following mathematical expressions which are presented in terms of variance parameters:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2,\ \gamma = \sigma_u^2/\sigma^2,\ 0 \le \gamma \le 1 \text{ and } \lambda = \sigma_u/\sigma_v. \qquad (4)$$

The variance ratio γ (Gamma) is an important indicator in the specification and validation of the model. It measures the part of the contribution of the error due to technical inefficiency (γ) or the random error (1-γ) in the total variability. The ratio of 0 indicates that there is no technical variation between farmers and that the total variation is due to random errors. In this case, it can be concluded that the stochastic frontier is not the correct specification of the model and that the estimation of the production function by the ordinary least squares method is sufficient to describe the technology. On the other hand, if γ = 1, it appears that the total variation observed between farmers is due to technical inefficiency. The deterministic frontier would then be preferable to the stochastic frontier. The parameter λ measures the ratio of the standard deviations of the error due to technical inefficiency and random error.

The Cobb-Douglas and the transcendental logarithmic (translog) are two of the most popular functional forms in the economics literature. The functional specification is tested using the log-likelihood ratio test. The result showed that the translog stochastic production frontier function can be reduced to a Cobb-Douglas stochastic production frontier. So, empirically, the stochastic frontier production function of Cobb-Douglas is the model used in this study to estimate the level of technical efficiency of the rice seed farmers in the irrigated perimeter of Koussin-Lélé. It is as follows:

$$LnProduction_i = \beta_0 + \beta_1 LnArea_i + \beta_2 LnSeed_i + \beta_3 LnFertilizer_i + \beta_4 LnHerbicide_i + \beta_5 LnInsecticide_i + \beta_6 LnLabor_i + \beta_7 LnCapital_i + \beta_8 Site_i + V_i - U_i \qquad (5)$$

With i = 1, 2, …, n (n is the sample size; *Ln* is the neperian logarithm).

Table 1 defines the variables of this model. According to the producer's neoclassical theory, the positive sign is expected for all inputs of production.

The site of Koussin is better fitted and equipped than that of Lélé. This is why the SITE variable is introduced in the production function. This variable is not an input of production. It was introduced to help neutralize potential biases in the estimates in accordance with the approach suggested by Sherlund et al. (2002).

Technical inefficiency (efficiency) determinants analysis

The final specification for the inefficiency model is as follows:

$$\text{Inefficiency } (\mu_i) = a_0 + a_1 Sex_i + a_2 Age_i + a_3 Activity_i + a_4 Primary_i + a_5 Secondary_i + a_6 Experience_i + a_7 Contact_i + a_8 Credit_i + \varepsilon_i \qquad (6)$$

Variables included in the inefficiency model are defined in Table 2. Variables such as level of education, number of years of experience, access to credit and access to technical advice (expressed here by the number of contacts with the agricultural adviser) capture the seed farmer's abilities to access technical knowledge and possibly apply them or seize economic opportunities.

The choices made by farmers are not only related to their capacities. Seed-farmers may seek to differentiate themselves because of its preferences and this behavior can be explained by factors such as age, gender, the fact of exercising production as a main activity.

On the other hand, all farmers are members of a group. Women are systematically members of women's groups and men are systematically members of men's groups. Thus, at the same time, the variable "sex" captures the status of the farm. The parameters of the stochastic frontier production function are estimated simultaneously with those involved in the inefficiency model for the method of maximum likelihood. Therefore, it is interesting to test three null hypotheses that:

1. The inefficiency effects are not present;

Table 1. Description of the variables of the frontier production function.

Variables	Description
Quantitative variables	
Production	Total harvested rice production (kg)
Area	Cultivated land area to produce rice seed (ha)
Seed	Quantity of basic seeds used (kg)
Fertilizer	Quantity of mineral fertilizers (NPK and Urea) used (kg)
Herbicide	Quantity of herbicide used (l)
Insecticide	Quantity of insecticide used (l)
Labor	Quantity of labor (man-day) which takes into account all types of labor used.
Capital	Total value of depreciation of equipment used in rice seed production (fcfa)
Variable qualitative	
Site	Dummy variable which the value 1 if the seed farmer belongs to Koussin site.

1 euro = 656 fcfa

Table 2. Description of the variables of the multiple linear regression model

Variables	Description	Type of variables
Dependent variable		
Efficiency	Technical efficiency indices of the seed-farmer	Quantitative
Explanatory variables		
Sex	Sex of the seed-farmer	Dummy: 1 if the seed-farmer is male
Age	Age of the seed-farmer	Quantitative
Activity	Main activity	Dummy: 1 if the seed-farmer's main activity is seed production
Primary*	Primary instruction level	Dummy: 1 if the seed-farmer has only primary school instruction level
Secondary	Secondary school instruction level	Dummy: 1 if the seed-farmer has only secondary school instruction level
Experience	Years of experience of rice production	Quantitative
Contact	Number of contacts with the agricultural adviser	Quantitative
Credit	Credit access	Dummy: 1 if the seed-farmer had access to credit over the studied cropping's season cycle

*The modality "uneducated or literate farmer" is the reference of the variable level of education.

2. The inefficiency effects are not stochastic;
3. All the coefficients of the variables in the model for the inefficiency effects are zero.

As the dependent variable of the inefficiency model in Equation 6 is defined in terms of technical inefficiency, a farm-specific variable associated with the negative (positive) coefficient will have a positive (negative) impact on technical efficiency.

RESULTS AND DISCUSSION

Technical efficiency analysis of rice seed-farmers

Table 3 presents characteristics of the variables of frontier production function. This table also shows the quantities of production inputs per unit area of cultivated land. Access to land on the perimeter is subject to membership in the Union of Rice Farmers' Groups of Koussin-Lélé (UGPR-KL). All producers are members of this organization and all of them have access to land by borrowing. The average area planted for rice seed production is 0.82 ha for men and 0.30 ha for women, or on average, 0.75 ha per farmer. The areas of cultivated land varied between 0.24 and 2.55 ha. All 106 ha of managed land are fully exploited.

Managed land is currently a scarce resource on the perimeter. The average amount of mineral fertilizer applied by farmers is 557 kg/ha, well above the

Table 3. Descriptive statistics of the production system

Quantitative variables	Mean	Std. Dev.
Production (kg)	3 684	1 575
Area (ha)	0.75	0.35
Seed (kg)	35	16
Fertilizer (kg)	408	180
Herbicide (l)	1.1	0.7
Insecticide (l)	0.4	0.2
Labor (man-day)	105	53
Capital (fcfa)	39 500	25 900
Partial productivity		
Seed (kg/ha)	47	5
Fertilizer (kg/ha)	557	85
Herbicide (l/ha)	1.3	0.3
Insecticide (l/ha)	0.5	0.2
Labor (man-day/ha)	135	10
Capital (fcfa/ha)	55 140	30 600
Qualitative variable	**Frequency**	**Proportion (%)**
Site 1 if the farmer is on the village Koussin)*	72	51

*On the site there are two villages: Koussin and Lélé.

recommended mineral fertilizer value of 275 kg/ha (Yabi, 2013). More than two-thirds of farmers (71%) applied a mineral fertilizer dose of more than 300 kg/ha. This overdose could be explained by the gradual decline in soil fertility and could have many environmental consequences. Similarly, the average quantity of seed applied is 47 kg/ha with a low standard deviation of 5 kg/ha. Practically, all farmers (99%) used a higher seed density than recommended (40 kg/ha) according to the agricultural advisors in the study area. All farmers use herbicides and insecticides. The applied doses are 1.3 and 0.5 l/ha, respectively with low standard deviations.

On the rice area, three types of labor were used. These included family labor, hired labor and mutual assistance. On average, the hired labor force, family labor and mutual assistance represented respectively 64, 30 and 6% of the total workforce employed. All farmers used external labor. Occasional labor is paid for on a piece-by-piece basis and the cost varies depending on the hardness of cultivation and the availability of specialized farmers. The average price is 1 430 fcfa per man-day. The average production is 3 684 kg with an average yield of 4 955 kg/ha which is significantly higher than that of 2 178 kg/ha found by Arouna and Diagne (2013). The potential yield of this rice variety is estimated at 5 tons/ha. The obtained results show that the farmers have succeeded in reaching and even exceeding this potential yield. This means that rice seed-farmers of the Koussin-Lélé area must be technically efficient.

Table 4 presents the results of the one stage Cobb-Douglas-type stochastic frontier production function involving a model for technical inefficiency effects. Preliminary tests showed that the area is highly correlated with each of the other inputs of production. Therefore, it was ultimately excluded from the model. This model is globally significant at the level of 1%. The coefficients of the inputs of production are positive as expected but only the inputs of production labor and mineral fertilizers are significant. Coefficients of inputs such as seeds, insecticides and herbicides are positive as expected but not significant at 10%. This does not mean that the use of these factors has no influence on rice production. In practice, all producers (99%) use a seed dose higher than recommended (40 kg/ha). So an increase in the dose of seeds, all other things being equal, could not improve production.

Similarly, the low variability in the amounts of herbicides and insecticides per ha adopted by producers could explain the estimation results obtained. Moreover, the results showed that the farmers of the Koussin block obtain a larger production than those of the Lélé block, all things being equal. As a result, they obtained an average yield of 5 069 kg/ha when compared with 4 836 kg/ha for the others.

The null hypothesis that the inefficiency effects are not present is rejected at the level 1% $Chi^2 = 65.60$ and Prob > $Chi^2 = 0.000$. Also, the null hypothesis that the inefficiency effects are not stochastic is rejected at the level 1% (Prob > |Z|.= 0,000). As a result, a part of the seed-farmers inefficiency is due to technical errors. The parameter γ which makes it possible to measure the contribution of the error due to technical inefficiency (γ) in

Table 4. Results of the one stage Cobb-Douglas-type stochastic frontier production function involving a model for technical inefficiency effects.

Variable	Coefficient	Std. Error	Z	P > | Z |
Stochastic frontier production function				
Constant	3.075***	0.3555	8.65	0.000
Seed	0.051	0.056	0.91	0.364
Fertilizer	0.575***	0.053	10.80	0.000
Herbicide	0.011	0.034	0.32	0.750
Insecticide	0.005	0.014	0.36	0.716
Labor	0.288***	0.083	3.49	0.000
Capital	0.023	0.034	0.67	0.503
Site (=1 If Farmer From Koussin Site)	0.022*	0.011	1.99	0.047
Inefficiency model				
Constant	0.738***	0.218	3.38	0.001
Sex	-0.021	0.034	-0.63	0.531
Age	-0.011	0.008	-1.29	0.196
Age^2	0.000	0.000	1.49	0.137
Activity	-0.105**	0.037	-2.85	0.004
Primary	-0.076*	0.0439	-1.93	0.053
Secondary	-0.115**	0.051	-2.26	0.024
Experience	-0.003	0.004	-0.74	0.459
Contact	-0.078**	0.038	-2.06	0.040
Credit	-0.046	0.043	-1.05	0.292
N (Sample Size)		141		
Log Maximum Likelihood Function		193.07		
Prob **>** Chi^2		0.0000		
σ_u		0.05***		0.000
σ_v		0.045		
σ_u^2		0.003		
σ_v^2		0.002		
σ^2		0.005		
γ (gamma) = σ_u^2/σ^2		0.64		
λ (lambda) = σ_u/σ_v		1.11		
Technical Efficiency		0.92		

In parentheses are reported the Student t values or the Z values. ***, ** and *: significant values at 1, 5 and 10%, respectively.

the total variability of the output is estimated at 64%. As a result, technical inefficiency is mainly due to errors in the management of available resources. However, on average, seed-farmers have a technical efficiency index of 92%. This level of mean technical efficiency implies that shrimp farmers are operating only 8% below the production frontier, given the level of technology. This result also indicates that the rice seed-farmers in the study area in Benin, on average, can increase the output only by 7% [1 − (92/99)] through improvements in technical efficiency. Otherwise, on the average, If the technical errors could be corrected, with the same resources, the production per rice seed cycle would increase from 3 684 (7 368 kg per year) to 3 942 kg per cycle (7 884 kg per year).

Figure 1 shows the distribution of the estimated technical efficiency indices. These efficiency indices varied between 69 and 99%. The gap between the minimum and the maximum scores is not very large. Unfortunately, no single farm appears as fully technically efficient. The proportion of seed-farmers with an efficiency index greater than or equal to the average is 62%, or close to two-third of the seed-farmers population. Figure 2 shows a positive correlation between the level of technical efficiency and rice seed yield. The most efficient farmers have the best yields (5 096 kg/ha) comparable to the experimental potential yields. Indeed, a study carried out in controlled farms shows that the average yield of IR 841 rice is 4 800 to 5 000 kg of paddy per hectare (Yabi, 2013; Konnon et al., 2014). The most efficient farmers

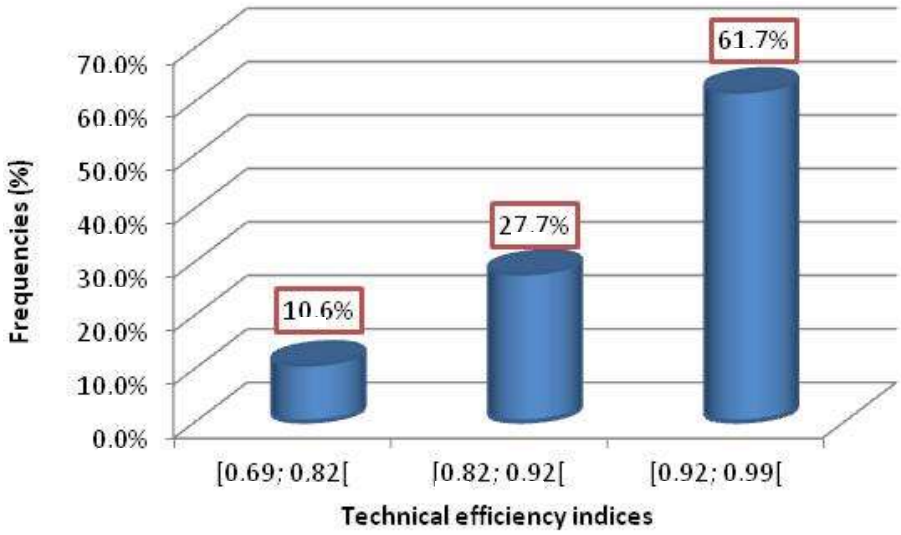

Figure 1. Distribution of technical efficiency scores for Koussin-Lélé seed-farmers.

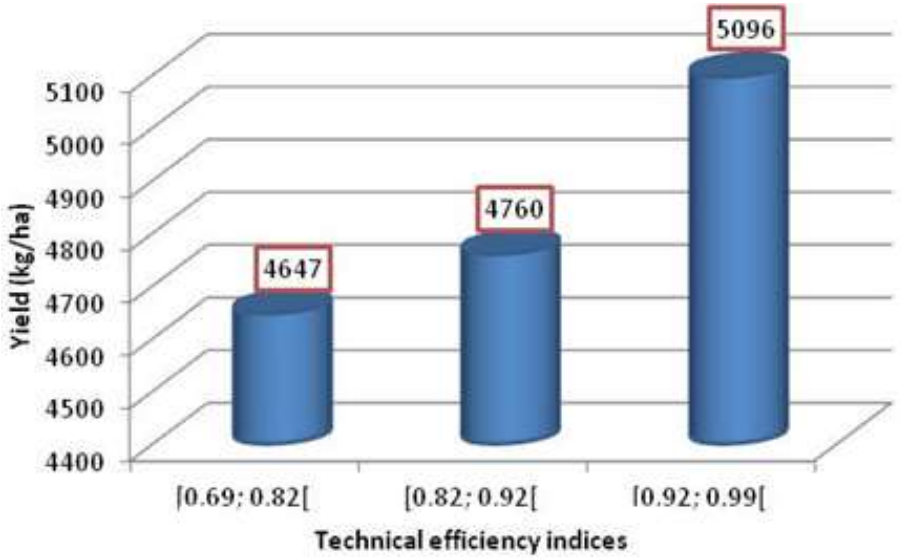

Figure 2. Evolution of rice yields (kg/ha) according to technical efficiency indices.

made small technical errors.

The results obtained on the technical efficiency levels are comparable to those obtained by Singbo (2007) in his study on the measurement of the efficiency of lowland exploitation systems in the central region of Benin. According to the results of this study, technical efficiency indices for rice farmers varied between 58.7 and 99.9% with an average of 88.9% for the rice monoculture system in the lowlands. Tijan (2006) also obtained a technical efficiency level of 87% in Nigeria ranging from 29 to 98%. On the other hand, the level of efficiency of the rice seed-farmers of the irrigated perimeter of Koussin-Lélé is higher than that obtained by Amoussouhoui et al. (2012) for seed-farmers in southern Benin. Their level of technical efficiency was estimated at 72%. Similarly, recent study by Oumourou et al. (2016) showed that rice farmers in south-western Niger have a technical efficiency level of 48%. The high level of technical efficiency in this study could be explained by several factors presented and discussed in the next section.

Technical inefficiency (efficiency) determinants analysis

The descriptive statistics of the variables included in the model for technical inefficiency effects are presented in Table 5. The average age of farmers is 41 years. These

Table 5. Descriptive statistics of the variables of the multiple linear regression model.

Quantitative variables	Mean	Std. Dev.
Age	41.08	9.42
Experience	17.59	7.61
Contact	2.49	0.50
Qualitative variables	**Frequency**	**Proportion (%)**
Sex (1 if the farmer is a man)	123	87.2
Primary	33	23.4
Secondary	33	23.4
Activity	131	92.9
Credit	136	96.5

Source: Survey data, Koussin-Lélé, 2016

farmers have on average 17 years of experience in rice production. The analysis in Table 5 shows that only 13% of women led rice farms on the irrigated perimeter. Less than half of the seed-farmers (47%) have at least primary level of education. Majority of the rice farmers consider seed production as their main activity. All farmers have access to agricultural advice facilitated by their membership of farmer organizations. They were visited on average two to three times for a six-month production cycle. They were also monitored by the department in charge of the Quality and Packaging Promotion (DPQC). Each seed supplier must therefore respect the recommended technical route in order to have the certification of the rice produced. Almost all farmers (97%) have access to credit. For the 2014-2015 season, it was the ALIDé microfinance structure that granted farmers some season's credits at an interest rate of 9.5% for a period of six months. These credits should be recovered automatically from sales revenue. Certified seeds are bought by National Society for Agricultural Promotion (SONAPRA) from farmers. The described environment below is favorable for better seed production.

The null hypothesis that all the coefficients of the variables in the model for the inefficiency effects are zero is rejected at the level 1% (Chi^2 = 20.84 and Prob > Chi^2 = 0.0076). The estimates for the parameters in inefficiency model presented in Table 4 showed that there is a positive and significant relationship between the nature of the main activity, the level of education and access to agricultural advice. The technical efficiency indices of those engaged in seed production as a main activity exceeds that of others by 10.5%. This result is comparable to that obtained by Amoussouhoui et al. (2012).

The results showed that the technical efficiency of farmers improves (technical inefficiency reduced) when the seed-farmer has at least the primary level of education. It exceeds that of other uneducated farmers by at least 7.6%. In the field, technical data sheets on technical recommendations and notices on the efficient use of phytosanitary products are produced in French. The educated farmers are therefore the most favored and are able to better understand the information conveyed. This result is consistent with that obtained by Wang (2010) in northern China. On the other hand, the level of education has no effect on the technical efficiency of rice farmers in Niger (Oumarou et al., 2016) and Côte d'Ivoire (Ekou, 2010). However, according to Ekou (2010), this result could be related to the low weight of educated farmers who constituted only 20% of the sample studied.

In addition, the extension system introduced reduced the level of productive inefficiency on the irrigated perimeter. The efforts of the agricultural advisors made available to farmers have been useful and should be encouraged. In Côte d'Ivoire, Ekou (2010) found that agricultural advisers are overloaded and their actions are null on technical efficiency.

The coefficients of the variables "Age" and "Age2" are not significant but the signs of these factors indicate that there are certainly many technical efficiency farmers among younger and older ones. The credit coefficient has the expected sign but was not significant. This does not mean that credit is not useful. The result obtained can be explained by the fact that almost all farmers have access to credits and the average amount obtained in 2014-2015 is 430 426 fcfa per farmer.

Conclusion

This research evaluated the technical efficiency of rice seed multipliers in the Koussin-Lélé irrigated area of the district of Covè, Benin. It used a stochastic frontier production function which incorporates a model for the technical inefficiency effects. The results obtained from all 141 rice seed-farmers show that all producers access land by borrowing. The average area planted for rice seed production is 0.82 ha for men and 0.30 ha for

women, or in average, 0.75 ha per farmer. The area of land sown varied between 0.24 and 2.55 ha. All 106 ha of managed land are fully exploited. All producers are members of the Union of Rice Producers' Associations of Koussin-Lélé (UGPR-KL). They all produced a single variety of rice, the improved rice IR 841. Men constituted 83% of the seed-farmers population. All producers have access to agricultural advice facilitated by their membership of farmer organizations. Almost all producers (97%) have access to credit. Basic seeds are made available to farmers and the production is systematically sold to the public body responsible for rice promotion. On the other hand, there is a trend towards greater use of chemical fertilizers by farmers in order to improve their yields.

The results of the estimates of the frontier production function show that the mean technical efficiency of the seed producers in the study area in Benin is 92% ranging from 69 and 99%. The gap between the minimum score and the maximum score is not very large. The proportion of seed growers with an efficiency index greater than or equal to the average is 62%, which is close to two-third of the seed farmers population. The most efficient farmers have the best yields, 5 096 kg/ha comparable to the experimental potential yields of IR 841 rice estimated at 4 800 to 5 000 kg of paddy per hectare in controlled farmer environment.

On average, the rice seed farmers, can increase the output only by 7% [1 − (92/99)] through improvements in technical efficiency. Otherwise, on the average, If the technical errors could be corrected, with the same resources, the production per rice seed cycle would increase from 3 684 (7 368 kg per year) to 3 942 kg per cycle (7 884 kg per year).

Moreover, the results show that the farmers of the Koussin site are more efficient than those of the Lélé site. They achieved an average yield of 5 069 kg/ha against 4 836 kg/ha for Lélé site. Finally, farmers who exercise multiplication of rice seeds as their main activity, educated producers and those who are often in contact with agricultural advisers are the most technically efficient.

It can therefore be concluded that the current institutional environment is favorable to rice seed farmers in the Koussin-Lélé irrigated perimeter. The undertaken actions implemented in recent years must be continued and strengthened. The content of extension should also be guided by appropriate techniques of fertilization and/or restoration of soil fertility to avoid the misuse of mineral fertilizers. Policies to stabilize the selling prices of rice seeds must also be pursued in order to guarantee farmers some assurance in the market demand of their production.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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