Ethiopian Economics Association

(EEA)

PROCEEDINGS OF THE SIXTH REGIONAL CONFERENCE OF THE AMHARA REGIONAL STATE ECONOMIC DEVELOPMENT

Edited by

Worku Gebeyehu

Samuel GebreSelassie

Demirew Getachew

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FOREWORD

The Ethiopian Economics Association (EEA) and its Bahir Dar Chapter are happy to issue the proceeding of the Sixth Annual Conference on the Amhara Regional State Economic Development which was organized on September 20, 2014 at Homeland Hotel Conference Hall. EEA has been organizing this important regional conference, every year, as one of its objectives of broadening its activities and coverage at regional level so as to contribute to the economic advancement of regional state through enhancing economic policy formulation capability; the dissemination of economic research findings; promotion of dialogue on critical socio-economic issues; promotion of education in economics in higher learning institutions; enhancing national, continental and global networks of professionals and institutions; and advancement of the professional interests of its members.

The Annual Regional Conferences that the Association has organized in collaboration with its Chapters have created important forums for presenting and discussing development issues that are highly relevant to the Regional Socio-economy. These forums have also provided incentives for researchers to conduct research and present their findings on regular basis. Indeed, the Annual Regional conferences were organized in an interdisciplinary fashion, thereby widening the interactive coverage involving both economists living here in the region and those living outside the region and non- economists who are working and experiences on the region. The 6th Annual Regional Conference on Amhara Regional State Economic Development has contributed towards a deeper understanding of the regional economy and the complex challenges it faces. It attracted about 150 participants including the X-President of the Amhara National Regional State and higher officials of the Regional Bureaus and expertise from Regional Bureaus, Universities, NGOs, private sector representative and EEA members in the region. The participants of the conference expressed their satisfaction on the organization of the conference and the content of the papers presented. They reflected that the papers largely focused on local issue that can contribute to the development of the region. They also recommended that the issues raised in the discussion are critical

that need due attention by policy makers and implementing organs of the regions.

Like the previous conferences, the conference was officially opened by H.E Ato Degu Andargachew, President of the Amhara National Regional State. In his opening speech, H.E Ato Degu Andargachew welcomed participants of the conference and thanked the Ethiopian Economics Association and its Bahir Dar chapter for hosting and organizing this important conference. He underscored that the conference offers best opportunities for policy makers and researchers to understand in depth the complex challenges that the region has faced in the face of fast moving Economic Growth that the country has registered in the past decade and enhances effective networking to synergize the efforts of like-minded individuals and institutions/organizations. H.E Ato Degu Andargachew also expressed his appreciation of the Ethiopian Economics Association's significant and growing efforts in the spheres of economic policy research and capacity building through which it has been contributing to the sustained advancement of the economics profession and to the policy formulation and implementation process.

In this publication, all papers which were presented at the Sixth Annual Conference were reviewed by external reviewers and comments and suggestions including editorial comments were communicated to authors for improvement. Finally, those papers which passed all the review and editorial process published in the Proceeding of the Sixth Annual Conference on the Amhara Regional State Economic Development.

I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economic Association, to the many people and organizations that made the conference resounding success. First and foremost, I thank the authors of the papers and the audience whose active participations made the Conference meaningful. The staffs of the Economics Department of the Bahir Dar University which runs the EEA Bahir Dar Chapter and the staff of EEA Secretariat deserve a special recognition for their passion and perseverance in managing the conference from inception to completion.

Our special thanks go to our partners who have shared our vision and provided us with generous financial support to materialize the activities of EEA. These include; The Friedrich Ebert Stiftung of Germany, The African Capacity Building Foundation (ACBF) and The Think Tank Initiative of International Development Research Center (IDRC) of Canada.

Finally, I would like to extend my sincere gratitude to H.E. Ato Gedu Andargachew, President of the Amhara National Regional State, for his an insightful opening addresses and for his continued interest on the activities of Bahir Dar Chapter since its establishment; and Dr. Tesfaye Shiferaw Bahir Dar University V/President for his Welcoming address. I would like also to thank other officials of the regions and Bahir Dar University for their encouragement for the successful conclusion of the conference and for their continued support for the activities of EEA Bahir Dar Chapter.

Alemayehu Seyoum Taffesse (DPhil)
President of the Ethiopian Economics Association

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URBAN HOUSEHOLD POVERTY IN BAHIR DAR CITY: DETERMINANTS AND SENSITIVITY

Dawit Gibru Tsegaw[1]

Abstract

The extent of poverty is determined by a number of factors and these factors are not considered to be the same across everywhere. Noting this, the objective of this paper was to identify the determinants and sensitivity of urban household poverty in Bahir Dar city. Data on 320 households was surveyed and descriptive and logit econometric models were applied to analyze the surveyed data. The results indicated that 27.8 percent of the sampled households were found to be below the locally determined poverty line, 18.5 Birr per day per adult equivalent. The estimates on the determinants of poverty indicated that household size, female headship, being unemployed, currently not married, not saving, health status and household shocks have the probability of increasing poverty. Household education and infrastructure provision are likely to reduce poverty in the area. Households living at the center of the city have a higher likelihood of being poorer than other residents. Further sensitivity analysis across different poverty lines indicated that only household size, education, currently not married, not saving, service access, household shocks and health of the household show a robust correlation with poverty. The result implies the importance of family planning, shock offsetting especially health shock, promotion of education and infrastructure provision and improving the saving culture of households for poverty reduction. It also underlined the formulation of Kebele prioritized programs of poverty reduction.

Key words: Poverty, Consumption, Logit, Determinants, Sensitivity, Bahir Dar city

[1] Email: dawitse@gmail.com

1. Introduction

Poverty affects people of all over the world and hence becomes an issue of global concern. It is the worst reflection of poor economic performance (Dercon, 1997). People in Ethiopia have experienced poverty for a long time. The country's per capita income is estimated to be 392 USD, and its human development index is low (HDI value of 0.396) which ranks it 173rd out of 187 countries (UNDP, 2013). Similarly, according to the UNDP human development report (2013) life expectancy at birth is 59.7 while only 78 percent of the urban populations are literate. Various studies on the issue show that a large proportion of both urban and rural people are affected by poverty (Asmamaw, 2004). According to the 2010/11 household income consumption and expenditure survey (HICES), the proportion of poor people (poverty head count index) in the country is estimated to be 29.6% of which 30.4% and 25.7% live in rural and urban areas (below the poverty line), respectively. The urban poverty level in Amhara region, where this study was conducted, is 29% which is equivalent to the national head count. This poverty level was about 37 percent in 1995/96 implying that the decline is linked to the economic growth MoFED, 2012). The government still prioritizes its efforts with international partners in order to further reduce the impacts of poverty on the livelihood of the people.

Poverty being a multifaceted problem, affects people with different characteristics in different ways, as they have different social setups, economic status and demographic features. The general likelihood causes of poverty are believed to be different between the poor and non poor which is reflected in their socio economic condition of a particular area like Bahir Dar. An area that differs in demographic and socio economic condition such as household demographic behavior, ownership of livelihood assets and access to infrastructure and services, etc. is much likely to differ in its poverty condition from an area that has different characteristics. Thus identification of these socio economic factors is an important component of

policy measures that public decision makers can undertake in order to mitigate poverty and improve the living conditions of their people (Fistum, 2002; Elisa, 2008).

Though most early literature on poverty and the government's effort in Ethiopia generally focus on rural rather than urban areas, poverty has continued to be a problem in urban areas. They have their own distinct urban profile (Elisa, 2008), i.e, major towns have their own urban status and poverty level that make them different from other small town or primate cities. According to MoFED (2012) national urban poverty head count was 25.7 percent in 2010/11. This poverty status is still high compared to the country's MDG poverty target.

The poverty head count index of Bahir Dar in 1999/000, for example, was 22% while the poverty head counts of Mekelle, Jimma, Harar, and Addis Ababa were 43%, 37%, 35% and 36%, respectively (MoFED,2002). The respective poverty indices for the cities in 2008 were 29.6%, 34.4%, 31.6%, 32.6% and 32.5% , implying that poverty in Bahir Dar showed an increase though it is still low compared to the other urban centers (MoFED, 2008). However, these studies have not identified the factors that determined the cities' poverty status. At the same time, the factors that determine poverty status of cities cannot be identical either. There is also no valid reason to believe that the key determinants of poverty are the same everywhere (Haughton and Khandker, 2009). Thus, policies aimed at reducing the magnitude of poverty should focus at a lower level by identifying the factors which account for the poverty of that particular urban area.

On the other hand, household poverty analysis can not be precise about the determinants of poverty status due to measurement errors and hence arbitrariness of poverty lines. Since there are imperfections during poverty line determination, sensitivity analysis is required to ensure the robustness of the estimators over the range of different poverty lines. This is lacking in

previous studies (Bigsten, A. et al, 1997; Mekonnen, T, 1999; Tesfaye, A, 2006), despite its importance. A variation in poverty lines helps to assess whether such a variation is significant enough to affect conclusions about the direction of impact of a given exogenous variable. Thus sensitivity analysis of the poverty estimates has to be checked before one confidently concludes about the likely impact of each variable. Following these problems, the main objective of study was identifying the determinants and sensitivity of household poverty in Bahir Dar city.

2. Methodology

2.1 Data

This study was based on household consumption expenditure and demographic survey conducted in 2013. Detailed primary data of a continuous and categorical nature was collected from 320 sampled households using structured questionnaires. Since poverty can be better measured using household consumption expenditure than income, consumption expenditure (food and non food items) and other socio-demographic characteristics of the households were collected (World Bank, 2005; UN, 2005). Secondary data, such as poverty head count index from MoFED and population census results from CSA, was also used.

Since the study used consumption expenditure as a measure of welfare, detailed consumption expenditure data of the households as well as imputed user values for owner occupied housing were included. The most common consumption food items that reflect the typical consumption pattern of the area were considered during the survey, but it was also open ended so that households could include the food items they used. For the food items that were purchased once and consumed for more than a month, an adjustment was made to get an estimated average monthly consumption of that food item. On the other hand, non food component of the consumption expenditure do not include consumption of durable goods

as a measure of poverty since consumption of such durable goods in Ethiopia including Bahir Dar is undertaken infrequently and once purchased they were consumed over a long period which makes valuation difficult.

A structured questionnaire which was prepared in English and later translated into Amharic was employed for ease of communication during data collection. For the data collection, eight data enumerators were selected and trained with a simple pilot test to improve the quality of data before they were assigned the task of collecting the main data. Households in each Kebele were selected randomly using simple random sampling. Samples were drawn from all the 9 Kebeles of the city to reflect the average socio- economic characteristics of the population in the city. During the survey, the head of the household were interviewed. In addition, other household members were allowed to supplement information given by the household heads.

2.2. Method of Data Analysis

The method of analysis employed in the study includes descriptive statistics and econometric models. First, the households' demographic and socio economic and other quantitative characteristics obtained from the survey were summarized using percentage and chi-square descriptive statistics. Second, to identify the main determinants of urban poverty, binary choice econometric model was applied given that the dependent variable is dichotomous that is equal to 1 when a household is poor and 0 otherwise. Binary logit model was used for empirical analysis and the analysis was conducted by Stata 11 Statistical Software.

During the data analysis poverty was measured using consumption expenditure rather than income of the households. This is due to the fact that consumption expenditure can reflect the long run welfare and shows the efforts to which households' consumption smoothing even during the

absence of income either in the form of disaving, risk sharing and borrowing (MoFED, 2012). The aggregate household consumption expenditure is adjusted by adult equivalent size2 to allow differences in consumption expenditure among household members.

This study employed the Greer and Thorbeck (1986) food energy intake method of food poverty line derivation. This food poverty line was mostly done using a regression of cost of calories function between consumption expenditure and food calorie intakes (Ravallion, 1998). The food component of the poverty line was assumed to meet the nutritional requirement of the individual's good health and those diets were chosen based on the prevailing consumption culture of the study area. In this case a food poverty line is a state of lacking resources necessary for achieving nutritionally adequate diet which also satisfies the major protein, vitamin and mineral needs (Greer & Thorbecke, 1986). Formally, this method is given as:

$$\ln FE_i = \alpha + \beta C_i + \varepsilon_i \qquad \textbf{(2.1)}$$

Where FE_i is the food expenditure per adult equivalent of the sampled household i, C_i is total calorie consumption per adult equivalent of household i, α and β parameters to be estimated and ε_i is random error term with constant variance and zero mean. The estimated regression equation of the above equation is given by

$$\ln \hat{FE}_i = \alpha + \beta \hat{C}_i \qquad \textbf{(2.2)}$$

[2] Household adult equivalence size is based on the summation of each member's age and gender specific calorie based adult equivalent values.

Given the result of this regression estimation, the food poverty line (Z^f) is calculated using the minimum standard 2200 kcal per adult per day for Ethiopia as

$$Z^f = e^{(\hat{\alpha}+2200\hat{\beta})} \qquad \textbf{(2.3)}$$

Where e the base of natural logarithm and Z^f is the food poverty line. The total calorie consumption of each household is obtained by using calorie conversion factors provided by the World Health Organization (WHO).

However those households who can afford to be above the food poverty line allocate expenditure for the non food items and thus a need for a minimum allowance for non food spending. A common practice for this is the one suggested by Ravallion and Bidani (1994) using the food share of Engle's curve or food demand function which compute the food share(S_i) of each household as a function of logarithm of total spending per adult equivalent (Y_i) relative to the food poverty line. This regression function is given by:

$$S_i = \alpha + \beta \log(y_i / z^f) + v_i \qquad \textbf{(2.4)}$$

Where again α and β are parameters to be estimated. Here α is food share of those just attaining the food poverty line which implies the non food share is given by (1- α) and hence the non food allowance is (1- α) times Z^f . Then, the total poverty line Z is

$$Z = Z^f + (1-\alpha) * Z^f = Z^f (2-\alpha) \qquad \textbf{(2.5)}$$

Thus, if the consumption expenditure per adult equivalent of the household is below this poverty line then the household is poor.

This poverty line is compared with households' per adult consumption expenditure to differentiate households into poor and non poor. If the consumption expenditure per adult equivalent of the household is below this line then the household is regarded as poor. In addition, the poverty head count, poverty gap and severity index measures of poverty are estimated in order to understand the city's poverty status. Using the local poverty line as a bench mark, potential determinants of poverty status are identified. Then allowing this poverty line to vary by a certain proportion from below and above, the robustness of the predictors is determined through regressing again the estimators across each poverty line. Thus the variable that is consistently significant in the direction of its impact on the probability of a household's poverty status is robust.

2.3. Model Specification

Modeling determinants of poverty can be performed using a regression of the individual poverty measure or consumption expenditure against a variety of household characteristics. An important modeling practice is the level regression $\log y_i / z$ as a function of a vector of household demographic and socio economic characteristics (Ravallion, 1996). Specifically, this can be written as $\log y_i / z = X\beta + \varepsilon_i$, where, y_i is consumption expenditure and z is the poverty line (Ravallion, 1996). However, such level regression suffers from a weakness; despite the fact that it is constantly estimable under weaker assumptions about the distribution, it imposes constant parameters over the entire distribution. In this modeling approach the consumption of the poor and non poor distribution are determined by the same process (Grootaert, 1997).

An alternative regression is a categorical model which allows the impact of each parameter to differ across different segments of the distribution and better predict the probability of being poor. The discrete choice model has

the advantage of independent variables to vary across poverty categories and helps to make probabilistic statements about the impact of these variables on the poverty status of households. Thus the above level regression can be rewritten by defining the binary dependent variable $P_i = 1$ if $y_i / z < 1$ and $P_i = 0$ otherwise. This form of binary logit model can be derived from a logistic function (Green, 2008) and the probability of a household being poor is given by:

$$pr(poor) = \frac{e^{X'\beta+\varepsilon}}{1+e^{X'\beta+\varepsilon}} \qquad \textbf{(2.6)}$$

Where β_i = are vector of coefficients to be estimated and X_i = are vector of explanatory variables. The logit function to be estimated can be written using the above probability function in the form of odds in favor of the households being poor as shown below.

$$\ln L = \frac{pr(poor)}{pr(nonpoor)} = e^{X'\beta+\varepsilon} \qquad \textbf{(2.7)}$$

Equation (2.7) is estimated by maximum likelihood method which does not require the assumption of normality and homogeneity of variance of the predictor variables. The X's represents a covariate of poverty that is those demographic and other socio economic characteristics of the household in the city. The error tem of the equation is assumed to have zero mean with a logistic distribution. In this study the marginal effects were computed that show the change in the probability of being poor when there is a unit change in the sample mean of independent explanatory variables.

The soundness of this logit econometric model was checked by the necessary model diagnostic tests such as collinearity (Collin) test for

multicollinearity problems, het test for hetroscedasticity, link test for model specification and l fit test to know the predictive power of the model.

2.4. Variable Definition and Hypothesis

The above binary logit model contains two main components. The first is a dependent variable urban poverty which takes the value 1 if the household is poor and 0 if the household is non poor. The second component is the set of explanatory variables which are assumed to explain the extent of urban poverty. It is believed that urban poverty is determined by a number of factors. However, this paper controlled a number of important and observable individual and household characteristics that may have significant roles. Thus, this section describes how the regressant and the regressor are constructed for empirical analysis and the theoretical argument about the relationship between household poverty and explanatory variables.

Households' poverty status (hh_pov): household poverty status is dummy for household's poverty level; 1 if the household is poor and 0 if the household is non poor.

Age of the household head (age_head): This is one of the demographic variables that affect poverty of the household. People in the adult age group are expected to have income unlike those in the elderly and young age group. Thus people in the adult age group have the probability of earning income and this helps them to be above the poverty line. On the other hand age square (***age_sqr***) is used to identify the effect of an increase in age on the poverty level of the households. Thus, age and age square variables are used to capture the work experience and life- cycle effect of age on household poverty, respectively (Rodriguez, 2011; Serumag-Zake and Naude(2002).

Household head sex (sex_head): This refers to dummy for the sex of the household head and it takes the value 1 if the head is female and 0 if the head is male. Experience shows that in developing countries including Ethiopia females are discriminated from getting different opportunities like education and employment. Due to more household responsibilities of females in their family their earning potential is also less and thus, it is hypothesized that female headed households are more likely to be poor than male counterparts. (Serumag-Zake and Naude, 2002; Houghton and Khandker, 2009).

Household Head Marital Status (mart_head): This refers to the binary values if the head of the household is not currently married gets a value of 1, 0 otherwise. According to Fagernas and Wallac (2007) an individual who is not currently married may have probability of falling into poverty because they have no chance of sharing risk during the time of income shocks whereas being married helps to increase their income in terms of reducing labor turn over.

Household Dependency ratio (hh_dep): This also represents dependency level of the household and it is obtained by dividing the number of family members in the age below 15 and above 65 by those members in the age group 15-64. Households with high dependency ratio may have low income and more likely to be poor (Runsinarith, 2011).

Household Family Size (fam_size): Household family size is one of the important demographic factors and it positively influences the poverty status of the household. Large family size is expected to put additional pressure on the household's asset and resource ownership. The smaller the household size, the more household consumption per size and the lesser probability of falling into poverty (Okurut, 2002).

Household Education (hh_edu): adult household members except children to obtain their good education. . Education of the household member is a source of skill to perform income generating economic activities and thus a significant determinant household of poverty. It is rare to find household members still at their schooling to generate household income. If there is such a case, the income is not directly associated with level of education. There is some evidence showing that while a head of the household is illiterate, education of the other adult member helps to generate household income and hence negatively affects poverty (for instance see Grootraert (1997).

Household Head occupation (oc_head): This variable depicts the type of occupation that the household head is involved. In this case the poverty level of the household depends on the type of job and its level of income and hence inversely related. Here a number of dummies are created representing 1 for unemployed, wage employed, self employed, casual worker, student with part timework and pensioner and 0 other wise, respectively, for each case. Those households with an occupation of formal wage and self employed are more likely to escape from poverty (Iqbal et al., 2009; Rodrigueze, 2011; Viet et al, 2010).

Household Savings (sav_acct): This refers to two dummies for a household's saving account; 1 if the household has no formal saving account or other forms of saving like Equb, 0 otherwise. It is hypothesized that households that save avoid poverty and those not saving do not..

Household Health Status (hh_health): Sickness or poor health affects one's productivity and increases the chance of being poor especially when the main income source of the family member is ill (Bruck et al, 2007). Hence, in this study if one of the family members had any illness during the previous two months or has chronic disease take the value 1, 0 otherwise.

Household Shocks (hh_shock): A household shock is an important correlate of poverty which enters the model using dummy variables having a value 1 if any of the household members had experienced any form of shock like job loss, theft, asset firing, death of main income source family member and divorce during the previous two months and 0 other wise. Bruck et al (2007) and Runsinarith (2011) showed that a household facing either of these shocks positively increases the probability of being poor.

Basic Service Access (serv_index): This is an important variable that shows the accessibility of households to basic services such as water, electricity, telecommunication and toilet facility. The measurement of this index is adopted from Woldehana et al(2008) sighted in Minasbo et al (2009) which gives a dummy variable for each service to capture whether a household had access or not through giving a value 1 for access and 0 otherwise. Those households with more accessibility to those services may have the chance of avoiding poverty (Fagernas and Wallace, 2007).

Kebele Dummy (kdummy): This is the variable for kebele fixed effects that help control Kebele level differences in the city. These fixed effects try to show all information that is peculiar to each Kebele (see also Datt and Jolliffe, 1999). Thus, a series of dummies are created taking the value 1 if the household was living at the given Kebele and 0 other wise. Such a set of Kebele level dummies arguably can control much of observed and unobserved Kebele level determinants of poverty.

The selection and construction of the above variables to appear as the determinants of household poverty is based on the rational that those variables are exogenous to consumption level and hence poverty status. For instance, the variables of average monthly income and the possession of housing are not included in the set of explanatory variables because income can also be regarded as an endogenous variable and the inputted user value of housing in the form of rent is entered into consumption expenditure of

the household. Such an effort can reduce the possibility of simultaneity or endogeneity problems among variables, though it is difficult to achieve in cross section data sets (see also Datt and Jolliffe, 1999; Fragernas and Wallace, 2007).

3. Results and Discussion

3.1. Descriptive Results

Table1 below shows the descriptive poverty situation in the city measured by the common poverty indices of head count, gap and severity using the food[3], non food and total poverty lines[4].

Table1: Poverty status in Bahir Dar city (percent)

Indices	Food Poverty	Total poverty
Head count (P_0)	16.6	27.8
Poverty Gap (P_1)	3.6	8.3
Poverty Severity (P_2)	1.1	3.4

Source: Own computation from the survey, 2013

As the result depicted, the poverty headcount or the proportion of the poor in Bahir Dar is 16.6 percent using the food poverty line and 27.8 percent using the total poverty line. The other measurements of poverty (Gap and Severity) are the measures of the distribution in relation to the poverty line. The finding shows that the poverty gap index is estimated to be 3.6 percent and 8.3 percent under the food and total poverty lines, respectively. On the other hand, severity of poverty in the city is 1.1 and 3.4 percent using both

[3] The regression result for the determination of food poverty line is based on the coefficients of = 13.6 birr per day; and both the coefficients are found to be significant

[4] The food share component of the regression result is indicated by its intercept (α= 0.6318) and thus the total poverty line is given as Z= 13.5(2- 0.6318) =18.5 Birr per day.

poverty lines. A higher gap and severity using the total poverty line implies that the inequality is high with higher poverty line.

3.2. Econometric Analysis Results

The determinants of the likelihood of being poor is estimated using the logit model and it indicated that the model fits the data well and passes all the model diagnostic tests. Among the hypothesized determinants of household poverty, those that significantly influence the probability of being poor include high household size, not currently marred, being unemployed, households not saving, households with health problems, experiencing shocks, households' education, access to basic services, living in Sefene Selam, Gish Abay and Fasilo kebele (Table 2). Accordingly, an addition of one household member into the household increases the chance of falling into poverty by 5.1 percent. Large households in urban areas are costly, because in addition to food, other non food expenses such as those for education, clothing lead to less consumption per household member and hence, more chances of remaining poor. Poverty is also associated with headship as the feminization of poverty increases by 29.5 percent when the gender of the head changes from male to female.

On the other hand, the number of years of education for household members excluding children still at school is an important determinant of poverty, which confirms most findings of previous literature (Mok et al., (2007), Rodirguez, 2011) and Grootraet, 2007)). According to this study, an increase of years of schooling by one year causes the probability of household poverty significantly to decline by 0.83 percentage point. Marital status of the head is another significant correlate of poverty. Household poverty increases by 12.5 percent when the head does not live with their partner. Viet et al (2010) and Getachew (2009) have also identified that the probability of being poor is high with household heads not currently married. This may be associated with the argument that when the head

gets married, he/she psychologically settles and strives searching for a better job for administering the household (Fagernas and Wallac, 2007).

Occupational status of the head is considered to identify the effect of occupational mix on poverty. Occupations that mostly require high human capital have high earning which indirectly reduces poverty. In this respect, among the occupational mixes of the household heads, being unemployed is significantly associated with poverty. The result of a study by Mekonnen (1999) and Tesfaye (2006) is also in agreement with this result. When a household head gets unemployed its likelihood of falling into poverty is increased by about 67 percent which is very scaring particularly during inflationary times since there is no unemployment benefit in Ethiopia, unlike in developed countries. Unemployed households may get a difficulty to smooth their consumption level particularly if they do not have other income generating assets and borrowing opportunities.

Another important correlates of household poverty status is the saving of the household head. Household heads not involved in either the formal or informal saving practice (eg. Iqub) are likely to increase poverty by 20 percent. Households facing the episodes of both illness and shocks are directly associated with poverty in Bahir Dar and the results are consistent with previous findings by Getachew (2009). Health is the prime concern of human beings because without good health not only the productivity of the individual is reduced through the loss of working days but also the asset ownership of the household is threatened. Similarly, the occurrences of household shock such as theft, lay offs, fire on assets death of an income source in the household and divorce create a burden on household resource ownership and increase the probability of being poor by 37 percent. The incidence of a shock highly contributes to poverty because the poor are those without consumption smoothing alternatives such as borrowing due to lack of collateral. In urban areas, households living situations depend on cash economy which has less purchasing power due

to the high cost of living and hence shocks reduce the expenditure for consumption.

The remaining correlate of poverty is a household's access to basic public provided services within its vicinity. The availability of these services is negatively associated with the likelihood of being poor. The provision of urban infrastructure could help households to leave their traditional way of life and may improve their standard of living (Viet et al, 2010). The result of the model confirms this; which reduces the status of poverty by 37.9 percent as the level of accessibility increases.

In order to understand the relative geographic distribution of poverty in the city and to account for unobserved Kebele specific characteristics, Kebele dummies are introduced in the model. It is believed that Kebele level fixed effects can control most of the omitted Kebele specific potential determinants of poverty. The analysis indicates that households living in the Kebeles of Gish Abay and Sefene Selam are significantly poorer as compared to the reference Kebele, Ginbot 20. Whereas living in Fasilo reduces poverty, the highest incidence of poverty is shown at the center of the city. These Kebeles are the oldest part of the city characterized by slums, congestion, weak housing structure and unsanitary living conditions which probably exposes them to the risk of communicable diseases. On the other side hand, residents of Fasilo, due to relative proximity to the urban center, infrastructural availabilities, such transportation, households have advantages over other Kebele residents.

Table2: Determinants of household poverty (logit output)

Variable	Coefficient	Marginal effect (dy/dx)
Age head	0.0723	0.0059
	(0.6600)	(0.0056)
Age square	-0.0006	-0.0001
	(0.0006)	(0.0001)
Sex head	2.1530	0.2949**
	(0.7781)	(0.1443)
Household size	0.6279	0.0512***
	(0.1551)	(0.0157)
Dependency ratio	0.4676	0.0381
	(0.5928)	(0.0492)
Household education	-0.1027	-0.0084***
	(0.0252)	(0.0023)
Currently not married	1.8059	0.1254***
	(0.7387)	(0.0443)
Casual	0.1632	0.0139
	(1.1489)	(0.1024)
Unemployed	3.6205	0.6727***
	(1.1166)	(0.2021)
Wage	-0.7742	-0.0569
	(1.1216)	(0.0733)
Self employed	0.0326	0.0027
	(0.9850)	(0.0811)
No Saving	1.8576	0.1994***
	(0.4993)	(0.0685)
Health status	1.4855	0.1686**
	(0.4848)	(0.0723)
Household shock	2.4076	0.3749***
	(0.6055)	(0.1267)
Service access	-4.6599	-0.3797**
	(1.9104)	(0.1774)
Dummy shinbit	-0.0421	-0.0034
	(0.9608)	(0.0761)
dummy tana	-0.8443	-0.0535
	(0.9827)	(0.0476)
Dummy fasilo	-2.7523	-0.1088***
	(0.9296)	(0.0290)
Dummy sefene selam	3.0280	0.5532*

	(1.4701)	(0.3306)
Dummy gishabay	2.7828	0.4955**
	(0.9019)	(0.2047)
Dummy shumabo	0.3933	0.0363
	(1.2338)	(0.1292)
Dummy hidar11	0.7614	0.0782
	(0.8876)	(0.1136)
Dummy belay zeleke	-1.0379	-0.0650
	(0.9149)	(0.0432)
Constant	-3.6841	
	(2.2897)	
Number of observation	320	
LR chi2(23)	223.63***	
Log likelihood	-77.3615	
Pseudo R2	0.5911	
% predicted Right	88.44%	

Note: figures in the bracket are robust standard errors

3.3. Sensitivity Analysis

The above poverty determinants are based on a particular poverty line which may suffer an inherent arbitrariness in its determination either due to measurement or sampling errors. Given that the basic poverty line is not definite, the arbitrariness of poverty line is addressed by testing how the estimators and incidence of poverty change when assumptions regarding the benchmark poverty line are changed. Thus, it is essential to undertake a sensitivity analysis to identity the estimators that are robust even after the variation of the benchmark poverty line by a certain percentage. For this analysis, two poverty lines which are 7.4 percentages below and above the basic poverty line are set based on the previous 7.4% general inflation rate of the country (CSA, 2013). The assumption of using this inflation rate is to shift reasonably the base line and account for the effect of an arbitrary poverty line on poverty determinants. An increase or decrease of inflation rate can cause a change in the cost of living and hence also changes the

value of the poverty line. Table (3) shows sensitivity analysis results based on the changed poverty lines.

The result indicates that household size increases the household's probability of being poor across all poverty lines employed. Similarly, the impact of household education on poverty is found to be robust implying that education can significantly help households to escape from poverty irrespective of the poverty line used. The results of other determinants such as currently not married, no saving, health status, household shock, service index, living in Gish Abay and Fasilo are also consistent across the three poverty lines. Thus, the most important and robust correlates of poverty are household size, education, currently not married, no saving, service index , household shock and health status of the household for the case of Bahir Dar city.

Table3: Sensitivity Analysis on the determinants of poverty (marginal effects)

Variable	7.4% below	Base poverty line	7.4% above
Age head	0.0032	0.0059	0.0049
	(0.0032)	(0.0056)	(0.0065)
Age square	-0.00002	-0.0001	-0.00004
	(0.0000)	(0.0001)	(0.0000)
Sex head	0.1608	0.2949**	0.3049***
	(0.1084)	(0.1443)	(0.1459)
Household size	0.0278***	0.0512***	0.0559***
	(0.0102)	(0.0157)	(0.0174)
Dependency ratio	0.0338	0.0381	0.0392
	(0.0270)	(0.0492)	(0.0174)
Household education	-0.0049***	-0.0084***	-0.0088***
	(0.0015)	(0.0023)	(0.0026)
Currently not married	0.0527*	0.1254***	0.1573**
	(0.0302)	(0.0443)	(0.0514)
Casual	0.0457	0.0139	0.0908
	(0.0825)	(0.1024)	(0.1708)
Unemployed	0.3502	0.6727***	0.7893***
	(0.2509)	(0.2021)	(0.1240)

Wage	-0.0420	-0.0569	-0.0197
	(0.0385)	(0.0733)	(0.1059)
Self employed	0.0380	0.0027	0.0590
	(0.0553)	(0.0811)	(0.1196)
No Saving	0.0956**	0.1994***	0.2169***
	(0.0401)	(0.0685)	(0.0734)
Health status	0.1290**	0.1686**	0.1786***
	(0.0621)	(0.0723)	(0.0750)
Household shock	0.1939*	0.3749***	0.3381***
	(0.1024)	(0.1267)	(0.1153)
Service index	-0.1853*	-0.3797**	-0.4819***
	(0.1024)	(0.1774)	(0.2102)
Dummy shinbit	-0.0412*	-0.0034	0.0592
	(0.0235)	(0.0761)	(0.1182)
dummy tana	-0.0504**	-0.0535	-0.0599
	(0.0223)	(0.0476)	(0.0571)
Dummy fasilo	-0.0593***	-0.1088***	-0.12764***
	(0.0195)	(0.0290)	(0.0330)
Dummy sefene selam	0.0786	0.5532*	0.5823**
	(0.1299)	(0.3306)	(0.2930)
Dummy gishabay	0.3795*	0.4955**	0.5305***
	(0.2089)	(0.2047)	(0.1924)
Dummy shumabo	0.0233	0.0363	0.0580
	(0.0816)	(0.1292)	(0.1653)
Dummy hidar11	0.0192	0.0782	0.1877
	(0.0510)	(0.1136)	(0.1685)
Dummy belayzeleke	-0.0328	-0.0650	-0.0548
	(0.0265)	(0.0432)	(0.0602)
Number of observation	320	320	320
LR $chi^2(23)$	111.04***	223.63***	110.54***
Log likelihood	-75.0788	-77.3615	-81.1383
Pseudo R2	0.5661	0.5911	0.5793
% predicted Right	86.88%	88.44%	88.44%

4. Conclusion and Policy Implications

The study has shown that households with large family size are associated with poverty especially when those members are found to be unproductive. Family planning programs should be designed in line with different possible options that could make them easily accessible for the poor. The poor are those with less education who always resist practicing the available family planning techniques. In this case awareness creation programs may have a good impact. Education of especially females also helps to curb the problem since education and fertility are inversely related. Thus, the practice of family planning by the poor reduces the pressure of supporting large family members as well as the incidence of poverty.

The level of educational attainment of household members is an important factor correlated with reducing poverty. The existing government's investment on education and training should be promoted but designed with special attention of accessing educational infrastructures to the poor. In urban areas, since the cost of private education is high, educational opportunities of the poor should be disbursed by the government in collaboration with community participation in order to improve the labor productivity which is the main asset of the poor. In addition, this policy should address the gender inequalities existing in education either in terms of reducing dropout rates or increasing enrollment rates. Though the return from investment in education is not immediate, high level of education is an instrument for poverty reduction in the long run.

On the other hand, households not currently married are highly exposed to poverty. In this respect creating environments that encourage marriage like measures to reduce the high cost of living and increase asset holding in urban areas are essential. Macro economic shocks such as high inflation in urban areas have the social cost of family dissolution through eroding the value of assets and other financial holdings. Additionally, urban households experiencing at least one shock are likely to be poor. The occurrences of shocks increase poverty through reduction of consumption. Policies and

interventions, that help to offset the episodes of shocks, such as improving asset ownership as a buffer and strengthening social relation or capital are essential.

The poor are those with less access to basic infrastructures (such as water, communication and others) and provision of infrastructure has a significant role in reducing the incidence of poverty. Interventions are needed that minimize the infrastructure provision disparities between the poor and non poor households in the city. Promotion of public private partnership in the area of investment on infrastructure and maintenance can be one of the modalities to provide effective service to the poor. Outsourcing some of the infrastructure management and service delivery system is essential to improve the delivery of those services to the poor.

Health status of the household is also found to be a significant correlate of poverty. There is a need to formulate health programs that economically address the health of the poor. Health shock is still a problem of the urban poor and urban health extension workers have the responsibility of making households aware of improving their health. Health care infrastructure distribution and delivery of the necessary equipment are important for effective health service delivery. Private investment in the sector can also help the improvement of health but the poorest still need affordable public health services.

Households' saving performance has another impact on poverty situation and policies that try to improve financial management of households are likely to enhance their saving level. Since Iqub is the easiest saving modality of most households and one of the decisive social capitals in the area, promotion of Iqub and other saving associations which are gradually converted to formal saving channels can be an important part of poverty reduction.

Lastly, the city administration should take into account to minimize the gap of poverty prevalence within its administrative Kebeles. Programs that will be designed and implemented may prioritize the administrative kebeles where the highest proportions of the poor are residing. Slum upgrading may benefit the poor in the form of job opportunities associated with investments in the area.

The study has identified some of the household characteristics as the determinants of household poverty status. Thus, poverty reduction policies that could augment those household characteristics such as increase household education, improve family planning, expand infrastructures, encourage marriage, improve the saving culture and modalities of the poor, reduce shocks and improve health of the poor are key areas of intervention.

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Appendices

Table1: Description of hypothesized determinants of household poverty

Variable	Variable type	Expected sign	Definition or measurement
Dependent variable			
Poverty status	Dummy		1= poor ,0 = non poor
Explanatory			
Age head	Continuous	+	Age of the household in completed years
Age square head	Continuous	_	Square of the heads age
Sex head	Dummy	+_	1= female headed, 0 = male headed
Household size	Continuous	+	The number of household members
Dependency ratio	Continuous	+	Dep=(age15-64) / (age <15 + age >65)
Household education	Continuous	_	Total years of schooling of adult household members excluding children at school
Currently not married	Dummy	+	1= not currently married, 0 = currently married
Casual employment	Dummy	+	1= casual, 0 = otherwise
Unemployed	Dummy	+	1= unemployed,0 = otherwise
Self employed	Dummy	_	1= self , 0 = otherwise
Wage employed	Dummy	_	1= wage, 0 = otherwise
No saving	Dummy	+	1= no saving, 0 = otherwise
Health status	Dummy	+	1= sick, 0 = otherwise
Household shock	Dummy	+	1= yes, 0 = no
Service access	Continuous	_	Index values between 0 and 1
Kebele dummy	Dummy	+_	1= if Shinbit kebele, Tana ,etc, 0 = otherwise

MULTIPLE CREDIT CONSTRAINTS AND BORROWING BEHAVIOR OF FARM HOUSEHOLDS: PANEL DATA EVIDENCE FROM RURAL ETHIOPIA

Hailu Elias[1]

Abstract

Promoting an inclusive rural credit market in developing countries is a re-emerging and pressing development agenda given its importance in the poverty reduction and economic growth process. Existing literature mainly focuses on the supply side of the market with little or no attention given to demand aspects. This paper analyzes both the demand and supply side factors affecting credit constraints and borrowing behaviour of farmers. In doing so, we use two waves of survey data, which included about 1200 randomly selected households from four zones of the Amhara region in Northern Ethiopia. To account for unobserved heterogeneity and potential correlations across credit constraint categories, we employed the Generalized Linear Latent and mixed model (gllamm).The results show that the probability of quantity rationing has increased in the study area between the years 2011 and 2013. We also found that exposure to climatic shocks, age and lack of education increase the probability of being constrained while female, and married heads are relatively less constrained. The results further indicate that borrower's perceived probability of rejection due to strict lending policies and institutional rigidities; the transaction cost of borrowing; and risk aversion behaviour of

[1] *Lecturer, Department of Economics, Addis Ababa University, hailu.econ@gmail.com, Addis Ababa, Ethiopia.* *I am grateful to Professor Pär Sjölander and Dr. Kristofer Mansson (Jönköping University, Sweden), and Dr. Assefa Admassie for their useful comments. I also would like to thank Professor Almas Heshmati (Jönköping University, Sweden), Dr. Tadele Ferede and participants of the 6th Annual Conference on the Amhara Regional State Economic Development (20 September 2014, Bahir Dar, Ethiopia), for their valuable comments. The usual disclaimer applies.*

farmers highly reduce the probability of borrowing from the formal credit market. Compared to North Shewa, farmers living in South Wollo zone are found to be discouraged and hence do not prefer borrowing from the formal sector. However, farmers in West Gojjam are less discouraged and have higher probability of participating in the formal credit market, signifying zonal variation in credit constraints and borrowing behaviour. This suggests the need to work on more innovative lending approaches by giving attention to context-specific factors to build demand-driven, climate-smart, and inclusive rural credit market.

Key words: Credit Constraint, borrowing behavior, rural credit market, inclusive finance, gllamm, Ethiopia.

1. Introduction

In developing countries where agriculture takes the lion's share of the GDP, the rural credit market plays crucial role in enhancing agricultural growth and transformation. For farm households, access to rural credit facilities is more than having access to other inputs of production. This is because, it is easier to acquire recommended agricultural technologies, and farming tools to improve productivity and produce marketable surpluses once financial resources are available. It also helps farm households to build assets and smooth out consumption in the face of fluctuating agricultural income due to climatic shocks.

However, prior studies show that most farm households in developing countries are credit constrained. It is estimated that only five percent of farmers in Africa and about fifteen percent in Asia and Latin America have access to formal credit. On average, 80 percent of this credit goes only to 5 percent of the borrowers in many developing countries (Bali Swain, 2001; Antwi and Antwi, 2010). The condition is not much different in rural Ethiopia. For example, during the period 1951 – 1969, smallholder farmers received only 7.5 percent of the total loan disbursed by the development

bank of Ethiopia. The rest was going to wrong groups of the society such as "absentee landlords", merchants, and government officials and it did not reach poor farmers (Admassie, 1987). Only 4.7 percent of domestic credit went to the private sector during the period from 1986 to 1991 (World Bank, 1991) and more than 89 percent of banks' agricultural credit went to state farms during that period (Admassie et.al., 2005). This created binding credit constraints on farm households over the decades.

Hence, promoting an inclusive credit market and ensuring farm households' access to financial services in developing countries is a re-emerging and pressing development agenda and the recent policy emphasis has shifted to "Finance for All" (Lamberte et.al., 2006; World Bank; 2007; 2008b).

In line with this policy shift, Ethiopia has done much in reforming its financial sector in recent years. Although there is an improvement in access to credit following these reforms, smallholder farmers still face credit constraints. Commercial Banks in Ethiopia, hesitate to lend to farmers due to the inherent risk in agricultural production and lack of the required loan collateral, and hence, farm households are excluded from the formal banking market. Microfinance institutions and financial cooperatives are the alternative credit providers to these households. However, despite the rapid growth of these institutions in recent years, they reach only about20 percent of the rural poor (AEMFI, 2011; EEA, 2011), implying the existence of binding credit constraints.

Studies confirm that such binding constraints have significant adverse impacts on farm investment (Carter and Olinto, 2003), agricultural output (Petrick, 2005), and efficiency of intra-household resource allocation (Fletschner, 2008). It also reduces farm profit (Foltz, 2004), and technical and financial efficiency in agriculture (Hamda and Öhlmer, 2006; Fletschner et. al., 2010). Credit constraints coupled with exposure to climatic shocks may also force farmers to shift away from high income and high risk

economic activities to low risk and low income activities, leaving them in unsustainable livelihoods and the vicious circle of poverty(Humphreys et.al, 2004; Charles, 2011).

Thus, identifying the nature of credit constraints and borrowing behaviour of households is crucial both from empirical and policy perspectives, since it is a central welfare and development issue. But, empirical evidence on this topic is rare in the context of rural areas in the sub Saharan Africa in general, and particularly in rural Ethiopia. In filling this gap, our study is set out to: (1) identify the types of households who are credit constrained; (2) investigate the demand and supply side factors affecting credit constraint status; and (3) examine how such constraints affect borrowing behavior of farm households. We contribute to the existing literature in three ways. First, there are only few studies on credit constraints and borrowing behaviour in rural Ethiopia and to our knowledge, there is no rigorous prior work on this topic in the context of our study area. Further, the existing few studies categorize households into two regimes as either credit constrained or unconstrained[2]. This is a crude measure and does not provide adequate information about the real causes and multiple manifestations of credit constraints. Guirkinger and Boucher (2008), and Reyes and Lensink (2011) argue that existence of the credit market may not guarantee participation of households in the credit market; or getting some amount of loan may not automatically solve the credit constraint problems of farmers. Hence, we extend the binary categorization into five, using the direct elicitation approach. These are: (i) Unconstrained non-borrowers; (ii) unconstrained borrowers; (iii) quantity constrained borrowers; (iv) transaction cost constrained borrowers; and (v) risk rationed borrowers. Such detailed categorization is expected to provide clear understanding about both the

[2]*see for example: Hamda and Öhlmer (2006);Kedir and Ibrahim (2007); and Ayalew and Deininger (2014) for recent studies. Though these studies recognize that using a dummy does not entangle between borrowing status and credit constraint condition, they classify the households only into two categories in their final econometric analysis*

demand and supply side causes of credit constraints in the rural credit market. (Section 3.3.2 provides further details about our classification strategy).Second, prior comparable studies mentioned above, rely on cross-sectional data which show only a one period picture of the credit constraint situation and may not provide precise estimates due to omitted variables. Our study is based on a unique panel data collected from randomly selected rural households and this is expected to show possible changes in credit constraint status of farm households over time. Moreover, we estimated a multinomial logit model with random effects to control for unobserved heterogeneity and this has an added advantage of providing more efficient and unbiased results. Third, using zone dummies, this study also shows to what extent the rural credit market is segmented and how credit constraints vary across the study sites.

The rest of the paper is organized as follows. Section 2 discusses the theoretical and empirical literature related to credit constraints and borrowing behaviour. Section 3 gives a description of the materials and methods used in the study. Section 4 presents a discussion on the results and section 5 concludes the paper.

2. Credit Constraints and Borrowing Behaviour: Theory and Empirical Evidence

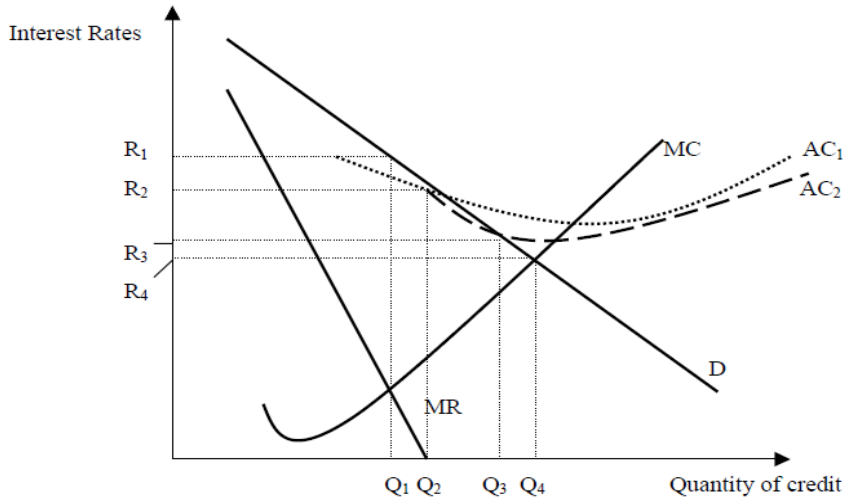
The concept of credit constraints and borrowing behaviour of households is linked with the permanent income or the life-cycle hypothesis (Friedman, 1957; Modigliani, 1986). This theory states that households try to maximize their utility by smoothing the marginal utility over the life cycle. It assumes existence of a perfect and complete capital market where households can borrow the amount of credit they want when they face liquidity problems and repay it in a period of high income. Thus, with standard convex preferences, and in the absence of borrowing constraints, transitory income

shocks will not affect consumption, since it depends only on permanent income.

However, the credit market literature provides three competing theories about structure of the rural credit market in developing countries, namely: the monopoly market theory, the perfectly competitive market theory, and the imperfect information theory (Stiglitz and Weiss, 1981; Hoff and Stiglitz, 1996; Bardhan and Udry, 1999; and Ho, 2004). The monopoly market theory argues that informal credit dominates in the rural credit market where village money lenders have a monopoly power and can charge the maximum possible interest rate to maximize their profits. This market is highly complicated because money lenders use various strategies to control their clients. This theory, however, does not capture the full image of the rural credit market in developing countries. It does not explain why formal and informal lenders co-exist despite the fact that formal loan interest rates are much lower than that charged by informal lenders. Moreover, it fails to explain the tricks and reasons for the inter-linkages between the formal and informal credit transactions in rural areas. The perfectly competitive market theory, on the other hand, predicts that the rural credit market clears with a market-clearing single equilibrium where the lending interest rate serves as the main screening device. It means that lenders increase the interest rate when the loan applicant is a high-risk borrower and they reduce the interest rate for low-risk borrowers. But, this theory is based on unrealistic assumptions and it fails to describe the real world condition, where we observe a pervasive credit-rationing in the rural credit market even when there is equilibrium in the market. Compared to the above two theories, the imperfect information theory provides a more advanced and realistic explanation about the nature of rural credit markets in developing countries. According to this theory, the rural credit market is characterized by market imperfections such as: uncertainty; the problems of incentive compatibility and information asymmetry, which lead to the problems of adverse selection, moral hazard, higher transaction cost and higher risk in

borrowing and lending transactions. This leads to multiple equilibriums and leaves many households credit constrained, as illustrated in Figure 1 below.

Figure 1: Market outcomes of different Credit market conditions



As shown in Figure (1), (Q_1, R_1) corresponds to a monopoly market equilibrium where the lender charges the highest possible interest rate and the loan amount is the smallest of the other two cases. In a perfectly competitive credit market, the market will clear at (Q_4, R_4) where the interest rate is the lowest and the credit amount is the largest. The two equilibrium points, (Q_3, R_3) and (Q_2, R_2) are the two possible outcomes of the imperfect credit market, assuming two different risk levels of the borrower but an identical demand function for both types. (Q_2, R_2) corresponds to a more risky borrower who faces higher interest rate and lower quantity of credit, while (Q_3, R_3) depicts an equilibrium point for a less risky borrower. This suggests failure of the predictions of the Life-cycle hypothesis in the context of developing countries, where the credit market is usually imperfect.

Prior empirical studies also confirm that most households in developing countries are credit constrained due to market imperfections (see for e.g.,

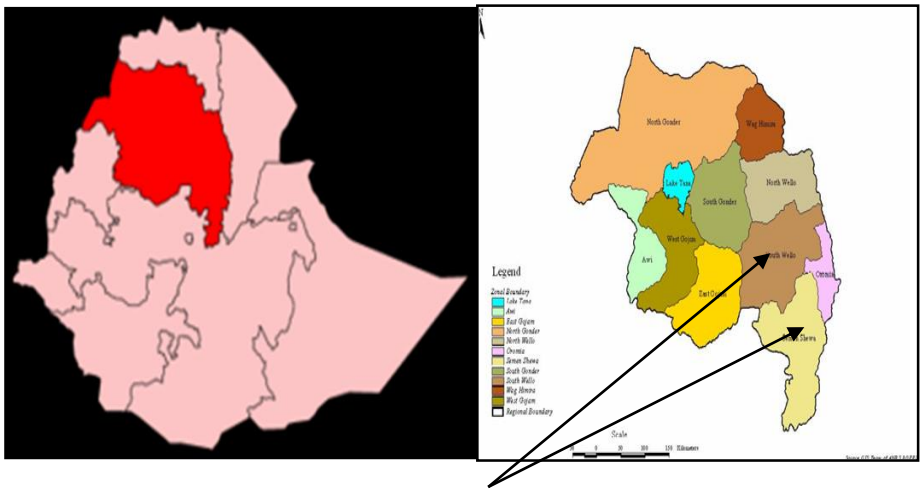
Kochar, 1997; Foltz, 2004; Khandker, 2005; Chen & Chivakul, 2008). However, in Sub-Saharan Africa, and particularly in rural Ethiopia, quantitative evidence on causes of credit constraints and borrowing behaviour of households is thin (Hamda and Öhlmer, 2006; Aterido et al., 2011; and Ayalew and Deininger, 2014). This calls for further studies aiming at explicitly addressing the demand and supply side causes of credit constraints and borrowing behaviour of households in the context of imperfect credit markets.

3. Materials and Methods

3.1 Description of the study area

Data used in this study were collected from four zones (North Shewa, South Wollo, North Wollo and West Gojjam) of the Amhara National Regional State located in the Northern and Central Highlands of Ethiopia (Figure 1). The Amhara region is located between 8°45'N and 13°45'N latitude and 35° 46' and 40° 25' E longitude. The total area of the region is estimated to be 156,960 km^2 (CSA, 2005). The climatic condition of the region, based on its altitude, is categorized in to: Kola (hot zone) - below 1500 masl which covers 31 percent of the region; Woyina Dega (warm zone) - between 1500 - 2500 masl covering 44 percent and Dega (cold zone) - between 2500 - 4620 masl and it covers 25 percent of the region. The mean annual temperature of the region is between 15 ºc and 21 ºc. But in valleys and marginal areas, it exceeds 27ºc. (Taye and Zewdu, 2012).

Figure 1: Location map of the study area, Ethiopia



3.2. Data Description

Our analysis is based on a balanced panel data collected from 1,189 households in two rounds in the years 2011and 2013.The surveys were conducted by the Ethiopian Economics Association, in collaboration with the University of California, University of Athens, FAO, and the European Commission Joint Research Center. About 33 percent of the households, for whom we have balanced data, reside in North Shewa zone, 31percent in West Gojjam, 23percent in South Wollo, and the remaining 13 percent reside in North Wollo zone (Table 1).

The two surveys provided information on livestock and crop production, marketing, farm and non farm income, household consumption expenditure, ownership of assets, participation in non agricultural enterprises, exposure to various climatic shocks and coping strategies, attitude towards risk, demand for crop insurance and credit constraints. Socio-economic and demographic characteristics of these households is presented in Table A1 in the appendix.

Table 1: Sample Households by zone (2011 and 2013)

Region	Percent
North Shewa	33.22

West Gojjam	31.12
South Wollo	23.13
North Wollo	12.53
Total	**100.00**

As indicated in Table A1, the average age of household heads in the sampled zones was about 50 years and heads in West Gojjam zone are relatively younger than those in the other three zones.

On average, each household had about 5 members of the family and the number of female headed households has increased from about 9 percent in 2011 to 12 percent in 2013. The survey instrument gathered information about the heads' years of schooling and on average, 51 percent of the heads have no any education while about 22 percent have about 5 years of formal education and 27 percent have attended some informal education.

3.2.1. Dependent Variables

Dependent variables of this study are: the probability that a household will fall in one of the credit constraint categories, and the probability of participating or getting credit from formal, semi formal, or informal sources. Unlike prior studies, which mainly focus on supply-side factors, we consider both demand and supply-side causes of credit constraints and borrowing behaviour of households. From the supply-side, prior studies suggest that potential borrowers may be constrained due to creditworthiness issues, and/or due to liquidity constraints of lending institutions. When lenders face shortage of loanable fund, they may ration credit, leading to quantity constraints. The creditworthiness factors include: (i) household's socio-economic characteristics; (ii) endowment of livelihood assets; and (iii) institutional constraints (Kon and Storey, 2003; Mpuga, 2008; Cheng, 2009; Reyes and Lensink, 2011).

We follow the theory of discouraged borrowers (Kon and Storey, 2003), which suggests that demand-side factors affect households' decision to participate in the credit market. The imperfect credit screening mechanisms used by lenders usually force potential borrowers not to apply for credit. Thus, the demand-side factors can be conceived as households' rational reaction to institutional rigidities of lending institutions. We hypothesize that farm households may shy away from formal lenders due to such factors including: (i) high transaction cost of borrowing; (ii) high risk costs of loan contracts or due to risk aversion behaviour of households; and (iii) cognitive and behavioral biases created due to previous borrowing experience. However, these factors which create barrier on credit market participation and hinder investment on profitable activities, have not been studied thoroughly in the context of sub-Saharan Africa. Top-down credit market policies which focus on simply increasing credit supply without giving due attention to such demand-side factors, may not result in an inclusive credit market and sustainable rural development. Thus, this study is set out to investigate the types of households which are discouraged, rejected, systematically excluded from the rural credit market in the context of rural Ethiopia.

3.2.2. Explanatory Variables and Hypothesis

Our choice of the explanatory variables is guided by the review of related literature, and context of the study area. After a brief account of each variable, we hypothesize their effects on credit constraints and borrowing behavior of farm households.

Age: of the household head is used in our study as a proxy for maturity and the potential for careful handling of bank loans and repayment capability of the borrower. We expect that lenders discourage individuals whose age is above 40 years given the health risks and shorter life expectancy in developing countries as in the Sub Saharan Africa (SSA).

Gender: In most developing countries, social norms and roles dictate the segregation of activities by gender, where women mostly concentrate on household issues and farm activities while men undertake other income earning activities (Ilahi, 2001a). There is also a difference in power relations between men and women where women usually have no role in deciding on household assets such as land and livestock. Thus, we expect that women are more credit constrained than men.

Education: We classified household heads as having no education, some informal education, and some formal education. It is expected that those who have some level of education have the potential to earn higher incomes and more likely to have assets that can serve as collateral. Therefore, we expect that educated farmers are less constrained.

Marital status: Married heads are more likely to be stable, trustworthy and abide by rules and regulations compared to the unmarried or separated heads and financial institutions view them as more reliable and may allow them to have better access to credit (Mpuga, 2008). Thus, married heads are expected to be less constrained.

Household size: We expect a positive relation between larger household size and household's access to rural credit because each member may contribute to the household's asset accumulation either directly as a labour input in the agricultural production process or through remittances.

Farm size and ownership of livestock: In this study, farm size (measured in hectares) and ownership of livestock are used as indicators of natural and physical assets, respectively. These assets are expected to ease credit constraints in two ways. First, households who own these assets are expected to have more potential for equity financing and thus may not even go for credit. Second, if internal finance falls short of the total required amount of cash, then those who own land and livestock have higher

probability of obtaining credit because of the positive influence of these assets on lenders' valuation of the applicant as creditworthy.

Membership in a primary credit cooperative: is expected to have positive effect on access to credit. Plausible reason for this is that the cooperatives are expected to serve as channels through which members can have access to credit from micro financing institutions; sources of product and credit market information, and in some cases, the cooperatives may also provide input loan from their own internal fund.

Location and exposure to climatic shocks: It is presumed that exposure to climatic shocks such as drought, and spatial location matter in the credit constraint status and borrowing behaviour of households. Households residing in drought prone areas are expected to be more constrained than those in less vulnerable zones.

Risk aversion: we hypothesize that risk averse farmers do not want to take group loans because they perceive group loans as risky and they do not want to put their land or other assets at risk in case they fail to repay the debt.

Discouraged households: Farmers, who are discouraged due to high transaction costs of borrowing and various institutional rigidities, may not want to apply for formal credit.

Quantity constrained borrowers: who lack the required collateral to obtain larger amounts of credit, may also shy away from formal sources and may look for informal lenders.

3.3. Theoretical model

3.3.1. Identifying multiple credit constraint categories: A Theoretical model

Following Kon & Storey (2003) and Cheng (2009), we present a theoretical discussion about the supply and demand side constraints in the credit

market and borrowing behavior of farm households under market imperfections. In doing so, we show how imperfections discourage poor farmers not to participate in the rural formal credit market; and which factors influence the borrowing behavior of farm households. We assume that a farm household looks for external sources of fund when its production and consumption needs exceed the available internal fund.
Let the total asset available to a farm household be:

$$TA = A_m + A_n \quad \textbf{[3.1]}$$

where the total household asset (TA) is composed of: assets which can serve as collateral for credit (mortgage-able asset, A_m)and other assets which are useful for the production process but cannot serve as a collateral (non-mortgage-able asset, A_n). This implies that the amount of money a household can borrow (B) is a function of mortgage-able asset ($B=f(A_m)$).
The costs of credit include the interest payment on the amount borrowed (r^L*B), costs of applying for credit such as cost of preparing the application materials, travelling cost and time, cost of informal payments for credit officers or managers, cost of psychological discomfort etc. (denote these costs by D). Thus the total cost of borrowing (C_b) is given by:

$$C_b= (1+r^L)*B + D \quad \textbf{[3.2]}$$

A smallholder's agricultural output (Q) in a developing country context normally depends on: the available production assets (TA), household labour input (H_L) and a vector of household characteristics (θ) :

$$Q=f(TA,H_L;\theta) \quad \textbf{[3.3]}$$

If the farm household borrows money to expand its agricultural production by using better technology such as high yielding variety (HYV) seeds, fertilizers, and pesticides, then the new agricultural output (Q^{β}) will be:

$$Q^{\beta} = f\left(T_m, A, H_L, \theta\right) \quad \textbf{[3.4]}$$

where T_m represents the minimum amount of capital required to purchase technological inputs to expand production. But, in rural settings, rain-fed agriculture is a risky activity which is prone to various climatic shocks and plant diseases. Hence, we can think that the probability of a farmer to harvest a Q^{β} amount of output is ϕ and $(1-\phi)$ is the probability of failure in which case the household will get only Q^{f} amount of output where $Q^{\beta} > Q > Q^{f}$. If a farmer gets only Q^{f} amount of output, then it becomes very difficult for the household to repay the loan and hence will lose the loan collateral asset (A_m).

Therefore, a rational farmer will borrow if and only if the following two conditions are met:

$$\phi.Q^{B} + (1-\phi)\left(Q^{f} - A_m\right) > Q + \left(1 + r^{L}\right)B + D \quad \textbf{[3.5]}$$

and

$$B\left(A_m\right) \geq T_m - A_c \quad \textbf{[3.6]}$$

Equation (3.5) says that the benefit from the loan should be greater than its cost and equation (3.6) states that a household will borrow if and only if the available current assets (A_c) can not cover the minimum required amount of capital to expand agricultural production (T_m).

If we denote a reservation cost of a rural household by δ_0, then we have:

$$\delta_0 = Q + \left(1 + r^{L}\right).B + D \quad \textbf{[3.7]}$$

From equation (3.5), it is clear that the cost of borrowing has two parts: the interest and principal cost ($(1+r^L).B$) and the application or transaction cost (D).A farmer who is willing to pay the interest cost ($r^L.B$) may not be willing to apply for credit if the application cost (D) is higher than the reservation cost (i.e. $D>\delta_o$). We classified such borrowers as "transaction-cost constrained (TCC)" borrowers. In addition to transaction costs, the behavior of borrowers is also affected by institutional inefficiencies of credit providers. In some cases, applicants who are willing to incur the transaction cost of borrowing apply for credit and lenders may adversely select wrong applicants due to information asymmetry or due to some special relationship with the lending institution or just because they are members of some social or political group. Such wrong decisions may marginalize genuine applicants and leave them credit constrained. If we capture the probability of being rejected due to institutional mistakes by λ, then the probability of getting the credit will be $(1-\lambda)$. If we further denote the expected benefit from borrowing by $E(Q_o)$ then, we have:

$$E(Q_0) = \phi.Q^B + (1-\phi)\left(Q^f - A_m\right) \qquad \textbf{[3.8]}$$

Using this notation, we can re-write equation (3.5) as:

$$(1-\lambda)\left[E\left(Q_o\right) - \left(1+r^L\right)B\left(A_m\right) - D\right] + \lambda(Q-D) > Q \qquad \textbf{[3.9]}$$

and after some rearrangement,[3] equation [3.9] can be transformed into:

$$E\left(Q_o\right) > Q + \left(1+r^L\right)B\left(A_m\right) + \frac{D}{1-\lambda} \qquad \textbf{[3.10]}$$

[3] *See appendix B for the mathematical derivation*

This implies that institutional mistakes made by lenders in selecting applicants (i.e. an adverse selection problem) in addition to the transaction cost, will create an extra cost of borrowing (say, δ_1) which is given by:

$$\delta_1 = Q + (1 + r^L)B + \frac{D}{1-\lambda} \qquad \textbf{[3.11]}$$

If a farm household cannot afford additional cost of borrowing given by equation [3.11] above, then it will not apply for credit. Such households are called credit constrained due to institutional mistakes or adverse selection.

A third category of households are those who want some compensation (say, ω) for taking the risk of borrowing money from a lender. These are risk-averse borrowers who usually do not want to lose their collateral in case they fail to repay the loan. Adding ω to equation [3.9] gives:

$$(1-\lambda)\left[E(Q_o) - (1 + r^L)B(A_m) - D\right] + \lambda(Q - D) - \omega > Q \qquad \textbf{[3.12]}$$

Again, after some calculus, equation [3.12] becomes:

$$E(Q_o) > Q + (1 + r^L)B(A_m) + \frac{D + \omega}{1-\lambda} \qquad \textbf{[3.13]}$$

This shows that cost of borrowing further increases by an amount of $\left(\frac{D+\omega}{1-\lambda}\right)$ for risk averse applicants and we classify them as households who are credit-constrained due to risk-aversion.

In general, the above discussion shows that there are at least three categories of farm households who are credit constrained from the demand side: (i) those who are constrained due to the high transaction cost of borrowing (δ_0); (ii) those who are constrained due to adverse selection (δ_1); and (iii) those who are constrained due to risk aversion (ω).

3.3.2. Identifying credit constraint categories using the Direct Elicitation strategy

Identifying constrained households is an empirical challenge since credit rationing cannot be observed directly. However, two identification strategies are documented in the literature (Boucher et.al, 2009; Cheng, 2009; Ayalew and Deininger, 2014). These are: The direct and the indirect approaches. The later is based on the life-cycle or the permanent income hypothesis which we discussed in section 2 above[4]. We follow the direct elicitation approach which is based on household survey data. Using this strategy, we identified five credit constraint categories as shown in Table 2. First, the unconstrained borrowers are those who are willing to participate in the credit market and have full access to credit facilities from a given lending institution. The credit limit set by lenders to overcome the information asymmetry problem will not be binding for such borrowers. Second, the unconstrained non-borrowers are those who do not borrow from credit institutions because they do not have an urgent need for external finance or they do not have a profitable project that would require a loan. The production and consumption (resource allocation) decisions of such households is not affected by the prevailing credit market imperfections.

Table 2: Criteria used to classify households into different credit constraint categories

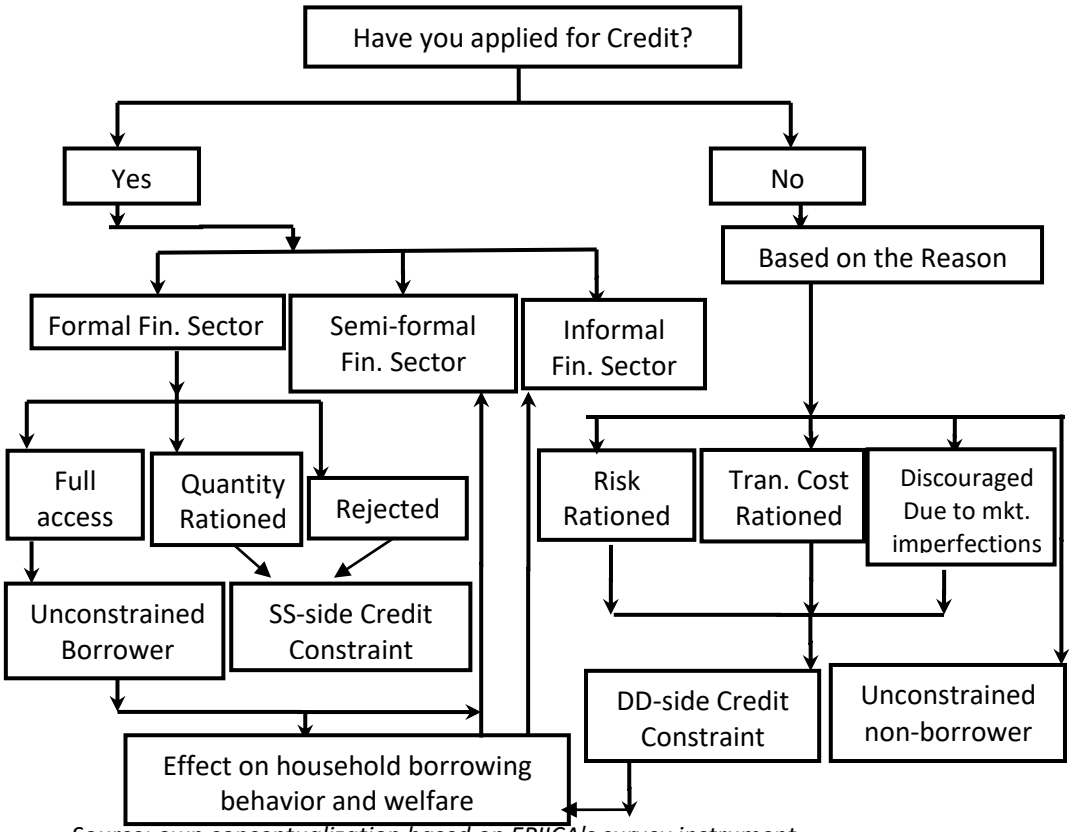
Classification Criteria based on the responses of HHs	Credit Constraint Category
I prefer working with my own funds	Discouraged HH (risk-rationed)
my productive activities do not give me enough to repay debt	Discouraged HH (risk-rationed)
I do not want to put my land and other assets at risk	Discouraged HH (risk-rationed)
I do not want to be worried; I am afraid	Discouraged HH (risk-rationed)

[4]*Further discussion about the strength and weaknesses of this strategy is given in Diagne et al. (2000).*

group loan is risky	Discouraged HH (risk-rationed)
My religion doesn't allow me to borrow	Discouraged HH (risk-rationed)
formal lenders do not offer refinancing	Quantity constrained borrowers
collateral asked is too large	Quantity constrained borrowers
interest rate too high	Quantity constrained borrowers
formal lenders are too strict, and inflexible	Discouraged HH (tran cost-rationed)
the bank branch is too far away	Discouraged HH (tran cost-rationed)
too time consuming to deal with commercial or other banks	Discouraged HH (tran cost-rationed)
I do not need a loan	Unconstrained non borrowers

Third, we identified quantity constrained borrowers who have an excess effective demand for credit but face a binding credit limit due to supply-side limitations. These households stated that they applied for credit and received the loan, but the loan amount is less than their effective demand given the available contract terms. Fourth, from the demand side, we found 'transaction-cost rationed' households who have a positive effective demand but do not apply for credit. These households confirmed that they do not want to incur the additional costs associated with the loan application process, including the extra paper work and the time they waste dealing with lenders. Further, from their past experience or from their knowledge about lenders' credit procedures, they are sure that their application will be rejected. Such households may have profitable agricultural projects but they do not participate in the credit market because their projects become unprofitable once these costs are accounted for. Fifth, lenders normally want borrowers to bear certain amount of risk to overcome the moral hazard problem in borrowers' effort or choice of investment project. One mechanism to do so is to ask for collateral. However, from the questionnaire, we identified risk-averse households who prefer working with their own funds not to put their land and other assets at risk. These farmers do not want to incur debt even if they qualify for the loan and have a profitable project after accounting for transaction costs. Based on the above discussion, our elicitation strategy is demonstrated in Figure 2 below.

Figure 2: The direct elicitation strategy



Source: own conceptualization based on EPIICA's survey instrument

3.4. Econometric Model

3.4.1. Panel Multinomial Logit model without Random Effects

We undertake a longitudinal analysis of farmers' credit constraint status and borrowing behavior using two waves of EPIICA's data. Following Long and Freese (2006); and Greene (2012: pp.763–766), we specify a multinomial logit model without random effects as follows:

Consider the outcomes 1, 2, 3,…, m recorded in the dependent variable, y and a matrix of the explanatory variables in X. We have m = 4 outcomes[5]:

[5]*Although we categorized the households into five constraint categories as discussed above, we combined the transaction cost constrained and risk rationed*

"unconstrained borrowers", "unconstrained non borrowers", "quantity constrained borrowers", and "discouraged borrowers (due to transaction costs and risk aversion)".In the multinomial logit model, we estimate a set of coefficients, $\beta^1, \beta^2, \beta^3, and\, \beta^4$ corresponding to each outcome as:

$$pr(y=i) = \frac{e^{X\beta^{(i)}}}{e^{X\beta^{(1)}} + e^{X\beta^{(2)}} + e^{X\beta^{(3)}} + e^{X\beta^{(4)}}} \quad \text{[3.14]}$$

where i = 1 to 4

To identify the model, we set any one of the β_s (say, β_1) to zero arbitrarily and the remaining coefficients, $\beta^2, \beta^3, and\, \beta^4$ will measure the change relative to the y = 1 outcome. The coefficients will differ because they have different interpretations, but the predicted probabilities for y = 1, 2, 3 and 4 will still be the same. Thus, either parameterization will be a solution to the same underlying model. Then we compute the relative probability of y = 2 to the base outcome as:

$$\frac{pr(y=2)}{pr(y=1)} = e^{X\beta^{(2)}} \quad \text{[3.15]}$$

However, a unique feature of longitudinal categorical data is the existence of unobserved heterogeneity among the repeated observations for a single individual (Train, 2009; Haan and uhlendorff, 2006; Hole, 2007; Reyes and Lensink, 2011). This heterogeneity may occur because each household can make several choices which may not be independent and hence the probabilities of each category for the same household will share the same

borrowers together as "discouraged borrowers" to simplify the analysis. Hence, we estimated our model for four different outcomes.

unobservable random effects (Reyes and Lensink, 2011). If we do not handle these unobservables, our parameter estimates will be biased. This calls for a more advanced estimation strategy beyond the traditional pooled multinomial model without the random effects. Hence, we employed the generalized linear latent and mixed model (gllamm) to fit a multinomial logit model with correlated random intercepts which accounts for any spurious dependence between individuals or categories.

3.4.2. The Generalized Linear Latent and Mixed Model (gllamm)

Consider an individual i who is faced with J different alternatives at time t. The probability that this individual falls in a specific category j conditional on observed characteristics χ_{it} which vary between individuals and over time; and also conditional on unobserved individual effects, α_i which are time constant, can be specified as:

$$prob(j \mid \chi_{it}, \alpha_i) = \frac{\exp(\chi'_{it}\beta_j + \alpha_{ij})}{\sum_{k=1}^{J} \exp(\chi'_{it}\beta_k + \alpha_{ik})} \qquad \textbf{[3.16]}$$

We follow the standard assumption that α is identically and independently distributed over individuals and it follows a multivariate normal distribution with mean μ and variance- covariance matrix (Ω), i.e. $\alpha \sim iid(\mu, \Omega)$ (Train, 2009; Haan and uhlendorff, 2006; Hole, 2007).

The likelihood function for equation (3.16) can be specified as:

$$L = \prod_{i=1}^{N} \int_{-\infty}^{\infty} \prod_{t=1}^{T} \prod_{j=1}^{J} \left(\frac{\exp\left(\chi'_{it}\beta_j + \alpha_j\right)}{\sum_{k=1}^{J} \exp\left(\chi'_{it}\beta_k + \alpha_k\right)} \right)^{d_{ijt}} f(\alpha)\, d\alpha \qquad \textbf{[3.17]}$$

This is so, because the choice probabilities given in equation (3.16) are conditioned on α_i and hence we must integrate over the distribution of α to get the sample likelihood for the multinomial Logit with the random intercepts. This model will be identified if the coefficient vector (β) and the unobserved heterogeneity term (α) of one category are set to zero. Hence, $d_{ijt} = 1$ when individual i falls in category j at time t and zero otherwise.

The key problem in solving equation (3.17) is that we cannot obtain an analytical solution for the integral part of the model. This is because the random effects are assumed to have a multivariate normal distribution and the marginal distribution can be found only after integrating out these random effects. This calls for some form of numerical integration. The literature suggests various simulation and quadrature techniques including: the Adaptive Gaussian Quadrature (AGQ), Monte Carlo Simulation, Laplace Approximation, Taylor series approximation, and Gauss Hermite quadrature to solve this problem (Hartzel et.al., 2001; Rabe-Hesketh et. al., 2004; Haan and Uhlendorff,2006; Train, 2009; Cameron and Trivedi, 2009).Among these simulation and quadrature techniques, the AGQ approach is preferred for a longitudinal categorical data because it is computationally more efficient than the ordinary quadrature in performing the numerical integration of equation (3.17) above. Another advantage of using the AGQ is that the number of quadrature points required to approximate the integral are much lower than that of the ordinary quadrature and prior studies used this technique to evaluate similar integrals (examples include: Hartzel et. al., (2001); Rabe-Hesketh et. al., (2004); and Haynes et. al., (2006)).

Inclusion of the AGQ technique is a recent development in statistical software. For instance, STATA software has a procedure called the generalized linear, latent and mixed model (gllamm) which is designed to model categorical dependent variables with repeated observations (Rabe-Hesketh et. al., 2004; Haan and Uhlendorff, 2006).It is an extension of the

generalized linear model because it incorporates both the fixed and random effects and hence the response distribution is defined conditionally on the random effects. This model takes care of individual unobservable heterogeneity by capturing them through the alternative-specific random intercepts or coefficients (ASC) and it accounts for the possible correlation of choices made by individuals.

4. Results and Discussion

4.1. Credit constraints and borrowing behavior: An Econometric assessment

We estimated a conventional, robust, panel data multinomial logit (MNL) model without random effects on the determinants of credit constraints and borrowing behavior of farm households in the study area (Tables A5 and A7 in the appendix).However, given the type of problem at hand and the panel nature of the data we have, we suspect an unobserved heterogeneity to exist between individuals and across different constraint categories. Therefore, we also estimated an MNL model with random effects using the generalized linear latent and mixed model (gllamm) (Tables 6 and 8).To select one of these two sets of specifications, we conducted various tests including: the Likelihood ratio (LR) test, the Bayesian Information Criterion (BIC) and Akaike's Information Criterion (AIC). The test results support the gllamm than the MNL model without random effects. Therefore, the discussion that follows is based on the results given in Tables 6 and 8. The unexplained variance in the first two categories and the correlation between all the three categories is captured by the random effects at the individual level (Table 6). These values statistically differ from zero and it implies that the individual effect captured by the MNL model with random effects explains a considerable portion of the total heterogeneity.

The null hypothesis of the Wald test that all coefficients except the intercept term are equal to zero is rejected at a one percent level of statistical significance and this confirms the theoretical predictions of our model. Variables explaining credit constraint and borrowing behavior are

categorized into: (i) household demographic characteristics; (ii) ownership of livelihood assets; (iii) risk preference behavior; (iv) institutional constraints; and (v) control variables such as location and exposure to shocks. A descriptive Statistics of the variables used in our analysis is given in Table A4 in the appendix.

Table 6: Determinants of different Credit constraint categories compared with unconstrained borrowers - Generalized linear latent and mixed model (gllamm)

Variable	Unconstrained non-borrowers	Constrained - Quantity rationed borrowers	Discouraged - Tran. Cost and risk rationed borrowers
Age	.0231***	.0127*	.0276***
	(0.00694)	(0.00652)	(0.00706)
Female	-1.4***	-0.553	-1.08**
	(0.454)	(0.44)	(0.461)
Married	-.745*	-0.424	-.735*
	(0.422)	(0.423)	(0.431)
Household size	-0.0772	-0.0245	-0.0545
	(0.05)	(0.0476)	(0.0509)
No educ.	.459**	-0.2	.497**
	(0.228)	(0.213)	(0.237)
formal educ.	-0.106	0.107	0.178
	(0.239)	(0.223)	(0.247)
Land hect.	.466***	0.00962	0.134
	(0.12)	(0.123)	(0.125)
Own livestock	-1.28**	-0.795	-1.11*
	(0.568)	(0.574)	(0.579)
Coop member	0.0732	0.137	-0.11
	(0.302)	(0.308)	(0.307)
Year dummy	-0.148	.613***	0.159
	(0.183)	(0.189)	(0.19)
Ln(food exp)	0.191	0.035	.274**
	(0.121)	(0.119)	(0.126)
Drought shock	0.18	.459**	0.279
	(0.187)	(0.181)	(0.192)
West Gojjam	-1.65***	-0.136	-1.32***
	(0.228)	(0.209)	(0.229)
South Wollo	1.56***	1.63***	1.38***
	(0.279)	(0.288)	(0.284)

North Wollo	-.493*	.93***	-.909***
	(0.297)	(0.271)	(0.314)
_Constant	0.944	-0.22	-0.283
	(0.95)	(0.947)	(0.982)

Variance - Covariance Matrix of the Random Effects

	ucnb	**qcb**	**disc**
Ucnb	1.49***(0.158)	0.567***(0.206)	1.36***(0.164)
Qcb	0.567***(0.206)	0.463*(0.239)	-0.314(0.200)
Disc	1.36***(0.164)	-0.314(0.200)	0.001(0.412)
Statistics			
Log likelihood	-2794.11		
N	2294		
AIC	5696		
BIC	6081		

Note: * p < .1; ** p < 0.05; *** p < 0.01
BIC and AIC are Bayesian Information Criteria and Akaike's Information criteria, respectively.
Ucnb, qcb and disc stand for unconstrained non borr., quantity constrained borr., and discouraged borr.

i) Household demographic characteristics

Age: of the household head has a positive and statistically significant effect on the probability of being discouraged (Table 6). This is as expected since the average age of the heads in the study area was 49 in 2011 and 51 years in 2013. Lenders usually discourage individuals whose age is above 40 years given the health risks and shorter life expectancy in poor developing countries like Ethiopia. Moreover, the result in Table 8 reveals that older individuals do not want to borrow both from formal and informal lenders. This is so, probably, because they are already discouraged by lenders or because they do not want to take the risk related to borrowing. These results are consistent with findings by Crook (2001) and Mpuga (2008) that the demand for credit becomes negative for individuals whose age is above 50 years.

Gender: of the household head is captured in our model as a dummy variable with a value of one for female and zero for male. Contrary to our expectation, the result shows that gender has a negative and significant effect on the probability of being credit constrained (Table 6) and they prefer borrowing from the formal sector (Table 8).This implies that, female headed households have higher probability of access to rural credit, compared to their male counterparts. This may be due to the recent micro credit revolution which focuses more on empowering women. It agrees with the actual case in rural Ethiopia where 54 percent of the clients of Micro Finance institutions are female (EEA, 2011). Ashraf et. al., (2003) showed that credit schemes which favor female borrowers has gained popularity in recent years and has become successful. Hansen and Rand (2011), using micro level data from eight Sub-Saharan African countries also found that there is female favoritism rather than discrimination in the African credit markets since women are considered as more loyal to their groups and have better repayment performance. Aterido et al. (2011) also reached to similar conclusion.

Table 8: Determinants of farm HHs' choice of Lenders compared to non-borrowers -Generalized linear latent and mixed model (gllamm)

Variable	HHs who prefer formal lenders	HHs who prefer informal lenders	HHs who prefer semi-formal lenders
Risk averse	-2.01***	-1.02***	.655*
	(0.224)	(0.226)	0.339
Discouraged borrower	-1.83***	.652*	-0.212
	(0.449)	(0.379)	(0.575)
Quantity constrained borr.	-.287*	-0.0258	0.0251
	(0.174)	(0.192)	(0.329)
Age	-.0154***	-.0192***	0.00489
	(0.00573)	(0.00592)	(0.00966)
Female	.698*	0.0463	0.0603
	(0.383)	(0.391)	(0.6)
Married	0.191	-0.176	-0.42
	(0.36)	(0.359)	(0.544)
Household size	.0771*	0.0167	-0.0377

	(0.0414)	(0.0457)	(0.0706)
No educ.	-.316*	-0.128	-.529*
	(0.19)	(0.199)	(0.319)
formal educ.	0.0766	-0.00907	-.81**
	(0.201)	(0.221)	(0.365)
Land hectare	-.215**	-0.19	0.0985
	(0.102)	(0.117)	(0.196)
Own livestock	1.11**	0.322	-0.169
	(0.508)	(0.438)	(0.61)
Coop member	-0.0416	0.165	-0.111
	(0.26)	(0.298)	(0.415)
Year dummy	.56***	.377**	-2.22***
	(0.166)	(0.185)	(0.38)
ln(food exp.)	-0.169	-0.1	-0.101
	(0.103)	(0.116)	(0.177)
Drought shock	-0.215	0.00795	0.239
	(0.163)	(0.18)	(0.3)
West Gojjam	1.07***	-.729***	-0.228
	(0.177)	(0.204)	(0.317)
South Wollo	-1.47***	-0.234	-3.06***
	(0.239)	(0.228)	(0.653)
North Wollo	-0.123	0.371	.629*
	(0.25)	(0.263)	(0.354)
_constant	-0.867	-0.691	-0.653
	(0.818)	(0.822)	(1.24)

Variance- Covariance Matrix of the Random Effects of HH Lender choice

	formal	**informal**	**Semi formal**
Formal	.992***(0.155)	0.219(0.201)	0.459***(0.384)
Informal	0.219(0.201)	0.127(0.305)	-0.966(0.73)
Semi formal	0.459***(0.384)	-0.966(0.73)	0.863(0.696)
Statistics			
Log likelihood	-2002.87		
N	2294		
AIC	4132		
BIC	4580		

Note: * p < .1; ** p < 0.05; *** p < 0.01
BIC and AIC are Bayesian Information Criteria and Akaike's Information criteria, respectively.

Marital status: married individuals have higher probability of access to rural credit as revealed by the negative and statistically significant coefficient on the probability of being discouraged (Table 6) and this is in line with our prior expectation discussed in the foregoing section.

Household size: Our finding seems to suggest that households having larger number of members more likely to demand credit from formal lenders. In developing countries where the rural labour market is usually imperfect or missing, family labour is an important source of agricultural labour supply. Hence, it is possible to argue that larger household size may mean more labour supply in agriculture which can lead to higher agricultural production, higher household income and better capacity to accumulate productive assets. Some members of the household may also migrate to nearby towns or bigger cities for off farm employment and may send remittances back to their families. This in turn, may help farm households to build assets which can serve as loan collateral.

ii) Ownership of livelihood assets

The literature on rural livelihoods argues that household income and participation in the credit market is determined by the portfolio of assets owned (Ellis, 2000). In relation to this, we used size of land owned, ownership of livestock asset, level of education, and membership in a primary multi-purpose cooperative as indicators for natural, physical, human, and social capital of households, in that order.

Farm size: As presented in Table 6, ownership of farm land has a significant positive effect on the probability of being unconstrained non borrower. This is in line with our hypothesis that households who own relatively larger size

of land asset are expected to have more potential for equity financing and thus they may not even go for credit. Mpuga (2008) also finds that households having larger size of land do not have demand for credit in rural Uganda.

Ownership of livestock asset: has a significant negative effect on the probability of being discouraged (Table 6) and they prefer borrowing from formal lenders (Table 8). This goes with our expectation that households who own livestock have higher probability of obtaining credit from formal sources because of its positive influence on lenders' valuation of the loan applicant, since livestock can easily be converted into cash in cases of default.

Human Capital: compared to those who have some level of education, uneducated heads are highly discouraged and hence do not want to borrow from the rural credit market. This finding is consistent with the results of Gropp et al., (1997) who showed the positive effect of education on access to credit. This suggests the importance of education in access and participation in the rural credit market. Some level of education is expected to increase technical knowledge, know-how and farming skills, better credit information and familiarity with credit procedures of lending institutions. It is also expected that educated individuals will be engaged in non-farm business activities and are more likely to use the loans wisely than the uneducated ones.

iii) Borrower's Risk Aversion Behaviour

We find a significant negative effect of risk aversion on the probability of borrowing from formal and informal sources of credit (Table 8). This can be explained by the fact that lenders require their clients to bear some amount of risk in the form of collateral. However, risk averse farmers do not want to put their assets at risk and hence prefer working with their own funds

(Table 2).It implies that these farmers choose less risky but low value crops or projects which require no credit. Choosing such less risky but low value crops in turn means that these farmers are less efficient in agricultural production and generating lower income for their household. Thus, following Boucher et al. (2009), it is possible to note that credit constraint can occur even when there is excess supply of credit and this arises when the effective demand for credit is lower than the supply due to risk aversion.

iv) Institutional Constraints

Table (2) presents institutional constraints in the credit market of our study area and these include: (a) long and strict credit procedures such as collateral requirements or group formation, fixed repayment schedules which do not fit with harvest seasons; (b) high transaction costs of borrowing associated with the loan application process, paper works, distance, and the number of times an applicant should visit lender's office to secure the loan; (c) cost of negotiation with lenders; and (d) institutional mistakes made in selecting applicants. As expected, we find a significant negative effect of these constraints on the demand for credit. Household heads, who are discouraged due to these constraints do not prefer borrowing from formal lenders. This can be explained by the fact that lenders usually make their credit procedures to be very strict to solve the screening, monitoring, and moral hazard problems which are very common in the credit market of developing countries (Stiglitz and Weiss, 1981; Hoff et al., 1996; Antwi and Antwi, 2010).However, these strict and lengthy credit procedures make the transaction cost of borrowing to be very high and hence discourage genuine applicants who want to have access to rural finance.

v) Control Variables

Year dummy: We used year dummy as a control variable to capture the change in credit constraints and borrowing behavior of farm households between 2011 and 2013.The result shows that demand for credit both from formal and informal sources has increased by 56 percent and 38 percent, respectively (Table 8). However, the probability of being quantity constrained has also increased by 61 percent which implies that farm households do not get the amount of credit they applied for. Possible reasons for this gap between the demand for and supply of rural credit include: lack of adequate loanable fund in the hands of lenders; strict refinancing policy of lenders; lack of loan collateral in the hands of borrowers; and lack of loan track record or long term relationships between borrowers and lenders.

Exposure to climatic shocks: As expected, exposure to drought shock increases the probability of being quantity constrained by 46 percent (Table 6). In a rain-fed smallholder agriculture (as the case in Ethiopia), good harvest is possible only if it rains, and other shocks do not occur. In such a fragile environment, access to external sources of finance is very difficult because lenders do not want to take the risk of default in case crops fail.

Location: Households living in drought and disease prone zones such as South Wollo are highly discouraged and also quantity constrained relative to households residing in the other three zones of the country. According to World Bank (2004), 45 percent of the South Wollo zone is exposed to Malaria. Households residing in West Gojjam have relatively better access to formal credit and this may be because, West Gojjam is a more fertile region known for its Teff production (a staple food “INJERA” in Ethiopia).

5. Conclusion and Implications

Using household level panel data from four zones of the Amhara region in Ethiopia, we examined the constraints to farmers’ access to rural credit. We attempted to explore the extent to which credit constraints stem from

demand or supply-side factors. We also made an in depth analysis on key variables explaining the probability of a household to fall in one of the four different credit constraint categories and their respective borrowing behaviour.

We estimated a generalized linear latent and mixed model (gllamm) and the result showed that credit constraint status and borrowing behaviour are significantly affected by:(1) borrower's perceived probability of rejection due to institutional rigidities; (2) location, borrower's exposure to climatic shocks and risk preference behavior; (3) availability of mortgage-able livelihood assets; (4) the transaction cost of borrowing; and (5) Household demographic characteristics such as: gender, age, education, family size, and marital status.

Understanding household socio-economic conditions is essential in designing credit market policies. For instance, gender-credit constraint gap is of central policy importance as many micro credit institutions in Sub-Saharan Africa target the female to enhance their asset building capacity and to pull them out of abject poverty. We find this story to be largely supported by our data as evidenced by the result that the probability of being credit constrained decreases for female (Table 6).

Our result also shows that education is an important determinant of credit constraint and the demand for credit in rural areas. Mobilizing and sensitizing literate people about the need for and importance of credit would be easier and this suggests that more investment on education in rural areas would reduce credit constraints and improve participation of farm households in the rural credit market. In addition, the demand for credit is higher for households who own livestock and they are also less discouraged in the credit market. It is therefore important to devise policies that aim at increasing household incomes and asset holdings so as to promote their participation in the credit market.

In Ethiopia, in contrast with Reyes and Lensink's (2011) findings for Chile, demand factors such as risk aversion behaviour of farm households play important role in access to rural credit as confirmed by our results given in Table 8.The key lesson from this result is that increasing the supply of credit alone is not the solution for the credit constraint problem of farm households. It is crucial to understand farmers' attitude towards risk and to design a bottom-up credit policy that encourages farm households to take risk. In Ethiopia, the credit market is basically supply driven in the sense that borrowers take only what the lender offers and do not ask too many questions. The type of loan products, prices (interest rate), quality and reliability of the services are determined by the supplier, and innovative loan products are not very common in this market. This implies that institutional issues of the credit market need more attention of the macro, meso and micro level policy makers and practitioners to make the market demand-driven, inclusive and more competitive.

As discussed above, lenders require their borrowers to bear some amount of risk in the form of collateral. However, risk averse farmers are not willing to take such risk and this necessitates designing innovative collateral-substitutes such as contract farming, using supply contracts as collateral, reputation-based lending, directly monitoring borrowers, lending according to crop cycle, and providing group loans. The sign and significance on the location and drought shock dummies also call for credit market policies which consider location-specific key variables and not simply make blanket recommendations to be applied across the board. For instance, farm households in South Wollo are vulnerable to drought shock and hence they are highly discouraged. Although it requires further study to identify its benefits and drawbacks, interlinking credit with insurance may also be suggested as a solution to the credit constraint problem stemming from risk aversion.

Information asymmetry is another important source of credit constraints in our study area as discussed above and credit reference bureaus can help lenders to have credit information of loan applicants. Hence, we suggest strengthening such credit reference bureaus to solve the information asymmetry problem and hence reduce credit constraints. As the sign and statistical significance of the year dummy reveals, there is an increased demand for formal credit and yet a serious quantity constraint over the years 2011 and 2013. This is consistent with the general situation in access to credit in Ethiopia as discussed in section 1 above. For instance, EEA (2011) and AEMFI (2011) showed that micro financing institutions, which are the major formal credit providers to rural farm households, reach only about 20 percent of the rural poor. This is, by and large, a supply side constraint which usually occurs due to lack of loanable funds in the hands of the rural credit service providers. As Kristen (2006) argues, compared to the bigger commercial banks which have excess liquidity, the rural credit service providers possess better information and enforcement mechanisms and are typically more flexible and innovative. However, these institutions are constrained by shortage of resources and infrastructure to reach more number of clients. Hence, collaboration between commercial banks and the rural credit institutions would lead to a win-win situation to both parties. This can increase the supply of credit and improvement in the operating environment of the rural credit institutions so that farm households will have better access to credit.

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Appendix A: Tables and Figures

Table A1: Socio-economic information of the Households (HHs) surveyed in 2011 and 2013 from Amhara

Socio-economic Info.	All		North Shewa		West Gojam		South Wello			
	2011	2013	2011	2013	2011	2013	2011	2013	2011	2013
Number of HHs surveyed	1189(50)	1189(50)	403(33.9)	395(33.2)	372(31.3)	370(31.1)	272(22.9)	275(23.1)	142(11.9)	149(12.5)
Female headed HHs (%)	111(9.3)	139(12)	40(10)	55(14)	25(6.7)	25(6.8)	29(10.7)	36(13.1)	17(12)	23(15.4)
Average age of HH head (years)	48.9	50.5	50.8	52.6	46	47.9	49.1	49.6	50.8	52.7
Average HH size	5.3	5.1	5.47	5.07	5.74	5.63	4.65	4.52	4.92	4.9
HH heads who have no education	606(51)	656(55)	171(42.4)	184(46.6)	231(62.1)	243(65.7)	126(46.3)	156(56.3)	78(54.9)	74(49.6)
HH heads who attended formal education	256(21.5)	243(20.4)	92(22.8)	81(20.5)	65(17.4)	56(15.1)	70(25.7)	71(25.8)	29(20.4)	35(23.5)
average years of formal education of head	4.8	5.2	4.9	4.8	4.5	4.6	5.2	6.1	3.9	5
HH heads who attended informal educ.	317(26.7)	290(24.4)	140(34.7)	130(32.9)	76(20.4)	71(19.2)	74(27.2)	49(17.8)	27(19)	40(27)
Average area of land owned by the HH (ha)	1.07	0.73	0.99	0.96	1.4	0.17	0.9	1.06	0.77	0.9
Average area of land cultivated by the HH (ha)	1.17	0.71	1.17	1	1.56	0.19	0.83	0.9	0.86	0.81
Average number of parcels cultivated	3.6	3.5	3.1	3	4.4	4.5	3.6	2.9	3.3	3.3
Households who own Livestock	1158(97.4)	1130(95.2)	394(97.7)	367(93.2)	371(99.7)	363(98.1)	261(95.9)	261(95.2)	132(92.7)	139(93.3)
Households whose house roof is made of Iron sheets	854(72)	932(78)	287(71.2)	298(75.4)	338(91)	344(93)	169(62)	214(78)	60(42.3)	76(51)
Average monthly income from a Microenterprise	528.84	926.23	504	1075.1	577.3	718.9	714	1047	317.8	733.2
Households who benefited from PSNP	146(12.3)	136(11.4)	20(5)	0	0	0	60(22)	57(21)	65(45.8)	79(53)
Households who have Bank account	164(14)	267(22.5)	60(15)	118(30)	50(13.5)	44(12)	25(9.2)	61(22.3)	29(21.2)	44(30)

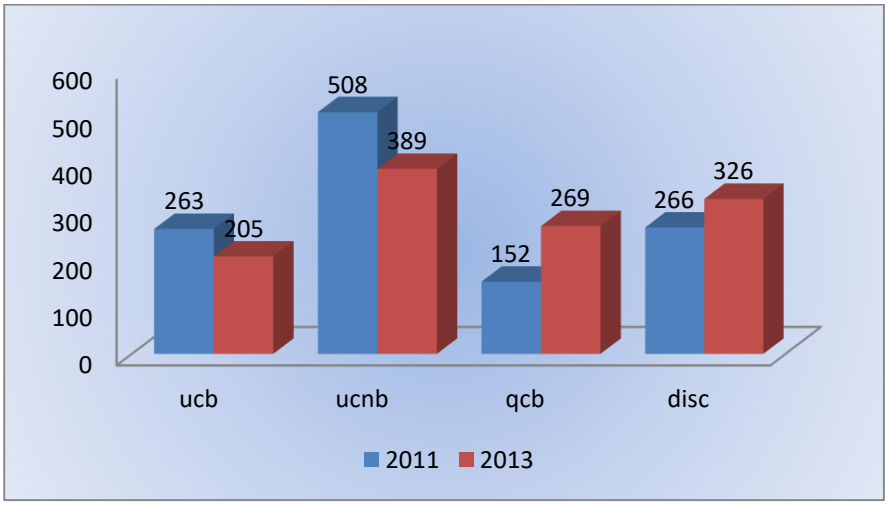
Source: Own calculation from EPIICA 2011 and 2013 survey

Table A3: Credit constraint status of HHs in the study area (%)

Credit Constraint Category	2011	2013	Full sample
Unconstrained			
Borrowers	263(22.1)	205(17.2)	468(19.7)
Non-Borrowers	508(42.7)	389(32.7)	897(37.7)
Total unconstrained households	771(64.8)	594(49.9)	1365(57.4)
Constrained Households			
Quantity Constrained borrowers	152(12.8)	269(22.6)	421(17.7)
Discouraged borrowers	266(22.4)	326(27.4)	592(25)
Total constrained households	418(35.2)	595(50.1)	1013(42.7)

Source: Own calculation from EIIPICA 2011 and 2013 survey data

Figure A3: Credit constraint status of farm households in the study area



Source: own calculation from EPIICA 2011 and 2013 survey data

NB. ucb, ucnb, qcb, and disc stand for: unconstrained borrowers, unconstrained non borrowers, quantity constrained, and discouraged borrowers respectively.

Table A4: Descriptive Statistics of variables used in the data analysis

Variable name	Variable definition and Unit of measurement	N	mean	St. dev.	Min.	Max.
Dependent variables:						
Constraint cat.	Credit constraint category of the household (multinomial response)	2,378	2.478	1.068	1	4
Sector choice	Households' Choice of loan sector (formal, semi-formal, or informal sector)	2378	1.54	.73	1	3
Explanatory variables:						
Age	age of the household head (years)	2377	49.725	14.118	18	100
Female	gender of the HH head (dummy = 1 if female, 0 for male)	2378	0.105	0.307	0	1
Married	marital status of the HH head (dummy = 1 if married, 0 otherwise)	2378	0.866	0.341	0	1
Household size	household size (number of members of the household)	2298	5.209	1.913	1	11
Educational Status of the HH head (Informal education is the reference group)						
Noeducation	level of education of the HH head (dummy = 1 if uneducated, 0 otherwise)	2378	0.531	0.499	0	1
Informaleducation	level of education of the HH head (dummy = 1 if attended informal educ., 0 otherwise)	2378	0.255	0.436	0	1
Formaleducation	level of education of the HH head (dummy = 1 if attended formal educ., 0 otherwise)	2378	0.210	0.407	0	1
Land hectares	area of land owned by the HH (ha)	2378	0.902	0.697	0	5.25
Own livestock	Livestock ownership of the HH (dummy = 1 if the HH owns livestock, 0 otherwise)	2376	0.963	0.189	0	1
Coop. member	membership in a cooperative association (dummy = 1 if member, 0 otherwise)	2378	0.925	0.264	0	1
Food expenditure	amount of money spent on HH consumption items	2377	309.766	225.346	0	4000
Drought shock	exposure to drought shock (dummy = 1 if the HH experienced drought shock, 0 otherwise)	2378	0.391	0.488	0	1
Agroecological zones (North Shoa is the reference zone)						
North Shoa	zone in which the HH resides (dummy = 1 if the HH resides in North Shoa, 0 otherwise)	2378	0.336	0.472	0	1
West Gojjam	zone in which the HH resides (dummy = 1 if the HH resides in West Gojjam, 0 otherwise)	2378	0.312	0.463	0	1
South Wollo	zone in which the HH resides (dummy = 1 if the HH resides in South Wollo, 0 otherwise)	2378	0.230	0.421	0	1
North Wollo	zone in which the HH resides (dummy = 1 if the HH resides in North Wollo, 0 otherwise)	2378	0.122	0.328	0	1

Table A5: Determinants of Credit constraint status of farm HHs compared with unconstrained borrowers - Multi-nominal Logit model with standard errors adjusted for Cluster Effects (Robust Model)

Variable	Unconstrained non-borrowers	Constrained Quantity rationed borrowers	Discouraged Tran. Cost and risk rationed borrowers
Age	.0167***	.0101*	.0215***
	(0.00529)	(0.00584)	(0.00557)
Female	-1.21***	-0.445	-.897**
	(0.35)	(0.391)	(0.379)
Married	-.684**	-0.394	-.674*
	(0.335)	(0.363)	(0.361)
Household size	-0.065	-0.0172	-0.0428
	(0.0398)	(0.0435)	(0.0424)
Noeduc.	.346*	-0.198	.391**
	(0.177)	(0.196)	(0.198)
formal educ.	-0.125	0.124	0.157
	(0.19)	(0.201)	(0.207)
Landhectares	.417***	-0.00162	0.0875
	(0.104)	(0.126)	(0.111)
Own livestock	-1.08**	-0.747	-.92*
	(0.486)	(0.529)	(0.505)
Coop member	0.00636	0.0882	-0.172
	(0.257)	(0.29)	(0.273)
Year dummy	-0.0681	.611***	0.238
	(0.147)	(0.182)	(0.159)
Ln(food exp.)	.158*	0.0494	.246**
	(0.0933)	(0.108)	(0.101)
Drought shock	0.13	.425**	0.236
	(0.159)	(0.18)	(0.17)
West Gojjam	-1.26***	-0.0616	-.947***
	(0.166)	(0.191)	(0.177)
South Wollo	1.38***	1.54***	1.22***
	(0.252)	(0.278)	(0.248)
North Wollo	-0.271	.911***	-.682**
	(0.251)	(0.259)	(0.275)
_Constant	0.818	-0.477	-0.452
	(0.75)	(0.81)	(0.801)
Statistics			
Wald $chi^2(45)$	367		
Prob > chi^2	0.000		
Number of obs	2289		
AIC	5746		
BIC	6022		

Note: robust standard errors in brackets; * p < .1; ** p < 0.05; *** p < 0.01; The Wald test clearly shows the joint significance of all regressors. The variables are estimated using robust standard errors based on the White's hetroscedasticity consistent estimators of variance. The AIC and BIC stand for the Akaike's information criteria and the Bayesian information criteria, respectively which are used to choose the appropriate model. The gllamm model (Table 6) is found to be more appropriate based on the values of BIC and AIC.

Table A7: Determinants of farm HHs' choice of Lenders compared to non-borrowers - Multi-nominal Logit model with standard errors adjusted for Cluster Effects (Robust Model)

Variable	HHs who prefer formal lenders	HHs who prefer informal lenders	HHs who prefer semi-formal lenders
risk_averse	-1.85***	-.979***	-.555*
	(0.194)	(0.229)	(0.289)
Discouraged borr.	-1.68***	-0.612	-0.117
	(0.438)	(0.386)	(0.468)
Quantity constrained	-0.227	-0.0131	0.0425
	(0.151)	(0.199)	(0.274)
Age	-.0128***	-.019***	0.00377
	(0.00489)	(0.0057)	(0.00813)
Female	.651*	0.0347	0.0141
	(0.336)	(0.368)	(0.397)
Married	0.207	-0.172	-0.375
	(0.317)	(0.348)	(0.367)
Household size	.0721**	0.0136	-0.0386
	(0.0342)	(0.0447)	(0.0658)
Noeduc.	-.281*	-0.118	-.459*
	(0.167)	(0.193)	(0.264)
formal educ.	0.0782	-0.00129	-.674**
	(0.175)	(0.216)	(0.301)
Land hect.	-.198**	-0.188	0.11
	(0.0945)	(0.125)	(0.149)
Own livestock	1.04*	0.308	-0.172
	(0.534)	(0.413)	(0.445)
Coopmem.	-0.0177	0.16	-0.054
	(0.24)	(0.291)	(0.358)
Year dummy	.497***	.361*	-2***
	(0.136)	(0.191)	(0.334)
Ln(food exp.)	-.17**	-0.102	-0.106
	(0.0843)	(0.124)	(0.144)
Droughtshock	-0.194	0.0145	0.217
	(0.14)	(0.18)	(0.271)
West Gojjam	.937***	.694***	-0.197
	(0.147)	(0.195)	(0.268)
South Wollo	-1.33***	-0.208	-2.8***
	(0.218)	(0.229)	(0.614)
North Wollo	-0.0968	0.377	.589*
	(0.225)	(0.258)	(0.305)
_constant	-0.76	-0.689	-0.225
	(0.755)	(0.769)	(0.923)

Statistics	
Wald chi^2(54)	455
Prob > chi^2	0.000
Number of obs.	2289
AIC	4138
BIC	4465

Appendix B: Mathematical derivation

Given equation (3.9) as: $(1-\gamma)\left[E(Q_o)-r.B(A_m)-D\right]+\gamma(Q-D)>Q$

Dividing both sides by $(1-\gamma)$ and re-arranging, will give:

$$E(Q_o)>{}^{Q}\!/_{1-\lambda}+r^{L}.B(A_m)+D-{}^{\lambda(Q-D)}\!/_{1-\lambda} \qquad \textbf{[3.9.1]}$$

$$E(Q_o)>r^{L}.B(A_m)+D+\left[{}^{Q}\!/_{1-\lambda}-{}^{\lambda(Q-D)}\!/_{1-\lambda}\right] \qquad \textbf{[3.9.2]}$$

But $\left[{}^{Q}\!/_{1-\lambda}\right]-\left[{}^{\lambda(Q-D)}\!/_{1-\lambda}\right] becomes Q+\left[{}^{\lambda D}\!/_{1-\lambda}\right]$. Hence, equation (3.9.2) becomes:

$$E(Q_o)>r^{L}.B(A_m)+\left[D+\left[{}^{\lambda D}\!/_{1-\lambda}\right]\right]+q \qquad \textbf{[3.9.3]}$$

Again, $D+\left[{}^{\lambda D}\!/_{1-\lambda}\right] becomes \left[{}^{D}\!/_{1-\lambda}\right]$ Thus equation (3.15.3) becomes: $E(Q_o)>r^{L}.B(A_m)+Q+\left[{}^{D}\!/_{1-\lambda}\right]$ which is same as equation(3.10) above.

DETERMINANTS OF ADOPTION OF EXOTIC POULTRY BREEDS AMONG SMALLHOLDER POULTRY PRODUCERS IN NORTH WESTERN AMHARA REGION, ETHIOPIA

Simegnew Tamir[1], Fessiha Moges[2], Yeshiwas Tilahun[2] and Molla Hile[2]

Abstract

The study was conducted in the Western part of the Amhara region, and considered East Gojjam, West Gojjam, Awi and South Gondar zones. The main objective of the study was identifying factors affecting the adoption of exotic poultry breeds in the Region distributed by the Andassa Poultry Multiplication Center and NGOs. A multi-stage random sampling technique was employed. Both descriptive and econometric analysis were used. For the econometric analysis Double Hurdle Model was applied. Despite huge efforts by the Government as well as NGOs to improve traditional poultry production through introduction of exotic poultry breeds specially Day Old Chicks (DOCs) with full packages for the last 20 years, adoption of exotic poultry breed is minimal in the smallholder poultry production system accounting only for 7.8% from the total population including cross and pure breeds. The reasons for low adoptions are lack of sustainable supply of the breed, disease, predation, feed problems, poor awareness on breeds, lack of extension service, lack of training and market problems. Moreover, under farmers condition DOCs distribution is not effective and only less than 8% DOCs live to become 2 month old pullets. Among the hypothesized factors only sex, family size, distance from roads, and towns, management system, number of chickens sold per year in the market and access to training significantly affected household decision to adopt exotic poultry breeds. Sex, distance from roads, and towns, management system, number of chicken sold, access

[1] *MSc., Socioeconomics Researcher at ARARI, simegnew.2004@gmail.com*

[2] *Andassa Livestock Research Center, ARARI*

to training and year of adoption also significantly affected the intensity of adoption of exotic poultry breeds. Therefore this study recommends provision of training and extension service about breed, management, feeding and health aspects before technology distribution. Making a sustainable supply of the exotic poultry breed, distribution of technologies (exotic poultry breeds) for women and resource poor farmers, distribution of technologies for market accessible areas are also recommended. This study strongly recommends pullets (2 months old exotic poultry breeds distribution either through out-growers model or poultry multiplication centers rather than investing much on the less effective DOCs distribution.

Key words: Double Hurdle Model, DOCs and Adoption

1. Introduction

1.1. Background and Justification

Chickens are widely available in Ethiopia and almost every rural family owns them. They are a valuable source of family protein and income (Tadelle et al. 2003). The total population of chickens in the country is estimated at 52.3 million (CSA, 2013/14). The majority (98%) of these chickens are maintained under a traditional system with little or no inputs for housing, feeding or health care. The most dominant chicken types reared in this system are local ecotypes, which show a large variation in body position, color, comb type and productivity (Teketel, 1986; Tadelle et al., 2003; Halima et al., 2007). The greater part of the feed for village chickens is obtained through scavenging, which includes the household cooking waste, cereal and cereal by-products, pulses, roots and tubers, oilseeds, shrubs, fruits and animal proteins (Tadelle, 1996).

Rural chickens in Ethiopia represent a significant part of the national economy in general and the rural economy in particular and contribute 98.5% and 99.2% of the national eggs and chicken meat production,

respectively (Tadelle 1996; Aberra 2000). However, the economic contribution of the sector is still not proportional to the large number of chickens, attributed to many technical, organizational and institutional constraints. According to CSA (2013/14) the total chicken population of the Amhara Region is estimated to be 14.6 million accounting for 27.9% of the national chicken population.

According to Ministry of Agriculture, in Ethiopia, like in many African countries, attempts have been made at various times to improve local chicken production through introduction of exotic chicken breeds. Distribution of pullets, cockerels, DOCs and fertile eggs, layers and duals breeds, has been one of the poultry extension packages accomplished by the Regional Office of Agriculture, since the last 20 years, aiming at improving chicken production and productivity. Despite this huge distribution of exotic chicken breeds, the contribution of improved chicken breeds in the current production system of the region is very low (<5%). A study by *Tekelewold et al, (2006)* on the adoption of poultry technology in the highlands of Ethiopia (East Shewa and Welayta) indicated that adoption has been limited by a set of factors such as lack of knowledge on chicken husbandry (feeding, housing, health care, etc), lack of complimentary inputs (feed, alternative breeds, etc), lack of strong extension follow-up, high disease prevalence and predation, unavailability of credit services and marketing problems. However, no study has been made so far on determinants of adoption of poultry technology in the Amhara Region. Therefore, this study aims at determining factors affecting the adoption of exotic poultry breeds in the Region.

1.2. Objectives of the Study

The main objectives of this study were to:

- assess the opportunities and challenges of smallholder improved poultry production systems,

- determine factors affecting decisions on adoptions of exotic poultry breeds, and
- estimate the extent of exotic poultry technology adoption.

2. Research Methodology

2.1. Description of the Study Area

The study was conducted at the Western part of the Amhara Region, Ethiopia. The Amhara National Regional State is grouped into Western and Eastern parts. The Western part of the region comprises five administrative zones, namely North Gondar, South Gondar, East Gojjam, West Gojjam, and Awi Administrative zone. According to the Regional office of Agriculture, compared to the Eastern part of the region, the Western part has a better potential for agricultural activities and crop production is the first priority. The western part has also the potential for chicken production. Most of the exotic breeds from Andassa Poultry Multiplication Center were distributed in this area. Therefore, the study selected this area purposively for its high potential, availability of large exotic breed and accessibility.

2.2. Sampling Procedures and Data Sources

2.2.1. Sampling Design and Procedure

From the Western part of the Amhara region, the study considers all zones (East Gojjam, West Gojjam, Awi and South Gondar). A multi-stage random sampling technique was employed. First two Woredas from each Zone were selected randomly. Second two Kebeles were selected randomly from randomly selected Woredas. Third, smallholder poultry producers were selected randomly based on representativeness of the population and finally sampled farmers were interviewed using a semi structured questionnaire. The main reason for using this procedure was to avoid sample bias so that the sample can represent the entire population.

2.2.2. Data Sources and Collection Methods

In this study both primary and secondary data were used. The primary data was collected from the sample poultry producers through semi-structured questionnaire prepared for this purpose. In addition to the semi-structured questionnaire, personal observations were made and group discussion were held using checklists. The enumerators, who speak the local language (Amharic), are research assistants of the research center and experienced in methods of data collection and interviewing techniques. The questionnaire was pre-tested and the contents were revised based on the feedbacks obtained during the pre-test. Informal discussions were also held with the experts and key informants. Continuous supervision was made to reduce error during data collection and to correct possible errors right on the spot.

2.3 Techniques of Data Analysis

Based on the objectives of the study appropriate tools and techniques of analysis such as descriptive statistics and double hurdle model was employed.

2.2.2. Descriptive analysis

Demographic and socio-economic conditions of sample households and institutional factors in the study areas were analyzed by using descriptive statistics like mean, standard deviations and percentages

2.2.3. Econometric analysis

A feature of many models of technology adoption, for example, straightforward binary or censored data models, is that the process, which results in non-adoption is assumed to be the same as that which determines the intensity of adoption. Thus, for example, if a given farmer's characteristic is known to have a positive effect on the extent of adoption, then a very high value of this characteristic would inevitably lead to the

prediction of adoption for such a farmer. While such assumptions may turn out to hold, there is no reason to expect this priory. One reason why such an assumption might fail is that there may exist a proportion of the population of farmers, who would out of principle, never adopt under any circumstances.

In principle, the decisions on whether to adopt and how much to adopt can be made jointly or separately (Berhanu and Swinton 2003). The Tobit model used to analyse under the assumption that the two decisions are affected by the same set of factors (Greene 1993). In the double-hurdle model, on the other hand, both hurdles have equations associated with them, incorporating the effects of a farmer's characteristics and circumstances. Such explanatory variables may appear in both equations or in one of them. Most importantly, a variable appearing in both equations may have opposite effects in the two equations. The double-hurdle model, originally due to Cragg (1971), has been extensively applied in several studies such as Burton et al (1996) and Newman et al (2001). However, this model has been rarely used in the area of adoption of agricultural technologies; an exception would be Berhanu and Swinton (2003).

The double-hurdle model is a parametric generalization of the Tobit model, in which two separate stochastic processes determine the decision to adopt and the level of adoption of technology.

The double-hurdle model has an adoption (D) equation:

$$\left.\begin{array}{l} Di = 1 if Di^{*} > 0 and 0 if Di^{*} < 0 \\ Di = \alpha' Zi + ui \end{array}\right\}$$

Being D* a latent variable that takes the value 1 if the farmer adopts exotic poultry breed and 0 otherwise, Z is a vector of household characteristics and α is a vector of parameters. The level of adoption (Y) has an equation of the following:

$$\left.\begin{array}{l} Yi = Yi^{*}\, if Yi^{*} > 0 and Di^{*} > 0 \\ Yi = 0 otherwise \\ Yi^{*} = \beta' Xi + Vi \end{array}\right\}$$

where Yi is the observed answer to the proportion of exotic poultry breeds, X is a vector of the individuals characteristics and β is a vector of parameters. The error terms Ui and Vi are distributed as follows

$$\left.\begin{array}{l} Ui \approx N(0,1) \\ Vi \approx N(0,\delta^{2}) \end{array}\right\}$$

The log-likelihood function for the double-hurdle model is:

$$LogL \sum_{0} \ln\left[1 - \Phi(\alpha Zi')\left(\frac{\beta Xi'}{\sigma}\right)\right] + \sum_{+} \ln\left[\Phi(\alpha Zi')\frac{1}{\sigma}\phi\left(\frac{Yi - \beta Xi'}{\sigma}\right)\right]$$

under the assumption of independency between the error terms U_i and Vi the model (as originally proposed by Cragg, 1971) is equivalent to a combination of a truncated regression model and a univariate Probit model.

2.3. Statistical tests of multicollinearity and hetroschedasticity problem

Before executing the econometric model, all the hypothesized explanatory variables were checked for the existence of a multicollinearity problem. Different methods are often suggested to detect the existence of a multicollinearity problem. Among them, variance inflation factor (VIF) technique will be employed in the present study to detect the existence of multicollinearity in continuous explanatory variables (Gujarati, 2004). Breusch-Pagan/Cook-Weisberg test was used for identifying heteroskedasticity problem.

3. Results and Discussion

3.1. Demographic characteristics of the households

In the study area (Table 1), 20.7% of female headed and 79.3 % male headed households are engaged in poultry production. This indicates that the majority of the female headed households are engaged in poultry production as the proportion of female headed households in any Kebele is less than 10%. Most (76.2%) of the households engaged in poultry production were married and the remaining (never married, divorced and widowed) mainly women and youngsters are also engaged in poultry production. Almost all (99.1%) of the poultry producers are Orthodox Christians; this is because most of the farmers in the western Amhara Region are Orthodox Christians. The majority of poultry producers (61.3%) are either illiterate or with adult education, while only 39.7% of the respondents have modern education.

Table 1: Demographic characteristics of the households

Variables	Attributes	Frequency (%)
Sex	Female	20.7
	Male	79.3
Marital status	Married	76.2
	Single	6.8
	Divorced	13.3
	Widowed	3.7
Religion	Orthodox	99.1
	Muslim	0.5
	Protestant	0.5
Education status	Illiterate	31.8
	Read and write	29.5
	1-4 grade	9.2
	5-8 grade	19.8
	9-10 grade	8.8
	11-12 grade	0.9

Source: own estimation, 2014.

3.2. Awareness on exotic poultry breeds

In the study area producers are aware of two exotic poultry breeds, the White Leg Horn (WLH) and Rod Il and rod (RIR). Producers were aware of the WLH breeds before the RIR breeds. Producers were aware of the WLH breeds starting from 1992 GC and adoption of the breed started from 1995

onwards while for the RIR breed awareness and adoption year was 1996 GC. This indicates that producers took three years to move from the awareness year to adopting the WLH exotic breed. However, once they start adopting new breeds, year of awareness and adoption become similar.

Table 2: Household's awareness on exotic poultry breeds

Variables	Category	Frequency (%)
Tried exotic poultry breeds	Yes	84.3
	No	15.7
Which breeds you tried	White leg horn (WLH)	16.8
	Red IIand rod (RIR)	18.2
	WLH and RIR	49.3

Source: own estimation, 2014

3.3. Exotic poultry breed adoption

From the total respondents non- adopters, discontinued, and adopters account for 41.9%, 18.4% and 39.6%, respectively. Non adopters are those producers who do not try the exotic breeds at all while the discontinued are those producers who tried the exotic breeds but totally stopped producing exotic poultry breeds due to some reasons. The adopters indicate those producers who are still in exotic poultry production either in pure or cross breed forms. The main reasons for discontinuing are lack of sustainable supply of the breed (43.2%), diseases and shortage of improved feed (48.6%), predation, lack of training and a combination of the mentioned problems (8.1%).

3.4. Additional packages adoption

The use of additional packages in exotic poultry production increases the survival of the breeds. Moreover, the use of improved package improves the productivity and reproductive performance of the breeds. However, in

this study only 40.6 % of the exotic poultry breed adopters use additional packages (see Table 3 below).

Table 3: Additional packages used by the households

Package type used	Frequency (%)
Improved feeding	1.8
Improved health (vaccination and medication)	3.0
Hey box brooder	0.9
Improved housing	1.9
Improved feeding and improved housing	6.9
Improved feeding and improved health	8.5
Improved feeding, improved housing and improved health	15.3
All of mentioned packages	2.3

Source: own estimation, 2014

3.5. Perceptions of farmers on day old chicks (DOCs) distribution

According to the Amhara Regional Agricultural Office, attempts have been made at various times to improve local chicken production through introduction of exotic breeds. Distribution of pullets and cockerels has been one of the poultry extension packages accomplished by the Regional Agricultural Office for a long time. However, the method creates a challenge in addressing many areas in a short period of time and this method of distribution failed to address the goal of the government as well as interested areas of the region. Thus, the Regional Agricultural Office was forced to search for a new method of distribution to address a wider area which is day old chicks (DOCs) distribution.

Despite the huge efforts to address a wider area using day old chicks distribution, the method is highly criticized by smallholder poultry producers. All (100 %) of the farmers do not like DOCs distribution and only 7.98% of the distributed DOCs reach the age of young chickens (2 months old) at smallholder level. There are so many problems associated with this lower survival rate such as lack of electrical facilities in rural areas, lack of

training, poor feeding and management chicken production system at smallholder level.

3.6. Exotic poultry production and management systems

The study indicated that 59.4% of exotic poultry breeds are managed under free scavenging systems. Producers' mange exotic breeds in the same ways they use for indigenous breeds as they have low awareness on improved management systems. The remaining 40.6% of exotic poultry breeds are managed under free scavenging systems with supplementations. This study confirms that the majority of poultry breeds reared by small-holder farmers are indigenous breeds accounting for 71.6% from the total population. The cross breeds and exotic breeds account for 20.6% and 7.8% respectively.

3.7. Training and extension services

The majority of small-holder poultry producers do not have access to training and extension services. None of the producers have accessed a training or extension service focusing on poultry production system. Those producers who obtained the service took the training and extension services together with disciplines such as crop and animal production.

Table 4: Sources of information related to poultry production

Type of participation related to poultry	Category	Frequency (%)
Extension package	Yes	28.1
	No	71.9
Research activity	Yes	4.6
	No	95.4

Workshop	Yes	6.9
	No	93.1
Training	Yes	12.9
	No	87.1

Source: own estimation, 2014

3.8. Access to inputs for improved poultry production

Sustainability of improved poultry production is highly associated with continuous supply and accessibility of the inputs to the smallholder producers. The most important inputs in improved livestock production include supply of exotic breed, improved feed, vaccine and medicaments and credit. According to this study, 100% of the farmers say there are problems in accessing of inputs in terms of timely availability, required quality and required amount.

3.9. Factors affecting adoption of exotic poultry breeds

Before executing the econometric model, all the hypothesized explanatory variables were checked for the existence of multicollinearity problems using variance inflation factor (VIF). Breusch-Pagan / Cook-Weisberg test was also used for identifying heteroskedasticity problems. In this data set there were no observed multicollinearity and heteroskedasticity problems.

Out of the twelve variables hypothesized to affect adoption of decisions only seven are significant. Sex of the household head significantly affects the exotic breed adoption decisions. Female headed households have 17.1% predicted probability to adopt exotic poultry breed. This might be due to the fact that females in the area mainly spend their time at home and take care of the chickens. Family size has also a significant effect on adoption. Households having higher family size have more probability to adopt the exotic breeds.

Distance from roads and towns have a significant impact on the predicted probability of adoption of exotic poultry breeds. The reason is that these factors are highly associated with access to information and markets. Thus, farmers who have access to information and market are more likely to adopt exotic poultry breeds. Number of chickens sold in the market per year has also a significant effect on adoption of exotic breeds. Every increase in the number of poultry sold increases the predicted probability of adopting exotic breeds by 29.8%.

Table 5: Factors affecting adoption of exotic poultry breeds

Probit regression		Number of obs.= 217		
		Wald chi2(12) = 54.77		
Log pseudo likelihood = -88.478		Prob > chi^2 = 0.0000		
		Pseudo R^2 = 0.3232		
Variables	**Coeff.**	**Marginal effect**	**Std.Err**	**Z-value**
Sex	-.440***	-.171	.287	-3.53
Education level	.190	.071	.234	0.82
Age	-.002	-.0006	.0009	-0.17
Family size	.078*	.029	.046	1.72
Distance from road	- .208*	-.078	.107	-1.95
Distance from town	-.092*	-.034	.053	-1.74
TLU	-.040	-.015	.025	-1.56
Number of poultry soled	.346**	.298	.456	2.07
Management system /add. package/	1.469***	.554	.240	6.11
Membership in formal organization	-.166	-.063	.286	-0.58
Access to training	.051***	.019	.240	4.20
Access to credit	.113	.042	.285	0.40
Constant	-.033	-	.663	-0.07

*Note: *, ** and *** means significant at 10%, 5% and 1% probability levels*
Source: own estimation, 2014

The use of additional packages is also one of the significant variables affecting adoption. It increases the predicted probability of adopting exotic poultry breeds by 55.4%. This is because the use of additional packages such as improved feeding, housing, vaccination and medication improves the survival as well as reproductive performances of exotic poultry breeds. Access to training has also a significant impact on the probability of

adopting exotic breeds. Those farmers who have accessed training are more likely to adopt the breeds, the reason being that training increases the knowledge of producers which in turn helps them to undertake informed decisions.

3.10. Factors affecting intensity of adoption of exotic poultry breeds

Out of the twelve variables hypothesized to affect intensity adoption of exotic poultry breeds only seven variables are significant. Sex of the household head significantly affects the intensity of exotic breed adoption. Female headed households increase the expected proportion of exotic poultry breeds by 10.9%. Distance from roads and towns have a significant and negative impact on the expected proportion of exotic poultry breeds. Number of chickens sold has also a significant effect on adoption of the exotic breeds. Every increase in the number of poultry sold increases the expected proportion of exotic breeds by 3.7%.

The use of additional packages is also one of the significant variables affecting intensity of adoption. It increases the expected proportion of exotic poultry breeds by 89.9%. Access to training has a significant impact on the expected proportion of exotic poultry breeds. Year of adoption has similarly a significant and positive impact on intensity of adoption. It increases the expected proportion of exotic poultry breeds by 2%.

Table 6: Factors affecting intensity of adoption of exotic poultry breeds

Tobit regression		Number of obs = 87		
		LR chi2(12) = 67.36		
Log likelihood = -126.7419	Pseudo R2 = 0.210	Prob > chi2 = 0.0000		
Variables	**Coeff.**	**dy/dx**	**Std.Err**	**t-value**
Sex	-.109**	-.109	.157	-2.70
Education	.054	.054	.137	0.39

Age	-.0008	-.0008	.005	- 0.16
Family size	.008	.008	.026	0.32
Distance from road	-.0048**	-.0048	.022	-2.18
Distance from town	-.021**	-.021	.031	-2.66
TLU	.016	.016	.015	1.06
Poultry sold	.038***	.037	.182	3.21
Management system /add. package/	.90***	.899	.140	6.42
Training	.001***	.0014	.142	3.01
Access to credit	.051	.052	.162	0.32
Year of adoption	0.021**	0.02	0.001	2.16
Constant	-.697	-	.324	-0.15

*Note: *, ** and *** means significant at 10%, 5% and 1% probability levels*

Source: own estimation, 2014

4. Conclusion and Recommendation

The study was conducted in the Western part of the Amhara region, and considered East Gojjam, West Gojjam, Awi and South Gondar zones. The main objective of the study was finding factors affecting the adoption of exotic poultry breeds in the Region. A multi-stage random sampling technique was employed. Both descriptive and econometrics analysis were used. For the econometric analysis double hurdle model was used. Despite huge efforts by the government and NGOs to improve traditional poultry production through introduction of exotic poultry breeds with full packages, adoption of exotic poultry breeds is very small accounting only for 7.8% of the population from the total chicken production. The reasons for low adoptions are lack of sustainable supply of the breed, disease, predation, feed problem, poor awareness on breeds include, lack of extension service, lack of training and marketing problems. Among the distributed DOCs, only 7.98% survived to become 2 months old pullets, while the remaining died before that time. This indicates that under smallholder condition DOCs distribution is not effective.

Among the hypothesized factors only sex, family size, distance from roads and towns, management system /additional packages such as improved feeding and management /, number of chickens sold per year in the market and access to training significantly affected households' decision to adopt exotic poultry breeds. Sex, distance from roads and towns, management system, number of chickens sold, access to training and year of adoption also significantly affected the intensity of adoption exotic poultry breeds. Therefore this study recommends provision of training and extension service about breeds, management, feeding and health aspects before technology distribution. Making a sustainable supply of the exotic poultry breeds, distribution of technologies (exotic poultry breed) for women and resource poor farmers, distribution of technologies for market accessible areas is also recommended. Finally, this study strongly recommends pullets (2 months old exotic poultry breeds) distribution either through out-growers model or poultry multiplication centers rather than investing much on the less effective DOCs distribution.

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DETERMINANTS OF KNOWLEDGE AND PRACTICE OF EXCLUSIVE BREAST FEEDING: CASE OF DEBRETABOR TOWN, ETHIOPIA

Solomon Bizuayehu[1] and Almaz Bizuayehu[2]

Abstract

Exclusive breast feeding is defined by the World Health Organization as "giving human milk with no supplemental liquids or solid food so the r than medication and vitamins". Breast milk is the safest and most natural food for an infant. It provides an infant's complete nutritional needs up to four to six months of age. However, there is a decline trend in the prevalence and duration of exclusive breast feeding. Hence this study was done to explore the main determinants of exclusive breast feeding knowledge and practice. The study was done in Debretabor town, with a total sample of 335 mothers having children in the age of 6 months to one year. Both descriptive and econometric methods were used to analyze the data. Accordingly, the study shows that 60.9% mothers have adequate knowledge about exclusive breast feeding but maternal knowledge on the definition of EBF is insufficient. Only 55.8% succeed to practice exclusive breast feeding. The binomial logistic regression model output from this study showed that, there is a significant association between knowledge about exclusive breastfeeding and total monthly income, maternal educational level and frequency of ANC follow up. Moreover, total monthly income, maternal educational level and frequency of ANC follow up have significant and positive effect on knowledge about exclusive breastfeeding. Hence, it is important to empower women in income and education to enhance the level of knowledge about exclusive breast feeding in particular and maternal and child health in general.

Key Words: Debretabor, Exclusive breast feeding, Knowledge and Practice.

[1] Contact author, Bahirdar University, sbizuayehu@gmail.com, +251939965895
[2] Debremarkos University, alme.bizuayehu12@gmail.com

1. Introduction

Breast milk is the safest and most natural food for an infant. It provides an infant's complete nutritional needs up to four to six months of age. There is no need for other food or drink before this age. Human milk is also fresh and free of bacteria, which reduce the chance of gastro-intestinal disturbances. When the baby is feed on breast milk only, it is called exclusive breast feeding. Exclusive breast feeding provides the best nutrition and growth for infants, and continued growth with the introduction of solid foods at six months (UNICEF, 2008).

Breast feeding is declining in almost all parts of the world despite its nutritional and immunological benefits. Death rates in third world countries are lower among breastfed babies and Breastfed babies have stronger immune systems and are healthier than bottle-fed babies (Ogunrinade, 2014).Research shows that breast-feeding can save the lives of over 1,500,000 babies who die every year from diseases such as diarrhea and pneumonia. Breastfed babies have stronger immune systems and are healthier than bottle-fed babies (*ibid, 2014*).

Generally speaking the advantages of exclusive breastfeeding include, (a) an infant receiving essential and adequate daily nutritional requirements, (b) an increased emotional and physical bond between mother and infant, and (c) a delayed return to fertility and the chance of a new pregnancy. So visa avis with this fact all children should exclusively be breastfed for the first 6 months and continue for as long as the mother and child wish. After six months of life, both appropriate and sufficient complementary food should be added to the breast milk (World Alliance for Breastfeeding Action, 2004).

Despite its demonstrated benefits, exclusive breast feeding prevalence and duration in many countries including Ethiopia are lower than the

international recommendation of exclusive breast feeding for the first six months of life. Based on several studies done in Ethiopia, breastfeeding is nearly universal but the proportion of exclusively breastfed children up to 6 months is less than the optimal recommendations (CSA, 2006). According to CSA (2011) only 52% of children under age of 6 months practice EBF in 2011, in Ethiopia. Hence this study was done with the following objectives.

2. General objective

To assess the level of knowledge and practice on exclusive breast-feeding among mothers of children aged from six months to one year.

Specific objectives

- Examine the level of knowledge and practice of exclusive breast- feeding among mothers of children aged from six months to one year.
- Determine factors that affect the knowledge and practice of exclusive breast-feeding among mothers of children aged from six months to one year.

Methodology

Study area: The study was conducted in capital city of North Gondar zone, Debretabor. It is about 100 kilometers south east of Gondar and 50 kilometers east of Lake Tana. Based on Debretabor Woreda Health Office report (2014), Debretabor has a total population of 46,397 of whom 23,523 are male and 22,874 female (Debretabor woreda health office, 2014).

Sampling method, sample size and data: In this study purposive random sampling technique was used. Mothers of children with age of 6 month to one year were purposively selected from the total population of mothers in

the town, group of interest. Then we use random sampling to get the total sample size, which was determined using the standard sample size determining method.

A single population proportion sample size determination was carried out through a prevalence value (P) of 34%, precession (d) marginal error of 5% and 95% of confidence interval. The sample size required for the study was calculated using the formula to estimate a single population proportions.

$$n = \frac{(Z/2)^2\, p(1-p)}{d^2}$$

Where: n = required sample sizes

z/2 = critical value for normal distribution at 95% confidence interval which equals to 1.96 (z value at alpha =0.05)

p = established prevalence from previous studies of the topic of interest (breast -feeding) in the locality.

d = an absolute precision (margin of error)

n = $[(1.96)^2$ 0.34(1-0.34)]/$(0.05)^2$

n = [(3.841) * 0.34(0.66)]/(0.0025)

n = 344

Operational Definition:

Knowledge about exclusive breast feeding: This was measured based on 4 knowledge related questions, asking whether the mother know it is good to give anything before age of 6 months is good. Those mothers who agreed to give one among the alternatives were considered as not having knowledge about EBF.

Practice of exclusive breast feeding: This was also measured based on 4 practice related questions, asking whether the mother give anything before age of 6 months. Those mothers who give anything before age of six months were considered as they do not practice EBF.

Data analysis: We employed both descriptive statistics and Econometric model. Given the dependent variables (Knowledge and Practice) are dummy; we used binary logistic regression to identify the major determinants.

3. Result and Discussion

In this part of the paper, both descriptive and econometric results are briefly discussed.

Descriptive Statistics

Table 1: Socio-demographic characteristics of sampled mothers

Description	Frequency	Percent
Marital status		
Marred	273	81.5
Divorced	28	8.4
Educational status of the mother		
Non educated	38	11.3
Educated	297	88.7
Husband's educational status		
Non educated	19	5.7
Educated	315	94.0
Occupation of sampled mothers		
House wife	196	58.5
Student	5	1.5
Civil servant	66	
Private	67	

Source Own survey (2014)

The table above indicates that marital status of majority of total sampled mothers 273 (81.5%), were married. Similarly, majority 297(88.7%) of

mothers were educated and 11.3% were non-educated[3], regarding to husband educational level 315(94%) were educated and 19(5.7%) were non-educated.

Among the total sample mothers 301(89.9%) experienced vaginal delivery and 33(9.9%) of them gave birth by censorial section (CS). Majority 289(86.3%) of respondents indicated that their last pregnancy was planned. Finding from this study indicated that, majority of mothers 285(84.8%) did not give anything to drink or eat before breastfeeding was started, while the remaining 49(14.6%) give pre-lacteal feeds.

Table 2: Obstetric history of mother

Description	Frequency	Percent
Type of delivery of sampled mothers		
Vaginal	301	89.9
CS (operation)	33	9.9
Was your last pregnancy wanted		
No	46	13.7
Yes	289	86.3
Antenatal care follow up		
No	18	5.4
Yes	316	94.3
Gave anything before breast milk		
No	285	84.8
Yes	49	14.6

Source Own survey (2014)

Table 3: Maternal characteristics

Description	N	Min.	Max.	Mean	Std. Deviation

[3]Those mothers who have some years of formal education are considered as educated otherwise non-educated.

Frequency of ANC follow up	316	1.00	9.00	4.54	1.648
Age of mother (years)	335	16.0	45.0	27.34	4.858
Age of mothers at first delivery (years)	335	14	39	21.64	4.168
No. of children	335	1	7	2.19	1.406
Age of your last child (months)	334	6.00	12.00	9.06	2.231
Duration of EBF (Months)	304	1.00	24.00	5.88	1.539
Initiation of breastfeeding (hours)	334	0.00	24.00	1.98	3.209
Total monthly income (Birr)	320	35	6000	1337.23	1092.4

Source Own survey (2014)

Data from this study showed that, average age of the mothers was 27.34 years (SD=4.858) and ranged from16 to 45 years. Mother`s age at first delivery ranged from 14-39 years with an average age of 21.61(SD=4.168). Children considered in this study was aged ranging from 6 to 12 months, with the average of 9.06 months (SD=2.231). In this study, mothers reported that initiation of breastfeeding was within an average of 1.98 hours after delivery (SD=3.209). Mothers believed that duration of exclusive breast feeding was on average for 5.88 months (SD=1.539). The largest number of children was 7 and the smallest was 1 per family on the other hand, with the average number of children being 1.05. According to the study, the average household monthly income was 1337.23ETB.

Based on the above assumption, more than half of the mothers had adequate knowledge about exclusive breast feeding while nearly 39% of them do not. In this study, out of the total 335 mothers with infants aged between 6 months and one year, 187(55.8%)were exclusively breastfeeding their infants for the first six months of life.

Table 4: Knowledge and practice of exclusive breast feeding

Description	Frequency	Percent
Knowledge about EBF		
Have no knowledge	131	39.1
Have knowledge	204	60.9
Practice of EBF		
Don't practice	148	44.2
Practice	187	55.8

Source: Own survey (2014)

Econometric result

Before estimation, the data was checked for possible econometric problems. Accordingly, the data was robust from multicollinearity and hetroskedasticity. Moreover, to control for possible effects due to other factors we have controlled variation in area by Kebele[4].

Table 5: Factors affecting knowledge of EBF

Description	Coefficients	Standard error	P value
Maternal education	0.504*	.403	.089
Household Income	1.00***	.000	.001
Frequency of ANC Follow up	1.161*	.087	.086
Number of children	0.894	.091	.221
Information about EBF	0.793	.477	.627
Constant	0.642	.489	.364

*Source: Own survey (2014) N.B * and *** refers to 10% and 1% significance, respectively.*

Findings from this study showed that, there is a significant association between knowledge about exclusive breastfeeding and total monthly income, maternal educational level and frequency of ANC follow up.

[4]Kebele is the smallest administration unit in Ethiopia

The survey result indicated that education has significant and positive (P=0.089) effect on knowledge of exclusive breastfeeding. This result was in line with study done by Tewodros*et.al.* (2009). Household income also affects knowledge of EBF positively and significantly. Mothers who had relatively high frequency of ANC follow up are more likely to have better knowledge about EBF than otherwise (p=0.086). In contrast, study done by Justina (2005) found negative association between ANC and knowledge.

As shown in the above table, the main factors affecting practice of EBF are knowledge about EBF and maternal age. There is positive and significant relationship between knowledge about EBF and practice of EBF, similar to other studies (Tesfaye*et.al.* 2012; Egata*et.al.* 2013). Similarly, maternal age also affects practice of EBF positively and significantly. This result is similar to Tewodros*et.al.* (2009).

Table 6: Factors affecting practice of EBF

Description	Coeff.	S.E.	P value
Maternal education	1.082	.444	.860
Household Income	1.000	.000	.650
Frequency of ANC follow up	1.084	.088	.357
Maternal age	0.932*	.38	.061
Number of children	1.202	.133	.165
Frequency of PNC follow up	1.335	.328	.378
Knowledge	8.36***	.290	.000
Constant	1.094	.961	.926

*Source: Own survey (2014) N.B * and *** refers to 10% and 1% significance, respectively.*

Given that the coefficients in the table above (Table 5 and Table 6) are direct coefficients of the model, it can be interpreted as follows. Having knowledge significantly (P = 0.00) increase probability of practicing EBF by

8.358 percent. Increase in mothers age by one percent will significantly (P = 0.061) increase the probability of practicing EBF by 0.932 percent.

4. Conclusion

EBF is the only source of nutrition that play an important role in the growth development and survival of infants for the first six months of life. This study shows that 60.9% mothers have adequate knowledge about EBF but maternal knowledge on the definition of EBF is insufficient. Only 55.8% succeed to practice EBF. Given the limitation in their knowledge about EBF, nearly 33% of mothers believe they are practicing EBF as they only give water for their infants. Other 17% of the working mothers give only cow milk as supplement to breast milk, as they will be less available during the day due to work. Maternal age and knowledge about EBF have positive and significant relationship with practice of EBF. As far as knowledge about EBF is concerned, the main determinants are income of the household, ANC follow-up and maternal education. Most of the time mothers who give birth by CS were given pre-lacteal feed. It might be due to delayed milk production. Therefore, they do not practice EBF to their infants.

5. Recommendation

Based on the current result of this study, the following recommendations are forwarded.

1. Policy makers should look in to the issue to give more emphasis in the practice of ANC follow up and fully defined knowledge about EBF.
2. Working mothers should be encouraged by institutions and coworkers to promote EBF practice by arranging working hours.
3. Female education should be encouraged so as to have a literate mother who could cope with scientific ways of infant care and support.

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DETERMINANTS OF FARMERS PARTICIPATION IN FARMERS RESEARCH GROUP AND ITS CONTRIBUTION ON THEIR INCOME FROM RICE: THE CASE OF FOGERA DISTRICT, AMHARA NATIONAL REGIONAL STATE, ETHIOPIA

Yazie Chanie[1*], Lemma Zemedu[2] and Tilaye Teklewold[3]

Abstract

Farmers Research Group which is one of the participatory agricultural research approaches being implemented by the Adet Agricultural research center aimed at improving the conventional top-down research approach that does not fully address the needs of smallholder farmers. This study identified determinants of farmers' participation decision in Farmers Research Group approach and assessed the contribution of the approach on farmers' gross margin earning level from rice production. The study was conducted in Fogera district of Amhara Region on four Kebeles by collecting cross-sectional survey data from a total of 120 participant and non-participant households in 2012/13. Treatment effect model of Heckman two step procedure was employed to analyze factors of participation as well as to measure contribution of the approach on gross margin earning level of participant farmers from rice production. Results of the study revealed that age, sex, education, access to research, access to training and access to credit affected positively and significantly the probability of farmers participation in the approach while family size affected negatively and

[1] Adet Agricultural Research Center, P.O. Box 08, Bahir Dar, Ethiopia, *Corresponding author: email: yaziechanie@yahoo.com

[2] Haramaya University, P.O.Box 138, Dire Dawa, Ethiopia.

[3] Amhara Region Agricultural Research Institute (ARARI), P.O.Box, 527, Bahir Dar Ethiopia.

significantly the probability of participation. The second stage estimation results of the treatment effect model showed that family size in adult equivalent, access to research, use of improved rice variety and dummy participation in farmers research groups approach have significant relations with margin earnings from rice. The gross margin analysis indicated that a farmer could generate an additional gross margin of Birr 5,378.97 per hectare of rice when participating in the approach than a non-participant which indicates the profitability of the approach. Therefore, implementing FRG research approach by improving the associated problems could lead to the increment of rice production and productivity that would in turn enhance income of farmers.

Key words: *rice, Farmers Research Groups, gross margin, Heckman two step, Fogera.*

1. Introduction

Ethiopia has a huge potential of land for rice production which is estimated at about thirty million hectares. The importance of the crop is increasing as the area under this crop is approaching 160,000 hectares within a short period of time, 2010). According to MoARD (2010), the National Rice Research and Development Strategy of Ethiopia,(2010) the area allocated has increased from about 18 thousand in 2006 to about 90 thousand ha in 2008 along with production increase from about 150 thousand tones in 2006 to about 286 thousand tones in 2008.

Rice is of crucial importance for Fogera farming community, being cultivated year after year, grown on waterlogged lands which are difficult for other cereals to grow. t Thus it becomes an important source of food, rural employment and income for the growing population of Fogera areas. Moreover, rice is one of the cereals which has attracted the attention of the research and development system of Ethiopia and efforts have continued to improve productivity and production of the crop. Several improved rice technologies like improved rice varieties, agronomic practices and pre and

post-harvest technologies have been evaluated and made ready for users through the research system. However, these improved rice technologies are not widely adopted by farmers as expected. This clearly shows that technology generation and transfer is not an end by themselves in any research endeavor unless they are demand-driven and client oriented and finally utilized by end users, in this case farmers (Chimdo *et al.,* 2005).

Participatory research emerged as a response to the limitations of earlier top-down conventional agricultural research approach that often failed to deliver significant improvements in levels of well-being for the poor in complex, risk prone environments (Chambers et al, 1989). One of the strategies currently adopted to form strong alliances with farmers in the process of making agricultural research and extension client oriented and demand-driven is the application of participatory agricultural research approaches like the establishment of Farmers' Field Schools (FFS), Farmers' Training Centers (FTC) and Farmers-Research-Groups (FRGs) approaches.
Participation has now become a widely accepted strategy for conducting research and development projects (Anandajayasekeram *et al*., 2008). According to Chimdo *et al*. (2005), increase in household food security; increase in income of farmers from high value crops; increased adoption of technologies; technical and financial empowerment of farmers; and an increase of farmers' participation in extension system (in spite of illiteracy levels) were some of the benefits of participatory research. Ashby and Lilja (2004), reviewed the efficacy of Participatory Plant Breeding (PPB) compared to conventional breeding for over 150 projects and they concluded that the efficacy of PPB compared to conventional breeding was demonstrated by increasing the overall level of benefits from the program, increased effectiveness of reaching women and the poor, improved research efficiency and varieties developed being more acceptable and getting adopted faster. On his review work of the FRG approach experience of the Holeta Agricultural Research Centre, Ethiopia, Kiflu (2005), described that farmers' participation in problem identification, priority setting,

planning and execution of on-farm experiments was improved due to the implementation of participatory research approach in the research center. He added that, farmers developed a spirit of working together, competitive spirit among farmers to experiment on better exchange of ideas, experiences and knowledge among and between the groups.

Research institutions/centers mainly conduct their research activities on research testing stations/sites without much exposure to farmers-the best end users of their research output. However, to increase production and productivity as well as to conduct client oriented and demand-driven research, these conventional research and transfer-of-technology methods would need some improvement. Farmers, the potential end-users of research output, should participate through the research process as much as possible. Based on this, the Adet Agricultural Research Center established FRGs in Fogera district at *Quhar-Michael, Tihua, Kokit and Bura* Kebeles of rice producing areas. FRGs were established based on the principles of farmers' common problems, interest and willingness to work in groups.

Therefore, this study was initiated to identify the determinants of farmers' decisions to participate in FRG research approach and their effect on the gross margin earning level from rice production in Fogera district of Amhara Region, Ethiopia, in order to draw some research and policy implications.
The specific objectives of the study were:

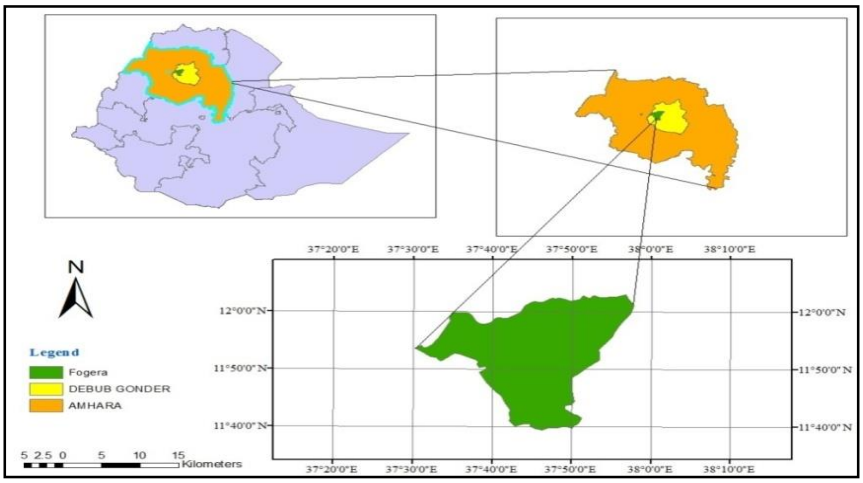
1. to identify determinants of farmers' participation in FRG approach, and
2. to measure the contribution of FRG participation on farmers' gross margin earning/ income level from rice production.

2. Research Methodology

Description of the Study Area

The study was undertaken in Fogera district of South Gondar zone, Amhara Region. The district is well known for its rice production and Fogera cattle breed. Fogera district is one of the 12 administrative districts (10 rural and 2 urban) of South Gonder zone of Amhara Regional State which is located about 625 km North of the country's capital Addis Ababa and 55 km North of the regional capital, Bahir Dar (BoARD, 2009). Average altitude of Fogera ranges from 1,750 to 2,500 meters above sea level (masl) with an average rainfall of 1284 millimeter and temperature ranging from 12°C to 27°C (Figure 1). Topographically, it is 76% plain, 13% gentle slope and 11% mountainous with 12%, 20%, 65%, and 3% red, brown, black and grey soil colors, respectively (IPMS, 2005). Land use pattern of the district includes: 51,472 hectares (ha) cultivated; 26,999 ha grazing land; 2,190 ha forest and bush; 23,354 ha water bodies; 7,075 ha settlement and infrastructure; and 1,698 ha swampy areas. Average land holding is about 1.4 ha with a minimum and maximum of 0.5 and 3.0 ha, respectively (IPMS, 2005).

Figure 1: Location of the study district, Fogera.



Source: Environmental Systems Research Institute, 2010.

Data Types and Method of Data Collection

Data was collected both from primary and secondary sources. Primary data was collected about the whole situation of agricultural production

(socioeconomic, demographic and institutional characteristics of households) from the sample farmers that are FRG members as well as non-FRG members using semi-structured questionnaires. In addition, Focus Group Discussions (FGD) with members and non-members and key informants from research centers, office of agriculture and NGOs were carried out for qualitative analysis and triangulation. Secondary data includes documents of district, zonal, regional and national office of agriculture as well as Central Statistical Authority (CSA) and books and journals from other sources.

A three stage purposive sampling plus random sampling techniques were used to select sample households. In the first stage, Fogera district was selected purposively and then four Kebeles where FRGs were found were selected purposively again in the second stage. In the third stage, 60 from FRG member farmers as well as 60 from non-member farmers were selected randomly in the same Kebele where FRGs are found which sum up to a total sample size of 120 households.

Method of Data Analysis

Cross-section data that was collected from sample farmers and key informants was analyzed by descriptive methods such as mean, standard deviation and percentage followed by econometric analysis. Furthermore test statistics such as t-test for continuous variables and chi-square (χ^2) test for dummy/discrete variables was used to supplement or testify significance of results for FRG participant and non-participant farmers. The statistical package of STATA version 11 was employed for the process of data analysis.

Econometric analysis and model specification

Heckman two step procedure of treatment effect model was used for this study to examine the factors influencing the decision to participate in FRG

research approach and its effect on the earning level of farmers' gross margin from rice, simultaneously. Many factors, which may be correlated with both participation decision of FRG research approach and its effect on the level of gross margin earning are unobservable. When this is the case, simply regressing gross margin on exogenous factors and a dummy participation indicator will result in biased parameters. Hence, it is necessary to check for self-selectivity bias in the estimation of the effect of participation decision in FRG research approach on the gross margin earning level of participant farmers (Greene, 2000; Key and McBride, 2003).

In the Heckman two step procedure of treatment effect model, two equations are estimated simultaneously through Heckman's two-step procedure (Heckman, 1979): a probit equation (selection equation) explaining the decision whether or not to participate and an equation explaining gross margin earning level (regression/outcome equation) which includes dummy participation and inverse Mill's ratio among the explanatory variables (Heckman, 1979; Key and McBride, 2003).

In the second step, the value of the inverse Mill's ratio is used as an additional explanatory variable in the gross margin equation of the selection model. This eliminates the potential sample selection bias and the result of the FRG approach/program evaluation equation can be used to make inferences about the FRG approach/program (participation) potential of FRG approach for all farmers; FRG approach participants and non-participants (Heckman, 1979).

Following Green (2000), the incidental truncation (treatment effect) model used to modeling FRG approach participation and its effect on gross margin earning level is specified as:

$$I_i^* = \gamma C_i + v_i \quad \textbf{(1)}$$

$$Yi = \beta X_i + \delta I_i + \varepsilon_i \quad \textbf{(2)}$$

Where,

I_i^* is the FRG approach participation model in the first-step (unobserved variable which has a dichotomous realization I_i that is related to it as $I_i = 1$ if $I_i^* > 0$, otherwise $I_i = 0$),

I_i is a dummy variable indicating the FRG approach participation decision (observed variable),

C_i are the independent variables determining participation in the probit model,

γ is unknown parameter to be estimated in the probit regression model,

Y_i is the value of gross margin earning level in the second-step,

X_i are the explanatory variables determining the gross margin,

β is unknown parameter to be estimated in the gross margin regression model,

δ is a parameter that shows the impact of participation on the gross margin earning level, and

v_i and ε_i are random error terms in the probit and regression (outcome) models respectively and are assumed to be correlated.

By assuming the presence of the correlation between v_i and ε_i, the equations of the gross margin earnings of the participant and non-participant farmers are formulated as follows (Greene, 2000):

$$E\left[Y_i \middle| I_i = 1\right] = \beta X_i + \delta + E\left[\varepsilon_i \middle| I_i = 1\right]$$

$$= \beta X_i + \delta + \rho\sigma_\varepsilon \lambda\left(-\gamma Z_i\right) \quad \text{(For FRG participants)} \quad \textbf{.(3)}$$

$$E\left[Y_i \middle| I_i = 0\right] = \beta X_i + \rho\sigma_\varepsilon \left[\frac{-\phi_i}{\Phi_i\left(1-\Phi_i\right)}\right] \quad \text{(For non-FRG participants)} \quad \textbf{(4)}$$

Where,

$\phi(.)$ represents the probability density function,

$\Phi(.)$ represents the cumulative distribution function,

ρ denotes the correlation coefficient between v_i and ε_i

σ denotes the value of the standard deviation of ε_i , and

the factor $\lambda(-\gamma Z_i) = \frac{-\phi(\gamma Z_i)}{1-\Phi(\gamma Z_i)}$ is defined as the Inverse Mills' ratio.

At the end, the expected difference in gross margin earning level between FRG participant and non-participant farmers is evaluated by employing the following form:

$$E[Y_i|I_i=1] - E[Y_i|I=0] = \delta + \rho\sigma_\varepsilon\left[\frac{-\phi_i}{\Phi_i(1-\Phi_i)}\right] \quad \textbf{(5)}$$

Where,

$E[Yi|Ii=1]$ is the expected gross margin earning level for FRG participant farmers, and

$E[Yi|Ii=0]$ is the expected gross margin earning level for non-FRG participant farmers.

Definition of Variables and Working Hypothesis

The study had two dependent variables: the dummy participation decision in FRGs and net gross margin earning level from rice. The dummy participation decision variable is the dependent variable that is regressed in the first stage (probit analysis) of the Heckman two stage estimation procedures and it is dichotomous in nature measuring participation of a farmer in FRG approach that takes a value of 1 if the farmer is a participant member and 0, otherwise.

The explanatory variables that are hypothesized to affect the farmers' participation decision in FRGs and level of net gross margin earning/income from rice production are combined effects of various household, socio-economic and institutional characteristics in the farming systems of farmers. Based on the past research findings and background information of the farming system of the study area, the following 16 potential

explanatory variables were hypothesized to influence the above mentioned two dependent variables. The summary of these independent variables is given in Table 1.

Table 1: Summary of variables and their measurements included in the two models

No	Variable name	Code	Type	Measurement
1	Age of the household head	AGE	C*	Age measured in years
2	Sex of the household head	SEX	D**	1 if male and 0 otherwise
3	Education status	EDU	D	1 if literate and 0 otherwise
4	Family size in adult equivalent	FAML	C	Family size converted to adult equivalent
5	Off-farm income	OFFAR	D	1 if participated and 0 otherwise
6	Land own total	AREA	C	Owned land measured in ha
7	Radio ownership	RADIO	D	1 if owned and 0 otherwise
8	Total livestock ownership	TLU	C	Total livestock excluding ox converted to TLU
9	Ox ownership	OXEN	C	Oxen numbers owned by the respondent
10	Extension service	EXTEN	C	Extension contact frequency per year
11	Access to research system	RESRCH	D	1 if has access and 0 otherwise
12	Training participation	TRAIN	D	1 if has access and 0 otherwise
13	Access to credit	CREDIT	D	1 if has access and 0 otherwise
14	Distance from the main road	DIST	C	Measured in minutes of on-foot walk
15	Leadership participations	MEMR	D	1 if has participated and 0 otherwise
16	Use of improved rice varieties	VART	D	1 if used and 0 otherwise
17	FRG-participation	FRGmem	D	1 if participant/member and 0 otherwise
18	Gross margin earning level	INCOMEnet	C	Gross margin/ha of rice land measured in Birr

Note: C=Continuous variables and D**= Dummy variables*
Source: Own computation, 2013.

3. Results and Discussion

Descriptive statistical results of the socio-demographic characteristics of respondents

The head of the household is normally responsible for the coordination of household activities. Out of 120 sample households, 95% and 5% of them were male-headed and female-headed households, respectively. The

percent of male-headed household heads were the same in FRG member and non-FRG member households. The Chi square test indicated absence of significant mean difference between FRG participants and non-participants in terms of sex of the household head (Table 2). The age of the household is considered a crucial factor, since it determines whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a younger farmer. Average age of the household heads for both participant and non-participant farmers in FRG approach was 45.48 years with a standard deviation of 12.40. The mean age for participant household heads was 45.48 years and that of non-participants was 45.47 years with a standard deviation of 10.93 and 13.80, respectively, and there was no significant statistical mean difference between them with respect to this variable (Table 2).

Education helps farm households to acquire and interpret information on agricultural technologies and rationally allocate existing farm resources to achieve their household farming objectives and goals. Out of the total 120 sample household heads, 45.8% and 54.2% were illiterate and literate, respectively. And 28.3% and 71.7% FRG participant respondents were illiterate and literate respectively, while 63.3% and 36.7% of non-FRG participants were illiterate and literate in that order (Table 2). The Chi-square test showed that there was a high significant mean difference in educational status between the FRG participant and non participant farmers at 1% level of significance. The average family size of all sample respondents was 6.57 persons with a standard deviation of 1.869. The average family size of participants and non-participant farmers was 6.92 and 6.22 in number, respectively. The corresponding standard deviations were 1.670 and 2.001. The mean comparison of family size between the two groups indicated a statistically significant mean difference in the mean family size at 5 percent probability level between participants and non participants (Table 2). The mean adult equivalent family size of respondents

was 5.35 and there was a statistical mean difference between the two groups.

Table 2: Household characteristics of sample respondents

Variables/Factors	Participants		Non-participants		χ^2	Total sample	
	N	%	N	%		N	%
Dummy variables							
Sex:							
- Male	57	95	57	95	0.000	114	95
- Female	3	5	3	5		6	5
Education							
- Illiterate	17	28.3	38	63.3	14.80***	55	45.8
- Literate	43	71.7	22	36.7		65	54.2
Continuous variables	**Mean**	**St.dev**	**Mean**	**St.dev**	**t-value**	**Mean**	**St.dev**
Age (in years)	45.48	10.93	45.47	13.80	0.007	45.48	12.40
Family size (no)	6.92	1.670	6.22	2.001	2.080**	6.57	1.869
Family size (AE)	5.63	1.39	5.08	1.62	1.970**	5.35	1.53

*** and ** show values statistically significant at 1% and 5% probability levels, respectively. AE=Adult Equivalent.

Source: Own survey result, 2013.

The total owned cultivated land size of sample respondents varied from 0.00 to 3.00 hectares with an average holding of 1.23 hectares with a standard deviation of 0.64. The average total cultivated land (including lease-in) was found to be 1.62 hectares for all respondents with a standard deviation of 0.67 and it was 1.77 and 1.47 hectares with a standard deviation of 0.67 and 0.63 for participant and non participant farmers, respectively. The average size of own land for FRG participant and non FRG participant farmers was 1.35 and 1.11 with a standard deviation of 0.61 and 0.65, respectively. There was a statistically significant mean difference between participant and non participant farmers in own land size. On average, total land allocated for rice production (owned plus rented-in) during the survey year was 0.95 hectare with a standard deviation of 0.585 (Table 4).

The use of good quality seed of adapted and improved varieties is widely recognized as fundamental to ensure increased crop production and productivity. Among the total respondents, 38.3% and 25% of FRG participant and non-participant farmers, respectively, use improved rice varieties. The mean area allocated for improved rice varieties by respondent farmers was found to be 0.281 hectare with a standard deviation of 0.184. The mean area allocated for improved rice varieties was 0.304 hectare and 0.245 hectare for FRG participant and non FRG participant farmers, respectively, with a standard deviation of 0.211 and 0.126 in that order and mean difference was found statistically insignificant (Table 3).

Livestock production is an integral part of the farming system in the study area that contributes a lot for rice production. Livestock are a source of draught power, food, and cash, animal dung for organic fertilizer and fuel and means of transport. They also serve as a measure of wealth in rural areas. Important animals kept by the sample households are cattle, equine (donkey, horse and mule) small ruminants (sheep and goats), poultry and beehives. For standardization and understanding purpose, livestock number was converted to tropical livestock unit (TLU) (Storck et al., 1991). The overall average TLU of the households was 5.395 TLU units with a standard deviation of 2.485. The mean TLU possession of the FRG participant farmers was 5.90 units with a standard deviation of 2.361 and that of the non-FRG participant farmers was 4.89 with standard deviation of 2.522; and there was a statistically significant difference between the participant and non-participant farm households in livestock holdings at 5% significance level (Table 3). Oxen are the main source of farm power for plowing, short haulage and threshing. The number of oxen owned by the respondents ranged from 0.00 to 4 with a mean holding of 1.95 oxen and a standard deviation of 0.829. The average number of oxen owned by FRG participant farmers was 2.18 with standard deviation of 0.813, whereas for non-

participants, it was 1.72 with a standard deviation of 0.783. The mean difference in oxen holding was found to be statistically significant at less than 1% depicting the positive influence of number of oxen on FRG participation decision and its income effect (Table 4).

Although agricultural production activities (crops and livestock integrated farming) are the main source of livelihoods of farmers, some farmers do participate in off-farm activities to supplement their income sources. Off-farm activities include weaving, petty trade, carpentry, casual labor, remittances, etc. Out of the total 120 sample households, 25% of them participated in off-farm activities and got an annual average income of Birr 4,848.6 with a standard deviation of 3814.4. About 20% of FRG participant and 21.7% non-FRG participant farmers participated in off-farm activities and got an average annual income of 5,214.5 and 4482.8 Birr/annum, respectively, (Table 3).

Table 7: Farm characteristics of sample respondents

Variables/Factors	Participants		Non-participants		χ^2	Total sample	
Dummy variables	**N**	**%**	**N**	**%**		**N**	**%**
Improved rice variety:							
- Use	23	38.3	15	25		38	31.7
- Do not use	37	61.7	45	75	2.47	82	68.3
Off-farm income:							
-Participate	12	20	13	21.7		25	20.8
-Do not participate	48	80	47	78.3	0.051	95	79.2
Continuous variables	**Mean**	**St.dev**	**Mean**	**St.dev**	**t-value**	**Mean**	**St.dev**
Area allocated for improved rice varieties (ha)	0.304	0.211	0.245	0.126	0.898	0.281	0.184
Total Livestock Unit	5.90	2.361	4.89	2.522	2.259**	5.395	2.485
Income from off-farm (Birr/annum)	5214.5	4428.5	4482.8	3226.4	0.481	4848.6	3814.4

*** show values statistically significant at 5% probability level.*

Source: Own survey result, 2013.

Table 4: Farm characteristics of sampled households (land holding and oxen number)

Variables/Factors	Participants		Non-participants		t-value	Total sample	
	Min (Max)	Mean (St.dv)	Min (Max)	Mean (St.dv)		Min (Max)	Mean (St.dv)
Total land owned (ha)	0.5 (3.00)	1.35 (0.61)	0.00 (3.00)	1.11 (0.65)	2.068**	0.00 (3.00)	1.23 (0.64)
Total land cultivated (ha)	0.75 (3.75)	1.77 (0.67)	0.38 (3.00)	1.47 (0.63)	2.522***	0.38 (3.75)	1.62 (0.67)
Area for rice total (ha)	0.125 (2.00)	0.954 (0.434)	0.125 (3.00)	0.951 (0.71)	0.029	0.125 (3.00)	0.95 (0.585)
Oxen number	0.00 (4)	2.18 (0.813)	0.00 (4)	1.72 (0.783)	3.203***	0.00 (4)	1.95 (8.29)

*** and ** show values statistically significant at 1% and 5% probability levels respectively. Note: Min=Minimum, Max=Maximum, St.dv=Standard deviation.

Source: Own survey result, 2013.

It was assumed that respondents who owned radios can get more information about new agricultural technologies, marketing and other related issues. Among the sampled households, 64% owned radios. The statistical result showed that 75% of FRG participants and 31.7% of non-FRG participants owned radios that helped them to get market information about their agricultural produce and inputs (Table 5). There was significant statistical mean difference among participant and non-participant farmers at less than 1% probability level in radio ownership.

Credit enhances farmers' financial capacity and plays an important role in increasing agricultural production and productivity of farmers. The survey result indicated that about 65% of the sampled farmers had access to credit and 17.5% of them took credit in 2012 (Table 5). Average credit received by farmers was 3184.2 Birr with a standard deviation of 1930.8 in 2012 cropping season (Table 6).

The problems of farmers to take credit includes fear of interest rate and defaulting (making groupings as means of collateral to take credit). Out of the total sampled farmers, 83.3% FRG participants and 25% non-FRG participants had access to credit. About 3.33% of FRG participants and 6.675% of non-FRG participants took credit in 2012 (Table 5). There was a significant difference in access to credit between these two groups of farmers while credit utilization was statistically insignificant (Tables 5 and 6). Concerning the credit sources, out of the total samples that took credit, 90.5% and 9.5 of them get it from the Amhara Credit and Saving Institute (ACSI) and farmers' cooperatives, respectively. The respective farmers' service cooperatives in each Kebeles were the main sources of credit for improved seed and inorganic fertilizer to the farmers. From a sample of total credit users, 61.9 % of them used the credit to purchase animals mostly for plowing and sometimes for fattening. The remaining 38.1% used credit for house construction and/or to purchase inputs and motor pumps for irrigation purpose (Table 5).

Training enhances farmers' local indigenous knowledge and is believed to improve their methods of agricultural production. According to the sample households, different training courses were give by governmental and non-governmental organizations on agricultural issues like crop cultivation (input application and weeding, harvesting and storage), marketing, consumption and post harvest handling. Among the total sample households, 55.8% of them received training 1.46 times on average per year for the last three years with a standard deviation of 0.633 (Tables 5 and 6). About 98.3% of FRG participant and 13.3 % of non-FRG participant farmers were trained. There was a statistical mean difference on training received between these two groups of farmers (Table 5).

In the study area, agriculture experts of the district office and most importantly, Development Agents (DAs) are the main sources for agricultural extension services for farmers. Contact with extension agents may not be an issue these days, rather frequency of contacts and quality of service obtained matters most. All sample households got extension services/contacts with an average of 11.8 times per year. And it was 13.567 and 10.033 times per year for FRG participant and non-participant farmers, respectively. There was a statistically significant mean difference between the FRG participant and non-participant sample households in terms of extension contact (Table 6). Access to the research system is believed to widen farmers' attitude of adopting new agricultural technologies like improved varieties and agronomic practices. The research system is also the best source for agricultural knowledge (production packages and leaflets) and initial seeds of improved varieties. Among the sample households, 68.3% of them had research access for the last three years before FRG establishment through demonstration plots, field days, training and experience sharing activities (Table 5). About 80% and 56.7 % of FRG participant and non-participant farmers had research access, respectively, even before the establishment of FRG. Hence, there was statistically a

significant mean difference between the FRG participant and non-participant sample households in terms of research access.

There are formal and informal institutions (grouping activities) in the study area. Informal institutions are mostly related to religious and pick-season group work activities like *Mahiber, Idir, Ekub* and *Debo/Wonfel* while formal institutions include farmers' cooperatives, youth and /or women associations, water use associations and the like. About 18.33% of farmers had responsibility/leadership positions in the formal associations (36.67% of FRG participants and none of non-participant farmers). The Chi-square test showed that there is a high statistical mean difference among FRG participant and non-participant farmers in participation and responsibility in associations (Table 5).

Table 5: Institutional characteristics of sample respondents (Dummy variables)

Variables/Factors	Participants		Non-participants		χ^2	Total sample	
	N	%	N	%		N	%
Radio ownership:							
- Yes	45	75	19	31.7		64	53.3
- No	15	25	41	68.3	22.63***	56	46.7
Credit access:							
- Yes	50	83.3	15	25		65	54.2
- No	10	16.7	45	75	41.12***	55	45.8
Credit obtained 2012:							
- Yes	2	3.33	4	6.67		21	17.5
- No	58	96.67	56	93.33	0.702	99	82.5
Credit utilization:							
-Input purchase	2	16.7	1	11.2		3	14.3
-Consumption	1	8.3	4	44.4		5	23.8
-Ox buying	9	75	4	44.4	4.928	13	61.9
Credit sources:							

-ACSI	10	83.3	9	100		19	90.5
-Cooperatives	2	16.7	0	0	1.658	2	9.5
Training received:							
- Yes	59	98.3	8	13.3	87.89***	67	55.8
- No	1	1.7	52	86.7		53	44.2
Research access:							
- Yes	48	80	34	56.7	22.19***	82	68.3
- No	12	20	26	43.3		38	31.7
Responsibility in associations:							
- Yes	22	36.67	0	0		22	18.33
- No	38	63.33	60	100	26.94***	98	81.67

*** show values statistically significant at 1% probability levels.

Source: Own survey result, 2013.

Table 6: Institutional characteristics of sample respondents

Variables/Factors	**Participants**		**Non-participants**			**Total sample**	
Continuous variables	**Mean**	**St.dev**	**Mean**	**St.dev**	**t-value**	**Mean**	**St.dev**
Trainings (no /year)	1.54	0.625	0.89	0.333	3.06***	1.46	0.633
Credit amount (Birr in 2012)	3909.1	2211.5	2187.5	798.10	2.09**	3184.2	1930.8
Extension services (no of times per year)	13.567	5.100	10.033	4.202	3.74***	11.8	5.452

*** and ** show values statistically significant at 1% and 5% probability levels respectively.

Source: Own survey result, 2013.

4. Econometric Model Analysis Results

Determinants of FRG participation decisions

The Heckman two stage procedure of treatment effect model in the first stage predicts the probability of participating in the FRG research approach of each household and in the second stage, it analyses the determinants of

household gross margin earnings/income from rice. Potential explanatory variables that were expected to influence the decision to participate in the FRG research approach were estimated using the maximum likelihood method. A total of 13 potential predicted variables (6 continuous and 7 dummy) were selected and entered into the probit model, out of which 7 variables were found significantly influencing the decision to participate in joining FRG research approach.

The results of the maximum likelihood estimation of the probit model are presented in Table 7. As it is indicated, age (AGE), sex (SEX), education (EDU), access to research (RESRCH), training (TRAIN) and access to credit (CREDIT) were positively and significantly related to the probability of participation in FRG approach while family size in adult equivalent (FAML) was negatively and significantly related to the probability of FRG participation. The probit model was highly significant with a χ^2-value of 146.65 and correctly predicted 71.2% of the observed outcomes.

Age of the respondents had a positive and significant influence on the decision of farmers to participate in FRG research approach at less than 5% probability level. This is due to the fact that older farmers may accumulate more knowledge than younger ones that may help them make productive decisions in their farming activities. It was found that as farmers' age increased by one year, the probability of participating in FRG approach increases by 0.84%, keeping other variables constant. Sex of the household head was positively and significantly associated with the probability of farmers to participate in FRG research approach at less than 1% probability level. This means that when the head of the household is male, the probability of farm households to participate in FRG approach would increase. The reason may be that male-headed households have more access to opportunities than female-headed household heads and would have greater probability of participation in FRGs membership and benefited in FRG research activities. There is a need to make female headed

households participate in and benefit from the FRG approach. When the household head is male the probability of participation in FRG approach increases by 66%, holding other variables constant.

As hypothesized, the educational status of the respondents was positively and significantly influenced the participation decision in FRG research approach at less than 5% probability level. The reason is that exposure to education would increase a farmer's ability to obtain, process, and use information relevant to his farming activities. In this case, keeping other variables constant, as a farmer got educated, the probability of deciding and participating in the FRG research approach will increase by 45%. Abdulmalik *et al.,* (2013) on determining factors influencing crop farmers' participation in agricultural insurance scheme; Kidanemariam *et al.* (2012) on examining the determinants of farm households' agricultural extension program participation decision and its effect on income level as well as income diversification situations in northern part of Tigray region, Ethiopia; and Tiwari *et al.* (2008) on determining factors affecting farmers' adoption of improved soil conservation technology in a Middle Mountain watershed of Central Nepal found also similar results. As hypothesized, access to research has a positive and significant effect on the participation of farmers in the FRG research approach at less than 5% probability level. This implies that farmers' access to research institutions in on-farm field experimentations, demonstrations, field days and trainings increases their awareness about new agricultural technologies thus increasing the probability of joining the FRG research approach. The result of marginal effect of the probit model showed that, as a farmer has access to the research system, the probability of participating in the FRG approach will increase by 56.6%, ceteris paribus. This result is consistent with Yusuf *et al.* (2013).

Access to training has been found to relate to the probability of participating in the FRG research approach positively and significantly at

less than 1% probability level. This implies that, as farmers have access to trainings, their probability of participating in FRG research approach will also increase. The marginal effect of the probit model showed that, as a farmer has access to training, his probability of participation in the FRG approach increases by 90.9%, keeping other variables constant. From this, we can conclude that training of farmers on different agricultural issues make them aware of improved agricultural technologies and can help them join FRG approach to get closer to sources of those improved technologies. A similar result was obtained by Barnabas *et al.* (2012). The result of the probit model showed that farmers' access to credit sources has been found to be positively and significantly related to the probability of the participation of farmers to be an FRG member at 1% probability level. This implies that, as farmers have more access to credit, the probability of being an FRG participant will also increase. Credit is important for farmers and it enhances their capacity to buy the necessary agricultural inputs like seeds, fertilizer and chemicals that are required by improved agricultural technologies to be adopted by farmers. The result showed that, as a farmer has access to credit, the probability of participating in FRG approach will increase by about 64%, holding other variables constant. Yusuf *et al.* (2013) and Abdulmalik *et al.* (2013) also found similar results.

Contrary to the hypothesized effect, family size in adult equivalent was found negatively significant at less than 5% probability level in influencing the probability of farmers' participation in FRG approach. This means that, as the size of the adult equivalent of family size of the household increases, the probability of participating in FRG approach decreases. One reason for non-participation may be that households with larger family size may have off farm employment and sufficient off farm income to secure the family's food need and may ignore participating in FRG approach. Another reason could be that households with larger family size may be conservative in taking risk by participating in grouping activities like the FRG approach and they may try to avoid risk by not participating in new activities in their

localities. The marginal effect of the probit model indicated that when the family size increased by one adult equivalent, the probability of participating in FRG approach decreased by 18%, holding other variables constant. This result was contrary to the finding of Kidanemariam *et al.* (2012) and Akobundu *et al.* (2004).

Table 8: Maximum likelihood estimates of Probit model

Variables	Coefficients	Robust std. errors	z-values	Marginal effect
DIST	-0.0439	0.0269	-1.63 (0.102)	-0.0164
AGE	0.0274	0.0136	2.01** (0.044)	0.0084
SEX	4.1669	1.0277	4.05*** (0.000)	0.6627
EDU	1.0009	0.4736	2.11** (0.035)	0.4502
FAML	-0.4741	0.2113	-2.24** (0.025)	-0.1810
OFFAR	0.5674	0.6831	0.83 (0.406)	0.1915
AREA	-0.8380	0.5707	-1.47 (0.142)	-0.2168
RADIO	0.3706	0.3932	0.94 (0.346)	0.1879
TLU	0.1690	0.1376	1.23 (0.219)	0.0553
EXTEN	-0.0264	0.0552	0.48 (0.631)	-0.004
RESRCH	1.9630	0.8088	2.43** (0.015)	0.5656
TRAIN	3.6856	0.8239	4.47*** (0.000)	0.9090
CREDIT	2.0459	0.5985	3.42*** (0.001)	0.6406

Number of observations 120

Log-likelihood function -17.607614 Restricted log likelihood = -1246.577

Chi-squared 146.65 Significance level 0.0000

Predicted Success 71.2%

Numbers in parenthesis are p-values.

*** and ** show the values statistically significant at 1%and 5% respectively.

Source: own survey result, 2013.

Determinants of gross margin earnings in participating in FRG approach

Nine potential explanatory variables that were expected to influence level of farmers' gross margin earnings from rice in participation in FRG approach were estimated by using the selection model (in the second step of treatment effect model). Moreover, dummy participation was included to see the FRG approach participation impact of farmers by estimating its coefficient.

As it can be seen from Table 8, family size in adult equivalent (FAML), access to research (RESRCH) and dummy participation in FRG approach (FRGmem) had positive significant relations with gross margin earnings from rice while

use of improved rice variety (VART) has negative significant relations with gross margin. The F-test value 9.25 for the selection model was highly significant and the R^2 was 60.5%. This shows that jointly the independent variables included in the selection model regression explain the level of participation.

Family size in adult equivalent influenced significantly and positively the farmers' gross margin earning level at less than 10% probability level. This implied that as the number of family size in adult equivalent increased, the gross margin earning level of farmers will also increase. Farm households who have large family size in adult equivalent have more chances to cultivate (weeding, harvesting and storage) their rice farms than those who have smaller family so that their production and productivity of rice would increase and thereby increasing the earning level of their gross margin. The marginal effect result of the selection model showed that, as family size in adult equivalent increased by one unit, the gross margin earning level of farmers from rice increased by Birr 537.83, holding other variables constant.

Access to a research system has a positive relationship with the gross margin earning level of respondent farm households at less than 10% probability level. The positive relationship could indicate that those households who participated in training, on-farm demonstrations, field days and experience sharing activities are expected to be aware of the advantage of improved agricultural technologies and are willing to adopt new technologies and produce more, thereby improving their income from rice production. Moreover, farmers who have access to a research system have the chance to get better knowledge and initial basic seeds of improved varieties. Holding other variables constant, a farmer having access to the research system, his gross margin earning level from rice will increase by Birr 2439.35 per hectare on the average.

Use of improved rice variety influenced the farmers' gross margin earning level negatively and significantly at less than 10% probability level. This means that as farmers use improved rice variety, their gross margin earning level from rice will decrease. This is due to the fact that, improved rice variety (*Nerica-4*) found in the hands of the farmers is not better than their well known local variety (*X-Jigna)* in terms of yield especially in the lowland rice ecosystems of rice farms at Fogera. Hence, rice yield may be low for farmers who grew *Nerica-4* than *X-Jigna*. Moreover, most farmers except in the low land rice ecosystem grew the local variety and only those who live in the upland grew the improved one. The improved rice variety, *Nerica-4* gives better yields in the upland rice ecosystem where there is less water and it can compete with other crops there like finger millet and Tef rather than with *X-Jigna* rice local variety. The marginal result of the selection model showed that, as a farmer uses improved rice varieties, gross margin earning level from rice will be decreased by Birr 2445.90 per hectare on the average, ceteris paribus.

The dummy participation (FRGmem) variable was an explanatory variable in the second-step of the Heckman two-step estimation (treatment effect model) employed for this study. Its coefficient is positive and significant at less than 5% probability level of significance that indicated the profitability of participating in FRG research approach/program. This shows that, on average, by participating in FRG approach, the FRG participant farmer has got an increment of gross margin earnings of Birr 5772.065 more than the non-participant from one hectare of rice land, ceteris paribus. This was also confirmed in gross margin analysis part of the study. Therefore, it can be concluded that the FRG research approach being implemented by a research institution at Fogera district is profitable. Kidanemariam *et al.* (2012) found that, extension participation, positively and significantly influenced total income and income diversification of participant farmers; and participant households were found to earn 14.7% more compared to non-participant households. Barnabas *et al.* (2012), participatory variety

selection (PVS) positively and significantly influenced the likelihood of adoption of improved sweet potato varieties in central Uganda and farmers who participated in variety selection processes were 6.7 times more likely to adopt the improved sweet potato varieties than those who had not. Moreover, Abonesh, (2006) on farmers' participation in irrigation; Getaneh, (2006) on bread wheat contract farming participation; and Kidanemariam *et al.* (2012) on agricultural extension program participation decision and its effect on income level have obtained similar results.

Lambda for the level of gross margin earning level was significant at 10 percent probability level, implying that selection bias would have resulted if the level of gross margin earning had been estimated without taking into account the decision to participate. Similar results were obtained by Berhanu *et al.* (2011) and Astewel, (2010).

Table 8: Estimates of selection (treatment effect) model for gross margin

Variables	Coefficients	Robust std. errors	z-values	Marginal effect
EDU	2014.627	1247.667	1.61 (0.106)	2014.627
FAML	537.827	279.823	1.92* (0.055)	537.827
AREA	-1147.718	1295.00	-0.89 (0.375)	-1147.718
RADIO	-229.497	1369.02	-0.17 (0.867)	-229.497
OXEN	-226.035	1169.587	-0.19 (0.847)	-226.035
TLU	255.134	463.118	0.55 (0.582)	255.134
RESRCH	2439.352	1429.988	1.71* (0.088)	2439.352
VART	-2445.914	1395.084	-1.75* (0.080)	-2445.914
MEMR	-546.854	2352.635	-0.23 (0.816)	-546.854
FRGmem	5772.065	2313.998	2.49** (0.013)	5772.065
Lambda	-3781.168	2246.947	1.68*	-3781.168

R-squared = 0.6049 F-value = 9.25 Probability value = 0.0000
Log-L = -17.607614 Log pseudolikelihood = -1246.577
Rho = 3.09 prob value=0.0788
Numbers in parenthesis are p-values.
** and * show the values statistically significant at 5% and 10% respectively.
Source: Model outputs of own survey result, 2013.

Gross Margin earning/income from rice production

Based on data collected during the interview of farmers about overall rice production (land preparation to harvesting and storage) and current market price of inputs and outputs, it was tried to estimate the cost and return per hectare of rice for FRG participant and non-FRG participant farmers. The mean paddy rice yield per hectare of land was found to be 41.9 quintals, (29.33 quintal per hectare of milled rice). The productivity of paddy rice for FRG participant and non-FRG participant farmers was 48.44 quintal and 35.35 quintals per hectare, respectively.

Rice producers generate income from sales of rice grain yield (either in paddy or milled rice form, but mostly milled one) and rice straw (by-product). Therefore, as it is shown in Table 9, the FRG participant and non-FRG participant farmers obtained a gross income of Birr 40,435.52 and 30,808.33, respectively, from one hectare of rice land and there is a high statistical mean difference between these two groups (with t-value of 6.706). To produce this gross income, the two groups of farmers on average invested a variable cost of Birr 30,177.61 and 25,929.39, respectively. After deducting these variable costs of production on the level of total gross income, the average gross margin of FRG participant and non-FRG participant ones became Birr 10,257.91 and 4,878.94, respectively, with a high statistical mean difference between these two groups of farmers. This result indicates that, keeping other things constant, due to productivity difference between these two groups, a farmer could generate an additional gross margin of Birr 5,378.97 per hectare of rice when participating in FRG approach than a non-FRG participant. This indicates that the profitability of farmers' participation in FRG research approach. There was a statistical mean difference at less than 1% probability level among FRG participants and non-participants in total gross income, total variable costs and gross margin earning from rice (Table 9).

Table 9: Benefit and cost analysis (gross margin) of respondents from 1ha rice production

Items	Participants (1)	Non-participants (2)	Difference (1-2)	t-value
Gross income (Birr/ha):				
-Rice grain value (Birr/ha)	35942.19	26231.66	9710.53	7.169***
-Rice straw value (Birr/ha)	4493.33	4576.67	-83.34	-0.342
Total gross income	40435.52	30808.33	9627.19	6.706***
Variable costs (Birr/ha)				
- Seed	2326.67	2261.67	65.00	0.342
- Fertilizer	1674.80	1293.91	380.89	2.258
- Chemical (Herbicide +Pesticide)	232.60	171.84	60.76	2.720***
- Human labor@	11324.17	10062.33	1261.84	2.349***
- Animal power	2670.967	2394.37	276.60	3.210***
- Land rental cost	12475.66	10468.04	2007.62	2.614***
Total variable costs	30177.61	25929.39	4248.22	3.914***
Gross margin (Birr/ha)	**10257.91**	**4878.94**	**5378.97**	**4.191*** **

***, ** and * show values statistically significant at 1%, 5% and 10% probability levels respectively.

@ All own and hired labor valued at local wage rate in Birr prevailing at farmers' village.

Source: Own survey result, 2013

5. Conclusion and Recommendations

Results from descriptive statistics showed that the FRG participant/member and non-participant households differed significantly from each other in educational status, family size in adult equivalent, land, livestock, radio ownership, credit, training, extension and research service accesses.

In the first stage of the probit estimation of the treatment effect model, age, sex, education, access to research, access to training and access to credit were positively and significantly related to the probability of participation in FRG approach while family size in adult equivalent was negatively and significantly related to the probability of FRG approach participation. The second stage estimation results of the treatment effect

model showed that family size in adult equivalent, access to research and dummy participation in FRG approach had positive and significant relations to gross margin earnings from rice while use of improved rice variety has negative and significant relation with gross margin earning.

In conclusion, the comparison between FRG participants/members and non-participants showed that participant households are better than non-participants/members in the gross margin earning/income obtained from rice production that indicates farmers participation (membership) in FRG research approach is found to be profitable both in descriptive and econometric analysis results. Therefore, implementing FRG research approach by improving the associated problems could lead to the increment of rice production and productivity that would in turn enhance income of farmers. Moreover, it would fasten improved agricultural technology evaluation and dissemination activities through farmers by minimizing efforts and money that has great implication on the lengthy and less client-oriented/demand-driven conventional research system/approach.

Therefore, introduction, adaptation/evaluation and dissemination of improved rice varieties, agronomic practices (fertilizer application, seed rates, weed management and post harvest techniques); promoting and facilitating access to credit, research, training and education services; designing a good rice seed system at farmers' level through "community-based-seed production and dissemination approach" and facilitating farmer to farmer seed exchange mechanism; and strengthening and implementing the FRG research approach are some of the recommendations suggested for future research, policy and development interventions.

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COMPARATIVE ADVANTAGE STUDY OF MAJOR CROPS: A CASE STUDY IN TRITICALE GROWING AREAS OF FARTA AND LAI-GAINT DISTRICTS OF AMHARA REGION

Yazie Chanie[1]

Abstract

The comparative advantage study of major crops in triticale growing areas of Farta and Lai-gaint districts in Amhara Region was undertaken in 2009/10 - 2010/11. The objective was to examine the major reasons behind the expansion of triticale production in wheat and barley growing areas by assessing the financial profitability and identifying major determinants of crop enterprise choice. The total number of sample farmers in the two districts was 78. Data was collected from both primary and secondary sources. In drought prone areas of the study districts, farmers manage a diverse and risk prone agriculture to reduce risk and maintain food self-sufficiency. Mean areas allocated for major crops grown, i.e. triticale, wheat, barley and potato were 0.46; 0.22; 0.27, and 0.32 hectares of land, respectively. The corresponding productivity of the crops was 31.04; 18.76; 22.08 and 65.48 qt ha^{-1}. Triticale (Triticosecale Wittmack) is adaptable to cold, drought, and acidic soil conditions and its production is being expanded due to its tolerance to hail damage, disease, moisture stress and frost. Moreover, it has better yield; weed suppressing ability; suitability for consumption; giving yield on degraded land and minimum fertilizer requirement. Farmers gain a net profit of 5,851.92, 3,728.60, and 3,031.86, Birr per ha of triticale, wheat and barley respectively. Hence, the main reason for farmers to shift from barely/ wheat based production system to triticale is the crop's tolerance to harsh environmental conditions, and financial profitability.

[1] Adet Agricultural Research Center, P.O. Box 08, Bahir Dar, Ethiopia.
Email- yaziechanie@yahoo.com.

1. Introduction

Farmers in developing countries have evolved complex farming systems and select species and varieties that fit their bio-physical and socio-economic environment through experiences as well as by trial and error approach. Farmers in a given cropping system tend to manage different crop enterprise, despite their observed differential short-term performance from the point of view of farm operation and resource allocation (profitability) (Regassa and Asmare, 1995). These strategies of growing a range of crops are explained as typical risk spreading methods and sustain a family's self-sufficiency.

Decisions of crop choice are influenced by uncertain variables like rainfall, diseases and pest incidence, price, yield, etc. Obtaining the largest net returns is frequently identified as the primary goals of most farmers' enterprise choice. On the other hand, non-profitability factors such as contribution to food consumption, compatibility of the enterprise to the farming system, ensuring food security, flexibility in management, and being complementary to livestock production are important in choosing an enterprise.

In drought prone areas, where there is a complex, diverse, and risk prone agriculture, farmers try to manage their activities according to the situation. Thus, risk reduction and the desire to maintain a viable enterprise are important goals of most farmers.

Triticale (Triticosecale Wittmack) was introduced to the Amhara Region by the German Technical Cooperation (GTZ) of Integrated Food Security Project- South Gonder (IFSP-SG) in the late nineties (Salilew, 2006). The most important advantages of triticale compared to wheat are: increased yield, low input requirements, good nutritional value (triticale grain has better amino acid balance than wheat, especially a high lysine content,

which limits amino acid in cereal grains) and has multiple end uses (*University of Stellenbosch 2002).*

Even though triticale is distributed and disseminated in the marginal highland areas of Amhara Region, it is spreading to high potential areas. Currently, it is replacing the wheat and barley growing areas in high potential areas of South Gonder Zone. Hence, this proposal was initiated to examine the major reasons behind the expansion of triticale production in wheat and barley growing areas of Amhara Region by assessing the financial profitability of different crops and identifying major determinants of crop enterprise choice.

Triticale production, research, and development in Amhara Region

Triticale *(Triticosecale Wittmack*) is a man made crop resulting from a cross between wheat (Triticum aestivum) and rye (Secale cereale). It possesses the yield potential of wheat and hardness of rye and adapted to cold, drought, and acidic soil conditions. The first commercial cultivars were released in 1968. Mexican (CIMMYT) cultivars of this crop were first introduced and tested in Ethiopia in 1973, but discarded due to the formation of shriveled kernels. In 1998, improved triticale cultivars and lines from the University of Stellenbosch in South Africa were tested in Ethiopia specifically in Amhara National Regional State by GTZ/IFSP, South Gonder. Yield and adaptability trials were conducted in South Gonder in collaboration with Adet Agricultural Research Center and two triticale cultivars, Maynet (long season) and Sinan (short season), were released in 2002. Triticale has now been successfully cultivated in Amhara region (South Gonder, North Gonder, Wollo, Gojam, Shoa, Sekota), Tigray (Mekelle, Mlazat), Oromia (Shoa, Illubabor, Bale), Southern National Regional State (Konso) (GTZ/SUN, 2006).

2. Methodology

Sampling techniques, data sources and analysis

Two major triticale growing districts (*Woredas*) i.e. Farta and Lai-gaint from South Gonder Administrative Zone were selected purposively in 2009/10 to 2010/11. And then, a two stage sampling procedure was used to select farmers for the study. In the first stage, three Kebeles were selected using a simple random sampling procedure from each district. A total of 78 household head farmers were randomly selected from both districts in each Kebele and interviewed using a structured questionnaire.

Data was collected from both primary and secondary sources. Secondary sources include published and unpublished information about production of major crops, farming systems, and other socio-economic information. Primary data was collected from sample farmers using a structured questionnaire. All sets of data were analyzed by Statistical Package for Social Sciences (SPSS) software and cost-benefit analysis was done. In the analysis of profit, private profitability was considered by calculating all costs incurred and returns earned by farmers. Returns are expressed in Birr per ha and labor is valued at the local wage rate.

3. Description of the study areas

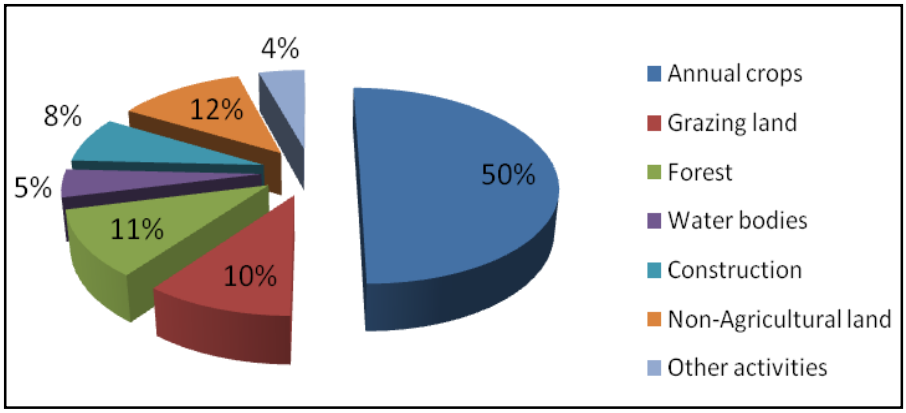
The study was undertaken in Farta and Lai-gaint districts of South Gonder Zone, Amhara Region.

Farta District

Farta district has a total land area of 112,788 ha of which 56,485.01ha are used for annual crops, 11,511ha for grazing land, 12,304ha for forest, 8,521ha for construction, 13,813ha are non-agricultural land, 5,154ha are water bodies, and 4,999.99ha are used for other activities. Geographical features of the district are 29% level, 26% rugged, and 45% mountain while

56% and 44% are agro-ecologically mid-altitude and high altitude respectively. The total population (2008) of the district is estimated to be 256,515. Major soils of the woreda are 20% black, 30% red, and 50% brown. The district has an annual rainfall of 1250-1599mm and temperature of 9 to 25°c while its altitude ranges between 1920 and 4235masl. Major crops grown are barley, wheat, potato, triticale, faba bean, field pea, etc. (Annual report of Farta District Office of Agriculture, 2009).

Figure 1: Land use in Farta district, South Gonder zone, Ethiopia in 2009/2010.

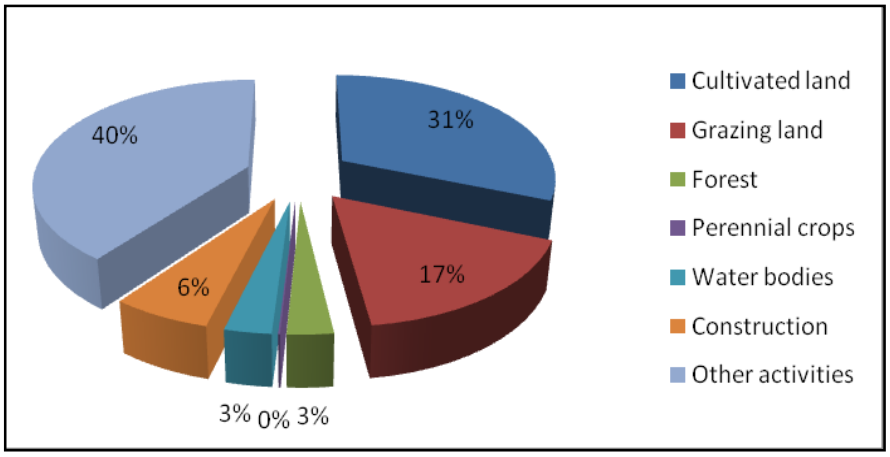


Lai-gaint District

Total land size of the district is estimated to be 132,031hectares (ha), out of which, 41,200 ha are cultivated, 22,160ha are used for grazing land, 3,800ha are covered with forest, 165ha are used for perennial crops, 3,868ha are water bodies, 8,201ha are used for construction and 52,637ha for others purposes. Agro-ecology of the district is 23.56% low land, 39.7% mid altitude and 36.74% high land while geographic features are 10% level (plateau), 75% rugged and 15% mountain. The district has 33 Kebeles, out of which 21 are triticale growers. The total population (2008) of the district is estimated to be 243,344. Soil type of the district includes 30% black, 16% red, 48% brown and 6% others, with a fertility status of 10% fertile, 35%

moderate, and 55% non fertile. Annual rainfall is 600-1250mm while temperature ranges from 4 to 24°c. Major crops grown are Tef, wheat, barley, finger millet, potato, triticale, oats, maize, sorghum, faba bean, chickpea, noug, etc (Annual report of Lai-gaint District Office of Agriculture, 2009).

Figure 2: Land use in Lai-gaint district, South Gonder zone, Ethiopia in 2009/2010.



4. Results and Discussion

Demographic and socio-economic characteristics of the study districts

Demographic characteristics

The average age of the respondent households was found to be 44.72 years with farming experience of 23.27 years for both districts. The minimum age of respondents was 25 years and maximum was 77 years for both districts of the study areas (Table 1). The average total family size of the two districts was found to be 6.5 with a standard deviation of 2.081. The number of children, active labor force and dependents is about 37.6%, 60.9% and 1.5%, respectively, in a family. The details are presented in Table 1 below.

Table 1: Family size and structure of the study areas (N=78)

Description	Farta (N=39)		Lai-gaint (N=39)		%	Total (N=78)	
	Min (Max)	Mean (Std. Dev)	Min (Max)	Mean (Std. Dev)		Min (Max)	Mean (Std. Dev)
Age of household	25 (77)	45.5 (12.1)	27 (65)	43.95 (11.0)	-	25 (77)	44.72 (11.5)
Farming experience	8 (57)	24.13 (12.4)	6 (50)	22.4 (11.4)	-	6 (57)	23.27 (11.9)
Total Family size	4 (12)	6.77 (2.06)	2 (12)	6.26 (2.1)	100	2 (12)	6.52 (2.08)
Children under 14 years old	0 (6)	2.7 (1.44)	0 (6)	2.21 (1.54)	37.6	0 (6)	2.45 (1.5)
Adult 15-64 years	2 (10)	3.97 (1.97)	2 (10)	3.97 (2.17)	60.9	2 (10)	3.97 (2.06)
Dependent 65 and above	0 (1)	0.13 (0.34)	0 (1)	0.08 (0.27)	1.5	0 (1)	0.10 (0.31)

Source: Survey result of 2011.

All the sampled households' heads are male. The reason was that since female headed households are not common, they were not included during random selection of farmers for interview. Among the sampled household heads, 16.7%, 41% and 28.2% are illiterate, can read and write and have attended primary school (1-6 grades) respectively. The majority of the sampled farm household heads are literate as depicted in Table 2.

Table 2: Sex and educational level of respondent households

Variables	Description	Percentage		
		Farta (N=39)	Laigaint (N=39)	Total (N=78)
Sex of House Hold head	Male	100	100	100
	Female	0	0	0
Educational level	illiterate	17.9	15.4	16.7
	Read and write	51.3	30.8	41.0
	Primary school (1-6 grade)	25.6	30.8	28.2
	Junior secondary (7-8 grade)	5.1	5.1	5.1
	Secondary school (9-12 grade)	0	17.9	9.0

Source: Survey result of 2011.

Socio-economic characteristics

Land Resource

The average farm size of the study districts is about 1.01 ha of land ranging from 0.25 to 2.75 hectares with a standard deviation of 1.833. Average cultivated, grazing, and fallow lands are 0.94, 0.062 and 0.006 hectares, respectively (Table 3). Since land is the most important capital asset in the study areas, 71.8% of the sampled farmers lease-in about 0.46ha of land on the basis of sharecropping and sometimes pay in cash to get access for additional land.

Table 3: Land holding (ha) of farmers in the study areas (N=78)

Description	Lai-gaint (N=39)		Lai-gaint (N=39)			Total (N=78)	
	Min (Max)	Mean (Std. Dev)	Min (Max)	Mean (Std. Dev)	%	Min (Max)	Mean (Std. Dev)
Total farm size	1.00 (6.00)	3.24 (1.08)	1.50 (11.0)	4.79 (2.10)	-	0.25 (2.75)	1.01 (1.83)
Cultivated land	1.00 (5.00)	3.15 (0.96)	1.50 (8.00)	4.38 (1.86)	100	0.25 (2.00)	0.94 (1.59)
Grazing land	0.00 (1.00)	0.10 (0.31)	0.00 (3.00)	0.39 (0.67)	21.8	0.00 (0.75)	0.06 (0.54)
Fallow land	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.05 (0.22)	2.6	0.00 (0.25)	0.01 (0.16)
Size of leased in land	0.00 (4.00)	0.91 (1.06)	0.00 (10.0)	2.78 (1.85)	71.8	0.00 (2.50)	0.46 (1.77)
Size of leased out land	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.0	0.00 (0.00)	0.00 (0.00)

Source: Survey result of 2011.

Livestock

Table 4 depicts major animals kept by farmers that include cattle, sheep and goats, equines (horses, donkey, and mules) poultry and beehives. Oxen are the main source of power for plowing and threshing while cows are major sources of milk and butter. The equines are used for plowing and transporting humans and agricultural commodities.

Table 4: Number of Livestock ownership (N=78)

Description	N	Minimum	Maximum	Range	Mean	Std. Dev.
Oxen	74	0	3	3	1.42	0.614
Cattle other than	68	0	9	9	2.10	1.624

oxen						
Sheep and goats	68	0	43	43	5.27	5.772
Equines	65	0	13	13	1.64	1.705
Chicken	61	0	25	25	2.32	2.991
Beehives	20	0	11	11	0.55	1.560

Source: Survey result of 2011.

Crop production patterns of the study districts

Trends of production of major crops grown in the study area

As presented in Table 5 below, 98. 7%, 87.2%, 61.5%, 48.7%, and 34.6% of the sample farmers produce potatoes, barley, faba bean, wheat and linseed crops, respectively.

Table 5: Different crops grown by farmers in the study districts

	Triticale	Barley	Wheat	Potato	Faba bean	Field pea	Tef	Linseed
Number of farmers growing	78	68	38	77	48	6	15	27
Percentage (%)	100	87.2	48.7	98.7	61.5	7.7	19.2	34.6

Source: Survey result of 2011.

Mean areas allocated for triticale, wheat and barley that are selected for the purpose of cost benefit analysis are 0.46, 0.22 and 0.27 hectares of land, respectively. The corresponding profitability of this areas is 31.04; 18.76 and 22.08 qt ha^{-1} (Table 6).

Table 6: Mean area allocated (hectare) and productivity (qt ha^{-1}) of major crops grown in the last three years:

Crop	Number of farmers growing		Area (ha)				Productivity (quintal/ha)		
	Freq	%	Min	Max	Mean	Stdv	Min	Max	Mean
Triticale	78	100	0.125	2.500	0.460	1.2934	14.0	60.0	31.04
Wheat	38	48.7	0.125	0.623	0.221	0.4362	8.0	50.0	18.76

Barley	68	87.2	0.063	0.875	0.265	0.5420	8.0	60.0	22.08

Source: Survey result of 2011.

The beginning of triticale production and its dissemination

Right from the introduction of triticale to the districts, the crop does not demand the efforts of the normal extension system since it goes on its own. It was highly diffused in the year 2006 as witnessed by 33.3 % of the sampled farmers (Table 7).

Table 7: Introduction, trend and status of triticale production

First Year of growing triticale				Trend of triticale production since started (in area)			Did you shift from wheat/barley to triticale production?		
No	Years	Freq (N)	%	Answer	Freq(N)	%	Answer	Freq (N)	%
1	2001	1	1.3	Increased	78	100	Yes	78	100
2	2002	3	3.8	Decreased	0	0	No	0	0
3	2003	11	14.1	No change	0	0			
4	2004	12	15.4						
5	2005	14	17.9						
6	2006	26	33.3						
7	2007	9	11.5						
8	2008	2	2.6						
	Total	78	100	Total	78	100	Total	78	100

Source: Survey result of 2011.

As indicated in Table 8, the market played the lion's share as source of seed for triticale crop accounting for 74.4% followed by the Agriculture Office (14.1%), German Technical Cooperation –GTZ (10.3%) and Adet Agricultural Research Center (1.3%). Farmers acquire their first triticale seed by means of cash purchase (48.7%) followed by seed for seed exchange (35.9%), loan (10.3%), and gift (5.1%).

Table 8: Main triticale seed sources in the study areas

First Source of seed for triticale	First means of acquiring triticale seed	Initial amount of triticale seed (kg)

Seed source	Freq	%	Means	Freq	%	Minm	Maxm	Mean
GTZ	8	10.3	Cash	38	48.7	2	100	31.82
Agriculture Office	11	14.1	Loan	8	10.3			
From market or farmers	58	74.4	Seed for seed exchange	28	35.9			
Adet Research	1	1.3	Gift	4	5.1			

Source: Survey result of 2011.

Consumption of triticale

The major purpose of growing triticale is for consumption, sale and to use the straw for animal feed and roofing. Like wheat, it can be locally prepared and consumed in a variety of traditional ways such as "*Injera*", bread, "*kollo*" (fried grain), "*tella*" (local beer) and "*nifro*" (boiled grain). Most Farmers prefer local beer of triticale. Triticale Injera when mixed with barley is also considered to be the best. Kollo and bread of triticale crop are not preferred by a few sampled farmers.

Determinants or motivation of farmers to grow triticale more than other crops:

- ✓ Hail damage tolerance
- ✓ Relatively good for home consumption (Injera and Tella)
- ✓ Suppress weeds than wheat and barley
- ✓ gives relatively better yields on degraded land
- ✓ Disease and pest tolerance
- ✓ Tolerance to waterlogged areas
- ✓ Frost tolerance

Source: Survey data from group discussion, 2011.

Farmers shift from wheat based to triticale based system due to its high yielding potential, adaptability, relatively good for home consumption and tolerance of water logging and wind.

Farmers ranked triticale, wheat, and barley as very high, medium, and low based on parameters presented in Table 9. Triticale crop dominates wheat and barley in disease, frost, hail damage and moisture stress tolerance

parameters as well as yield. These parameters are extremely important for the study districts, since the areas are food insecure, degraded and suffer from erratic rainfall. It scored low in threshability, straw quality for feed, early maturity, and fried grain ("*kollo*") quality parameters. Wheat is good in parameters like market price, threshability, straw quality, and bread quality. These parameters are not primary needs for farmers. Barley is good in threshability, straw quality, maturity, and "*kollo*" quality. In overall ranking, triticale comes first followed by barley and wheat.

Table 9: Rate of Triticale, Wheat and Barley in different parametrical scales. (N=78)

No	Parameter (1=Veryhigh,2=Medium 3=Low)	Triticale		Wheat		Barley	
		Mean	Stdv	Mean	Stdv	Mean	Stdv
1	Yield rank	1.00	0.000	2.81	0.397	2.19	0.397
2	Disease tolerance rank	1.00	0.000	2.83	0.375	2.17	0.375
3	Frost tolerance rank	1.12	0.360	2.77	0.454	2.10	0.524
4	Hail damage tolerance rank	1.00	0.000	2.58	0.497	2.38	0.490
5	Moisture stress tolerance rank	1.18	0.419	2.81	0.457	1.97	0.558
6	Market price rank	2.35	0.641	1.23	0.556	2.17	0.673
7	Threshability rank	2.94	0.295	1.67	0.474	1.29	0.486
8	Straw quality for feed source rank	2.79	0.437	2.00	0.360	1.04	0.194
9	Maturity rank	3.00	0.000	1.79	0.406	1.21	0.406
10	Flour Yield ("*Bereket*') rank	1.33	0.574	2.03	0.772	2.37	0.686
11	Need fertile land rank	1.91	0.956	1.92	0.786	1.83	0.692
12	Tilerring capacity rank	1.78	0.767	2.42	0.730	1.64	0.702
13	Bread quality rank	2.37	0.605	1.06	0.372	3.21	0.903
14	"Injera" quality rank	1.81	0.757	2.45	0.767	1.68	0.712
15	"kollo" quality rank	2.94	0.295	1.82	0.503	1.23	0.424
16	"Tella" quality rank	1.46	0.574	2.79	0.493	1.58	0.570
	Grand mean	1.87		2.19		1.88	
	Overall rank	1		3			2

Source: Survey result of 2011.

Cost benefit analysis of triticale production

Farmers have their own judgment on their production activities based on their limited physical capability, social and natural resources. The cost benefit analysis was done using the average prices, inputs, and output data obtained from farmers during the survey. The benefits were calculated from the grain and straw yield priced at the market rate during the study. The

cost components were material, labor, and animal power. Labor costs were considered mainly for the preparation of land, and planting, weeding, harvesting, and threshing activities. Oxen days were used to calculate costs plowing and threshing.

The average total production of triticale, wheat and barley was 31.1; 18.8 and 22.1 quintals per ha with average price of 413.85, 521.48 and 360.22 Birr/quintal, respectively. Total gross returns from triticale, wheat and barley production was 13,469, 10,262 and 8,684 Birr/ha, respectively. On the other hand, the average total costs per ha were 7,616.66; 6,533.59 and 5,651.93 Birr in that order. Therefore, farmers gain the net profit of 5,851.92, 3,728.60 and 3,031.86 Birr from one ha land of triticale, wheat and barley, respectively. The net return from triticale when compared with wheat and barley is greater by 56.95% and 93%, respectively Table 10).

In general, even though the price of triticale produce was cheap in the previous years, farmers are currently obtaining good yields as well as price. The result indicated that producing triticale crop is financially more profitable than other competitive crops.

Table 10: Cost benefit analysis of major crops in the study area (ETB)

RETURN		Triticale			Wheat			Barley		
		Yield (qt)	**Price /qt**	**Total value**	**Yield (qt)**	**Price /qt**	**Total value**	**Yield (qt)**	**Price /qt**	Total value
Average Yield (qt/ha)		31.01	413.9	12,844	18.77	521.5	9,788.2	22.1	360.22	7,950.1
Average Straw yield (bundle/ha		31.64	19.68	622.68	26.57	17.84	474.01	36.18	20.28	733.73
Gross return				13,469			10,262			8,684
COST		**Man-day/ha**	**Price/man-day/day in birr**	**Total cost/ha in birr**	**Man-day/ha**	**Price/man-day/day in birr**	**Total cost/ha in birr**	**Man-day/ha**	**Price/man-day/day in birr**	**Total cost/ha in birr**
Labor cost	Plowing	13.64	21.23	289.58	13.24	21.23	281.09	12.34	21.23	261.98
	Weeding	107.24	21.23	2,276.7	103.20	21.23	2,190.9	75.52	21.23	1,603.3
	Harvesting	22.76	21.64	492.53	21.16	21.64	457.90	20.60	21.64	445.78
	Threshing and winnowing	35.96	21.03	756.24	16.08	21.03	338.16	14.52	21.03	305.36
	Total labor cost			3,815.1			3,268.1			2,616.4
Animal power cost	Plowing*	13.64	39.74	542.05	13.24	39.74	526.16	12.32	39.74	489.60
	Threshing	49.76	21.64	1,076.8	26.48	21.64	573.03	26.48	21.64	573.03
	Transport	-	-	615	-	-	552	-	-	587.40
	Total animal power cost			2,233.8			1651.2			1,650.0
Material input cost	Seed (kg/ha)	168.76	4.14	698.67	147.92	5.21	770.66	212.72	3.60	765.79
	Fertilizer and manure	-	-	869.07	-	-	843.65	-	-	619.70
	Total material input cost			1,567.7			1,614.3			1,385.5
Total cost				7,617			6,534			5,652
NET RETURN				*5,852*			*3,729*			*3,032*

*NOTE: * Average cost of oxen days to plow including the plower = 60.97 ETB.*

Source: Survey result of 2011.

Opinions of farmers about future production of triticale

Farmers appreciate the triticale crop as indicated in Table 11 summarizing farmers' opinions on the crop.

Table 11: Summary of farmers' opinions about future triticale production

Opinions	Frequency	Percent (%)
Continue producing triticale in the future	28	35.9
Continue producing triticale but I need new varieties of it	23	29.5
Need supplementary crop (wheat) and new triticale varieties	17	21.8
Need supplementary crop (wheat) due to yield reduction of triticale	10	12.8
Total	78	100.0

Source: Survey result of 2011.

Major challenges and constraints of triticale production identified by farmers

The major challenge of triticale is its threshability problem. Triticale crop needs more labor and time to thresh than wheat and barley. Farmers thresh it with sticks even after threshing it by oxen. But some farmers said that, threshing is easy if harvested after it has dried well . Decreasing soil fertility and poorer straw quality for feed are other problems of the triticale crop.

5. Conclusion and Recommendation

- The major motives of farmers behind growing triticale are its tolerance against hail damage, disease, and frost. Weed suppressing ability; pest and disease tolerance; suitability for home consumption; giving yield on degraded land etc. are other advantages.
- Triticale is highly expanding in the study districts replacing wheat and/or barley. The market played the lion's share for the first source of seed for triticale.

- In general, the main reason for farmers to shift from wheat/barley based production system to triticale is its financial profitability as well as tolerance to harsh environmental conditions.

The following recommendations are suggested from the findings of the study:

- Additional crop choices with their improved varieties and packages like wheat, barley and potatoes should be introduced for the study areas.
  - Triticale should be disseminated in areas that are degraded and difficult to grow wheat and barley crops.
  - Improved triticale varieties such as high yielding, short maturing and easily threshable) should be encouraged.
  - Introduction of threshing machines for groups of farmers through farmers' cooperatives to minimize threshing time and cost of triticale is recommended.

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