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**Causes of Household Food Insecurity in Koredegaga Peasant Association, Oromiya Zone, Ethiopia**

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**Abstract:** The main objective of the study is to examine the determinants of households' food security using a logistic regression procedure. Initially the model was fitted with eleven factors of which six were found to be significant and all had the expected signs. These include farm land size, ox ownership, fertilizer application, education level of household heads, household size, and per capita production. The result obtained was further analyzed to compute partial effects and to conduct simulation studies on significant factors. Analysis of partial effects revealed that an introduction to fertilizer use and an improvement in the educational level of household heads give relatively higher changes in the probably of food security. On the other hand, simulations conducted on the basis of the base category of farmers, representing food secure households, revealed that both educational levels of household heads and fertilizer applications by farmers have relatively high potential to more than double the number of food secure households in the study area following improvements in these factors.

## 1. Introduction

Agriculture is the backbone of the Ethiopian economy. The sector makes multifaceted contributions to the economy[1]. The performance of agriculture, however, in terms of feeding the country's population, which is growing at about 2.9 per cent per annum, is poor. According to reports, compared to the medically recommended daily intake of calories per person per day of 2 100, over 50 percent of the Ethiopian population is food insecure, the majority of whom reside in rural areas (FAO, 1998). Recent estimates also show that about 60 percent of the population lives below the poverty line (FAO, 2001).

A number of studies which made use of various methodologies to identify determinants of food security are available in different parts of Ethiopia. According to these studies, ownership of livestock, farmland, family labour, farm implements, employment opportunity, market access, low level of technology application, level of education, health, harsh weather conditions, crop diseases, low rainfall, oxen, and family size are identified as major determinants of food security (Shiferaw et. al, 2003; Yared et al, 1999; Web et al, 1992). To our knowledge, there is no similar studies that have been conducted for Korodegaga Peasant Association. Therefore, this study takes as its objective the determination of factors influencing food security in the study area. It is believed that the results obtained will add to the wealth of information currently available regarding the determinants of food security in the country.

The study area (i.e., Korodegaga Peasant Association (PA)) is located in Dodota Woreda of the Arssi zone of Oromia region in Ethiopia. Agriculture is the principal activity in the study area. It is however at subsistence level. This can be attributed mainly to very low rainfall.[2] The area where the PA is located receives rain only in the months of June, July and August. During the rain months and the next harvest season, few households have enough to eat. Cattle, sheep, and goats are some of the principal livestock kept by farmers in the study area (Assefa & Mesfin, 1996).

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[1] Responsible for about 50% of Gross Domestic Product, and over 90% of foreign exchange earnings, and employs over 85% of the labour force

[2] The area farmed by the Peasant Association receives insufficient rain, with its major rainy months being in June, July and August

## 2. Literature

Food security is defined in different ways by international organizations and researchers. According to Smith et al. (quoted in Maxwell, 1996), there are close to 200 definitions of food security. These definitions were the result of the evolution, since the World Food Conference of 1974, from those that emphasized national food security or increase in supply to those that call for improved access to food in the 1980s (FAO, 1983). In the 1990s, improved access was redefined by taking into account livelihood and subjective considerations (Maxwell, 1996). It underwent another round of evolution after the 1996 World Food Summit. The definition was broadly set as achieving food security "at the individual, household, national, regional and global levels when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Currently, a synthesis of these definitions, with the main emphasis on availability, access, and utilization, serves as working definition in the projects of international organizations.

Though food security as a problem at the national level was first felt in Ethiopia in the 1960s, it only started influencing policy making in the 1980s. This occurred when food self-sufficiency became one of the objectives of the Ten-Year Perspective Plan (TYPP) in the early 1980s. This was after the 1983/84 drought and famine, which claimed millions of lives (Alemu, Oosthuizen, and Van Schalkwyk, 2002). While efforts to ensure adequate food supplies at the national level are laudable, this alone does not ensure food availability for households and the individuals who need it. As Sen (1981) argues, ensuring access to food, not merely increasing food supplies, should be regarded as the major pillar of food security. This assertion is borne out of empirical evidence that suggests that even in times when countries experience famine, food supplies have been generally available, even in those regions where large numbers of people died of starvation. The problem is that those who needed the food do not have the means to acquire it (Sen, 1986).

Much of the literature on food security focuses on developing and testing determinants of food insecurity at the household level (Maxwell, 1996). In this study too, constraints to food security are investigated. The constraints are categorized into three groups within the framework of the general definition of food security mentioned above, that is, food availability, food access, and entitlement. For example, food availability may be constrained by inappropriate agricultural knowledge, technology, inappropriate policies, inadequate agricultural inputs, family size, etc. On the other hand, access to food and its utilization are constrained by economic growth, lack of job opportunities, lack of credit, inadequate training, inadequate knowledge, etc. (Hoddinott, 1995). Accordingly, in general, the effects of eleven factors on the food security status of a household, which fall in any of the three categories discussed above, are investigated in this study.

## 3. Methodology

### 3.1. Data sources and measurement of variables

The primary data used in this study are adapted from the survey carried out by Centre for Studies of African Economies (CSAE, Oxford University) in collaboration with Addis Ababa University. The survey gathered qualitative and quantitative data pertaining to social, demographic and economic aspects of the households. The present analysis is based on data from a sample of 109 households randomly selected from 304 households residing in the study area.

The dependent variable, that is food security, was measured as follows. Firstly, cereal availability from own production and net transactions were calculated and used to determine calorie availability for each household[3]. Secondly, the medically recommended levels of calories per adult equivalent were used to determine calorie demand for each household[4]. Thirdly, the difference between calorie availability and calorie demand for households was used to determine the household's food security status. Households whose per capita available calories were found to be greater than their per capita calorie demand were

[3] Using conversion factors from IFPRI, quantities of each cereal were converted into available energy equivalents.

[4] Following the general practice in the literature, 2 100 kcal per day was assumed to be the minimum energy demand enabling an adult to lead a healthy and moderately active life.

regarded as food secure and were assigned a value of 1, while households experiencing a calorie deficit were regarded as food insecure and the were a assigned a value of 0[5].

Eleven explanatory variables, seven measured as continuous variables and five as discrete were identified to be major determinants of food security in this study. These include per capita aggregate production[6], off-farm work, technology adoption[7], land quality, household size, age of household head, household labour availability, ox ownership, wealth and education level of household head. Except for household size, the remaining 11 factors were *a priori* expected to have a positive impact on food security.

### 1.2. The model

Following the modelling of production and consumption behaviours of rural household by Strauss (1983), Barnum and Squire (1979) and Yotopoulos (1983) (cited in Shiferaw, Kilmer and Gladwin, 2003), the extent of household food security found in this study is modelled within the framework of consumer demand and production theories.
Households derive utility from the consumption of foods through the satisfaction found in a set of taste characteristics as well as the health effects of the nutrients consumed.

The model used in this study to determine factors affecting seasonal food insecurity is given below.

$$\phi_i = E(y_i = 1/X_i) = \frac{1}{1+e^{-(\beta_1 + \sum_i^k \beta_i x_i)}} \quad \text{......(1)}$$

Where: $\phi_i$ stands for the probability of household ***i*** being food secure, $y_i$ is the observed food security status of household ***i***, $x_{ij}$ are factors determining the food security status for household ***i***, and $\beta_j$ stands for parameters to be estimated.

Denoting $\beta + \sum_{j=1}^{k=n} \beta ij$ as Z, equation 1 can be written to give the probability of household ***i*** can be calculated as:

$$\phi_i = E(y_i = 1/X_i) = \frac{1}{1+e^{-Z_i}} \quad \text{......(2)}$$

From equation 2, the probability of a household being food insecure is given by (1-$\phi_i$) which gives equation 3, which can be written as

$$(1-\phi_i) = \frac{1}{1+e^{z_i}} \quad \text{......(3)}$$

Therefore the odds ratio, i.e., $\phi_i$/(1-$\phi_i$) is given by equation 4 as

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[5] Of the different nutrients derived from the consumption of foods, only calories are considered in this study.

[6] Per capita aggregate production consists of cereals output of the household only.
[7] Measured as a dummy variable reflecting whether or not the households applied fertilizer.

$$\left(\frac{\phi_i}{1-\phi_i}\right)=\frac{1+e^{z_i}}{1+e^{-z_i}}=e^{z_i} \quad \text{.......................................................(4)}$$

The natural logarithm of equation 4 gives rise to equation 5

$$Ln\left(\frac{\phi_i}{1-\phi_i}\right)=\beta+\sum_{j=1}^{k=n}\beta ij+\varepsilon_i \quad \text{.......................................................(5)}$$

Rearranging equation 5, with the dependent variable (food security) in log odds, the logistic regression can be manipulated to calculate conditional probabilities as

$$\phi_i=\frac{e^{\left(\overline{\beta_O}+\sum_{i=1}^{k=n}\overline{\beta_j}x_{ij}\right)}}{1+e^{\overline{\left(\overline{\beta_O}+\sum_{j=1}^{k=n}\overline{\beta_j}xij\right)}}} \quad \text{.......................................................(6)}$$

Once the conditional probabilities are calculated for each sample household, the "partial" effects of the continuous individual variables on household food security can be calculated by the expression

$$\frac{\partial\phi_i}{\partial x_{ij}}=\phi_i(1-\phi_i)\beta_j \quad \text{.......................................................(7)}$$

The" partial" effects of the discrete variables are calculated by taking the difference of the probabilities estimated when value of the variable is set to 1 and 0 ( $x_i=0, x_i=1$ ), respectively.

## 4. Results and Discussion

### 1.1 Descriptive results[8]

This section reports the descriptive results regarding the relationship between food security and determinants of food security. Out of the 108 observed households in the sample, 29 are food secure (26.9 %) and 79 (73.1 %) are food insecure.

**Table 1: Household Food Security Rates for significant variables**

| Variables | Food insecure | Food secure |
|---|---|---|
| Average farm land size (ha) | 3.34 | 4.85 |
| Average per capita production (kg) | 74.32 | 160.85 |
| Non fertilizer users (%) | 89.47 | 10.53 |
| Fertilizer users (%) | 64.29 | 35.71 |
| Average ox ownership | 0.87 | 1.24 |
| Average household size | 7.50 | 6.70 |
| Illiterate (%) | 87.5 | 12.50 |
| Primary education (%) | 58.33 | 41.67 |
| Secondary education (%) | 47.62 | 52.38 |

*Source*: Authors' computation based on survey data

According to Table 1, average farm land size, average per capita production, and average ox ownership of food secured households are higher than for food insecure households. On the other hand, household size, the percentage of non-fertilizer users and the percentage of illiterate household heads are higher among food insecure households than among food secure households. Therefore, the results confirm the findings of the literature regarding the relationship between food security and the major determinants of food security.

### 1.2 Empirical results (model characteristics)

In this section, results of the test for significance of the determinants of food security and of the predictive efficiency of the model are discussed. The former was conducted using the likelihood ratio chi-square statistic[9] while the Pesaran-Timmermann test statistic was used to test for the latter. According to results shown in Table 2, the log likelihood value of 21.9, with $p<0.001$ indicate that at least one of the parameters of the determinants of food security shown in equation 1 is significant.

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[8] Only descriptive statistics of significant determinants are reported in this section. Results of non-significant determinants can be provided upon request.

[9] Calculated on the basis of the formula LR=2(ULLF-RLLF) where ULLF and RLLF are, respectively, unrestricted log-likelihood function and restricted log-likelihood function. It is chi-square distributed with 6 degrees of freedom.

**Table 2: Parameter estimates of the logistic regression**

| Variable | Coefficient | Std. Error | z-Statistic | Probabilities |
|---|---|---|---|---|
| Constant | -2.872801 | 1.007998 | -2.850006 | 0.0044 |
| Fertilizer application(FAPP) | 1.686672 | 0.826574 | 2.040556 | 0.0413 |
| Farm land size(LANSIZE) | 0.491132 | 0.187123 | 2.624643 | 0.0087 |
| House hold size(HHSIZE) | -0.419186 | 0.153797 | -2.725587 | 0.0064 |
| Ox ownership(OXOWN) | 0.404942 | 0.21513 | 1.882316 | 0.0598 |
| Education(EDU) | 0.685413 | 0.352105 | 1.946614 | 0.0516 |
| Per capita production(PCAPRO) | 0.005813 | 0.003371 | 1.72415 | 0.0847 |
| Percentage of correct prediction | 87.04 | | | |
| The Pesaran-Timmermann test statistic | 6.8328 | | | <0.001 |
| Log likelihood value[10] | 21.98 | | | <0.001 |

Source: Authors' computation based on survey data

With regard to the predictive efficacy of the model, Table 2 shows that out of the 108 sample households included in the model, 94 (87.04% ) are correctly predicted. According to the Pesaran-Timmermann test statistic, there exists a significant association between the observed and the model's prediction of a household's food security status.

### 4.3 Parameter estimates of determinants of food security

First, all 11 factors were considered for the model. Then a step by step process of deletion of insignificant variables or variables of which the signs were contrary to expectation reduced the number of significant variables to six. The six factors which were found to be significant and possessing the expected signs in the final model, were farm land size, per capita aggregate production, fertilizer application, household size, ox ownership, and educational attainment level of farm household heads (Table 2).

The magnitude of the effects of changes in statistically significant individual determinants of household food security on the change in the conditional probability of food security was estimated using equation 7 shown in section 2. Tables 3 and 4 respectively give results on the partial effects of continuous and discrete variables.

**Table 3: Partial effects for continuous determinants**

| Determinants | "Partial Effects" |
|---|---|
| Farm land size (ha) | 0.096 |
| Per capita aggregate Production (kg) | 0.001 |
| Household size (#) | -0.082 |
| Ox ownership (#) | 0.080 |

*Source*: Authors' calculations

**Farm land size**

According to results reported in Tables 2 and 3, keeping the other variables in the model constant, land size is positively and significantly related to the probability of being food secure (Table 2). According to Table 3, the "partial" effect of a unit increase in farm size is 0.096. This means that the probability of food security increases by 0.096 (about 10%) for a one hectare increase in farm size.

**Fertilizer application**

Use of fertilizer is another factor which was found to have a significant impact on household food security. A positive and significant relationship was found between fertilizer usage and the probability of being food secure (Table 2). This implies that the likelihood of food security increases with a farmer's use of fertilizer. In other words, fertilizer users are more likely to be food secure than non-users. According to Table 4, a unit increase in using fertilizer defined by the shift from non fertilizer user ($X_i$=0) to fertilizer user ($X_i$=1) increases the probability of food security from 0.32 to 0.42.

**Table 4: Partial effects of discrete explanatory variables**

| **Determinants** | **" Partial Effects"** |
|---|---|
| **Educational attainment** : | |
| Illiterate | 0.08 |
| Primary education | 0.16 |
| Secondary education | 0.17 |
| **Fertiliser usage** : | |
| Fertilizer non users | 0.32 |
| Fertilizer users | 0.42 |

***Note***: The change in probabilities of household food security due to the change in the significant discrete explanatory variables can be calculated by taking the difference of the mean probabilities estimated for the respective discrete variables $X_i = 0$ and $X_i = 1$

*Source*: Author's calculation based on survey data

**Ox ownership**

Ox ownership is found to have a significant and positive relationship with household food security (Table 2). According to Table 3, a unit increase in ox ownership (ownership of an additional ox) increases the probability of being food-secure by 0.08.

**Education**

Education was found to have a significant and positive relationship with household food security (Table 2). This indicates that households with relatively better educated heads are more likely to be food secure than those with relatively less education. According to results reported in Table 4, an increase in educational attainment, defined by the shift in educational level from illiterate ($X_i$=0) to primary level ($X_i$=1) results in increase in probability of being food-secure from 0.08 to 0.16. Furthermore, as the educational level of the household head increases from primary ($X_i$=1) to secondary level ($X_i$=2), the probability of attaining food security increases from 0.16 to 0.17.

**Household size**

According to Table 2, household size has a negative and significant relationship with the probability of food security. Table 3 shows that the probabilities of being food secure decreases with an increase in family size. Each additional member of the household decreases the probability of food security by 0.082.

**Per capita production**

Per capita aggregate production, which is found to have a significant and positive influence on food security (Table 2)? As shown in Table 3, each unit increase in per capita aggregate production results in a 0.001 increase in the probability of food security.

To calculate the impact on food security of improvement in the significant determinants, simulations were conducted. The results of the simulations are reported in the next section.

### 4.4 Impact on food security of major determinants of food security

This section reports simulation results for the levels of change in the conditional probability of being food secure following improvement in any of the significant factors. Simulations were conducted with reference to a base group of households representing food secure households. The results are reported in Table 5. The base group includes households with an average farm land size of 4.85 ha, aggregate per capita production of 160.85 kg, average household size of 6.7 members, average ox ownership of 1.24 units, and the dummy variables for educational attainment and fertilizer application set to zero.

**Table 5: Simulated impact of determinants on the probability of household food security**

| Variables | Predicted probabilities |
|---|---|
| Base | 0.134 |
| Farm size increase by one hectare | 0.202 |
| Increase in per capita production by 70 kg. | 0.188 |
| If the households adopt fertilizer | 0.456 |
| Increase of ox ownership to two | 0.174 |
| If the household size is reduced by 1 | 0.191 |
| If the primary education is attained | 0.236 |
| If the secondary education is attained | 0.380 |

*Source*: Authors' computation

According to Table 5, the conditional probability of food security for the base group of households is 0.134. This means that out of one hundred farm households 13 are food-secure. If a group of households with characteristics similar to that of the base group of farmers apply fertilizer, the number of food secure farmers will increase to 46. Improvement in the educational level of household heads of the base group of farmers from illiterate to primary increases the number of food secured households to 25. Improvement in the education level from illiterate to secondary level will result in an increase in the number of food-secure households to 38. In addition, Table 5 shows that an increase in the average farm land size of the base group of farmers by one hectare results in an increase in the number of food secure households from 13 to 20. It is also shown in Table 5 that ownership of an additional ox by each household from a population with characteristics similar to those of the base group of farmers will increase the number of food secure households from 13 to 17. On the other hand, a decrease in the average family size of farmers in the base group of farmers from 6.7 to 5.7 leads to an increase in the probability of food security from 0.134 to 0.191. On the other hand, a 70 kg increase in aggregate per capita production (in wheat equivalent) for the base group of farmers causes an increase in the number of food-secure households from 13 to 18.

## 5. Conclusion

The objective of this study was to determine the causes of seasonal food insecurity in the members of the Koredegaga Peasant Association in the Eastern Oromia region of Ethiopia. According to descriptive statistics of the sample households, *a priori* expectations about the relationships between indices of food security and factors influencing it are satisfied. This was further supported by a binary logistic regression model applied to the randomly selected primary data of the 109 sample farm households. Factors identified as having significant influence on food security by the logistic regression model include farm land size, per capita aggregate production, fertilizer application, household size, ox ownership, and educational attainment level of farm household heads. Partial effects computed on the basis of the logistic regression model indicate that improvement of farmers' access to fertilizer, education level of household heads, farmers' access to land, and farmers' access to family planning significantly improve food security status of farmers in the study area. According to these results, farmers' access to fertilizer alone can increase the number of food secure households in the area from 13 to 46. A similarly high increase in food secure households is possible (from 13 to 38) if the education level of farm households can be improved from illiterate to secondary level. Therefore, it is recommended that introducing institutions which foster agricultural research and extension, family planning, efficient use of land use, and schools, should receive priority attention in policy making.

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