Determinants of Household Food Security: the Case of Mareko Woreda, Ethiopia

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Abstract

Food insecurity has begun to make a serious impact and has become a prominent issue in the development debate recently. This study was undertaken in Ethiopia to identify the socio-economic determinants of food security. The data analyzed came mainly from a survey of 150 rural households in 5 different Kebeles of the Woreda, which were selected based on probability proportional to size. The household food security/ insecurity status was measured by the direct measurement of household food consumption in the 12 months study period using the household food balance sheet model as reported from household recall. Logistic regression model was applied to identify the correlates of household food security in the study area. Land holding, total cereal production, income obtained from safety-net, number of oxen owned, off-farm and non-farm income, sex of household head and livestock holding were found to affect household food security positively; while adult equivalent household size and quantity of chemical fertilizer applied were found to have negative effect. Based on the findings of the study, short term and long term interventions are recommended to alleviate the food insecurity problem.

Introduction

Food insecurity has been in the public eye for a long time, since the biblical story of Joseph at the pharaoh's court predicting seven years of plenty followed by seven years of famine and stored crop harvests that saved lives during famine years, is an early example of food security planning in practice. However, food security began to make a serious impact and became a prominent issue in the development debate in recent history since 1970.

Even though the problem of food insecurity has been the concern of developing countries for a long time, it is now a world-wide issue. Estimates indicate that about 854 million people worldwide are chronically malnourished of which 820 million are in developing countries, 25 million in countries which are in transition and the rest 9 million in the industrialized countries. In Africa, an estimated 200 million or 27.4 per cent of the people are undernourished and this

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figure is expected to increase to 30 per cent by 2015. Sub-Saharan Africa accounts for 13 per cent of the population but 25 per cent of the undernourished people in the developing world (IFPRI, 2002; FAO, 2006; Quaye, 2008). More than half of Africa's food insecure population live in Ethiopia and five other nations viz. Uganda, Zambia, Chad, Zaire and Somalia (Ramakrishna and Demeke, 2002).

Ethiopia with a population of 73,918,505 is the third populous nation in Africa. Of the total population of the country 83.9 per cent is found in rural areas (FDRE, 2008). The country is predominantly agrarian, and agriculture plays a major role in the economy. It accounts for about half of the total GDP, employing and supporting about 84 per cent of the total population and accounts for about 90 per cent of the exports (NBE, 2002; Workneh, 2004; Girmay, 2006; FDRE, 2008), but its productivity and performance in terms of feeding the country's population which is growing at 2.6 per cent per annum is dismal (Habtom et al, 2005; FDRE, 2008).

Ethiopia is one of the poorest nations in the world, where agriculture plays a key role in sustaining the life and livelihood of the majority of the population. Per capita gross national income is among the lowest worldwide and estimated to be USD 220 in 2007 (World Bank, 2008). Nearly half its population is food insecure or live below the poverty line (Devereux, 2000; Ramakrishna and Demeke, 2002; Jema Haji, 2008), and it has a long history of famines and food shortages that can be traced back to 250 BC (Webb et al, 1992; Ramakrishna and Demeke, 2002). Since 1965 there have been 15 major droughts in the country, with four consecutive years of drought beginning in 1999 (Hiensch, A., 2009).

Failure of rains for consecutive years fueled by a rapidly growing population, rising prices, endemic poverty, and limited government capacity, have led the country to chronic food insecurity. Approximately 7.2 million people continue to receive food or cash assistance through the Productive Safety Net Program (PSNP), which is funded by many donors (USAID, 2008).

Problems of food security do not necessarily result from inadequate domestic food supplies, as is widely believed, but from a lack of purchasing power on the part of nations and of households (Kapunda, 1994). In the words of Ethiopia's Prime Minister, Meles Zenawi, " Even if we had the food available in the domestic market, the government does not have the money to buy this surplus food for redistribution" (BBC, 2002). United States Agency for International Development echoes this, saying that, many poor people at the household level in Ethiopia are food insecure because of the high domestic food prices resulting from local food shortages (USAID, 2008).

The problem of food insecurity in Ethiopia could also be manifested through the level of nutritional deprivation, stunting and wasting of children less than 5 years of age. According to the Ethiopian Demographic and Health Survey of the 2005, 37 per cent, 47 per cent and 11 per cent of children under the age of five were underweight, stunted and wasted respectively (CSA and ORC, 2006).

The above facts show the extent and depth of the food insecurity problem in the country. This research was proposed with the aim of generating area specific data to answer the question; 'What are the factors that determine household food security in the Woreda?'

Methodology

Data Description

The data examined in this study came mainly from the primary data which was collected from detailed rural households' survey in five different Kebeles of the Mareko Woreda*. The erratic nature of rainfall, scarcity of land, declining agricultural output and productivity and limited access to off-farm employment opportunities have made the Woreda vulnerable to food insecurity. Households were not capable of feeding their members round the year from their own production, so that many households have been and are dependent on the PSNP to supplement their produce. Thus, based on this background Mareko Woreda was purposively selected for this study.

The Woreda has 25 rural Kebeles, of which only 5 Kebeles were selected randomly for the study, taking into account logistic and financial limitations. Thereafter, the 150 sample households needed for the study were shared between the selected Kebeles using the probability proportional to size method. The sample households in each Kebele were selected using systematic random sampling technique from the complete household heads list obtained from the respective Kebele administrations. A structured questionnaire was employed as an instrument, for the collection of both qualitative and quantitative data from the household heads. Before the actual data collection, the questionnaire was pre-tested to check for its clarity and understandability.

*Woreda is an administrative division of Ethiopia (managed by a local government), equivalent to a district. Woredas are composed of a number of Kebele, or neighborhood associations, which are the smallest unit of local government in Ethiopia.

Measurement of Food Security/Insecurity Status

In the study, household food security/insecurity status was measured by the direct measurement of the household food consumption in the 12 months study period using the household food balance sheet model as reported from household recall. That is, the net amount of food energy available for household consumption was computed as a net amount from different kinds of crops, livestock meat and other by-products obtained through own production after adjustment made for sales, transfers, purchases, seed and future consumption reserves, and post-harvest crop losses over a year. In making use of this method, it was assumed that the net food that has come to the household's 'possession' through the different means' and 'disappeared' has been consumed.

The aggregation of the different types of foods consumed requires converting each quantity to its calorie equivalent. To do this the Food Composition Table for use in Ethiopia which is obtained from the Ethiopian Health and Nutrition Research Institute was used (EHNRI, 2000). Food availabilities are often reported in terms of adult equivalent or household consumption units to facilitate comparison with recommended intakes.

The average household food energy availability per person is measured as the amount of energy in the food acquired by the household over the survey reference period divided by the adult equivalent and days in the period.

Operationally, based on this average household food energy availability per person calculated, households were classified as food secure or food insecure, depending on which side of the line they were i.e., a household whose daily per capita calorie intake was above the minimum recommended daily calorie of 2,100 Kcal/AE/day was regarded as food secure and those below 2,100 Kcal/AE/day were regarded as food insecure households.

The data analysis incorporated use of econometric estimates and tests of significance computed using appropriate statistical package known as LIMDEP version 8.

Empirical Model to Analyze Determinants of Food Security

Prior to the execution of the empirical model, explanatory variables should be checked for the presence of intercorrelations (i.e.multicollinearity) among them. The underlying problem of multicollinearity is that if two variables are highly

correlated, they are essentially containing the same-or at least much of the same-information and are, therefore, measuring the same thing (Mertler and Vannatta, 2005). To detect the existence of this problem in the data, detection methods viz.,Variance Inflation Factor (VIF) and Tolerance (TOL), and contingency coefficient were used, as may be seen in Table 1.

Table 1: VIF and TOL of Continuous Variables

Variables	Nature	R2	VIF	TOL
Age of household head in years (AGE)	Continuous	0.387	1.631	0.613
Adult equivalent (ADEQ)	Continuous	0.968	31.25	0.032
Estimated asset value (ESASV)	Categorical	0.566	2.304	0.434
Amount of credit obtained (CRED)	Continuous	0.261	1.353	0.739
Off-farm and non-farm income (OFNF)	Continuous	0.089	1.098	0.911
Income obtained from safety-net (SAFAID)	Continuous	0.281	1.391	0.719
Land holding (LAHO)	Continuous	0.497	1.988	0.503
Number of oxen owned (OXEN)	Continuous	0.613	2.584	0.387
Number of extension contact (EXCON)	Continuous	0.083	1.091	0.917
Total cereal production (CERE)	Continuous	0.794	4.854	0.206
Fertilizer applied (FERAP)	Continuous	0.506	2.024	0.494
Amount of improved seed used (IMPSE)	Continuous	0.620	2.632	0.380
Household size in number (HHSI)	Continuous	0.966	29.41	0.034
Market distance from home in Km (MKTDIS)	Continuous	0.127	1.145	0.873
Dependency ratio (DEPR)	Continuous	0.256	1.344	0.744
Livestock holding (LIVH)	Continuous	0.571	2.331	0.429
Level of education of the household head (EDU)	Continuous	0.301	1.431	0.699

Determining food security status of a given household involves calculating the per capita food calorie consumption of the household to compare it with the cutoff level, which suggests a typical case of qualitative dichotomous variable.

This study makes use of the logit model.

The logistic distribution function for food security can be specified mathematically as (Gujarati, 2003):

$$P_i = \frac{1}{1+e^{-z_i}} \quad (1)$$

Where:- P_i is the probability of being food secure of a given household $_i$.

Z_i is a function of n regressors (x_i's) or a set of independent determinants which can be given as $Z_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + ... + \beta_n X_{ni}$ where β_1 is the intercept parameter while $\beta_2, \beta_3, ..., \beta_n$ are the slope parameters.

Therefore, if the probability of a household being food secure is P_i, the probability of a household being food insecure would be 1-P_i, which can be written as:-

$$1 - P_i = \frac{1}{1+e^{-z_i}} \quad (2)$$

Dividing equation (1) by equation (2) and simplifying it gives the odds ratio of being food secure:-

$$\frac{P_i}{1-P_i} = e^{z_i} \quad (3)$$

Taking the natural logarithm of equation (3) gives us the logarithm of the odds ratio which is called the logit. If the disturbance term Σi is taken into account, the logit model becomes:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i$$

$$= \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + ... + \beta_n X_{ni} + \varepsilon_i$$

$$= \beta_1 + \sum_{j=2}^{n} \beta_j X_{ji} + \varepsilon_i \quad (4)$$

The above econometric model was used in this study and was treated against potential variables assumed to affect household food security. The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. Rearranging equation (4), we can manipulate to calculate the conditional probabilities as follows:

$$P_i = \frac{e^{\beta_1 + \sum_{j=2}^{n} \beta_j X_{ji}}}{1 + e^{\beta_1 + \sum_{j=2}^{n} \beta_j X_{ji}}} \quad (5)$$

Once we calculate the conditional probabilities for each household covered in the study, the "partial" or marginal effects of the continuous individual variables on household food security can be obtained using the following expression:

$$\frac{\partial P_i}{\partial X_{ji}} = P_i(1 - P_i)\beta_j \quad (6)$$

The impact of each significant explanatory variable on the probability of food security is calculated by keeping the continuous variables at their mean values and the discrete variables at their most frequent values (i.e., 0 or 1).

Working Hypothesis

Following the development of the model that captures food security, it is high time to identify the determinant variables that can potentially explain household food security in the study area. To realize this, different literature and research works were reviewed, along with discussions with the Woreda Agriculture Experts. Therefore, the empirical model takes household food security as a dependent variable and the variables mentioned in the following table as explanatory variables. The a priori expected sign of these explanatory variables are given in the same table.

Table 2: Explanatory Variables and their Expected Signs

Variables	Expected sign
Age of household head	+/-
Household size	-
Adult equivalent household size	-
Dependency ratio	-
Sex of household head (Male = 1, 0 otherwise)	+
Variables	**Expected sign**
Education level of household head	+
Livestock holding size	+
Number of oxen owned	+

Land holding size	+
Credit	+
Extension contact	+
Off-farm and non-farm income	+
Fertilizer use	+
Improved seed use	+
Total estimated asset value	+
Income from safety net	+
Market distance from home	-
Total cereal production	+

Model Characteristics

Since R^2 as a measure of goodness-of-fit is not well suited for the binary regressand variable models (Ramakrishna and Demeke, 2002), the resulting model is tested for significance of the determinants of food security (i.e., the null hypothesis that all the estimated slope coefficients were equal to zero) using the log likelihood ratio, $\lambda = LR\text{-}LU$, where LR and LU are the log likelihood functions for restricted and unrestricted models, respectively.

The estimated value of chi-square is 102.07, which is significantly higher than the critical chi-square value of 33.41 with 17 degrees of freedom at one percent significance level. Hence, it can be said that at least one of the parameters of the determinants of food security included in the model is significant or the hypothesis that all the coefficients, except the intercept are equal to zero is rejected, implying the model is a good fit.

Another measure of the goodness-of-fit in logistic regression model is to look at the predictive efficiency (Count R2) of the model. With regard to this, out of the total 150 sample households covered by the study, 86 percent (i.e., 129 households) of them were correctly predicted by the model. Therefore, the model is good enough in classifying subjects into food secure and food insecure. A further look at the predictive power of the model within the two groups confirmed that 88.9 and 81.7 percent of the food insecure and food secure households, respectively, were correctly predicted. Thus, from the above goodness-of-fit measures it can be deduced that the estimated model predicts both groups of households fairly accurately and is appropriate for the data.

Discussion of Significant Explanatory Variables

Inspection of the logit maximum-likelihood estimates, shown in Table 3, illustrates that out of seventeen explanatory variables included in the model eight of them were found to be statistically insignificant at the conventional 1, 5 and 10 percent level of significance, with the rest being significant in affecting household food security in the study area.

Table 3: Binary Logit Estimates for the Determinants of Food Security

Variable	Coefficient	Standard Error	P [|Z| > z]	Marginal Effect
Age of household head in years (AGE)	-0.00545594	0.00504	0.2786	-0.5460
Adult equivalent (ADEQ)	-0.31547076***	0.07758	0.0000	-31.547
Sex of household head: 1, if the head is male; 0 otherwise (SEXH(1))	0.32236059*	0.16981	0.0576	32.236
Estimated asset value in Birr (ESASV)	0.00009657	0.00026	0.7056	0.0100
Credit obtained in Birr (CRED)	0.00016045	0.00013	0.1982	0.0160
Off and non-farm income Birr (OFNF)	0.00012146*	0.00007	0.0993	0.0120
Income from safety-net, Birr (SAFAID)	0.00018666**	0.00009	0.0429	0.0190
Land holding in hectares (LAHO)	0.39502003***	0.12758	0.0020	39.502
Number of oxen owned (OXEN)	0.23675789**	0.11275	0.0357	23.676
Number of extension contact (EXCON)	-0.00846558	0.01511	0.5753	-0.8470
Cereal production in kilogram (CERE)	0.00050867***	0.00014	0.0003	0.0510
Fertilizer applied in kilogram (FERAP)	-0.00367882*	0.00188	0.0501	-0.3680
Improved seed used, kilogram (IMPSE)	-0.00068812	0.00343	0.8411	-0.0690
Market-home distance, Kms (MKTDIS)	-0.01750680	0.01989	0.3788	-1.7510
Dependency ratio (DEPR)	-0.06454355	0.07643	0.3984	-6.4540
Livestock holding in TLU (LIVH)	0.08217905*	0.04506	0.0682	8.2180
Household head education level (EDU)	-0.00063960	0.03121	0.9836	-0.0640
Constant	-0.48585525	0.37773	0.1984	

Maximum Likelihood Estimates	
Percent correctly predicted (Count R2)	86.0%
Sensitivity	81.7%
Specificity	88.9%
Log likelihood function	- 49.92
Restricted log likelihood	-100.95
Chi-square	102.07
Sample size	150

Note: *** indicates significance at 1%, ** significance at 5% and * significance at 10% level
Source: Own computation

Land holding size was found to be highly significant in affecting food security status of the households in the study area positively. This suggests that food insecurity is more severe among those households with little land holding, and here with a precaution one can say that increasing land holding size could result in increased food security for both groups. One justification could be that, an increase in land holding could lead to the diversification of crops produced which minimize production risks, or it makes production of more yields possible. Therefore, all other variables held at their mean value, the probability of a household being food secure increases by about 40 percent as the land holding increases by a unit hectare.

Total cereal production shows significant positive relationship with food security at 1 percent significance level, implying that an increase in cereal production has a potential of reducing the likelihood of being food insecure. This is in agreement with the hypothesis of the research. Since the households in the study Woreda are dependent on the consumption of cereals, especially maize, the more they produce the more likely that they satisfy their requirement. In line with this, the logit model estimate indicates that the probability of being food secure rises by 0.051 percent as the total cereal output produced by the household increases by a kilogram, keeping all other factors constant at their mean value.

Of the household characteristics considered, adult equivalent household size is found to have negative significant relationship with the household food security at 99 percent confidence level. This variable is included in the model to capture the number of consuming units per household; the higher it is "too many mouths", it would imply increased risk of food insecurity. Other things held constant, the

marginal effect of -31.547 implies that, evaluated at the mean value, the probability of a household being food secure decreases by the given percent as the adult equivalent household size increases by a unit.

The other household basic demographic characteristic that affects food security is the household head, whether male headed or female headed. A positive and significant relationship was found between the sex of the household head and the probability of a household being food secure. This connotes that the likelihood of food security increases with the household head being male i.e. males are more likely to be food secure than females. This relation could be the outcome of differential access to production resources and choice of income generating activities between farm and off-farm/non-farm incomes due to culturally defined roles and social mobility limitation (Adugna Eneyew, 2008). According to table 3, male headed households are 32.24 percent more likely to become food secure than female headed households.

Number of oxen owned was found to have significant positive relationship with household food security at 95 percent confidence level. It can be said that the probability of a given household being food secure or food insecure, among others, could be due to a variation in oxen ownership. This is confirmed by the estimates of the binary logit model as; the likelihood of being in the state of food security, *ceteris paribus,* increases by 23.676 percent as the number of ox/oxen ownership of the household increases by one, calculated at mean oxen owned by sample households.

Fertilizer applied was found to have significant effect on household food security at 10 percent significance level. However, it is observed that the direction of its effect is contrary to the working hypothesis. This could be due to the nature of the soil (i.e., silt soil) in the study area or the wrong application rate of the fertilizer by the farmers.

Income from safety-net has a positive and significant relationship with household food security. It is significant at 95 per cent confidence level. Its presence has a supplementing role to the income of the household, which helps the realization of food entitlement through purchase. As a result the probability of a household being food secure increases, holding other factors on their average value, by 0.019 percent as the income obtained from participating in the PSNP rises by one Birr.

Number of livestock holding, measured in TLU was found to have a positive and significant influence on household food security. The relationship is statistically significant at 90 percent confidence level. This is in conformity with the hypothesis, and it strongly implies that livestock ownership is a source of traction, manure, food, cash and acts as a cushion against crop failure, in which case the household possession of this resource promotes the likelihood of being food secure. Thus, we can say that the likelihood of a household being food secure rises, holding all other factors the same, by 8.218 percent when the livestock holding in TLU increases by a unit.

Off-farm and non-farm income was found to have positive and significant relationship with household food security, in which case the estimate is in agreement with the working hypothesis of the study, at 10 percent significance level. This suggests that increased access to off-farm and non-farm activities have a potential of increasing the chances of the household being food secure through diversifying the sources of farm households' livelihoods. Therefore, other things remaining constant, the probability of a household being food secure lifts up by 0.012 percent as the income generated from off-farm and non-farm activities increases by one Birr.

Conclusion and Recommendations

Off-farm and non-farm activities were found to positively and significantly affect the rural household food security implying possible areas of intervention in the Woreda. It is imperative to work on the dearth of alternative economic opportunities in the rural area of the study Woreda through expansion and promotion of non-farm activities like petty trading, micro-enterprise development, formation of input and output service co-operatives, etc. through the provision of low interest credit, technical knowledge support and advice.

Land is another important factor that affects household food security in the study area. However, with an increase in population size of the Woreda, land is becoming in short supply and the farmers are now forced to produce crop on small plots of land with poor agricultural technologies and low productivity. It is, therefore, important that the zonal and regional government integrates development of the rural sector and the reorientation of economic activity through promoting off-farm and non-farm employment opportunities and social investments towards rural areas of the Woreda. This could shift some proportion of households from entire reliance on land. Furthermore, the problem of land shortage could be

approached through resettling some segment of the population, on voluntary basis, into other potential areas within the region.

Cereal crop production is found to affect household food security significantly in the study area. With the existing situation in the Woreda increased crop output is possible by improving labor and land productivity. Thus, intensifying agriculture and increasing yield of cereals, through adequate and proper applications of modern farm inputs such as fertilizers, improved seeds and herbicides; improving traditional farm implements and production practices; and encouraging farmers to grow cereal varieties with better yield, could be important areas to the research and agricultural extension programmes in the area.

Livestock and oxen ownership are key factors in assuring household food security in the study area in that their possession provides food for direct consumption, income from their sale or sale of byproducts and plough power. Therefore, in order to increase the households' oxen and livestock ownership, a tailor made credit scheme is very vital; and to improve their production and productivity, veterinary services and improved high yield forage plants should be availed.

Another important factor, according to the binary logit model, in explaining household food security in the study area is the adult equivalent household size. The higher it is, the less likely is the household becoming food secure, implying the need for intervention. Therefore, one way of improving the food security of households is to strengthen the family planning program in the health extension package. The family planning program to be employed should be contextual to the area culture, religion and other factors.

Safety-net programs strengthen the economic status of households beyond providing food for consumption, because it allows investment in animals and agricultural inputs and prevent disinvestment. In this study also the income generated from safety-net is found to have a positive role on food security status of households. Therefore, the program should continue its operation through proper targeting and identification of beneficiaries, and its results should be monitored and evaluated on a continuous basis. Moreover, the program should not last for a long time as it may create some kind of dependence.

Fertilizer use is one of the factors that explain the food security status of households in the study area. Furthermore, its high price and shortage of supply are the major causes of food deficit. Therefore, to avail it cheaply and timely the

government should work on setting up a factory that produces fertilizer, or mobilize large amount of fertilizer fund. However, as a short term alternative to chemical fertilizers, the extension system should promote preparation and use of compost, use of organic fertilizers as 'Orgam' and application of nitrogen fixing leguminous plants in crop rotation to increase crop production.

The study also found out that male headed households are more likely to be food secure than households of which the head is female. The logical implication, therefore, is that strengthening the capacity of females through education should be an integral part of the whole development process for it has a repercussion on household size which is another determinant variable of food security in the Mareko Woreda.

Finally, all options listed above can be materialized only if the farmers' problem regarding shortages of cash income could be overcome. Therefore, enhancing rural credit to the subsistence farmers in the Woreda should be one of primary areas of intervention during the coming years. Rural credit can indeed overcome the farmers' capital problem to buy farm oxen, the lack of start-up capital to work in non-farm activities, and the lack of money to buy modern agricultural inputs. These are the prime recommendations of this study.

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