International Journal of Academic Research
ISSN: 2348-7666 Vol.2, Issue-1(3), January-March, 2015

ANALYSIS OF RURAL HOUSEHOLD FOOD SECURITY IN WONAGO DISTRICT, GEDEO ZONE, SNNP REGIONAL STATE, ETHIOPIA

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Abstract:

The research is conducted in Wonago District with the objectives of measuring food security status of rural households and to identify factors influencing rural households' food security status. The results of Logistic regression model indicated that, Farm size, improved seed, Non-farm income and Soil fertility were important variables which had positively and significantly influenced rural household's food security status. On the other Slop of Plots had shown negative and significantly affected rural household's food security status. Based on the finding of the current study it can be concluded that, policy and development interventions should give emphasis towards improvement of such economical, physical and institutional support system so as to change food security, increased productivity and increase income level of small scale farmers.

Keywords: Logistic Regression, Food Security, Rural Household, Wonego Woreda,

1. Introduction

Food security, defined as "access by all people at all times to enough food for an active healthy life", is one of several conditions that support optimal human health and productivity. Households experience food insecurity when availability or ability to acquire nutritionally adequate, safe foods in socially acceptable ways is limited or uncertain. When food access becomes severely limited, adults and children in food insecure households may experience overt hunger-- "the uneasy or painful sensation caused by lack of food".

Food security is fundamental element in human existence. Without food, nothing happens: no economic growth, no science and technology, no music and literature, not even procreation. Food security, as defined by [5] is "a state of affairs where all people at all times have access to safe and nutritious food to maintain a healthy and active life". Since the year 1974, when the world was in the midst of food crisis, significant progress has been made towards providing food for reasonably larger number of hungry people.

The World Food Conferences of the 1970's and 80's made one of the sweetest declaration of "food for all…… within a decade no child will go to bed hungry, no family will fear for its next day's bread, and no human being's future and capacities will stunted by malnutrition…" Since these declarations, however, the world has faced the most uneven distribution of food (both quality and quantity) ever seen in the history of the world [14]. Actually, average availability of food (measured as dietary energy supply) is said to increase by over a tenth in the last three decades. During the same period, developing countries recorded increment in food availability by about a fifth. Today, more than any other time in the history of mankind, the volume of poverty and food insecurity coupled with serious malnutrition and morbidities are knocking many doors of the people in most developing world of sub-Saharan African countries. Ethiopia, as one of the poor nations of the world, is facing repeated macro-and micro level food insecurity coupled with environmental degradation and depletion.

In the last three decades, it has not been possible to produce adequate food to meet the needs of the fast growing population, attributed mainly to fragmented land holdings, successive droughts, untimely and unpredictable rainfall, antiquated farm technology, lack of farm input, low producer prices and other ecological factors. On top of this, the fast growing population has forced the practice of unhealthy cultivation systems that deplete the soil; its valuable nutrients and organic matters, promoted erosion that forced the land to loss its productivity. As a result of such poor land management, there has been excessive deforestation without forestation, over cultivation and the like. On the converse, agriculture is the main stay of the country, which supports about 85% of the population. This subsistence agriculture is actually dependent on the natural resource base of the country. According to several reports and studies, the rural environment of Ethiopia is suffering from heavy land degradation mainly due to recurrent drought and food insecurity, shortage of water and other resource materials.

In the southern highlands it is said that the dependence on perennial crops (coffee, chat, Ensete, etc) and the adoption of traditional farming systems have reduced the subsistence crop yield and resulted in food insecurity [4]. Even though there are cash crops like coffee and fruits as a source of income mainly together with others crops in the study area for food, there is food security problem. That is the reason why we are interested in this issue.

Therefore, the main purpose of the current study was to measure food security status of rural households and to identify factors influencing rural households' food security status in the study area. To deal with the aforementioned issues a combined effort of literature study, focus group discussion and questionnaire based survey were implemented

2. Methodology

2.1 Description of the Study Area

The study was conducted in Gedio zone, one of zones in Southern Nations Nationalities and People's Region (SNNPR) state, of Ethiopia. It is situated at 368km south west of Addis Ababa. The agro ecology (temperature and amount of rain fall) varies from place to place. Most of people living in the district are small scale farmers and based on crop production and rearing of an animal. Some of crops produced in the district are inset, maize, wheat, barley, coffee, chat and others. From the selling and exportable crops produced in the district, coffee is the most dominant crop. It is one of areas of Ethiopia where better quality coffee is produced. The study population includes rural households those currently reside in Gedeo zone.

Gedeo zone share the largest boundary with Oromiya region and only in the north- east with Sidama Zone. Wonago Wereda is located approximately between 6013`- 60 26` North latitude and 380 13`- 380 24` East longitude. The area of Gedeo Zone is about 134,700 hectares and the two PAs occupy 2506 hectares.

Data collection techniques

The survey was conducted over the period Oct 2013–Jan 2014 in three kebele in the study area. In order to get the overall image of status of rural household food security in the study area, the study was used both primary and secondary data. The primary data were collected using interview schedule (farmers) by considering 160 samples respondents.

Data Analysis techniques

Comparisons between food secured and food insecure were carried out through application of chi-square. The relative influences of various explanatory variables on the dependent variable were also analyzed.

Econometric Method (Logistic regression) *Specification of the Logistic regression*

Logistic regression analysis extends the techniques of multiple regression analysis to research situations in which the outcome variable is categorical. Logistic regression allows one to predict a discrete outcome, such as group membership, from a set of predictor variables that may be continuous, discrete, dichotomous, or a mix of any of these. Generally, the dependent or response variable is dichotomous (binary), such as presence or absence / success or failure/ binary logistic regression is used. Logistic regression has a peculiar property of easiness to estimate logit differences for data collected both retrospectively and prospectively [10]. There are two main uses of logistic regression: Firstly, to predict the group membership, since logistic regression calculates the probability of success over the probability of failure, the results of the analysis are in the form of an odds ratio. Secondly, logistic regression also provides knowledge of the relationships and strengths among the variables.

Model Description

The dependent variable in binary logistic regression is usually dichotomous, that is, the dependent variable can take the value 1 with probability of success P_i or the value 0 with probability of failure $1-P_i$. The model for logistic regression analysis assumes that the outcome variable Y is categorical. The logistic model is defined as follows. Let $Y_{nx\,1}$ be a dichotomous outcome random variable with categories 0 (food secure) and 1(food insecure). Let $X_{nx(k+1)}$ denote the collection of k-predicator variables of Y, where $\mathbf{X}$ is called regression matrix and without the loading column of 1s is termed as predictor data matrix. Then, the conditional probability that a household head is food insecure given $\mathbf{X}$ is denoted by Prob (Y_i =1/X_i) =P_i. The expression P_i has the form:

$$P_i = \frac{e^{\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta_k X_{ik}}}{1+e^{\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta_k X_{ik}}} = \frac{e^{X\beta}}{1+e^{X\beta}} ......1$$

P_i = the probability of household i being food insecure

Y_i = the observed food security status of household i

$\beta' = (\beta_1, \beta_2, ..., \beta_k)$ is a vector of unknown coefficients. The model given in (1) is logistic regression modal. The relationship between the predictor and response variables is not a linear function; instead, the logarithmic transformation of equation yields the linear relationship between the predictor and response variables. The logit transformation of P_i given as follows:

$$\text{logit}(P_i) = \log\left(\frac{P_i}{1-P_i}\right) = \beta_o + \beta_1 X_{i1} + \beta_2 X_{i2} + ... + \beta_k X_{ik} ....2$$

Parameter Estimation of Logistic Regression

The maximum likelihood estimation method is appropriate for estimating the logistic model parameters due to this less restrictive nature of the underlying assumptions [9]. Hence, in this study the maximum likelihood estimation technique was applied to estimate parameters of the model. Consider the logistic model $P_i = \frac{e^{x_i\beta}}{1+e^{x_i\beta}}$, since observed values of Y say, Y_i's (i=1, 2, 3... n) are independently distributed as binomial with parameter P_i, the maximum likelihood function of Y is given by:

$$L(\beta \mid y) = \prod_{i=1}^{n} \left[\frac{e^{x_i\beta}}{1+e^{x_i\beta}}\right]^{y_i} \left[\frac{1}{1+e^{x_i\beta}}\right]^{(1-y_i)} ...3$$

Where, $\beta' = (\beta_0, \beta_1, \beta_2, \quad, \quad, \beta_k)$

The objective of stating likelihood function is to get an estimator $\hat{\beta} = (\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_k)'$ of β which maximizes the likelihood function expressed in equation (3). Since the likelihood equations are nonlinear in the parameters, the Newton-Raphson iterative maximum likelihood estimation method that expresses $\hat{\beta}$ at the (u+1) the cycle of the iteration is expressed as $\hat{\beta}_{u+1} = \hat{\beta}_u + (X'V_u X)^{-1} XR_u$, where u = 0,1,2,3 ... and $\hat{V}$ is a diagonal matrix with its diagonal elements $\hat{V} = \text{diag}\left[\hat{P}_i(1-\hat{P}_i)\right] = \text{cov}(y)$.

Finally, $\hat{\beta}$ is the resultant maximum likelihood estimator of $\hat{\beta}$ with residual $R = y - \hat{P}$ (Collet, 1991; Greene, 1991). Newton's method usually converges to the maximum of the log – likelihood in just little iteration unless the data are especially badly conditioned (Greene, 1991). All the parameters $\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_k$ and estimates of P_i for each subject were computed using the SPSS and R.

Assessment of the Fitting Logistic Regression Model

After estimating the coefficients the importance of each of the explanatory variables have been assessed by carrying out statistical tests of the significance of the coefficients and the overall goodness of fit of the model was tested. Finally, the predicting power of the model to discriminate between the two groups defined by the response variable will be evaluated [3].

The Wald Statistic

The Wald test is a way of testing the significance of particular explanatory variables in a statistical model. In logistic regression we have a binary outcome variable and one or more explanatory variables. With each explanatory variable in the model there is an associated parameter. The Wald test, described by [2], is one of a number of ways of testing whether the parameters associated with a group of explanatory variables are zero. If for a particular explanatory variable, the Wald test is significant, then we would conclude that on parameter associated with that variable is not zero, so that the variable should be included in the model. If the Wald test is not significant then that particular explanatory variable can be omitted from the model. Wald χ^2 statistics to test the significance of individual coefficients in the model is:

$$W = \left(\frac{\hat{\beta}_j}{SE(\hat{\beta}_j)} \right)^2 \quad \ldots\ldots(4)$$

The Wald statistic was compared with a χ^2 distribution with 1 degree of freedom. It is easy to calculate but its reliability is questionable, particularly for small samples. For data that produce large estimates of the coefficient, the standard error is often inflated, resulting in a smaller value for the Wald statistic, and therefore the explanatory variable may be incorrectly assumed to be unimportant in the model [3].

Likelihood-Ratio Test

An alternative and widely used approach to testing the significance of a number of explanatory variables is the likelihood ratio test. This is appropriate for a variety of types of statistical models. [2] Argues that the likelihood ratio test is better, particularly if the sample size is small or the parameters are many. The likelihood-ratio test uses the ratio of the maximized value of the likelihood function for the full model (L_1) over the maximized value of the likelihood function for the simpler model (L_0). The likelihood-ratio test Deviance statistic equals:

$$-2\log\left(\frac{L_0}{L_1}\right) = -2[\log(L_0) - \log(L_1)] = -2(LL_0 - LL_1) \ldots\ldots(5)$$

This log transformation of the likelihood functions yields a chi-squared statistic when n-(k+1) is large.

Goodness of Fit of the Model

The goodness of fit of a model measures how well the model describes the response variables. Assessing goodness of fit involves investigating how close values predicted by the model with that of observed values [3]. The comparison of observed to predicted values using the likelihood function is based on the statistic called deviance.

$$D = -2\sum_{i=1}^{n}\left[y_i \ln\left(\frac{\hat{P}_i}{y_i}\right) + (1-y_i)\ln\left(\frac{1-\hat{P}_i}{1-y_i}\right)\right] \ldots\ldots (6)$$

For purposes of assessing the significance of an independent variable, the values of D are compared with and without that particular independent variable in the equation:

χ^2=D (model without variable)-D (model with variable).

The goodness-of-fit x^2 process evaluates predictors that are eliminated from the full model, or predictors (and their interactions) that are added to a smaller model. In general, the question in comparing models is whether the log-likelihood decreases or increases significantly with the addition or deletion of predictor(s).

RESULTS AND DISCUSSION

This chapter presents and discusses the results of households' food security analysis in the study area. The first section of the chapter reports the food security status of the households. The next three sections present socio-economic background, about physical factors, institutional characteristics of the sample households. The purpose of these sections is to provide the first impression about households' food security status. Finally, the results of econometric analysis of the determinants of food security status of the households is presented and discussed.

3.1 Food Security Status of the Households

The households' food security status was measured by direct survey of consumption. Data on the available food for consumption, from home production, purchase and /or gift/loan/wage in kind for the previous seven (7) days before the survey day by the household was collected. Then the data were converted to kilocalorie and then divided to household size measured in AE. Following this, the amount of energy in kilocalorie available for the household is compared with the minimum subsistence requirement per adult per day (i.e. 2100 kcal). As a result, from all respondent households, 48 households were found to be food insecure and 102 of them food secure. It means that (32%) of the respondent households were food insecure and (68%) of them were food secure.

3.2 Determinates of Food security among the Rural Household

The second objective of this study was to assess determinants of food security status in the study area. This section highlights the demographic, economic, Physical and institutional characteristics of sample household in the study area. The variables discussed under this topic are those expected to have certain relations with food security.

Household Personal and Demographic Variables

Table 1: Descriptive statistics between food security and food insecure categories

	Food security category				
	Food secured		Food insecure		χ^2
	N	%	N	%	
Age of HHH					
<30	4	2.67	2	1.33	
30-39	20	13.33	15	10	
40-49	35	23.33	18	12	
50-59	28	18.67	11	7.33	
>= 60	15	10	2	1.33	
					45.61***
Marital status of the HHH					
Single	10	6.67	5	3.33	
Married	45	30	2114		
Divorced	27	18	128		
Widowed	20	13.33	10	6.67	
					5.622^{NS}
Educational level of the HHH					
Can't read/write	35	23.33	14	9.33	
Can read/write	27	18	17	11.33	
Primary(1-4)	18	12	6	4	
Primary(5-8)	14	9.33	8	5.33	
High school	8	5.33	3	2	
					31.55***

Source: own survey data, 2013; ***, and NS significant at 1 and non-significant respectively

Economic Variables

Table 2: Descriptive statistics between food security and food insecure categories

	Food security category				
	Food secured		Food insecure		χ^2
	N	%	N	%	
Off-farm activates					
Yes	40	26.67	17	11.33	
No	62	41.33	31	20.67	5.12***
Farm Land Size					
0.25-1	32	21.33	18	12	
1-1.5	40	26.67	12	8	
1.5-2	20	13.33	10	6.67	
>= 2	10	6.67	8	5.33	31.55NS

Source: own survey data, 2013; ***, and NS significant at 1 and non-significant respectively

Physical Factors

Table 3: Descriptive statistics between food security and food insecure categories

	Food security category				
	Food secured		Food insecure		χ^2
	N	%	N	%	
Soil Fertility Status					
Low	12	8	7	4.67	
Medium	60	40	21	14	
High	30	20	20	13.33	52.61***
Categories of slope					
Plain	52	34.67	22	14.67	
Steep	37	24.67	18	12	
Hilly	13	8.67	8	5.33	36.187***

Source: own survey data, 2013; ***, and NS significant at 1 and non-significant respectively

Institutional Factors

Table 4: Descriptive statistics between food security and food insecure categories

	Food security category				
	Food secured		Food insecure		χ^2
	N	%	N	%	
Access of Improved Seed					
Yes	49	32.67	34	22.67	
No	53	35.33	14	9.33	9.421***
Access of Farm Credit					
Yes	50	33.33	25	16.67	
No	52	34.67	23	15.33	38.067***
Agricultural input availability					
Yes	53	35.33	27	18	
No	49	32.67	21	14	1.073NS

Source: own survey data, 2013; ***, and NS significant at 1 and non-significant respectively

3.2.1 Summary of Results of Descriptive Statistics

Before passing to the econometric part of the analysis it is important to summarize the results of the descriptive statistics. The overall respondent's personal and demographic, economic, institutional and physical variables were discussed using descriptive statistical techniques. The results on each variable were demonstrated using tables and percentage. In doing so, respondents were treated in two food security categories. The difference between food securities categories were assessed using Chi-square test statistics for discrete/dummy variables. Distribution was used to discriminate the two food security categories for dummy variables. Out of the hypothesized discrete/dummy variables; age, education level of household, off-farm income, access of credit, access of improved seed, Slop of plots and soil fertility of farm were found to significantly difference across households at less than 1% level. Similarly, farm size, agricultural input availability and marital status were also discrete variables which fail to discriminate between food security categories.

3.3 The Results of Econometric Model

Table 5: Variables in the Final Multiple Logistic Regression Model

Predictor Variables	$\hat{\beta}$	Wald	d.f	Sig	Exp ($\hat{\beta}$)
Constant	-3.96	1.62	1	0.000	0.005
Plot slop	-0.712	0.349	1	0.079	1.64
Farm size	0.789	0.074	1	0.000	1.603
Improved Seed	0.33	0.011	1	0.000	0.866
Non-farm income	0.69	0.269	1	0.005	0.285
Soil fertility	1.268	6.406	1	0.011	3.55
Log likelihood = 76.507161					
ANOVA based fit measure (R^2) = 0.6387					

Source: Model output, *, ** and *** represents significance at 10%, 5% and 1% level respectively.

Total Farm Size: Land size owned by household heads was found to have significant ($P < 0.01$) and positive relationship with food security status of households suggesting the larger the land size, the better food secure state of the household. The possible explanation is that the major source of food in the study area comes form own production and there was limited access to other means of income generating activities. So the household who have large size of land has better production which gives a better chance for the household to be food secured. The odds ratio of 1.603 for farm size indicates that, other things being constant, the odds ratio in favor of farmer's food security status by a factor of 1.603 as the farm size increases by one hectare. This result is in agreement with the findings of [12, 16, 11 and 13].

Soil Fertility Status: This variable was also found to be significant ($p < 0.05$) and positively related with the food security status of the household. Model results show that those farmers with relatively fertile land are more food secure than. The possible explanation is that assumption was soil fertility problem is one of the physical factors affecting crop production and productivity. If farmers perceive they have fertile land, they can get more production from a given plot of land than. In the model soil fertility status as perceived by farmers was positively related to food security. As a result, other things held constant, the odds ratio in favor of farmer's food security status by a factor of 3.55 for a unit increase of soil fertility. Therefore, this result is in agreement with the finding of [7].

Use of Improved seed: As expected this variable was found to have significant positive ($p < 0.01$) effect with the food security status of households. Households using improved seed are more likely to be food secure than those who did not apply. Improved seed and other technological inputs help farmers to augment productivity and to boost production. Farmers can enhance their production by using high yielding varieties and other complementary farm. As a result, other things held constant, the odds ratio in favor of farmer's food security status increases by a factor of 0.886 for a unit increase of the use of improved seed.

Non-Farm income: As expected non-farm income was found to have significant ($p < 0.01$) and positive relation with the food security status of the household indicating farmers engaged in non-farm activities have better chance to be food secure. This might be due to the fact that households engaged in non-farm activities are better endowed with additional income and more likely to escape food insecurity. The odds ratios 0.805 indicate that keeping the influences of other factors constant, the use of SWC practices decrease by the rate of 0.285as non-farm income increases by one unit. This finding is consistent with the finding of food secure authors [1, 16, 12, 11 and 13].

Slope of the plot (SLOPLOT): This variable has negatively and significantly correlates with rural household food security status at less than 10% significant level. The higher slope category of a plot, the greater will be food in security. This means that on sloppy plot the impact of soil erosion would be more visible to the farmers and this lead to reduce the fertility of soil and reduced the a mount of yield that the farmers obtained from their farms thereby there is high probability that the households failed in food insecure category. The results of the odds ratio show that the status of household food security by a factor of 1.64 for a unit increases in slope of the plot. The result of this study confirms the findings of [15 and 6] which revealed the slope of the plot negatively and significantly related to the status of rural household food security.

Conclusion

The data were analyzed using SPSS software employing descriptive statistics, logit econometric model and presentation of group discussion results. Core Food Secure Modal was used to determine the status of food security among sampled respondents. logit model was used to identify the major determinants of food security among the rural household.

The two Food security categories differed at less than one percent level in most of the hypothesized variables. The explanatory variables were age of HH head, marital status, level of education, household off-farm income, Farm size, soil fertility, slop of plot, Access to improved seed, Access to farm credit and Agricultural inputs.

A total of ten variables were fitted into the model of which, five variables were found to have influence on food security status. Consequently, Slop of Plots, Farm size, improved seed, non-farm income and Soil fertility were found to have influence rural household food security status.

Policy Recommendations

To enhance the food security situation of the Wereda, concerned development actors should give appropriate attention to review the safety net implementation manual and forward strategic decision to revise the criteria set for distinguish food secured and food insecure Weredas.

Land size is one the variables that significantly influence the food security status. Due to population pressure and the emerging of new prides (households) every year, land fragmentation continued. The caring capacity of the cultivated land decreased year after year. This situation more fastens the vulnerability of farmers to word food insecurity. To cover the situation, enhancing the productivity of land through intensification using different technologies is become vital. Introducing technology like drip irrigation, promotion of high values crops and high yielding varieties are some of the possible alternatives.

Diversifications of income through non-farm activities are other potential area for lift up the food secure status of the poor. The development actors should gear their attention to work on this line highly required. The wereda also have a huge potential and favorable climate condition for woodlot production. However, market for this potential is not available as expected. Thus, it is vital to facilitate the modern system of woodlot production and its associated market. Facilitation of credit service and business skill capacity building to farmers (to encourage non-farm engagement) especially for youngster who always leaves their village in search of temporary labor one another area of intervention.

Use of Improved seed varieties was positively and strongly associated with food security in the study area. Improved seed augmented agricultural production and improved the food security situation of farmers. Introduction of different varieties of improved seed required appropriate attention by relevant actors. Strengthen linkage among farmer, extension and research to the required levels highly recommended in order to make the technology more suitable to end users.

Soil fertility status was one of the critical factors determined food security status in the study area. Improving the soil fertility status through implementing different integrated physical and biological soil and water conservation practice are some the possible alternatives.

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