World Journal of Food Science and Technology
2022; 6(2): 19-30
http://www.sciencepublishinggroup.com/j/wjfst
doi: 10.11648/j.wjfst.20220602.11
ISSN: 2637-6016 (Print); ISSN: 2637-6024 (Online)

Socio-Economic Determinants of Household-Level Food and Nutrition Security Among Smallholder Farmers of Eastern Oromia, Ethiopia

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To cite this article:

Beyan Ahmed Yuya, Jema Haji Mohammed, Mengistu Ketema Aredo. Socio-Economic Determinants of Household-level Food and Nutrition Security Among Smallholder Farmers of Eastern Oromia, Ethiopia. *World Journal of Food Science and Technology.* Vol. 6, No. 2, 2022, pp. 19-30. doi: 10.11648/j.wjfst.20220602.11

Received: March 24, 2022; **Accepted**: April 18, 2022; **Published**: May 10, 2022

Abstract: Background: Meeting the overgrowing world population's food and nutrition demands without harming the environment is a current global issue. This study identified household-level determinants of food and nutrition security status in Eastern Oromia, Ethiopia. Method: Both primary and secondary data about the 2020/21 production year were collected for this study. Primary data was collected from 461 smallholder farmers that were collected using a simple random sampling technique. Descriptive statistics and econometric models were used for data analysis. Logit model and ordered logit econometric models were employed to identify the major determinants of households' food insecurity and dietary diversity, respectively. Results: The results indicated that 54.01 and 18.22 percent of the total sample household was in the medium level, high-level nutritional categories, and the rest of 27.77 percent was a low nutritional level household category. Similarly, the result indicated that 63.1 percent of the total sample household was found to be food secured, and the rest of 36.9 percent was not. Logit model results indicated that food security status was significantly influenced by education level, social membership, farm income, farmer training, technical advice, livestock holding, and level of information on climate change. Likewise, the ordered logit results indicated that the household level nutritional status was significantly influenced by age of the household head, membership of cooperative education of the head, extension contact, market information, soil fertility status, livestock holding, and road distance. Conclusion: This study indicated that there is room to improve rural household-level food and nutrition security status using more of the aforementioned socio-economic variables. Therefore, policymakers should give due emphasis to the identified variables and improve the livelihoods of rural households.

Keywords: Food and Nutrition Security, Socio-Economic, Determinants, Ordered Logit Model, Ethiopia

1. Introduction

1.1. Background and Statements of Problems

Rural farm household food insecurity is one of the most important global agendas because, in 2018, and still today, there are some food insecurity issues among populations all over the world. According to the worldwide meals safety network [1] approximately 124 million people in fifty-one countries faced a food safety disaster in 2017. War and lack of confidence are the primary causes of food insecurity, and the number of meals-insecure people in the world has been growing over time [1]. On a global scale, no matter how difficult it is to feed the growing number of people, the population continues to grow over time.

Globally, the number of undernourished people is expected to have increased to 815 million in 2016, up from 777 million in 2015, but remains below 900 million in 2000 [2]. More than half of those people are in Africa, but Africa continues to have the highest rate of malnutrition, with an estimated

one African region of a thousand million Africans malnourished. As a result, improving food security has become a priority for African leaders as well as global leaders and policymakers [3].

Ethiopia's economy is dominated by the subsistence agricultural sector, which accounts for approximately 42 percent of the country's gross domestic product [4]. Furthermore, smallholders (85 percent) own less than 2 ha of land in Ethiopia, with nearly half (40 percent) owning less than 0.5 ha [5]. Ethiopia has a population of 112 million people, four out of every five of whom are food insecure [6]. The country's food-insecure population exceeds 30 million people who live below the poverty line, i.e., on less than $1.25 per day [7]. The share of households level with insufficient caloric intake (<2,550 kcal per adult equivalent) constitutes 31% of the entire households in Ethiopia, of this 24% live in urban areas and 33% in rural regions [8]. Thus, large portions of the Ethiopian population are affected by chronic and transitory food insecurity.

Food insecurity and malnutrition among the rural population are particularly severe in Ethiopia. Furthermore, this population is harmed by small farms, lack of product diversification, weak institutional arrangements, and poor market integration [9-13]. Due to legal restrictions prohibiting free movement within the reserve, whether for farm expansion or hunting, these rural families' food supply and access to food may be further reduced, resulting in a lower score for dietary diversity. Food insecurity patterns in rural Ethiopia are seasonal and linked to rainfall patterns, making the rural population highly vulnerable to changes in climatic conditions [15]. Climate is an important factor in agricultural productivity, but its change has an impact on all aspects of food security, including food availability, accessibility, utilization, and food system stability [16]. Nonetheless, there have been insufficient empirical studies on the drivers of household-level food security and dietary diversity in the country, particularly in Ethiopia's eastern Oromia State.

Therefore, given the high level of food insecurity, agricultural land scarcity, and malnutrition, it is important to examine the characteristics of local food diversity in order to rehabilitate existing agricultural policies that are in place [14]. In the context of the prevalence of malnutrition and over 95% of the population relying on poor agriculture as a livelihood, it is imperative that the country's agricultural policy process be scrutinized in depth [14]. Therefore, this study aims to explore in-depth food security and nutrition at the local level and to identify food security and nutrition decisions in eastern Oromia, Ethiopia.

1.2. Objective of the Study

The specific objectives of the study are;

1. To measure the household level food and nutrition security status of smallholder farmers.
2. To identify the major socio-economic determinants of household-level food and nutrition security.

2. Materials and Methods

2.1. Description of the Study Area

Girawa, Haramaya, and Meta districts in the East Hararghe Zone of Oromia Regional State, Ethiopia, were chosen on purpose due to their cereal crop potential and a high number of rural households experiencing food insecurity. Its elevation ranges from 1200 to 3405 meters above sea level, with a minimum and maximum rainfall of 400 and 1200 millimeters, respectively. This zone encompasses an area of approximately 22,622.6 km^2. The zone is divided into three agro-ecological zones: highland (>2300), midland (1500–2300), and lowland (1500) meters above sea level (m.a.s.l.) [17]. Girawa's elevation ranges from 500 to 3230 meters above sea level. The district's total population is estimated to be 300,661 [18]. In the district, a mixed crop and livestock production system is used, and sorghum, maize, and vegetable crops are grown. According to available data, the total population of Haramaya is 352,031, with 172,495 females [19]. The Meta district is well-known for its potential for growing cash crops such as coffee. The district's total population is estimated to be 318,458, with 160,334 men and 158,124 women [20].

2.2. Sources of Data and Methods of Data Collection

Primary and secondary data sources were used. The primary data was collected using a questionnaire distributed by trained enumerators. In the study area, there are a total of 135 kebeles out of which eight kebeles were selected randomly. To select sample respondents from the eight kebeles, simple random sampling based on probability proportional to size was used. The sample size was determined through the application of the [21] sample size determination formula and finally, about 461 sample size was taken to overcome the problems of discarded sample size and to increase the accuracy of representativeness of the study population.

2.3. Methods of Data Analysis

In addition to descriptive statistics, the logistic model and ordered logit econometric models were used to analyze the data.

2.3.1. The Logit Model

The daily food consumption score is used as a proxy for food insecurity (caloric intake). The study's primary goal is to examine the key factors influencing food and nutrition security. By fitting logistic equations to observed data, logistic regression attempts to model the relationship between two or more explanatory variables and a response variable. Each independent variable x value corresponds to a value of the dependent variable y. To identify determinants of household food security, calorie intake can be classified based on a cut point of 2550 kilocalories per day per adult and modeled as a logistic function of various socioeconomic variables. Following Gujarati, the functional form of the

logistic regression model is specified as follows;

$$\text{Pi} = \epsilon\left(Y = \frac{1}{1xi}\right) = + \frac{1}{1+e^{-(\beta 0+\beta ixi)}} \quad (1)$$

Here Pi is the probability that a given household is being food insecure. For simplicity, we can write (14) as

$$\text{Pi} = \frac{1}{1+e^{-zi}} \quad (2)$$

Where zi=yi

$$y_i = \beta_0 + \beta_i x_1 + \beta_2 x_2 +, \ldots \beta_n x_n + \varepsilon_i, i = 1,2,\ldots,n \quad (3)$$

The probability that a given household food secure is

$$1 - pi = \frac{1}{1+e^{z}} \quad (4)$$

Therefore, the odds ratio in favor of food insecure is

$$\frac{pi}{1-pi} = e^{z} \quad (5)$$

Taking the natural logarithm of (17), we obtain;

$$\text{Li} = \ln\left(\frac{pi}{1-pi}\right) = Zi = yi \quad (6)$$

The dependent variable is dichotomous (2 categories) which takes 1 or 0 values. The category (groups) as a dependent variable must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups [22].

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 +, \ldots, + \beta_n X_n \quad (7)$$

The log transformation is arguably the most popular among the different types of transformations used to transform skewed data to approximately conform to normality.

Where Li is the log of odds ratio, Yi is the function of n explanatory variables, Pi is the probability of being food insecure, 1- Pi is the probability of being food secure, β is the intercept of the equation, $\beta 1 \ldots \beta n$, are the slopes of the equation in the model and Xi's are the explanatory variables included in the model.

2.3.2. The Ordered Logit Model

Let Y_i be an ordinal response with q categories (low, medium, high) for observation i, where i=1,…, n. The ordered stereotype model [23] for the probability that Y_i takes the category k (k=1,…, q) is characterized by the following log-odds.

$$\log\left(\frac{P[Y_i=K)x_i]}{P[Y_i=1)x_i]}\right) = \alpha_k + \phi_k \beta' x_i, i = 1, \ldots, n, k = 2, \ldots, q \quad (8)$$

Where the inclusion of the following monotone is non - decreasing constraint.

$$0 \leq \phi_1 \leq \phi_2 \leq \cdots \leq \phi_q = 1$$

Ensures that the response Y_i is ordinal [23]. The vector x_i is a set of predictor variables (covariates) for observation i which can be categorical or continuous, and the p×1 vector of parameters β represents the effects of x_i on the log odds for the category k, relative to the baseline category of Y_i. This formulation of the model treats the first category as the baseline category, the parameters $\{\alpha_2,\ldots, \alpha_q\}$ are the intercepts, and $\{\phi_1, \phi_2,\ldots, \phi_q\}$ are the parameters which can be interpreted as the "scores" for the categories of the response variable Y_i. We restrict α_1=ϕ_1=0 and ϕ_q=1 to ensure identifiability. With this construction, the response probabilities are as follows.

$$\theta_{ik} = P\left[\left(Y_i = k/X_i\right)\right] = \frac{\exp(\alpha_k+\phi_k\beta' x_i)}{\sum_{i=1}^{q}\exp(\alpha_k+\phi_k\beta' x_i)} \text{ for K=1,…,q} \quad (9)$$

An advantage of the stereotype model is that it is more parsimonious than the baseline category logit model that has the form of $\alpha_k + \beta' x_i$ on the right - hand side of the model. Furthermore, because of the k parameters, the ordered stereotype model is more flexible than adjacent categories of the logit model with a proportional odds structure [24]. They demonstrated that when the scores k are equally spaced, the stereotype model is equivalent to the proportional odds version of the adjacent categories logit model [24]. Despite its advantages, the model is not as popular as the proportional odds model because the parameters are more difficult to estimate due to the intrinsic nonlinearity caused by the predictor's product of parameters. The parameter estimates, on the other hand, can be calculated using the standard maximum likelihood (ML) method [24] by imposing the monotone non-decreasing constraint via the parameterization described by Arnold and Pledger (2016).

The following table shows the summary of the variables used for this study.

Table 1. *Definitions, measurements, and hypotheses of the variables used in the study.*

Variables	Measurements	Expected effect
Dependent variables		
Food and nutrition security	1 if secure and 0 otherwise and, 1 if low, 2 if medium and 3 if high in nutritional status	
Independent variables		
Age	Age of head in years	+/-
Gender	1 if male-headed, 0 if Female-headed	+
Family size	Family size in numbers	+
Land area	Cultivated land area in hectors	+
Education	Education of head grade completed	+
Training	1 if trained 0 otherwise	+

Variables	Measurements	Expected effect
Extension	Number of contact with extension	+
Market distance	Distance to market in kms	-
Climate information	1 if accessed 0 if not	+
Perception climate change	1 if perceived 0 otherwise	+
Training on land mgt	1 if participated 0 otherwise	+
Livestock holding	Total livestock holding in TLU	+
Social memberships	1 if member 0 if not	+
Market information	1 if accessed 0 if not	+
Soil fertility status	1 if fertile 0 otherwise	-
Non/off- farm income	1 if accessed 0 if not	+
Access to finance	1 if accessed 0 if not	+

3. Results and Discussion

This chapter presents the results of descriptive statistics and econometric models used to address the objectives of the study.

3.1. Descriptive Statistical Results

Based on the variables used, the descriptive statistics of household characteristics were presented as continuous and categorical descriptive results. The sample households in this study were described using both continuous and discrete variables. Tables 2 and 3 show the mean differences in socioeconomic variables across nutritional status groups of sample households in the study area.

3.1.1. Descriptive Results for Sample Households' Continuous Variables

Family size**:** According to the study results, the average family size among low, medium, and high nutritional status were found to be about 6, 6.4, and 5 persons, respectively. The mean comparison results among the three groups showed that there is a statistically significant mean difference among the groups in terms of family size. This indicated that the sample households with fewer family sizes were in a higher nutritional status.

Age of the household head: The average age of the total sample household was found to be 39 years, whereas 20 years and 70 years are the minimum and maximum years of age. The average age for low, medium and high nutritional status was found to be 40, 37, and 39 years, respectively. From the F statistical analysis performed, it is found that there is a statistically significant difference in the mean age of the household heads among the groups of nutritional status.

Level of education: The average educational level of the total sample household was found to be 3.4 school grades. Comparing the sample households' educational levels among the groups of nutritional status, the study found that the average years of educational level for low, medium, and high nutritional status was 2.8, 3.4, and 4.17 years, respectively. From the F-test statistical analysis performed, it was found that there is a statistically significant difference in the mean level of education of the household heads among the groups of nutritional status at a 5 percent probability level.

Livestock holdings: The mean livestock holding in Tropical Livestock Unit (TLU) for the sample household was found to be 2.57. The average livestock holding for low, medium, and high nutritional status households were found to be 2.08, 2.69, and 2.89 TLU, respectively. The F-test results of the group mean difference comparison indicated that there is a statistically significant mean difference among the three groups at a 1 percent probability level. This shows that more livestock holding households were in better nutritional status than fewer livestock holding households (Table 2).

Distance to whether road**:** Market access is a determinant of the profitability and sustainability of agricultural products, or it serves as a proxy for agricultural marketing services. The average distance in minutes (walking on foot) between the sample households or villages and the main road was found to be 33.8 minutes. Similarly, the average distance from the main road for households with low, medium, and high nutritional status was found to be 31.7, 29.8, and 33.8 minutes, respectively. The F-test results of the groups' mean difference comparison revealed a statistically significant mean difference in terms of distance from the main road among the three groups at a 5% probability level.

Total farm income: The total sample household's average farm income was found to be 27797.2 Ethiopian Birr (ETB). The farm income and nutritional status of the sample households were compared. According to the findings, the average annual farm income for people with low, medium, and high nutritional statuses was 23029.4, 25867.5, and 37956 ETB, respectively. The F-test statistical analysis revealed that there is a statistically significant difference in the mean level of the annual income of household heads among nutritional status groups at a 5% probability level.

An analysis of the cultivated land area, extension, labor, and off/non-farm income showed an insignificant figure, i.e., showed no meaningful differences among the low, medium, and high-level nutritional status households (See Table 2).

Table 2. *Descriptive statistical results for sample household continue variables.*

Variables	Low	Medium	High	All sample	F- Value
	Mean	Mean	Mean	Mean	
Age	40	37.6	39.5	38.78	2.84*
Family size	5.9	6.4	5.8	6.19	2.41*
Cultivated	0.506	0.484	.487	0.4903	0.07
Livestock	2.08	2.69	2.89	2.57	5.32***
Labor	203	216	209	211.7	1.09
N/oF. income	1157.3	1083.38	723.45	953.09	0.44
Extension	3.4	3.6	3.7	3.6	0.44
Education	2.8	3.4	4.17	3.4	4.14**
Crop income	18674.2	23376.9	16459.2	23679.2	4.82**
Livestock inco	4236.9	3983.8	4290.01	4117	0.21
Farm income	23029.4	25867.5	37956	27797.2	3.51**
Weather road dist	31.7	29.80	35.7	33.83	3.38**

Source: Own computation results,** and *** means significant at 5% and 1%, respectively.

3.1.2. Descriptive Results of Household Dummy Variables

Membership in cooperatives: According to the survey results, 48.6 percent of the total sample was found to be a member of a cooperative or farmer group, while the remaining 51.4 percent was not a member of a cooperative. A comparison of nutritional status groups revealed that among those who had participated in cooperatives, approximately 11.1 percent, 24.1 percent, and 13.4 percent of the households were in low, medium, and high nutritional status, respectively. The chi-square test revealed a statistically significant mean difference in the membership status of the household head among the three groups. This indicates that participant households had a better nutritional status than nonparticipant households.

Farmers' training: According to the findings of the study, 65.5 percent of the total sample households participated in the training for farmers provided by development agents, while the remaining 34.5 percent did not. A comparison of nutritional status groups reveals that approximately 14.1, 34.3, and 17.1 percent of the households participating in the farmer training program are found to be in the low, medium, and high nutritional status, respectively. The chi-square test reveals a statistically significant mean difference in household head training between the three groups. This demonstrates that participating households (in the farmer training) had better nutritional status than non-participating households.

Technical advice on land management: According to the study's findings, 52.9 percent of the total sample households received technical advice on sustainable land management, while the remaining 48.6 percent did not. When comparing nutritional status groups, approximately 17.6, 30.4, and 16.5 percent of the households were found to be in low, medium, and high nutritional status, respectively, and these had received technical advice on land management. Similarly, the chi-square test revealed a statistically significant mean difference in access to technical advice among the three groups. This means that households who received technical advice on land management had better nutritional status than those who did not.

Access to market information: According to the study findings, 63.8 percent of the total sample household had access to market information, while the remaining 36.2 percent did not. Around 14.5 percent, 31 percent, and 18.2 percent of those with access to market information had low, medium, or high nutritional status, respectively. The chi-square test revealed a statistically significant mean difference in access to market information among the three groups. This demonstrates that households that had access to market information had better nutritional status than households that did not. The chi-square test revealed a statistically significant mean difference in market information among the three groups at a 1% level.

Access to climate change information: According to the findings of the study, 64.2 percent of the total sample households had access to the necessary climate change information, while the remaining 35.8 percent did not. When we compare nutritional status groups, we find that approximately 15.2 percent, 30.4 percent, and 18.7 percent of the households were in low, medium, and high nutritional status, respectively. The chi-square test revealed a statistically significant mean difference between the three groups in terms of household head access to climate change information. This demonstrates that households with access to climate change information had better nutritional status than households without access.

Perception about climate change: According to the data obtained, 64.4 percent of the total sample households were aware of climate change, while the remaining 35.6 percent were not. The comparison across nutritional status groups revealed that among those who were aware of climate change, approximately 117.6 percent, 30.4 percent, and 16.5 percent of the households were in low, medium, and high nutritional status, respectively. The chi-square test revealed a statistically significant mean difference between the three groups in terms of household head climate change awareness. This demonstrates that households who were aware of it had better nutritional status than those who were not.

Table 3. *Descriptive results for the sample household dummy variables.*

Variables		Low nutrition		Medium		High		Total		X^2 value
		Numb	%	Numb	%	Numb	%	Numb	%	
Mkt info	No	54	11.7	95	20.6	18	3.9	167	36.2	
	Yes	67	14.5	143	31.0	84	18.2	294	63.8	20.340***
	Total	121	26.2	238	51.6	102	22.1	461	100	
Membership status	No	70	15.2	127	27.5	40	8.7	237	51.4	
	Yes	51	11.1	111	24.1	62	13.4	224	48.6	8.444**
	Total	121	26.2	238	51.6	102	22.1	461	100	
Technical advice land managemen	No	40	8.7	98	21.3	26	5.6	164	35.6	
	Yes	81	17.6	140	30.4	76	16.5	274	64.4	11.965***
	Total	121	26.2	238	51.6	102	22.1	461	100	
Training on irrigation	No	40	8.7	98	21.3	26	5.6	164	35.6	
	Yes	81	17.6	140	30.4	76	16.5	274	64.4	12.837***
	Total	121	26.2	238	51.6	102	22.1	461	100	
Access to climate change info	No	51	11.1	98	21.3	16	3.5	165	35.8	
	Yes	70	15.2	140	30.4	86	18.7	296	64.2	23.072***
	Total	121	26.2	238	51.6	102	22.1	461	100	
Farmers Training	No	56	12.1	80	17.4	23	5.0	159	34.5	
	Yes	65	14.1	158	34.3	79	17.1	302	65.5	13.963***
	Total	121	26.2	238	51.6	102	22.1	461	100	
Perception of climate change	No	40	8.7	98	21.3	26	5.6	164	35.6	
	Yes	81	17.6	140	30.4	76	16.5	274	64.4	8.119**
	Total	121	26.2	238	51.6	102	22.1	461	100	

Source: own survey results, 2021. ***, ** means significant at 1% and 5% probability level, respectively.

3.2. Food and Nutrition Situation of the Sample Household

Low food diversity and malnutrition are most prevalent in Ethiopia with significant variability between urban and rural areas, across regions, and in other social and economic aspects [25, 26] and in all agricultural seasons [27]. Other studies examining food, therefore, the state of healthy eating in Ethiopia examined energy intake without the slightest attention to dietary and nutritional adequacy. Some authors used the proportion of household food variants as an agent for access to nutrients without measuring nutritional deficiencies [27]. This may be due to a lack of information on food consumption at the individual level, especially due to the capitalization of representative samples at the national level. However, recent research suggests that home-level data may provide another useful way to draw more policy-related information about structural defects (in) [28].

Therefore, to better understand food and nutrition problems and to identify potential intervention strategies, the emerging approach is to understand food as a system, taking into account food supply chains, food chains, and consumer behavior [29]. For example, based on survey data from rural homes in the East Hararghe Zone in Ethiopia, [30] found that households relied heavily on the market to supplement their food production and that land size and farm income were closely linked to food consumption. This means that improving the nutritional status and nutrition of people is partly dependent on other components of the food system. Therefore, the nutrition system approach can help to identify the problem in the context of nutrient acquisition, facilitate the establishment, and provide a clear understanding of energy interactions between the various components of the diet system including production, processing, distribution, and marketing, restaurants and consumer behavior in Ethiopia [31].

For a similar reason, in this study, household food security was assessed by analyzing household food calorie consumption within 7 days using data on the food type and amount consumed. The household food consumption for 7 days was converted into calories, then the calories were divided by the number of Adult Equivalents (AE) in the household, and then the results were again divided by 7 days which, ultimately, resulted in on-average calories consumed per AE per day in a given household. Based on the result, the households were categorized into food secure and food insecure which is the minimum calories required per AE per day and 2550kcal consumption per adult equivalent per day as cut-off points or the daily minimum subsistence requirement of 2550kcal per AE which is set by the Ethiopian Government [32]. Therefore, based on 2550kcal as crosscut, the study result indicated that 63.1 percent of the total sample household was found to be food secured and the rest of 36.9 percent was not.

Table 4. *Household-level food security status of sample households.*

Food security status	Number	Percent
Otherwise	170	36.88
Secure	291	63.12
Total	461	100.00

Sources: own survey, 2021.

Household-level nutritional status

In addition, the household's nutritional status was measured by using a household dietary diversity score. Data on household dietary diversity was collected using the 24-hour recall method, and the household dietary diversity score was calculated by summing the number of food groups consumed by the household as a whole. However, food

consumed outside the home or which was not prepared in the respective home of the household was not included. Accordingly, the results indicated that 54.01 percent and 18.22 percent of the total sample households were found in the medium and high nutritional categories, respectively, and the rest of the 27.77 percent was in the low nutritional level household category. Therefore, taking 2550kcal as the crosscut, the result indicated that 63.1 percent of the total sample household was food secured while the rest of 36.9 percent was not food secured.

Table 5. *Household-level nutritional status of sample households.*

Nutritional status	Dietary diversity	Number	In percent
Low	<=3	128	27.77
Medium	>3 and <=6	249	54.01
High	>6	84	18.22
Total	12 Food groups	461	100.00

Source: own survey results. 2021.

3.3. Econometric Model Results

This section presents the results of the determinants of the study outcome variables. In this study, household-level food and nutrition security status were the outcome variables of key interest. Therefore, the results of logistic regression and ordered logit models that were employed to identify the determinants of household food security status and nutritional level are presented below.

3.3.1. Determinants of Household Food Security Status

The logistic regression model was used to estimate household-level food security status, and the results of the logistic regression model are presented in this section, which is used to identify the determinants of farm households' food security status in the study area. As previously stated, the dependent variable in this model is a binary variable indicating whether or not the household was food secure. STATA 14.2 computing software was used to estimate the model. The logit model's dependent variable is the farm household's food security status, which takes a value of 1 if the household is food secure and 0 otherwise.

Before running the logit model, the Variance Inflation Factor (VIF) was used to see if there was a strong multicollinearity problem among the explanatory variables. As a result, no explanatory variable was removed from the estimated model because the VIF results revealed no serious concern of multicollinearity (vif=10). The Breusch-Pagen test was also used to assess heteroscedasticity. As a result of this test, the existence of heteroscedasticity in the data was rejected (p= 0.5625). There was no evidence of a violation of the IIA assumption. The results of the omitted variable test also resulted in the acceptance of the null hypothesis of no omitted variable, as (p=0.6123).

According to the estimated coefficients, seven explanatory variables have a significant influence on food security status: educational level, social membership status, farm income, farmer training, technical advice, livestock holding, and climate change information. In other words, these were significant variables that influenced household food security status and, as a result, are discussed in greater detail below.

Education: This variable was found to be positively and significantly related to household-level food security status at a 1% probability level. The odds ratio of 1.116 implies that other things are constant, the odds ratio in favor of being food secure increases by a factor of 1.116 as the education level of the household head increases by one year. Educated farmers are more likely to use improved farming practices and fast in implementing modern technologies. This result is consistent with the findings of [33, 34, 38, 39].

Farm income: At a 1% probability level, this variable was found to have a positive and significant influence on food security status. The odds ratio of 1.71 for total farm income implies that, if all else remains constant, the odds ratio in favor of food security increases by a factor of 1.71 as farm household income rises by one Ethiopian Birr. Agricultural productivity is the most important factor that all producers worry about and invest heavily in order to protect and maintain farm production. This finding is consistent with those of [35, 36, 38, 39].

Farmer's training: This variable was hypothesized to positively influence household food security status, and it was found to be positively and significantly related to the likelihood of being food secure at a 1% significant level. The odds ratio of the variables indicated that, if all else remains constant, the probability of the farm household being food secure increases by 2.05 for the farm household that received farmer training. Farmers' ability and awareness in adopting and expanding productivity-enhancing agricultural practices and technologies improve as a result of training. This result agrees with the findings of [33, 34].

Livestock holding: At a 5% probability level, the results also revealed that livestock ownership has a positive and statistically significant effect on farm household food security status. Its odds ratio effect shows that livestock ownership increases the likelihood of being food secure by 1.14 when all other variables are held constant, and as livestock ownership increases by one tropical livestock unit. The implication of this finding is that farming, like any other business, necessitates financial investment. Livestock assists farm households in producing food and income for their families. Furthermore, when there is a problem of food insecurity, farm households may sell their livestock as a coping strategy. Livestock enterprises could also be used as a supplement to crop production to increase productivity, increasing farm inputs. This result is consistent with the findings of [35, 36].

Technical advice on land management practices: This variable was hypothesized to positively influence household food security status, and it was found to be positively related to the likelihood of being food secure at a 5% significant level. Other things being equal, the odds ratio of the variables indicated that as the farm household accessed technical advice on land management practices, the probability of the household being food secure increased by 1.56. This is because technical advice improves farmers' ability and

awareness in the adoption and implementation of land management practices, which increases farmland productivity in response to the effects of climate change. This result agrees with the findings of [33, 34].

Climate change information: At a 1% probability level, this was found to be positively and significantly related to the likelihood of being food secure. The reason for this could be that having information on the fragmentation of cultivated land and the effects of drought on crop and livestock production allows producers to develop their own alternatives in response to the risks that climate change may bring. If all other factors are held constant, the odds ratio in favor of food security increases by a factor of 1.91 as the household gains access to climate change information. This result agrees with the findings of [37].

Social organization membership status: At a 1% probability level, this variable has a positive and significant relationship with the likelihood of being food secure. The possible justification is that farmers with positions in social organizations are more likely to obtain various information that helps producers use as production inputs because the social organization is a place where model farmers, farmer groups, elders, and others get together to exchange and share information. The odds ratio of the variables indicated that other things remained constant; the odds ratio in favor of food security increased by a factor of 2.23 as farmers participated in social organizations. This result agrees with the findings of [33, 34].

Table 6. *Determinants of sample, household level, food security status.*

Variables	Odd ratio	Coefficient	SD	P>|z|
Family size	.9973109	-.0026927	.0440919	0.951
Age	.989195	-.0108638	.0098026	0.268
Education	1.126969***	.1195314	.0342057	0.001
Extension	.9907066	-.0093369	.0417675	0.823
Non/off farm income	.792959	-.2319837	.3129583	0.459
Training	1.565827*	.4484141	.2300882	0.051
Farm income	1.709188***	.5360181	.1258957	0.001
Training water mgt	1.398957	.3357268	.2228298	0.132
Technical advice	1.564407**	.4475068	.224169	0.046
Livestock holding	1.121365**	.1145468	.0579423	0.048
Memberships	2.231258***	.8025654	.2291642	0.001
Mkt info	1.369125	.3141715	.2333449	0.178
C. change info	1.907276***	.645676	.23494	0.006
Perception	1.271376	.2400997	.2341778	0.305
W/Road dist	.9939451	-.0060733	.0079469	0.445
Land area	.9329686	-.0693838	.2180447	0.750
Constant	.0019141	-6.258532	1.364714	0.001
Number of obs = 461				
LR chi2 (16) = 97.55, Prob > chi2 < 0.0001				
Log likelihood = -248.85536, Pseudo R2 = 0.1639				

Sources: Own survey results, 2021. ***,** and * means significant at 1%. 5% and 10% probability levels, respectively.

3.3.2. Determinants of Household-Level Nutritional Status

This study employed both logit and ordered logit models to estimate household determinants of nutritional status. Looking at the estimated coefficients of the ordered logit model, the results indicated that the household level nutritional status was significantly influenced by seven explanatory variables, namely: age of household, head, membership in cooperatives, education of the head, market information, soil fertility status, livestock holding and whether road distance. Each is discussed next.

Age of the household head: At a 5% probability level, this variable was positively related and statistically significant with the level of nutritional status. The marginal effects of 0.003, 0.001, and -0.002 for household head age imply that assuming all else is constant, the probability of being in the low, medium, or high nutritional status increases and decreases by 0.3, 0.1, and 0.2 percent, respectively, as household head age increases by one year. The possible reason is that younger people are more aware of modern technologies and are quicker to adopt new technologies that would increase farm production, as well as having easier access to production information than their older counterparts. This result agrees with the findings of [40, 41].

Education of head**:** At a 1% probability level, this variable has a positive and significant relationship with the probability of household-level nutritional status. Keeping other factors constant, the marginal effects of 0.023, 0.007, and 0.016 of education level indicated that the probability of being in low, medium, or high nutritional status decreases and increases by 2.3 percent, 0.7 percent, and 1.6 percent, respectively, as the educational level of the household head increases by one year. The reason for this is that households with formal education are more likely to understand the importance of crop diversification and consuming a diverse diet. They might as well be aware that by doing so, they reduce both production and health risks. This result agrees with the findings of [40, 41].

Soil fertility status: At a 5% probability level, this variable has a positive and significant relationship with the likelihood of household-level nutritional status. Keeping other factors constant, the marginal effects of 0.070, 0.024, and 0.047 of

soil fertility status indicated that the probability of being in the low, medium, or high nutritional status decreases and increases by 7.0, 2.4, and 4.7 percent as the household farmland are fertile. The possible justification is that farmers with fertile farmland have a greater chance of producing high nutritional crops and generating higher farm incomes, which increases the likelihood of being in high nutritional status. This result agrees with the findings of [36].

Membership of the head of cooperatives: Participation of household heads in cooperative or farmer groups is found to have a significant and positive impact on the nutritional status of the household at a 5% probability level. Keeping other factors constant, the marginal effects of 0.085, 0.026, and 0.058 of membership indicated that the probability of being in the low, medium, or high nutritional status decreases and increases by 8.5, 2.6, and 5.8 percent as the household participate in a local cooperative or farmers groups. This means that rural households that are members of farmer groups and cooperatives are more likely to obtain information on nutrition quality and the importance of dietary diversity, particularly for women and children's health and development. This result agrees with the findings of [41-43].

Livestock holding: At a 5% probability level, this variable has a positive and significant relationship with the likelihood of household-level nutritional status. Keeping other factors constant, the marginal effects of 0.020, 0.006, and 0.014 of livestock holding indicated that the probability of being in the low range was low. As household livestock holdings increase by one tropical livestock unit, medium and high nutritional status decreases and increases by 2.0, 0.6, and 1.4 percent, respectively. The reason for this is that farmers with livestock in eastern Ethiopia primarily consume a variety of locally produced beverages made primarily of milk, water, and salt. As a result, livestock serves as a proxy for milk, increasing households' access to dietary diversity. This finding is consistent with the findings of [33, 40, 42].

Market information: At a 5% probability level, this variable has a positive and significant relationship with the likelihood of household-level nutritional status. The marginal effects of 0.082, 0.031, and 0.052 for market information indicated that, while other factors remained constant, the probability of having a low, medium, or high nutritional status decreased and increased by 8.2 percent, 3.1 percent, and 5.2 percent, respectively, as the households accessed the market information. Market information serves as a proxy for agricultural and food crop price information, and it improves access to nutritional foods by lowering both information searching and time costs. This finding is consistent with the findings of [44-46].

Distance to whether road: This variable was found to be negatively and statistically significantly related to the nutritional status of the household at a 1% probability level, as well as negatively related to the probability of being in a high nutritional status at a 1% probability level. The marginal effects of 0.003, 0.001, and 0.002 for whether road distance implies that assuming all other variables remain constant, the probability of being in the low, medium, or high nutritional status increases and decreases by 0.3, 0.1, and 0.2 percent as the distance to weather road increases by one unit. Whether road distance is considered because of its relationship with market transportation costs in accessing both the market's input and output. This result agrees with the findings of [41, 44, 45].

Table 7. *Determinants of sample, household level, nutritional status.*

Variables	Ordered logit results for Households nutritional status					
	Low		Medium		High	
	ME	S. E	ME	S. E	ME	S. E
Famsize	-0.004	0.007	0.001	0.002	0.003	0.005
GEND	-0.032	0.045	0.012	0.018	0.021	0.027
age1	0.003**	0.002	-0.001*	0.001	-0.002**	0.001
edu1	-0.023***	0.005	0.007***	0.003	0.016***	0.004
In	-0.019	0.021	0.006	0.007	0.013	0.014
NEXT	-0.007	0.007	0.002	0.002	0.005	0.004
MSH	-0.085**	0.035	0.026**	0.013	0.058**	0.024
TRIN	-0.054	0.039	0.019	0.015	0.035	0.024
DAIR	-0.039	0.036	0.012	0.012	0.027	0.025
LSHH	-0.020**	0.009	0.006*	0.003	0.014**	0.006
SFS	-0.070*	0.036	0.024*	0.014	0.047**	0.023
MKTIN	-0.082**	0.039	0.031*	0.018	0.052**	0.023
CCINFO	-0.007	0.038	0.002	0.013	0.005	0.026
PCC	-0.015	0.037	0.005	0.013	0.010	0.025
DWR	0.003***	0.001	-0.001**	0.001	-0.002***	0.001
Cultland	-0.020	0.031	0.006	0.010	0.013	0.021
Number of obs = 461 LR chi2 (16) = 68.88, Prob > chi2 < 0.0001 Log likelihood = -421.94926, Pseudo R2 = 0.0755						

Sources: Own survey results, 2021. *** and ** means significant at 1% and 5% probability levels, respectively.

4. Conclusions and Recommendations

The purpose of this study was to identify the drivers of household-level food and nutrition security in three districts of Oromia, Ethiopia's East Hararghe Zone. For data extraction, the study used both primary and secondary sources. A semistructured questionnaire was used to collect primary data from 461 sample households. Secondary data were gathered from various sources to supplement the primary data. Finding reliable information on food and nutrition status at the household level was deemed critical. As a result, the data was analyzed using logistics and ordered logit models.

The 24-hour recall method was used to collect data on household dietary diversity, and the household dietary diversity score was calculated by adding the number of food groups consumed by the household as a whole, rather than by a single member, in the 24 hours preceding the survey. Food consumed outside the home that was not prepared in the home, on the other hand, was not included. The study found that 54.01 percent and 18.22 percent of the total sample household were in the medium and high nutritional status categories, respectively, while the remaining 27.77 percent were in the low nutritional status category. Therefore, based on a 2550kcal crosscut, 63.1 percent of the total sample household was found to be food secured and the rest of 36.9 percent was food insecure.

Similarly, the estimated coefficients of the ordered logit model revealed that eight explanatory variables, namely education level, social membership status, farm income, farmer training, extension contact, technical advice, livestock holding, and climate change information, have a significant influence on food security status. These are important factors that influence food security at the household level. Similarly, the estimated coefficient results showed that seven explanatory variables, including the age of the household head, membership in cooperatives, education of the head, market information, soil fertility status, livestock holding, and distance to the main road, have a significant influence on household-level nutritional status.

To that end, the following policy recommendations are made based on the study's findings. Increasing the accessibility of quality information to smallholder farmers will, first and foremost, increase household food and nutrition security, because the effectiveness of food and nutrition security necessitates some knowledge and skills. Second, improving farmers' education by providing training opportunities is critical to long-term household food and nutrition security. Finally, it is critical to empower smallholder farmers so that they can access extension services. These are some of the most important policy measures that will boost agricultural productivity.

Authors Contributions

Beyan contributed to all aspects of this paper including data collection, data entering, analyzing, interpreting, and writing of this manuscript. Jema and Mengistu contributed by commenting on the aspects of this paper from data analyzing, interpreting, and writing up of the final report.

Funding

The preparation of this research manuscript was funded by the College of Agricultural and Environmental Sciences of Haramaya University, Ethiopia. However, there is no direct fund for the publication of this paper.

Declarations

Ethics Approval and Consent to Participate

Not applicable.

Data Availability

The author confirms that the data will be available based on the request.

Competing Interests

The authors declare that they have no competing interests related to the publication of this research manuscript.

Acknowledgements

The authors acknowledge the College of Agricultural and Environmental Sciences of Haramaya University for facilitating this research study.

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