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Determinants of household-level food and nutritional security in urban vegetable producers: A case study

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Abstract

As the world population keeps growing, the demand for food and nutrition security is increasing; requiring sustainable practices that boost food production with environmental preservation is a current world issue. Hence, determining the factors influencing the household food and nutrition security of urban vegetable producers in Chelenko and Kullubi cities in the East Hararghe Zone, Ethiopia, was carried out in this study The research collected information from both primary and secondary data sources. A random sampling technique was used to collect primary data from 232 sampled household respondents. As a result, the data was analyzed using binary logistic and ordered logit models to determine the factors influencing household food and nutrition security, respectively. The descriptive statistics result revealed that 45.69% of households are food secure and the rest 54.31% are food insecure. Similarly, it was found that 40.09%, 33.19%, and 26.72% of the total sample households were in the low, medium, and high nutritional status categories, respectively. The results from the estimated coefficients of the binary logit model revealed that the households with factors such as the sex of household head, cultivated land size, total livestock owned, access extension service, more farming experience, participation in training, and membership in a cooperative were more likely to be food secure. The result of the estimated coefficients of the ordered logit regression model showed that the sex of the household head, cultivated land size, total livestock, extension service, access to credit, off-farm activity, and income have a significant influence on the household-level nutrition security status. While the large family size and dependent ratios were negatively associated with food and nutrition security status. Thus, policymakers should consider the above-mentioned variables to increase agricultural productivity to improve their food and nutrition security status.

Keywords: binary logistic, Ethiopia, food and nutrition security, ordered logit model, vegetable producers

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Introduction

As the world population keeps growing, the demand for food and nutrition security is also on the rise, addressing sustainability requires a focus balance between the need for efficient practices and environmental considerations. The rapid growth of cities area significant pressures strain on the food system supply and urban environment, particularly in developing cities, by generating great challenges in socioeconomic and demographic factors that complicate resource use and management (Güneralp *et al.*, 2018; Ranagalage *et al.*, 2021). Additionally, the rising challenge posed by climate change threatens both urban and rural farming. It also puts food systems at risk, exacerbating hunger and malnutrition, issues that have affected a significant portion of the world population for years (Mumed *et al.*, 2023), this results in an increase in the level of food and nutritional insecurity in urban and peri-urban household framer (Khumalo and Sibanda, 2019). This increasing emergency highlights the urgent requirement for innovative and improve the existing method to ensure food security and the protection of our ecosystem.

In many cities in developing states, urban farming is being implemented as a solution to combat urban poverty and food insecurity. It is mainly practiced by the urban poor as a crucial livelihood strategy to supplement diets and incomes (Galt *et al.*, 2014). Agriculture (urban farming hereafter) is an important strategy for increasing food production and distribution, improving access to nutritious food, and promoting the sustainability of urban environments. The primary focus is on local food production, generating income, improving food security, and creating employment, ultimately helping to alleviate poverty. Whether the potential urban agriculture may enhance urban livelihoods has been a widely debated topic, particularly among those emerging patterns with the simultaneous rise of urban population and urban food and nutrition insecurity (Davies *et al.*, 2021).

Urban agriculture (UA) has the potential to enhance food security by involving activities such as cereal crop cultivation, horticulture, and animal production (Poulsen *et al.*, 2015). It involves individuals or households growing crops or small ruminants on small plots near their homes or on urban farms within city limits (Walters and Midden, 2018). Many cities in Sub-Saharan Africa follow traditional food production methods, focusing on growing crop vegetables and fruits that are in high demand in the domestic market, easy to handle, and can be cultivated in small spaces. Thus, by producing their food and earning income, individuals can help reduce food and nutrition insecurity (Atinafu *et al.*, 2022).

Today, urban agriculture is becoming a crucial lifeline for many vulnerable households in African cities, providing an essential source of food security as incomes decline. Despite many African governments prioritizing rural agriculture, they are neglecting and underestimating UA in urban areas. Encouragingly, some governments are now taking steps to address this oversight by establishing agencies dedicated to managing and promoting UA in urban areas (Abera *et al.*, 2017).

In Ethiopia, UA provides a unique opportunity for urban households to diversify employment, income, and dietary options, thereby contributing to the livelihoods of urban residents (Yalew *et al.*, 2020). In Ethiopia, urban agriculture involves cultivating crops and raising livestock, including the production of milk, meat, and eggs, within urban centres and their surroundings (Workineh, 2017; Gibtan *et al.*, 2023). The majority of urban agriculture (UA) activities revolve around the production of high-value vegetable crops that play a crucial role in reducing poverty in Ethiopia's towns and cities (Yalew *et al.*, 2020). These crops are primarily grown by urban farmers for both personal consumption and income generation (Girma *et al.*, 2019). Therefore, efforts to increase vegetable production in urban areas warrant further attention as a potential means of addressing this. The idea of producing food in cities to support food security.

Recognizing urban agriculture's potential, the Ethiopian government prioritizes it for food security and environmental protection (Serbessa *et al.*, 2023; Serbessa, 2024). Recently, the government launched initiatives such as the Ye Lemat Trufat (Abundant Food) program aimed at achieving food self-sufficiency at both household and national levels. Despite these efforts, UA remains largely under-researched, receiving little attention from scholars (Abera *et al.*, 2017; Yalew *et al.*, 2020). Therefore, there is a pressing need for empirical research to investigate the scale and impact of UA in Ethiopian cities, which can inform policymakers and urban planners while stimulating further academic inquiry.

A few studies have explored urban agricultural practices in Ethiopia, focusing on various urban areas. Abera *et al.* (2017) examined its role in enhancing livelihoods in Addis Ababa, similarly Ayenachew and Abebe (2024) highlighted challenges in urban farming. Research by Milkias Degefu (2024) in Ambo and Waliso towns, as well as Alemu *et al.* (2024) in Addis Ababa, has also addressed urban agricultural practices, challenges, and opportunities. Moreover, studies by Jeneral Kibret (2022) and Nigus *et al.* (2024) investigated the determinants of adopting urban agricultural practices and their contributions to household livelihood. The post-studies on urban agriculture primarily focus on its contribution to household income and look at the factors that affect household practices in urban agriculture while ignoring the problem of food and nutrition security altogether in their research. These studies underscore the varying socio-economic backgrounds and resource challenges faced by urban vegetable producers, pointing to the need for further research across different cities of Ethiopia.

In the Chelencko and Kullubi cities of the East Hararghe Zone, urban households frequently experience significant declines in productivity due to human-induced and natural factors, leading to food and nutrition insecurity (AOEHZ, 2019). The local government authorities in the studied areas have been actively promoting urban agriculture to enhance food security. To date, no empirical studies have thoroughly and comprehensively investigated the status and determinants of food and nutrition security to urban vegetable production in the study area. This study aims to address the research gap by offering current insights to measure household-level food and nutrition status and determinants of the factors influencing the household-level food and nutrition security status of urban vegetable producers in Chelencko and Kullubi cities in the East Hararghe Zone, Ethiopia.

Materials and Methods

Description of the Study Area

The study was carried out in the Chelencko and Kullubi cities, located in the East Hararghe zone, Oromia National Regional State, Ethiopia. Chelencko and Kullubi are located 435 km and 448 km east of Addis Ababa and 82 km and 69 km from Harar town, respectively. Chelencko town has a total population of 10,756, comprising 5,450 males and 5306 females, while Kullubi town has a total population of 6,464, with 3458 males and 3006 females (AOEHZ, 2019).

Geographically, Chelencko town lies between 09°23'30"N latitude and 41°33’30” E longitude, while Kullubi town lies between coordinates at 09°25'30"N latitude and 41°41’0”E longitude (Figure 1). The annual rainfall ranges from 600 mm to 900 mm, the temperatures range from 18 to 28℃ and the altitude ranges from 1400 to 2,800 m above sea level in both towns. The town is mainly characterized by highland Weynadega climatic conditions. Cereal crops like sorghum, maize, wheat, barley, and pulses as most commonly grown, followed by cash crops Khat and vegetables, and livestock species like cattle, goat, and sheep.

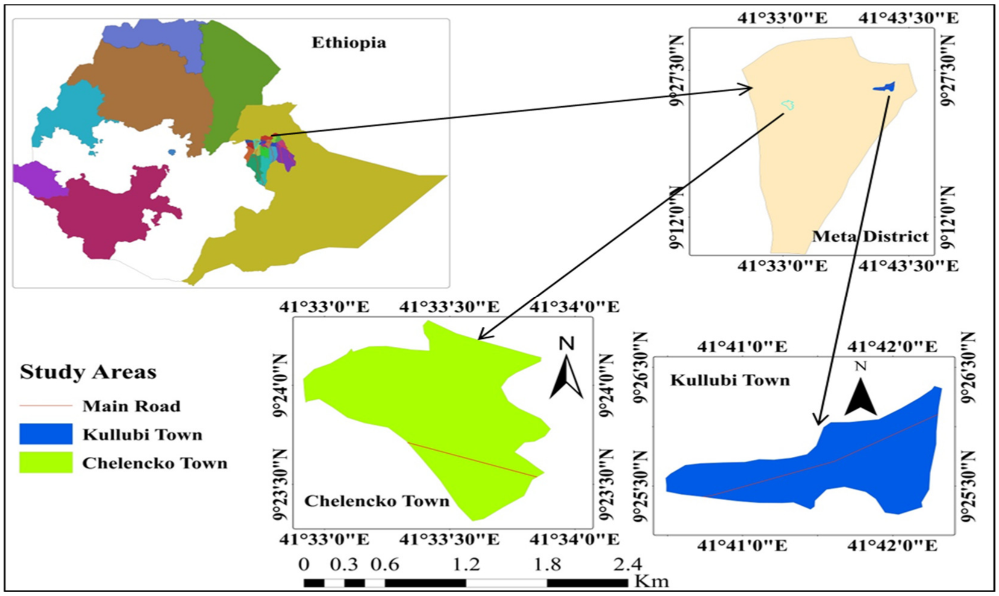

Figure 1. Geographical location and area where the study was carried out

Source and Method of Data Collection

For this study, both primary and secondary data were collected. Primary data was collected using trained enumerators and a survey schedule. A structured survey questionnaire was first prepped in English-language and then translated into Oromia, the region's native language, to ensure clarity and effective communication. The primary data was gathered from randomly selected sample respondents using structured questionnaires on urban vegetable production activity from sampled participant and non-participant households. The secondary data was gathered from various published and unpublished documents of the district's agricultural offices, governmental and non-governmental that are relevant for the general description and verification of the primary data. Data was collected through household surveys from 232 households to examine and measure the food and nutrition security attributes of these households.

Sampling technique and sample size

To select the sample households for this study, two cities Chelencko and Kullubi were randomly chosen from the East Hararghe zone. Based on discussions with the Zone's Office of Agriculture and aligned with the study's objectives, whole kebeles found in the two cities were chosen due to their potential for vegetable production according to the report (AOEHZ, 2019). From these, a random sample was selected for the study. Finally, the study involved randomly selecting 232 household heads and conducting interviews, with the sample proportionally distributed between the two cities to ensure balanced representation. The households were stratified into urban vegetable production participants (104) and non-participants (128).

Due to time and financial limitations, a 94% confidence interval with a 6% level of precision was utilized in order to calculate the size of the sample. The appropriate sample size was determined using a simplified formula by Yamane (1967):

$$n = \frac{N}{1 + N(e^2)}$$

$$n = \frac{1423}{1+1423(0.06^2)} = 232.4 = 232$$

The sample selected from each town was proportional to the number of participant and non-participant households and was determined using the following formula:

$$n_i = \frac{(N_i)(n)}{\sum N_i}$$

Where n_i is the sample to be selected from the i^{th} town; N_i= the total population living in i^{th} town; $\sum N_i$ = the summation of the population in the two towns; n = total sample size for the towns in the Meta district.

Methods of data analysis

To address the objective of the study and analyze the data, descriptive statistics and econometric methods were used. To determine the main factors that influence food and nutrition security, we used binary logit and ordered logit models, respectively.

Determinates of households' food security

The calorie food consumption information collected using the seven-day recall method on the food type and amount consumed was converted for food processing into calorie intake according to the recommended conversion by (EHNRI, 1998). Then the sum of calories was divided by the number of Adult Equivalents (AE) in the family size of the household, and then the results were divided by the last seven days which, ultimately, resulted in on-average calorie intake per Adult Equivalent (AE) per day in a given household. The quantity of food in the package is determined to satisfy the minimum calorie requirement, which is set at a minimum of 2,200 Kcal per day to ensure food security for an individual (UNDP, 2018). If the household whose daily calorie intake per AE is found to be greater than 2200 Kcal is said to be food security taking value 1, and otherwise food insecurity taking value 0. The subsequent step involves identifying the socioeconomic factors linked to food insecurity after categorizing the groups into food secure and food insecure. The study used a logit regression model to identify the main factors affecting food security in sample households, focusing on the dichotomous relationship between explanatory variables and dependent variable, household food security status, to determine whether a household is food secure or insecure.

In practical terms, the logit regression model according to Gujarati and Porter (2009) is defined as such:

$$P_i = prob(Y_i = 1|x_i) = \frac{1}{1+e^{-(\beta_0 + \beta_i x_i)}}$$

The equation can be simplified as

$$P_i = prob(Y_i = 1|x_i) = \frac{1}{1 + e^{-Z_i}}$$

$$P_i = prob(Y_i = 1|x_i) = \frac{e^{L_i}}{1 + e^{L_i}}$$

Where Pi is the probability that the ith given household is being food security.

Where $Li= Y_i$

$$Y_i = \beta_0 + \beta_i X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_i$$

1-Pi represents the probability of food insecurity

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

The ratio of the probability of household food security (Pi) to the probability of food insecurity ($1 - Pi$) defines the odds of food security (Y = 1) versus the odds of food insecurity (Y = 0), which can be expressed as odds = $Pi/(1 - Pi)$.

By taking the natural logarithm of both sides, we arrive at the prediction equation for individual households:

$$\frac{Pi}{1 - Pi} = e^{Z_i}$$

$$Y_i = Z_i = L_i = \ln\left[\frac{P_i}{1 - P_i}\right] = \beta_0 + \beta_i X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_i$$

$$Y_i = \beta_0 + \beta_i X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_i$$

Where: Yi is the log of the odds ratio (dependent variables), $\beta_1, \beta_2, \beta_3, \ldots, \beta n$ are the coefficients to be estimated, Xi are the vectors of explanatory variables and ε_i is the disturbance term.

Determinates of households' nutrition security

The nutritional status of a household was assessed using the household dietary diversity score (HDDS), ensuring its security and overall health. It is determined by the overall number of foods or food categories eaten during the period before the survey, typically within 24 hours. Including total dietary intake and diet quality, can assess overall food access (Leroy *et al.*, 2013). Therefore, to assess the quality of food intake among farm households, it is essential to evaluate dietary diversity, nutrient adequacy, and the consumption patterns of various food groups, providing a comprehensive understanding of their nutritional status, according to McGuir (2015) as a crosscut, Dietary diversity or food groups can be categorized based on the number of food types consumed into the following indicators: low dietary diversity (1-3) types, medium dietary diversity (greater than 3 but less than 6) types and high dietary diversity (greater than 6) types.

The study employed an ordered logistic regression model to analyze the factors that determine the nutritional security status of households. The dependent variable in this model is the household's nutrition security status, categorized based on dietary diversity levels. Households with a dietary diversity score below 3 are classified as having the lowest level of nutrition security, assigned a value of (1). Those with a dietary diversity score (greater than 3 but less than 6) are considered to have a medium level of nutrition security, assigned a value of (2). Finally, households with a dietary diversity score greater than 6 are classified as having a high level of nutrition security, assigned a value of (3). Therefore, as outlined by Greene (*2003*), the simplified version of the ordered logit regression model is presented to illustrate a simplified representation of the relationship between the independent variables and the ordered categorical dependent variable.

$$Y_j^* = X_{ij}\beta + \cup_{ij}$$

Where Y_j^* represents the unobserved latent variable (representing the underlying choice), X_{ij} represents the independent variables (explanatory variable), $\cup_{1j}$ is a random error term disturbance, β is a vector of coefficients to be estimated.

The observed level of nutrition security status outcome Y is determined by Y* represents the unobserved latent variable, crossing certain threshold values μ_j, where

$$Y_j = j \ of \ \mu_j < Y_J^* \leq \mu_{j+1}$$

$$Y_j = 1 \ if \ Y_j^* \ \leq \mu_1$$

$$Y_j = 2 \ of \ \mu_1 < Y_J^* \leq \mu_2$$

$$Y_j = 3 \ of \ \mu_2 < Y_J^* \leq \mu_3$$

The probability that an observation falls into one of the j-ordered categories is given by:

$$P(Y = j) = P(\mu_j < X_{ij}\beta + \cup_{ij} \leq \mu_{j+1})$$

The households are categorized based on their level of nutrition security: lowest level assigned Y = 1, medium level assigned Y = 2, and highest level assigned Y = 3.

Thus, the probability for each category Y= j is the difference between the cumulative probability evaluated at respective thresholds:

$$P(Y = j) = F(\mu_{j+1} - X_{ij}\beta) - F(\mu_j - X_{ij}\beta)$$

Where F(.) is the cumulative distribution function (CDF) of the logistic distribution, typically expressed as:

$$F(z) = \frac{1}{1 + e^{-z}}$$

Table 1. This is the standard simplified version of the ordered logit model

Variables	Types and Measurements	Expected Sign
Food security	1 if secure and 0 otherwise	
Nutrition security	1 if low, 2 if medium, and 3 if nutritional status	
Independent variables		
Age of respondent HH	Continuous (Years)	-/+
Sex of household head	Dummy (1 if male, 0 otherwise)	+
Household size	Continuous (person)	+
Educational level household	Continuous (Number of years)	+
Dependency ratio	Continuous (%)	-
Farming experience	Continuous (Number of years)	+
Access to Extension Service	Continuous (Number of day)	+
Distance from the nearest market	Continuous (minute)	-
Total livestock owned	Continuous (TLU)	+
Participation in non/off-farm	Dummy (1 if yes, 0 if no)	+
Access to credit	Dummy (1 if yes, 0 if no)	+
Training participation	Dummy (1 if yes, 0 if no)	+
Cultivated land size	Continuous (m^2)	+
Membership in cooperative	Dummy (1 if yes, 0 if no)	+
Access to improved vegetable seed	Dummy (1 if yes, 0 otherwise)	+
Income	Continuous (birr)	+

Ethical consideration

This study adheres to strict ethical principles to ensure participant protection and data integrity. Participants will provide informed consent, with all details about the study's purpose, procedures, and voluntary nature explained in local languages. Confidentiality and anonymity will be maintained, with data securely stored and used solely for academic purposes. The study does not harm participants, and cultural sensitivity will be observed during data collection. Prior approval for data collection will be obtained from local administrative offices and agricultural bureaus, aligning with Ethiopia's national research ethics guidelines. The researcher declares no conflict of interest, ensuring the study is conducted for academic purposes without commercial or political influence. The Ethiopia Social Sciences Study Ethical Review Board has reviewed and approved the research, which confirms compliance with all ethical standards.

Results and Discussion

Descriptive statistical of dummy variables

Access to credit: According to the findings of the study, 58.19% of the total sample households had access to credit from different organizations like save and credit associations and Agricultural cooperatives, while the remaining 41.81% did not. When we compare nutritional status among households showed that 20.26%, 17.67%, and 20.26% of households fell into low, medium, and high nutritional status categories, respectively. The Chi-square test showed a statistically significant difference in the mean access to credit between these groups based on the household head. This result indicated that households with access to credit are more likely to have better nutrition status compared to those not having access.

Table 2. Descriptive statistic of results for sample households' dummy variables (N=232)

Dummy variables		Low		Medium		High		Total		Chi²
		Num	%	Num	%	Num	%	Num	%	
Access to improved vegetable seed	No	47	20.26	33	14.22	33	14.22	113	48.71	1.68
	Yes	46	19.83	44	18.97	29	12.50	119	51.29	
	Total	93	40.09	77	33.19	62	26.72	232	100	
Sex of household head	Female	19	8.19	9	3.88	6	2.59	34	14.66	4.25
	Male	74	31.90	68	29.31	56	24.14	198	85.34	
	Total	93	40.09	77	33.19	62	26.72	232	100	
Membership in coop	No	48	20.69	32	13.79	19	8.19	99	42.67	6.74**
	Yes	45	19.40	45	19.40	43	18.53	133	57.33	
	Total	93	40.09	77	33.19	62	26.72	232	100	
Access to credit	No	46	19.83	36	15.52	15	6.47	97	41.81	10.9***
	Yes	47	20.26	41	17.67	47	20.26	135	58.19	
	Total	93	40.09	77	33.19	62	26.72	232	100	
Off-farm activity	No	48	20.69	33	14.19	20	8.62	100	43.5	5.79*
	Yes	45	19.40	45	19.0	42	18.10	132	56.5	
	Total	93	40.09	77	33.19	62	26.72	232	100	
Training participation	No	50	21.55	34	14.66	23	9.91	107	46.12	4.34
	Yes	43	18.53	43	18.53	39	16.81	125	53.88	
	Total	93	40.09	77	33.19	62	26.72	232	100	

Membership in cooperatives: According to the survey result showed that 42.67% of the total sampled households were active members of a cooperative, while the remaining 57.33% were not affiliated with any such cooperative (Table 2). A comparison of nutritional status groups revealed that among households who had participated in cooperatives, approximately 19.4 %, and 18.53% of the households were classified as having in low, medium, and high nutritional status, respectively (Table 2). The Chi-square test showed a statistically significant mean difference in cooperative membership status across these groups. This indicates that households involved in cooperative membership have better nutritional status than non-member households.

Off-farm activity: is becoming increasingly important for urban farmers seeking to improve their food and nutrition security under urban challenges. Among the households surveyed, 56.5% participated in these activities while the remaining 43.5% was not. A comparison of nutritional status across different groups indicated that 19.40%, 19.0%, and 18.10% of the households with low, medium, and high nutritional status, respectively, participated in off-farm activities. A statistically significant mean difference in the off-farm activity status between these groups was found by the Chi-square test. This showed that the households that had participated in an off-farm activity have had more nutritional status than those that had not participated (Table 2).

Descriptive statistic the results of continuous variables (N=232)

Household Size: The mean family size of the total sample households' respondent was found to be 6.47 persons (Table 3). The average household sizes for low, medium, and high nutritional status were determined to be about 7.08, 6.25, and 5.85 persons, respectively. The analysis from the F-test showed a significant difference in average family size among the three nutritional status groups, with a significance level of 1%. This showed that households with smaller family sizes had a greater nutritional status.

Dependency ratio: The finding of the study indicated that the mean total sample households' dependency ratio in the family was found 49.46%. The mean dependency ratios of family households for low, medium, and high nutritional status were found to be 66.22, 40.16 and 35.87%, respectively. The F-test of statistical analysis revealed a statistically significant difference in the family's dependency ratio between the nutritional status groups at less than 1% significance level. This indicated that households with a higher number of dependents may be less nutritional status.

Cultivated land size: The study showed that the average total sample households cultivated land size was found 2312.01 m^2. The average cultivated land size for low, medium, and high nutritional status was found to be 1758.58, 2715.65, and 2640.85 m^2, respectively. The F-test results showed that, at a significance level of less than 1%, there was a statistically significant mean difference in the size of the cultivated land between the nutritional status groups. This shows that the sample household with a significant amount of cultivated land had a nutritional status that was high (Table 3).

Total livestock: The mean livestock holding, measured in Tropical Livestock Unit, for the households included in the sample was found to be 2.85. The average livestock holding interim nutritional status was 1.97 for low, 2.95 for medium, and 4.06 for high nutritional status. The F-test indicated that there is a statistically significant difference in the means among the nutritional status groups at the 1% probability level. The data indicates that a greater proportion of livestock-holding households are in better nutritional status compared to those without livestock.

Table 3. Descriptive statistic the results of continuous variables (N=232)

Continuous variables	Mean of nutrition status				F-value
	Low	Medium	High	Total	
Household size	7.08	6.25	5.85	6.47	15.33***
Dependency ratio	66.22	40.16	35.87	49.46	9.17***
Cultivated land size	1758.58	2715.65	2640.85	2312.01	10.44***
Educational level	7.81	8.03	8.65	8.10	1.16
Total livestock	1.97	2.95	4.06	2.85	13.83***
Extension Service	1.58	2.23	2.45	2.03	7.3***
Farming experience	7.52	8.69	9.44	8.42	5.01***
Age of respondent	37.72	38.30	38.29	38.06	0.1
Distance to nearest market	28.92	29.27	27.35	28.62	1.04
Income	22880.78	29608.79	30651.17	27190.36	21.18***

Extension Service: According to the data indicated that extension agents have averaged 2.03 days of contact with urban farmers over the years, as observed across the entire sample of households. The survey revealed that the average extension agent contact for households with low, medium, and high nutritional status was 1.58, 2.23, and 2.45 days per year, respectively. The F-test for comparing group mean differences showed a significant difference among nutritional status groups at the 1% probability level. This indicates that households with more extension contact have higher nutritional status than those without extension contact.

Farming experience: The data found that the average urban farming experience among vegetable producers in the sample households was 8.42 years. The results found that the average farming experience for low, medium, and high nutritional status was 7.52, 8.69, and 9.44 years, respectively. The F-test analysis revealed a significant difference in the farming experience of household heads among nutritional status groups at a less than 1% significance level.

Income: The mean yearly income of the entire sample household's farm was found to be 27190.36 ETB. The survey data that mean annual urban farm income is different according to household nutritional status; households with low, medium, and high nutrition status were 22880.78, 29608.79, and 30651.17 ETB, respectively (Table 3). According to the results of the F-test analysis, there is a 1% significant difference in the mean yearly income of household heads across nutritional status groups. This indicates a relationship between increased farm earnings and enhanced nutritional status.

An analysis of the variables in Table 2, like access to improved vegetable seed, sex of respondent and training participation, and educational level, age of respondent, and distance from the nearest market in Table 3, revealed no statistically significant differences among households with low, medium, and high-level nutritional status.

Food security status of households

In this study, the household's food security was assessed through an examination of the calorie intake of food within the household over seven days, utilizing data concerning the variety of food items and their corresponding quantities consumed.

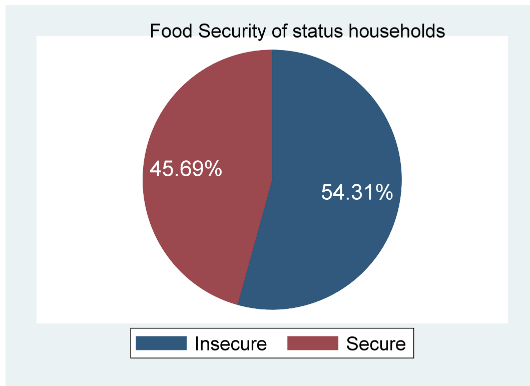

Figure 2. Food security status

The average daily calorie intake per adult equivalent (AE) within the household was determined by summing the total calories, dividing by the number of AEs in the household, and further dividing the result by the seven-day recall period. According to the result, the household heads were grouped into food secure and food insecure, which is by taking the minimum calorie required kcal/AE//day of 2200 kcal as cutoff points, which were set by the (EHNRI, 1998). Based on the 2200 kcal as cutoff value, the result revealed that 45.69% (106) of the total sample households were found to be food-secured, while the remaining 54.31% (126) were food insecure. The data presented in (Figure 2) clearly illustrates a significant change in the food security status among sample households.

Nutrition security status of household

The household dietary diversity score was employed as an essential measure to assess nutritional security within households. As a result, the nutritional status at the household level was determined by computing this score. This score, which was based on data collected through a 24-hour recall period, quantified the range of foods consumed by the household members. The study calculated the household dietary diversity score by calculating the total number of food groups consumed by all household members and not a single member during a specific reference period. However, food consumed outside the home was not included. The survey conducted in the study area revealed that 40.09% (93), 33.19% (77), and 26.72% (62) of the sampled households fell into the low, medium, and high nutritional security categories, respectively (Figure 3).

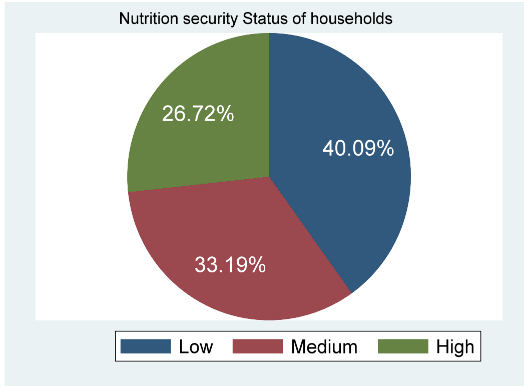

Figure 3. Households' level of nutrition security

Econometric model results

Determinant household's level of food security status

First, to estimate the model, several tests were conducted to determine if the model meets the different assumptions of logistic regression (Table 4).

Table 4. Summary model diagnosis test

Model test	Test name	Results
vif	Multicollinearity	Mean=1.11
hottest	Heteroscedasticity	(Prob > chi^2 = 0.06)
ovtest	Ramsey reset test	(Prob > F = 0.054)
estat gof	Goodness-of-fit	Prob > chi^2 = 0.589
linktest	Omitted variables	_hatsq P>|z| =0.288

Household size. The finding showed that this variable is negatively associated with household-level food security status, significant at a probability level of 1%. The negative sign indicates that as the household size increases, the likelihood of food security decreases. An odds ratio of 0.67607 indicates that the likelihood of food security decreases by a factor of 0.67607 as the number of family members increases by one, while all other variables remain constant. Households with larger family sizes are 67.61% more likely to experience food insecurity compared to those with smaller family sizes (Table 5). Urban farmers with multiple families may face challenges in feeding due to high food consumption demands, which may divert resources from immediate needs to additional productive practices. The results align with the findings of Abafita (2020), Geda *et al.* (2024), Mulugeta *et al.* (2018).

Sex of household head. The result indicated a positive relationship between this variable and household food security status with statistical significance at a level of less than 1%. The odds ratio effect for this variable is 7.8999, indicating that when all other variables stay the same, the likelihood of being food secure increases by 7.8999 when the household is headed by a male. This result is consistent with the findings of Yuya *et al.* (2022).

Cultivated land size. This variable was shown to have a significant and positive effect on food security of households with statistical significance at a level of less than 1%. The odds ratio indicates that the likelihood of being food secure increases by 1.00037 for every additional unit of cultivated land, assuming all other factors remain constant. Therefore, the household has large cultivated land offers significant opportunities for increased food production, thereby enhancing their food security status. This result is agree with the finding of Assefa (2022), Bekele *et al.* (2021), Rammohan and Pritchard (2014).

Table 5. Determinants of household level- food security status (N=232)

Variables	Odds Ratio	Coefficient	S.E.	P>z
Access to improved vegetable seed	1.59914	0.46946	0.60448	0.214
Household size	0.67607	-0.39146	0.0918	0.004
Sex of household head	7.89991	2.06685	4.96464	0.001
Cultivated land size	1.00037	0.00036	0.00012	0.003
Dependency ratio	0.994	-0.00602	0.00354	0.091
Educational level household	1.08327	0.07999	0.05913	0.143
Total livestock owned	1.16465	0.15242	0.09218	0.054
Extension Service	1.32891	0.28436	0.15996	0.018
Farming experience	1.21912	0.19813	0.06393	0.001
Training participation	3.00395	1.09993	1.13474	0.004
Membership in cooperative	2.2315	0.80268	0.82211	0.029
Access to credit	1.73061	0.54847	0.63584	0.135
Off-farm activity	1.76674	0.56914	0.66388	0.130
Distance from nearest market	0.99292	-0.00711	0.02196	0.748
Age of respondent	0.98575	-0.01435	0.01839	0.442
Constant	0.00981	-4.62451	0.01668	0.007

Number of obs. = 232
LR $chi^2(15)$ = 119.65
Prob > chi^2 = 0.0000
Log likelihood = -100.122
Pseudo R^2= 0.3740

***, **and * means at 1%, 5% and 10% respectively

Dependency ratio. This variable has a significant and negative relationship to the likelihood of food security status at less than 5% significance level. The negative sign indicates that increasing the dependency ratio reduces the likelihood of food security. The negative relationship between the household dependency ratio and food security status suggests that, holding all other factors stay same, the odds ratio of food security decrease by a factor of 0.994 for each additional dependent household member (Table 5). Household food security is more likely in households with a large number of adults or people of working age compared to those with more non-working age groups. These results are consistent with Milkias and Degefu (2024).

Total livestock owned. The study found that the quantity of livestock in tropical livestock units' significant and positive effect on household food security status, with a significance level of less than 10%. This indicates that households with more livestock holdings are able to achieve household food security status compared to those with fewer livestock holdings. The odds ratio effect reveals that livestock ownership increases the likelihood of being food secure by 1.16465 when all else is held constant and as livestock ownership increases by one tropical livestock unit (Temesgen and Aweke, 2023; Feyisa *et al.*, 2024*;* Jebessa *et al.*, 2024) reported the same result that livestock holding has a positive influence on the food security status of households.

Extension service. The result was found that extension services significantly improve household food security status at with a significance level of less than 10%. The odds ratio of 1.3289 for the frequency of extension service indicates that, when all other factors remain unchanged, the likelihood of achieving food security increases by a factor of 1.3289 for each additional instance of contact with the extension agent. Missing any interaction with an extension agent decreases the likelihood of achieving food security by 32.89%, highlighting the important role of consistent extension services. The importance of extension agents in enhancing urban agricultural productivity, which in turn contributes to household food security by providing advice on modern farming practices and facilitating increased crop and vegetable yields. This result is consistent with previous studies of Feyisa *et al.* (2024), Geda *et al.* (2024)*,* Milkias and Degefu (2024).

Farming experience. This variable is a significant determinant of household-level of food security status, showing a significant and positive relationship at with a significance level of less than 1% (Table 5). This shows that as farmers become more experienced, they become better at providing food for their families, emphasizing the significance of practical knowledge in urban vegetable production practices. The odds ratio effect value of 1.219 for farming experience indicates that, assuming all other factors remain constant, the probability of being food secure increases by 1.219 as the farming experience of the household head increases by one year. This outcome is line with the finding of Serbessa *et al.* (2023) and Temesgen and Aweke (2023).

Training. This variable was found to have a significantly and positive related to the likelihood of a household's food security status at a 1% probability level. With everything else being equal, if an urban farm household received advice on vegetable production practice, the odds ratio of 3.004 indicates that the likelihood of the household being food secure increased by 3.004. Hence, households that engage in urban farming training are more likely to have food secure than those that do not receive any training. Training improves farmers' capabilities and understanding, leading to increased adoption and expansion of productivity-enhancing vegetable production practices. This finding is consistent with the finding of Temesgen and Aweke (2023) and Nigus *et al.* (2024), who reported that Households that receive training are more likely to implement effective urban farming practices, thereby increasing their food production and security.

Membership in cooperative. This variable shows a positive and positive correlation with the probability of being food secure at a 5% significance level. One possible argument is that farmers who join agricultural cooperatives are more likely to get information that helps them use production inputs more effectively. The odds ratio value of 2.232 of the variables indicates that, keeping other factors constant, the favour of food security increased by a factor of 2.232 when farmers were members of agricultural cooperatives. This result is agree with the finding of Yuya *et al.* (2022), Temesgen and Aweke (2023).

Determinant household's level of nutrition security status

This study used ordered logit regression model in order to estimate household determinant of nutrition security status, the model results clear indicated that out of fourteen (14) independent variables expected to influence the household nutrition status, nine (9) were identified as significant determinants, namely: household size, sex of respondent, cultivated land size, dependency ratio, total livestock, extension service, access to credit, off-farm activity and income (Table 6). Each variable's discussions are presented as follow:

Household size. This variable shows a statistically significant and negative relationship with the probability of achieving a higher level of household nutrition status, observed at less than 1% significance level. The marginal effect of value 0.04535, -0.0083, and -0.037, while keeping all other variables equal, reveals that an increase in the number of family members increases the likelihood of falling into the low nutrition status category by 4.53%. Whereas, the likelihood of being in the medium and high nutrition status decreased by 0.83% and 3.7% as the number of family members increased by one person. This is because having a large family can lead to competition for limited resources, ultimately increasing nutrition insecurity within the household. This result line with the finding of Ergando and Belete (2016), Abera and Mekonin (2022).

Sex of household head. The likelihood of the household having a higher level of nutrition status is determined in a significant and positive at the less than 10% significance level. A correlation exists between being food secure and having a male as the head of the household because males typically have greater access to external information compared to females (Abera and Mekonin, 2022). However, at a 10% significance level, it exhibited a negative association with the likelihood of low nutritional status and a positive association with the likelihood of medium and high nutritional statuses, respectively (Table 6). The marginal effect of value -0.12681, 0.0233 and 0.1035 for low, medium and high levels of nutritional status that keeping all other variables equal, the likelihood of being in the low, medium and high nutrition status of household decreased by 12.68% and increased by 2.33% and 10.35%, respectively, as the number of male-headed households increased by one unit. The sex of the household significantly correlates with food and nutrition security, with male household heads having a higher probability of food security due to income-generating activities (Wedajo and Lerong, 2017; Abera and Mekonin, 2022).

Cultivated land size. This variable was found to have a negative and positive statistical significance in relation to the likelihood of being in low and high nutrition security status, respectively, less than 10% significance level. The marginal effects of land size are estimated at -0.0003 and 0.0003 for low and high levels of nutritional status, respectively. Assuming all other factors remain constant, the likelihood of being in low nutritional status is reduced by 0.03%, while the likelihood of being in high nutritional status is increased by the same percentage for each addition unit increase in farm size. Households with larger cultivated land holdings had more diverse diets due to the importance of land in food production. This result agree with the finding of Dereje *et al.* (2021) and Geda *et al.* (2024).

Dependency ratio. The survey result indicated that statistically significant and negative relationship with household nutrition security status at a 1% significant level. There was a statistically significant relationship between the variable and household nutritional status. The variable was positively associated with the likelihood of low nutritional status, while it was negatively associated with medium nutritional statuses at less than 1% and 5% significance levels, respectively (Table 6). The marginal effect of value 0.0015 indicates that the likelihood of being in a lower nutritional status increase by 0.15% for each additional family member when all other variables are held constant. Whereas other factors being constant, marginal effects of -0.0003 and -0.0012 of dependency ratio mean that, the likelihood of medium and higher levels of nutrition status decreases by 0.03% and 0.12% as the number of family members evolves by one unit. A higher probability of nutrition security at the household level is expected when there are more adults or productive age groups compared to non-productive age groups. This result is consistent with Rammohan and Pritchard (2014) Milkias and Degefu (2024).

Total livestock. This variable was indicated to be statistically significant and positively at a 1% significant level with likelihood of high nutrition security status. When other factors keeping constant, the marginal effect of-0.0293, 0.0054 and 0.0239 of livestock holding showed that the probability of being in low, medium and high nutrition security status decreases and increases by 2.93%, 0.54% and 2.39%, respectively, household livestock holdings increase by one TLU (Ayele *et al.*, 2020; Yuya *et al.*, 2022) reported the same result that livestock holdings has a positive influence on nutrition security status by providing household with the access to milk, which enhances dietary diversity. This finding is supported by the findings of Magaña-Lemus *et al.* (2016), Abera and Mekonin (2022).

Extension service. At less than 1% significance level, the frequency of extension contact was positively and statistically significant related with a likelihood of medium and high nutrition security, respectively (Table 6). The marginal effect values of 0.0066 and 0.0295 of extension contact implies that holding all other factors stay same, the likelihood of medium and high level of nutrition security increases by 0.66% and 2.95% as frequency of contact with development agent increases. As a result, urban farmers who have frequency contact with development agents are more participated to vegetable production in study area. This indicates that agricultural development agents play a key role in encouraging the use of vegetable production practices and technology by addressing the challenges and increasing farmers' awareness about their importance, they significantly contribute to improving household nutritional status. This finding is therefore in line with those of Yuya *et al.* (2022), Feyisa *et al.* (2024) and Geda *et al.* (2024).

Access to credit. This variable was also found to be positively and statistically significant associated with the likelihood of having a medium and high level of nutritional status at the 10% and 1% levels of significance. The marginal effect value of 0.024 and 0.1063 for urban farm households with access to credit, the probability of medium and high-level nutritional status increases by 2.4% and 10.63%, respectively, when the household being accessed credit, assuming all other factors remain constant. This is because access to credit enhances households' involvement in income-generating activities while also improving their ability to purchase agricultural technologies such as improved vegetable seed and fertilizer (Geda *et al.*, 2024). The farmers' access to credit consumed more nutritious and divers diets, with improving food consumption patterns and dietary diversity. This finding is line with the finding of Addai *et al.* (2024) and Mugure *et al.* (2013).

Table 6. Determinants of household level nutrition status (N= 232)

Variables	Low			Medium			High		
	dy/dx	S.E.	P>z	dy/dx	S.E.	P>z	dy/dx	S.E.	P>z
Household size	0.04535***	0.0164	0.006	-0.0083**	0.0036	0.021	-0.037***	0.014	0.007
Sex of respondent	-0.12681	0.0686	0.065	0.0233	0.0141	0.097	0.1035	0.056	0.067
Cultivated land size	-0.0003*	0.0000	0.079	0.00002	0.0000	0.118	0.0003*	0.000	0.08
Dependency ratio	0.0015***	0.0005	0.002	-0.0003**	0.0001	0.011	-0.0012***	0.000	0.004
Educational level	-0.0071	0.0069	0.303	0.0013	0.0013	0.311	0.0058	0.006	0.307
Total livestock	-0.0293***	0.0095	0.002	0.0054**	0.0025	0.03	0.0239***	0.008	0.002
Extension Service	-0.0361**	0.0152	0.018	0.0066*	0.0034	0.05	0.0295**	0.013	0.018
Training	-0.05530	0.0478	0.247	0.0102	0.0088	0.25	0.0451	0.039	0.253
Membership status	-0.0314	0.0483	0.517	0.0058	0.0092	0.529	0.0256	0.039	0.515
Access to credit	-0.1303***	0.0464	0.005	0.024**	0.0106	0.023	0.1063***	0.039	0.006
Off-farm activity	-0.1065**	0.0469	0.023	0.0196*	0.0104	0.058	0.0869**	0.038	0.023
Distance to the nearest market	0.0012	0.0028	0.678	-0.0002	0.0005	0.684	-0.0010	0.002	0.677
Age	0.0002	0.0025	0.943	0.0000	0.0005	0.943	-0.0001	0.002	0.943
Income	-0.00001***	0.0000	0.001	0.00002**	0.0001	0.016	0.0006***	0.000	0.001
Number of obs	=232								
LR chi^2 (14)	=105.76								
Prob > chi^2	= 0								
Log likelihood	= -198.87								
Pseudo R2	= 0.21								

Off-farm activity. This variable has a positive and significantly determines the likelihood of being in a medium and high-level nutrition security status at 10% and 5% probability level. However, it was significantly and negatively associated with low nutritional status at less than 1% significance level (Table 6). The marginal effects value of -0.1065, 0.0196 and 0.0869 for off-farm activity indicated that when all other parameters are held constant, the probability of being in the low-level nutrition status decreases by 10.65%. While the likelihood of being in the medium and high-level nutrition status increases by 1.96% and 8.69% as access to off-farm activity increases by one unit, respectively. Off-farm and non-farm activities help increase dietary diversity by providing extra money to families. These sources of income enable families to purchase a wider variety of foods, resulting in improved nutritional status. This outcome is consistent with the findings of Ergando and Belete (2016)*,* Abera and Mekonin (2022).

Annual income. This variable was expected to have a positive effect on the nutrition security status of households, and it was found to be significant and positively associated to the probability of having medium and high-levellevels of nutrition security at 5% and 1% significant level (Table 6). This indicates that as the annual income of a household increases, the nutritional status at the household level tends to enhance. The marginal effect values of 0.00002 and 0.0006 of yearly income for both medium and higher levels of nutritional status are noted, other things being equal. This increases the likelihood of being on a medium and higher level of nutritional status by 0.002% and 0.06% as total income increases by one birr. This indicated that household head with greater annual income were able to buy the different items of food and uphold diverse eating habits. This result agrees with the findings of Habtewold (2018) and Geda *et al.* (*2024*).

Conclusions

This study examined the factors influencing food and nutrition security at the household level in Chelencko and Kullubi, East Hararghe, using data from 232 households. A semi-structured questionnaire was employed for primary data collection, while secondary data was gathered from published and unpublished sources. Binary logistic and ordered logit regression models were used to analyze the determinants of food and nutrition security. Findings from 24-hour recall data on dietary diversity showed that 40.09% of households had low nutritional status, 33.19% medium, and 26.72% high. Additionally, household calorie acquisition over seven days revealed that 45.69% of households were food secure, while 54.31% were food insecure. Key factors contributing to food and nutrition insecurity included large family size and high dependency ratio. The binary logit model identified several factors positively influencing food security, including sex of household head, cultivated land size, total livestock owned, extension services, farming experience, training participation, and cooperative membership. Similarly, the ordered logit regression model highlighted sex of household head, cultivated land size, total livestock, extension services, access to credit, off-farm activities, and income as significant determinants of nutrition security. The study underscores the need for targeted interventions to enhance food and nutrition security. Expanding family planning initiatives, strengthening agricultural and health extension services, and promoting livestock support programs are essential. Training programs aimed at boosting livestock productivity and optimizing land use can significantly improve household nutrition. Additionally, access to credit and promotion of off-farm income opportunities can enhance nutrition security. Gender-sensitive policies and nutrition education are critical, as the sex of household heads was a key determinant of food security. Empowering women farmers can have a significant impact on household nutrition. Furthermore, collaborative efforts between local governments, municipal administrations, and donor organizations are necessary to implement urban vegetable production initiatives and enhance food and nutrition security. Strengthening these policies will contribute to increased agricultural productivity and long-term household resilience.

Authors' Contributions

Conceptualization: Y.U.; Data curation: Y.U. and P.C.; Formal analysis: Y.U. and P.C.; Investigation: Y.U. and S.A.; Methodology: Y.U. and E.A.; Resources: Y.U. and A.E.; Software: Y.U. and M.A.; Supervision E.A.; Validation: E.A. and A.A.A.; Visualization M.A.; Writing - original draft: Z.F. and E.A.; Writing - review and editing: P.C. and Y.U.

All authors read and approved the final manuscript.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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