

Household Food Security Status and Its Determinant: Case of Atsbi District, Tigray Regional State, Ethiopia

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Abstract People living in developing countries, such as Ethiopia, suffer from food insecurity and lack of access to nutrition. Hence, this study aimed to assess the food security status of rural households and identify the factors that influence food security. For the purpose of this study 173 households were selected randomly from two peasant association of Atsbi district. Therefore, data were collected using household survey. The collected data were analyzed using descriptive statistics and ordered probit model. The findings indicated that the majority of households had high diet diversity, this suggests that they had access to a wide range of food groups. Despite the high dietary diversity, the study revealed that a significant proportion of households experienced food insecurity. Most households had higher household food insecurity access scale and this indicates an inability to access sufficient and nourishing food. Moreover, the results indicates that income, gender, land size, farm experience, potato farming, and access to extension are positively associated with food security. Generally, household food insecurity was measured at a greater level showing that diet diversity at household level is not a guarantee to stay food secured. In light of these results, this study suggests that more gender-based capacity-building initiatives are necessary to ensure food security at household level.

Keywords: food security, diet diversity, household food insecurity access scale, extension service, income

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1. Introduction

Food insecurity and malnutrition continue to be global problems [1]. Food insecurity and malnutrition are interconnected and represent significant global challenges that have been addressed by several United Nations Sustainable Development Goals (SDGs). In 2020, there was a significant global increase in the number of people unable to afford a healthy diet particularly in developing countries. Approximately 3.1 billion individuals of which 282 are from Africa faced challenges in accessing a nutritious diet [2] that has resulted a wide range of issues including poverty, hunger, and health problems. However, progress towards meeting these goals particularly in developing countries, has been sluggish. In Africa, since the onset of the COVID-19 pandemic, the number has increased by 57 million. Moreover, over one billion individuals are unable to afford a nutritious diet, and approximately 30% of children experience stunted growth owing to malnutrition. Unfortunately, Africa and many other developing countries not making sufficient progress towards achieving the food security and nutrition goals

outlined in the Sustainable Development Goals by 2030 targets to eradicate hunger and malnutrition by 2025 [3,4,5]. Many African countries are facing acute food insecurity, the majority are concentrated in five conflict-affected nations. East Africa, specifically Sudan, Ethiopia, South Sudan, and Somalia, is home to four of the top ten countries facing acute food insecurity [6]. According to a report from the Africa Center for Strategic Studies, Ethiopia is currently facing food insecurity, with approximately 20.1 million people affected and 15.1 million requiring emergency assistance. This situation was the result of war in Tigray, conflicts in other regions of the country, and severe drought in the Horn of Africa [6]. In Tigray regional state, food security remains a pressing concern, with 89% of the households experiencing food insecurity. Among the population, 42% were moderately and 47% were severely food insecure. Additionally, over 80% of households have inadequate diets and approximately 57% consume poor-quality diets. The consumption of nutritious foods such as meat, vegetables, and fruits has significantly declined since October 2020, averaging less than one day per week [7]. In addition, factors affecting the food security status of households in the study area have not been well studied. To the best of

our knowledge, little is known about the factors associated with food insecurity and the status of household food security in Tigray regional state and in the study districts in particular. Hence, this study was aimed to fill this knowledge gap. The main objectives of this study were to (1) assess the food security status of rural households (2) identify the factors affecting household food security and (3) identify the food insecurity coping mechanisms used by households during hardship seasons.

2. Methods and Materials

2.1. Description of the Study Area

The study was conducted in the Atsbi district, located in eastern zone of the Tigray regional state, it found approximately 65 km from the regional city Mekelle. The district is situated northeast of the regional city at coordinates 13° 36N and 39° 36E [8].

2.2. Sampling Procedure

A multistage sampling techniques were used to select respondents from the study area. In the first stage, Atsbi district was purposively selected based on the vulnerability of food insecurity. In the second stage, two peasant associations Gebrekidan and Felege-Woyni were selected purposively. Finally, 173 respondents (heads of household) were selected using simple random sampling. The sample size was determined using Cochran formula [8] to make the sample respondents more representative of the population.

$$n = Z^2 \frac{p(1-q)}{e^2} = p = \frac{4094}{31708} = 0.13 = q = 1 - p, q = 0.87 \quad (1)$$

$$n = 1.96^2 \frac{.13 \times .88}{.05^2} = 173$$

Z= 95% degree of confidence (1.96)

P= population proportion of target population

Q=1-p

n = the sample size

e=allowable error (5%)

2.3. Method of Data Collection

Data were collected through household surveys that consists household resources, income, diet diversity, and the socioeconomic activity of respondents through interviews using structured questionnaires. In addition, secondary data were collected from various sources, such as farmers' training centers, relevant published literature, and official district Agriculture and Rural Development reports.

2.4. Method of Data Analysis

The collected data were analyzed using econometrics model and descriptive statistics such as frequency, percentage, mean, and standard deviation. Food security status was measured using the household food insecurity access score (HFIAS) and household diet diversity

developed by the Food and Nutrition Technical Assistance Project (FANTA) in 2007. The codes for each of the nine questions about the frequency of occurrence of food insecurity were added to determine the HFIAS score for each household [9]. Additionally, the HDDS was used in this study by counting the number of food groups which varied from 0 to 12 that a household was advised to have consumed in the 24 hours prior to the survey [10,11].

Then, the determinants of household food security were examined using the ordered probit model. A widely used approach to estimating models of this type is an ordered response model. This model is thus often referred to as the ordered probit model.

The equation for the ordered probit model for the determinants of household food security can be represented as follows:

$$y^*_i = x_i\beta + \varepsilon_i, \varepsilon_i | x_i \sim N(0, 1)$$

$$\text{And, } y_i = \{1, \text{ if } y_i \leq 0, 2, \text{ if } 0 < y_i \leq \alpha, 3, \text{ if } y^*_i > \alpha$$

In this model, for each observation i , there is a latent variable y_i^* that is determined by the linear function of the independent variables x_i and the coefficients β . The error term ε_i follows a standard normal distribution.

Table 1. Summary of working hypothesis

Definition of variables	Measurement and sign
Age of household head	Year (+)
Land size	Hectar (+)
Livestock size	Tropical Livestock Unit (+)
Distance from home to the district market	Hour (-)
Education level of the household head	1 if household access to formal education
Access to extension service	Frequency of development agent contact
Ownership of irrigated land	1 if the household has irrigated land, 0 otherwise
Membership in saving and credit cooperative	1 if membership in saving and credit cooperative, 0 otherwise
Access to market information	1=yes, 0=no
Non-farm activity	1 if the household participates in non-farm activities, 0 otherwise
Annual income	Ethiopia birr
Household food insecurity access scale	frequency-of-food insecurity occurrence
Household diet diversity	Number of food groups consumed per 24 hours

3. Results

3.1. Socioeconomic and Demographic Characteristics of Household

The Table 2 presents the socioeconomic and demographic characteristics of household. The average age of the household heads is 47.6 years. This indicates the households were found in productive age. The average family member was 5.5 per household. The average land size of the households was 1.85 hectare, and the livestock size of the respondents was 2.5 (TLU). Additionally, farm experience, which has an average duration of 23.9 years, shows how long people have been involved in farming activity. This shows that the degree of skill and understanding among farmers. The market distance calculates the average distance between a household and the nearest market, with an average value of 1.94 hour.

This indicates that the market was far from residence of the households, which can have an impact on how easily they can obtain goods and services including food items. Remittances, which the money people send back to their home country, has an average value of 999.6 birr. This is often associated with migrant laborers who support their families or contribute to their communities. Furthermore, 64.7% of households are headed by males, while 35.2% are headed by females. Most of the respondents are illiterate; however, education plays a crucial role in enabling farmers to understand agricultural information and participate in different agricultural businesses. As farmers become more educated, they can easily access agricultural information and engage in diverse agricultural activities.

Moreover, the annual income of the households was 17369.8 birr and households have an average diet diversity score of 6.4. This suggests that households were consumed relatively diverse range of foods groups. Having access to a varied diet is important for maintaining good health and ensuring an adequate intake of essential nutrients, vitamins, and minerals. However, the household food insecurity access scale (HFIAS) was 4.3, indicates that households have experience some degree of food insecurity. This can lead to malnutrition, poor health outcomes, and reduced productivity, which negatively impact the overall well-being and health of household members.

Table 2. Socioeconomic and Demographic Characteristics of Households

Variables	Mean
Age of the household head	47.6±9.2
Family size	5.5±1.8
Land size in hector	1.9±1.21
Livestock size in (TLU)	2.5±2.06
Farm experience in year	23.9±8.72
Remittance received in birr	999.6±2012.8
Annual income of household in birr	17369.8±11323.4
Distance to nearest market (in hour)	1.9±1.1
Household diet diversity	6.4±1.4
Household food insecurity access scale (HFIAS)	4.3±4.7
Categorical variables	Frequency (%)
Gender of HH	Female 61(35.3)
	Male 112(64.7)
Education level	Illiterate 138(79.8)
	Literate 35(20.2)

3.2. Household Access to Institutional Service

Table 3 presents the meaningful results about the household's participation in different social groups and access to resource. Accordingly, approximately 50.9% of the households engage in nonfarm activities to generate additional income. This indicates a reliance on diversified income sources apart from traditional farming. The majority of households (54.3%), were access to irrigation, which can contribute to increased agricultural productivity. The fact that 36.4% of people have access to credit emphasizes the importance of financial resources for

investment and growth. On the other hand, only 21.4% of people have access to market information, which may have an impact on decision-making and market participation. Nearly 47.4% of the population are members of savings and credit cooperatives, promoting financial inclusion. Additionally, 40.5% of households were member of in the potato production and marketing cooperative.

Table 3. Household Access to Institutional Service

Discription	Frequency	Percentage
Participation in nonfarm activity	88	50.9
Access to irrigation	94	54.3
Credit access	63	36.4
Access to market information	37	21.4
Membership in Saving and Credit	82	47.4
Participation in potato business	70	40.5

3.3. Food Security Status of the Households

The household diet diversity (HDD) categories that presented in Table 4 shows the food security status of a household. Accordingly, most of the households have high diet diversity (54.3%). It is found that the majority of households have better food security and easier access to a variety of nutrient-dense foods. There's a higher probability that the diets in these households are nutritious and well-rounded. Furthermore, about 44.5% of the households have moderate level of dietary diversity. Even though they might have access to a respectable range of foods, they might still gain from additional dietary diversity. However, 1.2% of the household had low dietary diversity. This indicates restricted access to a wide range of foods diversity. This could point to a greater chance of nutritional deficiencies and food insecurity.

Table 4. Household Diet Diversity

Food security status of households	Freq.	Percentage
Low diet diversity (0_3 food groups)	2	1.2
medium diet diversity (4-5 food groups)	77	44.5
high diet diversity (>=6 food group)	94	54.3

Table 5. Household Food Insecurity Access Scale of the Household

HFIAS	Freq.	Percentage
Food secure	83	47.98
Mild food insecure	19	10.98
Moderate food insecure	52	30.06
Severely food insecure	19	10.98

A useful tool for understanding the various degrees of food security among households is the Household Food Insecurity Access Scale (HFIAS). The result in Table 5 indicated that food security was identified in nearly half of the households (47.9). This indicates that there is regularly access to enough nourishing food. About 10.9% of households experience mild food insecurity and occasionally struggle to obtain a balanced, healthful diet. They might run into restrictions with regard to the variety and amount of food. On the other hand, 30.1% of households were classified as having moderate food insecurity, meaning they had more substantial challenges getting enough food on a regular basis. They might

experience sporadic shortages and restricted availability of a variety of food sources.

3.4. Determinants of Household Food Security

The determinants of household food security were identified using the ordinary probit model. The result presented in Table 6 indicated that income, gender, farm experience, and land size were the main factors that affect household food security.

Household income: income levels have a positive relationship with household diet diversity and food access measured by household food insecurity access scale. This means that as the income of a household increases by 1 birr, the consumption of diversified food groups also increases by 1.1% and. However, the household food insecurity access scale decreased by 2.1%. This indicates having high income allows households to purchase a wider variety of foods, which helps them meet their dietary needs and have access to nutritious food consistently. Additionally, household with higher income have ability to access food from market. This result is consistent with finding of [10] which reported that there is high dietary diversity in households with high household annual incomes.

Gender of household head: The gender of the household head had a positive relationship with the household diet diversity of the households. This implies that as the chance of being male headed household increases by one unit the consumption of diversified food group increased by 68.6%. The statistical significance at 1% indicates that this relationship is highly reliable and indicating that male-headed households may have better access to diverse food sources or have cultural and social

factors that contribute to a wider range of food choices. This finding is consistent with the findings of [12,13], who reported that male headed households are more food secure than female headed households.

Farm experience: The significantly negative coefficient for farm experience indicated that farming experience may have a lower range of dietary diversity. The marginal effect indicates that as farm experience increases by 1 year, household diet diversity decreases by a mean value of 5%. This could be due to several factors, including specialization in specific crops or agricultural practices, a preference for traditional or limited crop selection, and prioritizing market demands over household consumption.

Land Size: The significant positive coefficient of land size indicates that, households with larger landholdings have greater dietary diversity and lower food insecurity access scale. Large land sizes allow for the cultivation of a wider range of crops, including staple crops, vegetables, fruits, and other foods. This leads to improve the food security by reducing household food insecurity access scale. Crop diversity in turn helps to provide a more varied and nutritious diet. This finding was consistent with several studies. According to [14] households with larger areas of agricultural land had higher diet diversity. Similarly, [15,16] discovered a positive and significant relationship between farm size and the likelihood of food security. However, [12] investigated that large cultivating land areas were less likely to be food secure because cultivation land is not regarded as the only critical agricultural production unit.

Extension services: Food insecurity appears to be lower in households with access to extension services, and it shows positive coefficient (0.41). In order to give farmers, the information, support, and tools they need to enhance their farming methods, extension services are essential.

Table 6. Determinants of Household Food Security

Explanatory variables	HDD		HFIAS	
	Coef.	P-value	Coef.	P-value
Member in potato cooperative	0.003	0.993	-0.314	0.361
Access to market information	0.366	0.131	0.273	0.212
Remittance	0.166	0.478	0.231	0.263
Livestock size (TLU)	0.099	0.183	0.008	0.888
Income	0.011	0.006 ^a	-0.021	0.046 ^b
Non-farm activity engagement	-0.061	0.777	-0.030	0.878
Household age	0.030	0.161	-0.018	0.323
Gender of household head	0.686	0.009 ^a	-0.007	0.976
Education level	-0.013	0.791	-0.002	0.961
Family size	-0.090	0.182	0.072	0.236
Access to irrigation	0.047	0.861	0.071	0.762
Extension service	-0.130	0.356	-0.410	0.001 ^a
land size	0.186	0.018 ^b	-0.176	0.069 ^c
Farm experience	-0.050	0.020 ^b	0.028	0.131
Market distance	-0.061	0.556	0.049	0.602
Saving and credit cooperative	0.334	0.136	0.113	0.572
Aid received	0.010	0.813	0.001	0.157
Number of obs	173		173	
LR chi2(17)	47.39		55.76	
Prob > chi2	0.0001		0.0000	
Log likelihood	-104.28236		-78.78443	
Pseudo R2	0.3852		0.4349	

Note: "a" at 1%, "b" at 5% and "c" at 10% significance level

3.5. Household Food Insecurity Coping Mechanism

People who are food insecure face many difficulties, especially in hard financial or when resources are scarce. There are several coping mechanisms that people have used to deal with this problem (Table 7). The result of this study indicated that about 8.1% of people who experience food insecurity choose less desirable or lower-quality foods to eat instead of more palatable ones. A little over 6.7% of the households were cut back on daily meals and stretched their food supply. Similarly, portion sizes were lowered to extend the shelf life of the food, this results in a 7.15% decrease in food quantity during each meal. In the worst circumstances, 0.12% of people might skip a full meal due to scarcity and 66% of people resorted to asking their relatives for help by borrowing food. To make ends meet, some turn to selling animals (3.5%) or taking out credit for food purchases (3.8%).

Table 7. Household Food Coping Strategies

Food insecurity coping mechanism	Frequency	Percentage
Consume less preferable food	138	79.7
Reduce number of meals per day	115	66.5
Food quantity reduction	122	70.5
Skip whole day meal	2	1.2
Borrowed food from relative	112	64.7
Purchase food on credit	64	37
Seek employment	44	25.4
Sell animal	59	34
Restrict food consumption by adult	13	7.6

4. Discussion

This study employed household diet diversity and household food insecurity access scale as measurement of food security. Dietary diversity represents the number of different foods or food groups consumed over a given reference period. In this case, this study applied the 24-hour recall period for the 12 food groups [10,11,17,18]. The result revealed that majority of the households have high diet diversity. This result is inconsistent with the finding of [18] which suggests that more than 57.3% of the farmers had low diet diversity. However, a significant proportion of the households were experienced food insecurity problem. In addition, this study utilized the Household Food Insecurity Access Scale (HFIAS) and the result indicates that households were unable to access sufficient and nourishing foods. According to [9], the higher score of the HFIAS implies the households found at severe food insecure. However, this result is inconsistent with finding of [18] that found majority of the farmers were food secure (lower HFIAS). Furthermore, this study identified the determinants of household food security using ordered probit model. The result of the model investigated that annual income has a positive relationship with household diet diversity and food access (lower HFIAS). Higher income level in households help to purchase a diversified food from market. This helps households to meet their dietary needs. This result is in line with finding of [1,19,20,21,22], claim that there is

less dietary diversity in households with low household incomes. However, [23] revealed that income is insufficient to guarantee for household diet diversity. The study also finds out a positive correlation between household gender and diet diversity. This implies that male-headed households may have better access to diverse food sources than women. This could be influenced by factors such as income levels, decision-making power, or cultural norms related to food preferences. Similarly, [12,13,14,15,20,21,24] revealed that male headed household were more food secure than women headed. Studies have shown that female headed household were more food insecure than male headed household due to inequality in access to productive resources such as land between male and female-headed households [25]. More importantly, the significantly negative coefficient for farm experience suggests that households with more farming experience have a narrow range of dietary options. With more farming experience, households may focus on a specific set of crops or agricultural practices. This specialization may limit the variety of crops grown and, consequently, the diversity of foods available for consumption. This result is in line with [16] that found a negative relationship between farm experience and food security. However, [26] pointed out farm experiences are positively correlated with dietary diversity.

Land size positively affects both the diet diversity and household food insecurity access to scale. This implies that large land sizes allow farmers to cultivate different food and cash crops, including staple crops, vegetables, fruits, and other foods. An increase in a households' farmland by a one hectare makes the household to have high diet diversity and less likely to fall within the severely food insecure situation. This result is consistent with past studies reported positive relationship between land size and food security [14,15,16] found that, households with larger areas of agricultural land size had higher HDDS and lower HFIAS [25]. However, [12] reported that households with larger cultivating land size were less likely to be food insecure.

Moreover, extension services can help to boost food production and improve food security. This finding is consistent with the finding of [24], stated that access to extension may help much to improve the food security status of households. A farmer who has better access to training has better awareness about improved technologies and has an opportunity to improve their food security status. Therefore, the finding revealed that extension service negatively correlated with food insecurity access scale. Furthermore, people who experience food insecurity face a number of challenges. In these circumstances, people use various coping mechanisms to deal with the scarcity of food. These strategies include deciding on less appetizing or inferior food options, cutting back on the number of meals each day, reduce portion sizes, sometimes skipping meals completely, borrowing food from family members, selling animals, and access credit to make food purchases.

Conclusion and Recommendation

Generally, this study examined household food security

status of rural household using food security measures such as household dietary diversity and the household food insecurity access scale (HFIAS). The study found that the majority of households had high diet diversity, indicating access to a variety of foods. However, as reflected in higher HFIAS scores significant proportion of households still experienced food insecurity. Furthermore, several factors associated with diet diversity and HFIAS were identified using ordered probit model. The result shows that gender, larger land sizes, access to extension services and income contributed to improved food security. However, farm experience negatively affects food security. These findings underscore the need for targeted interventions to address specific challenges in ensuring adequate and diverse food access for households. Based on the finding we suggests that female headed households have sever food insecurity problem; hence address gender disparities in resource access and decision-making authority within households by providing equal access to loans and agricultural training for women-headed households. Government and other stakeholders in Tigray regional state should invest in scaling up of agricultural value chains and create market access for smallholder farmers to increase incomes and improve food security at household level.

Limitation and Strengthens of the Study

The study on household food security in rural Tigray, Ethiopia has some limitations, including its geographical scope being limited to the Tigray regional state, which may impact the generalizability of the findings. However, the study's strengths include the use of well-established and validated food security measures, a comprehensive analysis of both diet diversity and HFIAS, the identification of key determinants of food security through econometric modeling, the provision of valuable insights for policymakers and stakeholders in the Tigray region and the study's contribution to the existing body of knowledge on food security in rural, developing contexts, which can inform future research and policy decisions.

Abbreviations

FAO: Food and Agricultural Organization
HFIAS: Household Food Insecurity Access Scale
ACFSS: Africa Center for Strategic Studies
WFP: World Food Program

Author's Contribution

All authors contributed to this study. AB collects data, analyzes data and writes the paper. KM and TH edited the paper and supervised the study. All authors read and approved the final manuscript.

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data collection.

Competing Interest

The authors declare that they have no competing interests.

Availability of Data and Materials

The data set used in this study is available from the corresponding author on reasonable request.

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