Scientific Research Publishing

Open Journal of Social Sciences, 2024, 12, 219-234
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

Factors Contributing to Persistence of Food Insecurity in Gairo District, Tanzania

Flora Valentine Mlage, Sadick Alex, Omary Magasha*

Department of Rural Development and Regional Planning, Institute of Rural Development Planning (IRDP), Dodoma, Tanzania
Email: *omary.magasha@irdp.ac.tz

How to cite this paper: Mlage, F. V., Alex, S., & Magasha, O. (2024). Factors Contributing to Persistence of Food Insecurity in Gairo District, Tanzania. *Open Journal of Social Sciences, 12,* 219-234.
https://doi.org/10.4236/jss.2024.1212014

Received: November 6, 2024
Accepted: December 10, 2024
Published: December 13, 2024

Abstract

The purpose of the current study was to assess the factors contributing to persistence of food insecurity in Gairo district. The study adopted cross sectional research design with which the used data were collected through interview method from 301 small scale farming households from Mkobwe, Lufikiri, Makuyu, and Kilama villages. A multi-stage sampling technique was applied, and simple random sampling was employed to select households. Data were analyzed using Chi-square, multiple linear regression and factor analysis in STATA 16 and SPSS 26. Cross tabulation results show that household size and education were demographic characteristics significantly influencing food insecurity in the study area. Similarly multiple liner regression results show household sizes, lower household incomes, access to agricultural inputs and extension services, education levels of household heads and climate variability were predictors of food security ($p < 0.05$), while Distance to markets and participation in farmers' organisations were not statistically significant with food security in Gairo district ($p > 0.05$). Further results on factor analysis revealed the five key dimensions being economic resources, access to agricultural inputs, education and training, climate resilience, and social support systems influencing food security in Gairo district. The study concludes that larger household sizes and lower incomes are consistently associated with higher levels of food insecurity whereas education, access to agricultural inputs, and climate variability also play critical roles in improved food security. It is recommended that Gairo district in collaboration with national and international development practitioners should enhance household income through income-generating activities, improving access to agricultural inputs such as fertilizers, improved seeds, and extension services, provision of educational programs including formal schooling and practical agricultural training, promotion of climate-smart agricultural practices and strengthening social safety nets and community support programs to provide immediate relief during times of crisis.

Keywords

Factors, Persistence, Food Insecurity, Factor Analysis, Gairo District

1. Introduction

Measuring food security is a complex issue because it encompasses various elements such as food production, distribution, and consumption, all of which contribute to its extensive nature. Food insecurity arises when individuals lack consistent access to sufficient, safe, and nutritious food essential for healthy growth, development, and an active lifestyle. This can result from either a food shortage or a lack of resources to obtain it. The intensity of food insecurity can vary significantly from one region to another, and the FAO assesses it using the Food Insecurity Experience Scale (FIES) (Cafiero et al., 2024).

Food insecurity remains a pressing global challenge. In 2023, approximately 282 million people, or 21.5% of the evaluated population in 59 countries and territories, experienced severe acute food insecurity, requiring immediate support for food and livelihoods (UNICEF, 2024). This crisis has been exacerbated by the combined impacts of the COVID-19 pandemic, ongoing conflicts, and climate change, all of which have severely disrupted food systems around the world (Paudel et al., 2023). Alarmingly, around 720 to 811 million individuals globally faced severe food insecurity in 2020, meaning they went days without food or were uncertain about where their next meal would come from (WHO, 2021). The United Nations has indicated that an additional 122 million people have been driven into hunger since 2019, marking a setback in the efforts to eliminate hunger by 2030 (Alaimo et al., 2020).

The crisis of food insecurity is particularly severe in regions like sub-Saharan Africa and parts of Asia, where issues such as economic instability, poor governance, and environmental stress have worsened food shortages. Africa is the most affected area, with one in five people suffering from hunger, a rate that is more than double the global average. The situation is equally alarming in countries experiencing prolonged conflicts, where food supply chains are disrupted, humanitarian access is limited, and cereal crop yields are negatively impacted by factors like stem borer pests, striga weeds, and degraded soil. Climate change further threatens food security in sub-Saharan Africa, significantly affecting cereal production. Approximately 54 million people in East Africa are food-insecure, with Sudan being a notable example. The food insecurity in this region stems from unfavorable climate conditions, conflict, inflation, disease outbreaks, and limited access to nutritious diets. In Tanzania, food insecurity is a pressing issue, especially for rural communities and smallholder farmers. In almost each year, several regions are identified as facing food insecurity which is characterized with seasonal variations and trends, whereby the severity of food insecurity is experienced from December to February whereas the food security status is good between June to

September (Rogawski McQuade et al., 2019). Currently, around 900,000 individuals, or 13% of the 7.1 million population across 21 district councils in Mainland Tanzania are facing severe acute food insecurity as examined within IPC Phase 2 (Nyange et al., 2024). The status of food insecurity has been varying from year to year across various regions in Tanzania. Taking an example in 2012/2013 seven regions which are Dar es Salaam, Arusha, Shinyanga, Simiyu, Geita, Tabora and Manyara were identified to experience food insecurity in the year 2013 (URT, 2013a), where as in 2023/2024 acute food insecurity is experienced in some parts of Simiyu, Shinyanga, Singida, Dodoma, Tanga, Manyara and Tabora regions (Intergated Food Security Phase Classification, 2023). This situation is driven by various social, environmental, economic, and institutional factors which are not underlaid clearly in Gairo district in particular. Despite efforts like the Agriculture Sector Development Programme I and II (ASDP I & II), the National Strategy for Growth and Reduction of Poverty (NSGRP), and the Participatory Irrigation Development Programme (PIDP), along with follow-up initiatives such as the Food Security and Nutrition Assessment, household food insecurity remains a significant challenge in Tanzania.

Gairo is one of the seven districts found in Morogoro region, the district is found 132 kilometers western part of the region headquarters. The district is characterized with several agro-ecological zones of which the large parts receive up to 1200 mm annual rainfall while the other flood plains get average rainfall of 600 mm with poorly drained black clay and loam soils which are suitable for maize cultivation (United Republic of Tanzania, 2018). According to 2022 national census results, Gairo district has a population of 258,205 with 53,818 households of which 90% rely on agriculture as their mainstay (URT, 2022). United Republic of Tanzania (2018) documented that 22% of the households in the district had food insecurity, of which the council was struggling to minimize the rate to 10% by 2023 of households in the district. This extent is an alarming condition considering that the district is found in the region which has higher level of agricultural production. Therefore, the study came into the ground to determine the factors for food insecurity among households and to examine the underlying dimensions that affect food security in the Gairo district.

2. Materials and Methods

The study took place in Gairo district, concentrating on four specific villages: Mkobwe, Lufikiri, Makuyu, and Kilama. These villages were selected randomly from two wards, Chagongwa and Iyogwe, with each ward contributing two villages to the sample, then simple random sampling was used to choose households. Prior to selection of households, a multi-stage sampling technique was utilized to pick administrative units from the district to the villages level. Gairo district was chosen due to its significant levels of food insecurity, which have led to high rates of stunting (54.3%) and underweight (23.3%), exceeding both national and regional averages (Mtonga & Nyaruhucha, 2022). A cross-sectional

study design was implemented, enabling researchers to collect data from respondents at one specific time. Data were gathered through survey interviews and documentary review with interview guide and checklist instruments respectively. Households were treated as the study units since food insecurity is mainly experienced at this level (Maxwell, 1996a). A total of 301 households involved in small-scale farming were selected, with this sample size calculated using Cochran's formula (Cochran, 1997).

$$n = \frac{Z^2 * p(1-p)}{d^2}$$

where:

- n = sample size,
- Z = the standard normal distribution value, approximately 1.96 for a 95% confidence interval,
- p = the estimated population proportion, set at 0.5 when the population size is unknown,
- d = the margin of error, set at 5% for categorical data as suggested by Krejcie and Morgan (1970).

The collected data were analyzed using Chi-square and Multiple Linear Regression (MLR) to identify the factors contributing to the ongoing issue of food insecurity in the study area. Factor analysis was performed in STATA 16 and SPSS 26. Before running the model, diagnostic tests for collinearity and multicollinearity were carried out to evaluate the linear relationships between the independent variables and to identify any high correlations among them. In instances where the data showed skewness, a natural log transformation was applied to normalize the distribution, ensuring that the data adhered to the assumptions required for regression analysis. Although MLR does not necessitate that the dependent and independent variables follow a normal distribution (Williams et al., 2019), the model was crucial in quantifying the combined effects of the factors affecting food production and supply (independent variables). It also evaluated the relative contribution of each factor in explaining the variability in the dependent variable, which is food security.

The MLR model used is specified below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_i$$

where:

- Y = Food security,
- X_1 to X_n = explanatory variables,
- β_0 = constant,
- β_1 to β_n = regression coefficients,
- ε = error term.

This methodology aligns with contemporary research in food security, which highlights the importance of using household-level data and multivariate analysis to understand the intricate dynamics of food insecurity (Bofa & Zewotir, 2024). In this study, we assessed collinearity through the Variance Inflation Factor (VIF)

and tolerance values, both of which evaluate the correlation between independent variables. A VIF value exceeding 5 indicated a potential issue with high collinearity, suggesting that the variable might be closely related to other predictors in the model. We also employed a correlation matrix to pinpoint pairs of variables with high correlation coefficients (generally above 0.8), which could lead to collinearity. If multicollinearity was identified, we made necessary adjustments, such as removing or combining highly correlated variables, to ensure that the multiple linear regression model yielded reliable results. The collinearity check indicated that all independent variables had VIF values below 5, suggesting that multicollinearity was not a major concern in the model. Furthermore, all tolerance values were above 0.2, confirming that no variable was overly correlated with others. To further validate the results, we analyzed the data using a correlation matrix, which showed no correlation coefficients exceeding 0.8 between any pairs of independent variables. These diagnostic checks, along with applying a natural log transformation to variables with skewed distributions, helped normalize the data and improve the reliability of the regression estimates, thereby preserving the integrity and validity of the regression analysis (Table 1).

Table 1. Key variables and their measurements in the study of food insecurity in Gairo District.

Variable	Description	Measurement
Food Security	Household's ability to consistently access sufficient, safe, and nutritious food.	Food Insecurity Experience Scale (FIES) or household food access score.
Household Size	Number of individuals in the household, influencing food demand.	Total number of people living in the household.
Household Income	Total income of the household, related to purchasing power for food.	Monthly household income in Tanzanian Shillings (TZS).
Access to Agricultural Inputs	Availability of seeds, fertilizers, and farming tools, crucial for food production.	Binary (1 = access, 0 = No access).
Land Ownership	Size of land owned or accessed by the household for farming activities.	Size of land in acres.
Education Level of Household Head	Level of formal education of the household head, affecting decision-making and practices.	Number of years of formal education.
Climate Variability	Exposure to weather shocks such as droughts or floods, impacting crop yield and food supply.	Number of weather-related shocks experienced in the past 5 years.
Participation in Farmers' Organizations	Membership in farmers' groups/cooperatives, which provide resources, training, or market access.	Binary (1 = member, 0 = Non-member).
Access to Extension Services	Availability of agricultural advisory services from government or NGOs.	Binary (1 = access, 0 = No access).
Crop Yield	Quantity of crops produced, directly affecting food availability.	Kilograms of crops harvested per season.
Distance to Markets	Proximity of household to markets, influencing access to food and ability to sell produce.	Distance to nearest market in kilometers.

3. Results and Discussion

3.1. Demographic Characteristics of Respondents in Relation to Food Insecurity Levels in Gairo District

This section provides an analysis of the relationship between key demographic characteristics and food insecurity levels among respondents in Gairo district. By looking at factors such as age, gender, household size, and education level, the analysis seeks to uncover significant patterns and determinants of food security. Understanding these relationships is essential for creating targeted interventions that tackle the underlying causes of food insecurity, as certain demographic groups may be more susceptible to food shortages and their negative impacts. The results are further supported by statistical validation through chi-square tests, which shed light on the factors that most strongly correlate with food insecurity in the area. The cross-tabulation results presented in Table 2 illustrate the considerable impact of demographic characteristics on food insecurity levels in Gairo district. Notably, household size and education level emerge as significant determinants, with larger households (7 or more members) facing more severe food insecurity (43.7%) compared to smaller households. This suggests that as family size increases, the strain on resources also intensifies. This observation aligns with findings from a recent study by Duda et al. (2018), which highlights that larger households in rural Tanzania often encounter greater food insecurity due to higher dependency ratios. Education is another critical factor, as households without formal education report the highest levels of severe food insecurity (56.3%), while those with secondary and tertiary education experience significantly lower rates of food insecurity. This underscores the importance of education in empowering households to make informed decisions and enhance agricultural productivity. This conclusion is supported by a study conducted by Pandey et al. (2024), which found that education facilitates better access to resources and the adoption of modern farming practices, ultimately improving food security. The chi-square test results further confirm that household size and education level are statistically significant factors influencing food security, calling for targeted interventions in education and family planning to mitigate food insecurity in Gairo district.

Table 2. Demographic characteristics of respondents in relation to food insecurity levels in Gairo district.

Demographic Characteristic	Food Secure (n = 45)	Mildly Food Insecure (n = 85)	Moderately Food Insecure (n = 100)	Severely Food Insecure (n = 71)	Chi-Square (χ^2)	*p*-Value
Age (Years)						
18 - 30	33.3%	23.5%	30.0%	21.1%		
31 - 45	40.0%	35.3%	40.0%	35.2%	4.24	0.237
46 and above	26.7%	41.2%	30.0%	43.7%		
Gender						

Continued

Male	55.6%	47.1%	55.0%	42.3%	3.12	0.373
Female	44.4%	52.9%	45.0%	57.7%		
Household Size						
1 - 3	44.4%	29.4%	30.0%	14.1%		
4 - 6	33.3%	41.2%	40.0%	42.3%	10.62	0.014
7 and above	22.2%	29.4%	30.0%	43.7%		
Education Level						
No formal education	11.1%	23.5%	35.0%	56.3%		
Primary education	33.3%	41.2%	45.0%	28.2%	24.76	<0.001
Secondary education	44.4%	29.4%	15.0%	7.0%		
Tertiary education	11.1%	8.5%	5.9%	5.0%		

3.2. Factors for the Persistence of Food Insecurity in Gairo District

The results from the multiple linear regression analysis shown in Table 3 highlight several key factors that significantly affect food insecurity in Gairo district. Notably, larger household sizes and lower household incomes are linked to higher levels of food insecurity, which underscores the pressure on resources faced by larger families (Maxwell, 1996b). Access to agricultural inputs and extension services has proven to be vital for food security, supporting the findings of Osei et al. (2019a) that suggest better agricultural practices and access to support services can enhance food production and security. Furthermore, the education levels of household heads are positively associated with food security, reinforcing the argument made by Ninh (2021) that education enables individuals to make better agricultural choices. Climate variability, especially the impact of weather shocks, has a detrimental effect on food security, consistent with research by Roudier et al. (2016) that highlights the vulnerability of rural communities to climate-related challenges. A recent study by Mncube et al. (2023) also found that access to agricultural inputs and services plays a significant role in reducing food insecurity in rural Africa, further emphasizing the importance of these factors in Gairo district. These insights suggest that initiatives focused on increasing household income, improving access to agricultural resources, and expanding educational opportunities could greatly enhance food security in the area. Overall, this analysis highlights the complex nature of food insecurity and the necessity of addressing these interconnected factors to build resilience among households in Gairo district.

Household Size and Food Insecurity

The analysis indicates a positive relationship between larger household sizes and food insecurity (Table 3), suggesting that as the size of a household grows, the severity of food insecurity also increases. This reflects the demographic and economic realities faced by these families. In larger families, the pressure on limited household resources—especially food—becomes evident, as they require more food without necessarily seeing a corresponding increase in income or production

capacity. This aligns with Maxwell's (1996a) assertion that larger families contribute to food insecurity due to higher dependency ratios. In the Gairo district, this means that any efforts to alleviate food insecurity must incorporate family planning education and resource allocation strategies specifically aimed at larger households.

Household Income and Food Security

Results in Table 3 indicate that household income has proven to be a crucial factor in determining food security levels in Gairo district, with lower-income households being more vulnerable to food insecurity. This highlights the strong connection between economic capacity and the ability to access enough nutritious food. In Gairo district, where many people depend on subsistence farming and have limited access to markets, low incomes often result in an inability to buy essential agricultural inputs or diversify food sources. This situation reflects the region's economic reliance on agriculture, where market price fluctuations, limited job opportunities, and a lack of financial support services (like microfinance or cash transfer programs) worsen food insecurity. Osei et al. (2019b) and Alex et al. (2024) emphasize that income is vital for food security, as it allows households to invest in farming tools, purchase food during lean seasons, and enhance their overall living conditions.

Access to Agricultural Inputs and Extension Services

Table 3 shows that access to agricultural inputs, including fertilizers, improved seeds, and extension services, has been identified as a key factor in reducing food insecurity all over Tanzania and Gairo district in particular. This is recognized by Tanzania in the 2013 National Agriculture Policy for improving production, enhancing economic levels and ensuring food security to households (URT, 2013b). Households that reported better access to these resources and services tended to be more food secure, underscoring the importance of improved agricultural practices in increasing food production. In Gairo district, where agriculture remains the backbone of the economy, this access is essential for enhancing food security.

Education Levels of Household Heads and Food Security

The regression analysis results in Table 3 indicate that higher education levels among household heads are closely linked to better food security. In the Gairo district, this underscores the role of education in enabling individuals to make informed decisions regarding agriculture and economic matters. Educated household heads tend to embrace innovative farming methods, explore market opportunities, and diversify their sources of income, all of which enhance food security. Ninh (2021) suggests that education provides individuals with the necessary skills and knowledge to tackle agricultural challenges and stay informed about market trends and new technologies. In Gairo district, where many rural households are led by individuals with limited formal education, this suggests that educational programs focused on adult literacy and vocational training could significantly improve household food security.

Climate Variability and Food Security

A key finding (presented in Table 3) from the analysis is the detrimental effect

of climate variability, particularly weather shocks like droughts and floods, on food security in Gairo district. Households facing these shocks reported increased levels of food insecurity, highlighting the district's dependence on rain-fed agriculture. This aligns with research by Roudier et al. (2016), which points out the vulnerability of rural farming communities to climate-related risks. In Gairo district, ongoing droughts and unpredictable rainfall have resulted in lower agricultural yields, leaving households struggling to produce enough food to get through the lean season. This challenge is further intensified by the lack of irrigation infrastructure and climate-resilient farming practices.

Table 3. Results of Multiple Linear Regression (MLR).

Independent Variable	Coefficient (β)	Standard Error	t-Value	*p*-Value	Significance
Household Size	−0.324	0.086	−3.76	0.000	Significant
Household Income	0.562	0.144	3.90	0.000	Significant
Access to Agricultural Inputs	0.298	0.127	2.35	0.020	Significant
Land Ownership (in acres)	0.102	0.052	1.96	0.051	Marginally Significant
Education Level of Household Head	0.215	0.075	2.87	0.004	Significant
Climate Variability (weather shocks)	−0.414	0.108	−3.83	0.000	Significant
Participation in Farmers' Organizations	0.145	0.132	1.10	0.271	Not Significant
Access to Extension Services	0.327	0.101	3.24	0.001	Significant
Crop Yield (in kg per season)	0.481	0.123	3.91	0.000	Significant
Distance to Markets (in km)	−0.112	0.069	−1.62	0.106	Not Significant
Model Summary Results					
R					0.786
R-squared					0.617
F-statistic					47.36
p-value (F-statistic)					0.000

3.3. Factor Analysis Results

In this study, we performed a factor analysis to uncover the underlying dimensions that affect food security in the Gairo district, building on insights from our multiple linear regression analysis. The goal of this analysis is to reveal the latent constructs contributing to food insecurity, which will help us understand the complex interactions among various socioeconomic and environmental factors. By breaking down these variables into distinct factors, we can better guide targeted interventions and policies that address the multifaceted nature of food security, ultimately enhancing resilience among households in the area.

URT (2022) acknowledges that for improving agricultural performance of Morogoro region, the region needs to improve extension services, ensure reliable supply of agricultural inputs and market for both food and cash crops. **Table 4** factor analysis results reveal that five key dimensions that influence food security

in Gairo district, with economic resources and access to agricultural inputs being the most significant. The strong correlations with economic indicators suggest that improving household income and job opportunities could greatly improve food security outcomes. This aligns with research by Assenga and Kayunze (2020), which emphasizes the crucial role of household income in ensuring food access in rural Tanzania. Access to agricultural inputs, like seeds and fertilizers, is vital for increasing agricultural productivity, highlighting the need for focused interventions in this area. This is supported by recent findings from Hamasalih & Layeeq (2023), which underline the positive effects of agricultural inputs and extension services on food security in Africa. URT (2013b) Tanzania through the national agricultural policy of 2013, recognize and acknowledges that increased use of modern inputs (fertilizers, agrochemicals, seeds, farm machinery) is a pre-requisite for achieving sufficient agricultural production and growth to meet economic development, poverty reduction and food security among the farmers in the country.

Table 4 results on education and training factor shows that enhancing educational opportunities and agricultural training enables households to make informed decisions, thereby increasing their resilience to food insecurity. This finding is consistent with the conclusions of Kazungu and Kumburu (2023), who found that agripreneurship and agricultural education significantly bolster household food security in Tanzania. Furthermore, the climate resilience factor underscores the vulnerability of households to climate shocks and the urgent need for adaptive strategies. Similar to component number two of ASDP II by Tanzanian government to realize agricultural productivity and profitability strengthening agricultural extension, training and promotion/info services to its farmers is of high importance (URT, 2018).

3.3.1. Factor Loadings and Eigenvalues: Assessing the Contribution of Key Dimensions to Food Insecurity

Factor loadings assess how strongly each variable is linked to its corresponding factor, revealing which elements are crucial for each aspect of food security. **Table 4** results in the Economic Resources category, household income show a loading of 0.78, while employment status has a loading of 0.72, indicating that both are significant contributors to maintaining food security. For Access to Agricultural Inputs, the availability of seeds has a loading of 0.85, and fertilizer accessibility stands at 0.76, emphasizing the vital role these inputs play in enhancing productivity. In the Education and Training dimension (**Table 4**), the education level of the household head loads is at 0.81, and involvement in agricultural training programs is at 0.70, underscoring the importance of knowledge and skills. Climate Resilience shows high loadings for exposure to climate shocks (0.83) and awareness of adaptation practices (0.67), highlighting the necessity of resilience in addressing food insecurity. Lastly, in Social Support Systems, social safety nets load at 0.77, and community support programs at 0.65, indicating that these are additional, albeit moderate, contributors to food security.

Table 4 results on Eigenvalues reflect the variance explained by each factor, aiding in the assessment of their significance. The factor with the highest eigenvalue, Economic Resources, accounts for 22.5% of the variance, underscoring its essential role in food security. Access to Agricultural Inputs follows with an eigenvalue that explains 15.1% of the variance, while Education and Training accounts for 12.4%. Climate Resilience explains 10.2% of the variance, and Social Support Systems accounts for 8.1%. With each factor having an eigenvalue greater than 1, it confirms that all five factors play a meaningful role in understanding food security in Gairo district, with each factor contributing unique insights to the model.

Table 4. Results of factor analysis for food security in Gairo district (N = 301).

Factor	Items	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Economic Resources	Household income	0.78	22.5	0.87
	Employment status	0.72		
Access to Agricultural Inputs	Availability of seeds	0.85	15.1	0.82
	Fertilizer accessibility	0.76		
Education and Training	Education level of household head	0.81	12.4	0.78
	Participation in agricultural training programs	0.70		
Climate Resilience	Exposure to climate shocks	0.83	10.2	0.80
	Awareness of climate adaptation practices	0.67		
Social Support Systems	Availability of social safety nets	0.77	8.1	0.75
	Community support programs	0.65		
Total Variance Explained			**68.3**	

3.3.2. Scree Plot Analysis for Determining the Optimal Number of Factors in Food Security Dimensions

The scree plot serves as a visual tool to help identify the optimal number of factors by pinpointing the "elbow point", where the curve flattens out, indicating that additional factors provide diminishing returns in explanatory power. In this analysis, the scree plot suggests that keeping five factors is suitable, as any factors beyond this contribute very little additional variance. This visualization reinforces the choice to focus on the most significant dimensions, ensuring a concise and relevant set of factors to explain food security without introducing unnecessary complexity. Figure 1 presented with scree plot reveals a steep decline in eigenvalues after the first factor, Economic Resources (22.5), followed by notable decreases for Access to Agricultural Inputs (15.1), Education and Training (12.4), Climate Resilience (10.2), and Social Support Systems (8.1). The clear "elbow" in the plot after these five factors indicates that any additional factors add only marginally to the variance, implying they are less significant in explaining food security. Therefore,

retaining these five factors is both efficient and theoretically justified, as it enables a concentrated understanding of the key influences on food security. A study by Change (2016) corroborates these findings, emphasizing the essential roles of economic resources, agricultural inputs, education, and climate adaptation in enhancing rural food security. The alignment of this study with the scree plot results suggests that focusing on these core dimensions can greatly enhance food security interventions by targeting the most critical determinants while steering clear of the complexities associated with less influential variables.

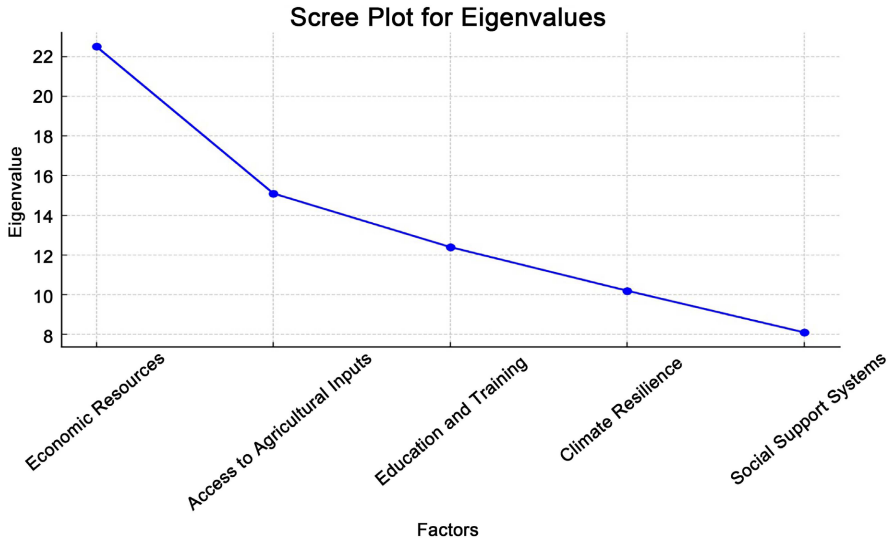

Figure 1. Scree plot for eigenvalues.

A closer interpretation of these dimensions reveals that food insecurity in Gairo district is influenced by a mix of economic, agricultural, educational, environmental, and social factors. Economic stability and agricultural input access emerge as the strongest determinants, while education and climate resilience also play crucial roles in equipping households to secure food resources. Social support systems are additionally valuable, albeit to a lesser degree. Together, these findings underscore that food security requires a comprehensive approach, addressing both material and knowledge-based needs. The factor analysis findings imply that effective interventions to improve food security should be multidimensional, addressing economic resources, agricultural inputs, education, climate resilience, and social support. Prioritizing these areas based on factor loading strengths enables policymakers to focus on the most impactful factors for this specific context. By tailoring support across these identified dimensions, strategies can be better aligned to the local determinants of food security, thereby fostering sustainable improvements.

The findings from both the multiple linear regression and factor analysis offer a detailed view of the factors affecting food security in Gairo district. The regression analysis pinpoints significant predictors of food insecurity, such as larger household sizes and lower incomes, which highlight the pressure on resources in

bigger families and the need for interventions that focus on boosting household income through microfinance programs or vocational training. In addition to these insights, the factor analysis identifies five key dimensions: economic resources, access to agricultural inputs, education and training, climate resilience, and social support systems. Each of these dimensions is closely connected to the regression results. Economic resources stress the vital importance of household income and employment status, while access to agricultural inputs points to the need for enhancing the availability of essential agricultural supplies to improve productivity. Moreover, education and training align with the regression findings that show a positive relationship between higher educational levels and food security, suggesting that educational initiatives should prioritize both literacy and practical agricultural skills. The climate resilience aspect highlights how vulnerable households are to climate-related shocks, underscoring the need to promote climate-smart practices and adaptive strategies. Finally, social support systems emphasize the importance of community assistance and safety nets in reducing food insecurity, indicating that bolstering social protection programs can offer immediate relief during difficult times. Collectively, these analyses reveal the intricate relationship between socioeconomic and environmental factors impacting food security, highlighting the need for a comprehensive approach that weaves these interconnected elements into policy planning to enhance resilience among households and contribute to a sustainable and secure food system in Gairo district.

4. Conclusion and Recommendations

4.1. Conclusion

The examination of food insecurity in Gairo district highlights a complex issue shaped by various demographic, socioeconomic, and environmental factors. Larger household sizes and lower income levels are consistently linked to increased food insecurity, as the strain on resources in bigger families heightens their vulnerabilities. Education, access to agricultural resources, and climate variability are also significant, with higher educational levels and better access to farming inputs associated with improved food security. In contrast, climate shocks like droughts and floods severely threaten household food stability. These insights emphasize the intricate relationship between household characteristics, economic capacity, agricultural practices, and environmental conditions in determining food security outcomes. The factor analysis identifies five essential dimensions—economic resources, access to agricultural inputs, education, climate resilience, and social support systems—that are vital for tackling food insecurity in the area. Overall, the study points to the necessity for comprehensive, targeted interventions that address these varied factors to enhance resilience and reduce food insecurity among at-risk households in Gairo district.

4.2. Recommendations

To alleviate food insecurity in Gairo district, targeted interventions should

concentrate on several critical areas. First, boosting household income through income-generating activities, such as microfinance initiatives or vocational training programs, is essential for easing economic constraints and improving access to food and agricultural resources in the district and other areas which have been continuously experiencing food insecurity situation. The sentence should be: Second, Agricultural development practitioners like policy activists, ministry of agriculture, NGOs and inputs suppliers should enhance access to agricultural inputs—like fertilizers, improved seeds, and extension services—to increase productivity and fortify food security. Third, educational programs should be broadened to encompass both formal education and practical agricultural training, equipping households with the necessary knowledge and skills.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Alaimo, K., Chilton, M., & Jones, S. J. (2020). Food Insecurity, Hunger, and Malnutrition. In B. P. Marriott, D. F. Birt, & A. A. Yates (Eds.), *Present Knowledge in Nutrition* (pp. 311-326). Academic Press. https://doi.org/10.1016/b978-0-12-818460-8.00017-4

Alex, S., Magasha, O., & Mlage, F. V. (2024). Contribution of Farmers' Organisations on Smallholder Farmers Market Access: A Case of MVIWATA in Morogoro District, Tanzania. *Open Journal of Social Sciences, 12,* 314-329. https://doi.org/10.4236/jss.2024.129018

Assenga, E. A., & Kayunze, K. A. (2020). Socio-Economic and Demographic Determinants of Food Security in Chamwino District, Tanzania. *Tanzania Journal for Population Studies and Development, 27,* 82-105. https://tjpsd.udsm.ac.tz/index.php/tjpsd/article/view/107

Bofa, A., & Zewotir, T. (2024). A Bayesian Spatio-Temporal Dynamic Analysis of Food Security in Africa. *Scientific Reports, 14,* Article No. 15132. https://doi.org/10.1038/s41598-024-65989-z

Cafiero, C., Gheri, F., & Viviani, S. (2024). Validating the Food Insecurity Experience Scale for Use in Analyses of Recent Food Insecurity. *Global Food Security, 42,* Article 100783. https://doi.org/10.1016/j.gfs.2024.100783

Change, C. (2016). *Agriculture and Food Security. The State of Food and Agriculture*. FAO, Rome.

Cochran, W. G. (1977). *Sampling Techniques* (3rd Ed.). Johan Wiley & Sons. https://www.academia.edu/29684662/Cochran_1977_Sampling_Techniques_Third_Edition

Duda, I., Fasse, A., & Grote, U. (2018). Drivers of Rural-Urban Migration and Impact on Food Security in Rural Tanzania. *Food Security, 10,* 785-798. https://doi.org/10.1007/s12571-018-0788-1

Hamasalih, C., & Layeeq, T. (2023). The Importance of Agricultural Extension Program in Technology Transfer for Rural Farmers: A Review. *Zagazig Journal of Agricultural Research, 50,* 387-394. https://doi.org/10.21608/zjar.2023.313661

Intergated Food Security Phase Classification (2023). *United Republic of Tanzania (Mainland): IPC Acute Food Insecurity Analysis November 2023-October 2024.*

Kazungu, I., & Kumburu, N. P. (2023). Agripreneurship as a Panacea for Food Security in Tanzania: A Systematic Review. *Heliyon, 9,* e13305. https://doi.org/10.1016/j.heliyon.2023.e13305

Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement, 30,* 607-610. https://doi.org/10.1177/001316447003000308

Maxwell, D. G. (1996a). Measuring Food Insecurity: The Frequency and Severity of "Coping Strategies". *Food Policy, 21,* 291-303. https://doi.org/10.1016/0306-9192(96)00005-x

Maxwell, S. (1996b). Food Security: A Post-Modern Perspective. *Food Policy, 21,* 155-170. https://doi.org/10.1016/0306-9192(95)00074-7

Mncube, L. N., Ngidi, M. S. C., Ojo, T. O., & Nyam, Y. S. (2023). Addressing Food Insecurity in Richmond Area of Kwazulu-Natal, South Africa: The Role of Cash Transfers. *Scientific African, 19,* e01485. https://doi.org/10.1016/j.sciaf.2022.e01485

Mtonga, T., & Nyaruhucha, C. (2022). Prevalence and Factors Associated with Undernutrition among Under-Five Children in Gairo District in Morogoro, Tanzania. *Tanzania Journal of Health Research, 23,* 1-10. https://doi.org/10.4314/thrb.v23i4.8

Ninh, L. K. (2021). Economic Role of Education in Agriculture: Evidence from Rural Vietnam. *Journal of Economics and Development, 23,* 47-58. https://doi.org/10.1108/jed-05-2020-0052

Nyange, A. K., Jonas, A., & Yusuph, A. R. (2024). Factors Affecting Food Security: A Case of Tanzania. *Journal of Economics, Finance and Management Studies, 7,* 5291-5302. https://doi.org/10.47191/jefms/v7-i8-50

Osei, R. D., Asem, F. E., & Asante, F. (2019a). The Impact of Agricultural Inputs on Food Security: Evidence from Rural Ghana. *African Development Review, 31,* 32-42.

Osei, R., Owusu, G., & Asem, F. E. (2019b). The Impact of Income and Agricultural Inputs on Food Security in Rural Areas: Evidence from Ghana. *Food Security, 11,* 601-611.

Pandey, S. C., Modi, P., Pereira, V., & Fosso Wamba, S. (2024). Empowering Small Farmers for Sustainable Agriculture: A Human Resource Approach to SDG-Driven Training and Innovation. *International Journal of Manpower*. https://doi.org/10.1108/ijm-11-2023-0655

Paudel, D., Neupane, R. C., Sigdel, S., Poudel, P., & Khanal, A. R. (2023). COVID-19 Pandemic, Climate Change, and Conflicts on Agriculture: A Trio of Challenges to Global Food Security. *Sustainability, 15,* Article 8280. https://doi.org/10.3390/su15108280

Rogawski McQuade, E. T., Clark, S., Bayo, E., Scharf, R. J., DeBoer, M. D., Patil, C. L. et al. (2019). Seasonal Food Insecurity in Haydom, Tanzania, Is Associated with Low Birthweight and Acute Malnutrition: Results from the MAL-ED Study. *The American Journal of Tropical Medicine and Hygiene, 100,* 681-687. https://doi.org/10.4269/ajtmh.18-0547

Roudier, P., Sultan, B., Quirion, P., & Berg, A. (2016). The Impact of Future Climate Change on West African Crop Yields: What Does the Recent Literature Say? *Global Environmental Change, 41,* 10-23.

UNICEF (2024). *The State of Food Security and Nutrition in the World 2024: Financing to End Hunger, Food Insecurity and Malnutrition in All Its Forms*.

United Republic of Tanzania (URT) (2013a). *Agstats for Food Security: Volume 1: The 2012/13 Preliminary Food Crop Production Forecast for 2013/14 Food Security*. Ministry of Agriculture Food Security and Cooperatives, Dar Es Salaam.

United Republic of Tanzania (URT) (2013b). *National Agriculture Policy*. Ministry of Agriculture Food Security and Cooperatives, Dar Es Salaam.

United Republic of Tanzania (URT) (2018). *Gairo District Council Strategic Plan 2018/2019-*

2022/2023. Gairo District Council, Morogoro, Tanzania.

United Republic of Tanzania (URT) (2022). *Morogoro Region Socio-Economic Profile, 2020*. National Bureau of Statistics.

Williams, M. N., Grajales, C. A. G., & Kurkiewicz, D. (2019). Assumptions of Multiple Regression: Correcting Two Misconceptions. *Practical Assessment, Research, and Evaluation, 18,* 1-14.

World Health Organization (WHO) (2021). *The State of Food Security and Nutrition in the World 2021: Transforming Food Systems for Food Security, Improved Nutrition and Affordable Healthy Diets for All (Vol. 2021)*.