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Socioeconomic and Environmental Factors Affecting Food Security among Smallholder rice farmers in Kahama District, Tanzania

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ABSTRACT

This study explores the impact of socioeconomic and environmental factors on food security among smallholder rice farmers in Kahama District, Tanzania. A random sampling technique was employed to gather data from 460 smallholder rice farmers through structured questionnaires. Socio-demographic characteristics reveal that the majority of smallholder farmers were male (74.2%), had primary education (57.9%), were aged between 46-55 years (32.9%), earned a monthly income of less than TZS 200,000 (72.3%) and a majority of smallholder farmers used local seeds (86.7%). Interestingly, 62% sold their rice post-harvest, despite 60.87% acknowledging the importance of maintaining an adequate rice stock for food security. Regression analysis revealed farm credit (β=0.258, $p<0.05$) and farm size (β=0.151, $p<0.001$) as positively influencing rice stock. Age showed a marginally positive association (β=0.045, $p<0.10$), while non-farm income (β=−0.085, $p<0.05$) and household size (β=−0.075, $p<0.05$) had negative impacts. Stable temperatures (β=0.115, $p<0.05$) and high rainfall (β=0.257, $p<0.001$) also positively correlated with rice stock. The findings suggest that increasing farm size and access to credit can enhance rice production while also addressing climate change concerns. The study recommends smallholder farmers focus on expanding farm size and utilizing farm credit to enhance rice production while adapting to climate change effects. Policy implications stemming from our findings include promoting access to agricultural credit, implementing supportive land policies, and providing extension services to improve farming techniques and management of larger farms to bolster food security among smallholder rice farmers in Kahama and similar regions

1. Introduction

Food security is the foundation of national security and the cornerstone of economic development and social stability (Lee *et al.,* 2024). It directly impacts the well-being and livelihood of citizens (Durán-Sandoval *et al.,* 2023). When food production is secure, people have access to the nutrients they need to stay healthy and thrive, thus contributing to social stability by reducing poverty, inequality, and conflict (Lee *et al.,* 2024; Arouna *et al.,* 2017). Furthermore, food security is vital for supporting industries such as agriculture, tourism, and food processing (Lee *et al.,* 2024), as a stable food supply can attract investment and promote economic growth (Timmer, 2000). The decline in food production has led to higher food prices, economic downturns, and a shift from growing food crops to cash crops, affecting both men and women and contributing to food insecurity (Abay *et al.,* 2023). Issues such as food shortages, starvation, malnourishment, and a lack of safe food sources persist globally (Zerbian and de Luis Romero, 2023). Currently, food security remains a critical concern in many countries (Wudil *et al.,* 2022). For instance, approximately 30% of the population in sub-Saharan Africa (SSA) suffered from malnutrition between 2013 and 2020 (Adeyeye *et al.,* 2023), with about 45% of the undernourished individuals being under 15 years old, particularly affecting children under five years (Mumin and Abdulai, 2022). In 2000, the number of undernourished people in SSA exceeded 240 million, highlighting the region's high levels of food insecurity (Wudil *et al.,* 2022; Cassimon *et al.,* 2023). The United

Nations Human Development Report of 2022 revealed that three out of every four households in SSA lack access to adequate food, contrasting with the Food and Agriculture Organisation (FAO), 2020) report suggesting global availability of sufficient food (Wang *et al.,* 2023). According to FAO (2024), food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Food security encompasses availability, access, and utilization (Manikas *et al.,* 2023).

According to FAO (2020), there are four main dimensions of food security, namely Physical *availability* of food: Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade. Economic and physical *access* to food: An adequate supply of food at the national or international level does not in itself guarantee household-level food security. Concerns about insufficient acess to food have led to a greater policy focus on incomes, expenditure, markets and prices to achieve food security objectives. Food *utilization* is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, the diversity of the diet and the intra-household distribution of food. *Stability* of the other three dimensions over time: Even if food intake is adequate today, you are still considered to be food insecure if there is inadequate access to food periodically, risking a deterioration of your nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status. Moreover, it is claimed that rural households experience greater food insecurity than urban areas (World Food Program (WFP), 2022).

Rice is one of the common foods consumed in Tanzania which smallholder farmers engaged in can be assured of food security (Sesabo, 2025). Tanzania is a country that is the leading rice producer in Eastern and Southern Africa (Mwaseba *et al.,* 2024; URT, 2019). Despite this significant production, challenges such as low yields persist, impacting food security at various levels, from households to national levels. On the other hand, the Tanzania Bureau of Statistics (NBS) predicted that the Shinyanga region is among the regions experiencing a decline in food supplies (NBS, 2020). Furthermore, the NBS (2019/2020) estimates that over 60% of the population in Kahama District, in Shinyanga Region, is food insecure. However, the Government of Tanzania (GoT) does take several initiatives to ensure food security by introducing programmes aiming at increasing agricultural production to increase food availability and access, but still, the level of food insecurity remains a major concern in the country. For example, Kahama district experiences high levels of food insecurity despite being one of the largest rice-producing districts in Tanzania (URT, 2019). The reason for the district to face food insecurity could be influenced by socio-economic similar to those explained by Asadullah and Kambhampati (2021). However, smallholder farmers who grow rice often claim to experience high incomes and food security (Arifin *et al.,* 2021), but that is not always the case.

There are limited studies on the impact of socioeconomic and environmental factors affecting the food security of smallholder rice farmers in Tanzania, particularly in the Kahama District. It is also argued by Randell *et al*. (2022) that 48.1% of the population studied in Tanzania is suffering from severe food insecurity and that there is a strong association between high food insecurity and low education levels. Although other studies such as those of Umarjonovna and Gulomjonovna, (2022) and Bjornlund *et al..*(2022), have been conducted to examine food security and demographic factors such as employment and income in the African context, their findings are not convincing since they came up with mixed views.

Therefore, assessment of the effects of rice production on food security is crucial for policymakers in Tanzania for various reasons. First, rice holds significant importance as a staple food and a commercial crop in Tanzania, hence playing a vital role in the national economy. Addressing issues related to rice production and food security can directly impact economic growth by enhancing productivity, improving farmer livelihoods, and ensuring food security at both household and national levels (Timmer, 2000). Secondly, a considerable proportion of Tanzania's population lives below the poverty line, relying on agriculture for their sustenance (Charles *et al.* 2023). Exploring rice production as a food

security crop will allow policymakers to identify avenues for enhancing agricultural productivity, thereby uplifting smallholder farmers from poverty. Enhancing rice production can lead to increased farmers' incomes and contribute to poverty alleviation efforts across the country. Thirdly, tackling food security challenges, particularly those concerning staple foods like rice, is crucial for enhancing nutrition and health outcomes in Tanzania. Maintaining a consistent and adequate rice supply can help combat malnutrition, especially among vulnerable groups such as children and women. Therefore, policymakers should also focus on rice production from a food security perspective and implement strategies to promote the consumption of nutritious foods which have been obtained from healthy food processing techniques such as the use of unpolished rice to boost overall public health.

Furthermore, the novelty of this study lies in its comprehensive approach to analysing the impact of various socio-economic factors, such as gender, income, education, farm size, and household size, along with the inclusion of climate variables like temperature and rainfall in assessing the food security of smallholder rice producing farmers. In addition, the use of multiple linear regression analysis to assess the relationships is also a notable methodological contribution that could be adopted by other scholars who will be undertaking similar studies in the future.

In this context, our study aims to examine the impact of socio-economic and other factors affecting the food security of smallholder rice farmers in Kahama District, Tanzania. Specifically, this study aims to answer two research questions which are (i) What are the socio-economic factors that affect small-scale rice farmers in Kahama District? and (ii) Is there any association between the socio-economic factors and food security in Kahama District, Tanzania?

This paper is organized into five sections. Section one presents the introduction while section two presents a literature review. Section three describes the methodology and data collection procedure, while section four presents the results and discussion. The last section, that is, section five, provides a conclusion and recommendations.

2. Literature Review

2.1. Theoretical Literature Review

This study is guided by three theories of food security, climate change and household behaviour.

2.1.1. Food Security Theory

Neo-Malthusian Theory (1798): The foundation of this theory lies in Thomas Malthus's that posits a fundamental link between population growth and the availability of resources, including food. He argued that population grows geometrically while food supply increases arithmetically, leading to inevitable resource scarcity and social issues. The theory explains that unsustainable population growth can outstrip food production, leading to food insecurity and environmental degradation. This theory often focuses on the supply side and the potential limits of agricultural production to keep pace with increasing populations.

2.1.2 Climate change theory

There has been a notable impact of climate change on crop yields as follows: *(i) Temperature Effects***:** According to the Intergovernmental Panel on Climate Change (IPCC) (2013) rising global temperatures can have both positive and negative impacts on crop yields, depending on the crop and the region. In some higher-latitude regions, warmer temperatures may lengthen growing seasons and potentially increase yields for certain crops. However, for many staple crops, especially in tropical and subtropical regions, exceeding optimal temperature thresholds can lead to reduced yields due to accelerated development, decreased grain filling, and increased water stress. Heat waves can directly damage crops.

(ii) Changes in Precipitation Patterns: Ullah (2025), climate change is causing shifts in rainfall patterns, leading to more frequent and intense droughts in some areas and increased flooding in others. Droughts lead to water scarcity, impacting plant growth and survival, especially in rain-fed agricultural systems. Increased rainfall and flooding can cause waterlogging, soil erosion, and nutrient loss, damaging crops and infrastructure.

2.1.3 New Household Economics (NHE) Theory

The Theory of New Household Economics (NHE), developed in the mid-1960s was largely pioneered by Nobel laureate Gary Becker. The theory offers a distinct perspective on household behaviour compared to traditional consumer theory. The NHE posits that households actively produce the things they value, such as meals, childcare, health,

entertainment, and even the quality of their children. This production process involves a household production function where market goods and services (inputs) are combined with the household members' time (another crucial input) and their skills/knowledge (human capital) to yield these "basic commodities" (outputs). For example, a meal isn't just purchased; it's "produced" by combining groceries (market goods), the cook's time and effort, and their culinary skills.

2.1.4. Linkage between the theories and the study

The linkage is developed from theories reviewed, namely food security (Neo-Malthusian Theory of 1798), climate change and household behaviour (New Household Economics Theory of the 1960s). This theoretical link provides insights into the root causes of food insecurity, strategies to address it, and the broader impacts on society. The theoretical literature provides a rich and diverse body of work on food security and other socioeconomic and environmental factors, addressing the complexities of ensuring access to sufficient and nutritious food for all individuals. Scholars have explored various aspects of food security, including its relationship with poverty, health, environmental sustainability, and social justice. A significant focus in the theoretical literature revolves around the social determinants of food security, analyzing how factors like household income, geographical location, employment, education levels, and social support networks impact individuals' access to adequate and nutritious food (Lu and Carter, 2024; Kandel *et al.,* 2024; Zhu *et al.,* 2024).

The Neo-Malthusian Theory (1798) lies in Thomas Malthus's that posits a fundamental link between population growth and resource availability, including food. The theory explains that unsustainable population growth can outstrip food production, leading to food insecurity and environmental degradation. This theory often focuses on the supply side and the potential limits of agricultural production to keep pace with increasing populations. There must be a proportion of population growth with the extent of food production; otherwise, food insecurity will occur.

Another strand of the theoretical literature is climate change-related theory which explains how variations in rainfall patterns, temperature and changes in precipitation patterns affect food security outcomes (Misra, 2014; IPCC, 2013; Ullah, 2025). Adequate and timely rainfall is crucial for crop growth and yields, ensuring a stable food supply. Conversely, droughts or high temperatures can result in crop failures, food shortages, and increased vulnerability to food insecurity in communities dependent on agriculture for their livelihoods (Lee *et al.*, 2024; Misra, 2014). The rising global temperatures can have both positive and negative impacts on crop yields, depending on the crop and the region. In some higher-latitude regions, warmer temperatures may lengthen growing seasons and potentially increase yields for certain crops (IPCC, 2013). Similarly, shifts in rainfall patterns lead to more frequent and intense droughts in some areas and increased flooding in others. Droughts lead to water scarcity, impacting plant growth and survival, especially in rain-fed agricultural systems. Increased rainfall and flooding can cause waterlogging, soil erosion, and nutrient loss, damaging crops and infrastructure, hence food insecurity (Ullah, 2025).

Furthermore, the theory that governed the study was the theory of household behaviour (New Household Economics). The theory delineates a semi-commercial family business model within a competitive labour market (Halik *et al.,* 2021). This theory is particularly relevant for households with established food security achieved when individuals have both physical and economic means to access safe, sufficient, and nutritious food consistently, meeting their dietary requirements for a healthy and active life (FAO, 2020). The pillars of food security encompass availability, accessibility, utilization, and stability.

2.2. Empirical Literature Review

Zhou *et al*. (2019) utilized binary logistic regression to determine that factors such as age, gender, education, remittances, unemployment, inflation, wealth, and disease significantly influence household food insecurity in Pakistan. They highlighted the pivotal role of gender, noting that female-headed households were more likely to experience food insecurity compared to male-headed households. Aidoo *et al.* (2013) also employed a logistic regression model and identified farm size, off-farm income, access to credit, and marital status as key determinants of household food security in Ghana. They observed that larger households tended to face

more food insecurity than smaller ones. Additionally, their research emphasized the positive impact of farm size, off-farm income, and access to credit on household food security. Moreover, Ahmed *et al.* (2017) used a logistic regression analysis in a food security study in Pakistan and concluded that family size, monthly income, food prices, health expenditure, and debt significantly affect the food security status of rural households in this country. Conversely, Mwalyagile *et al.* (2024) argued that female-headed agricultural households in Tanzania exhibited higher rice production values than male-headed households, despite facing challenges in land access.

Addai *et al.* (2021) found that female plot managers are not disadvantaged in rice production and produce 18% more rice than male plot managers in Ghana. Their study suggested that differences in rice productivity between male and female plot managers within regions are influenced by factors such as age, marriage status, wealth, family labour, herbicide use, and membership in farmer organizations. Similarly, Sesabo (2024) found that average yields on male-run rice farms are significantly higher than on women-run farms, due to higher seeding and fertilizer rates in Tanzania. However, there is no significant difference in rice cultivation area between men and women. The author argued that differences in rice productivity were negatively influenced by factors like poor access to cultivated land, small farm size, household expenditure, and hired labour, resulting in a gender gap in rice productivity.

Also, Bello *et al.* (2021) examined gender differences in agricultural performance in Nigeria and identified causes of performance differences among rice farmers. The results showed inequality between men and women, with a gender performance gap of about 11% in favour of men, of which 77.66% of this gap remained unexplained after accounting for gender differences in household characteristics, access to supply-side factors, and agricultural production resources in Nigeria.

A study conducted by Sesabo (2024) to look at the determinants of food security among smallholder farmers in Tanzania revealed irrigation extension services crop storage, land ownership and female land ownership as crucial determinants of food security in Tanzania.

A study conducted by Huang *et al.* (2020) in Kahama District found that smallholder farmers produce rice for their consumption and sell the rest for income generation. However, the amount of food secured by production levels at the household level varies depending on socioeconomic and environmental characteristics, climatic conditions, and accessibility to agricultural inputs (Alais and Magoti 2023).

It is also noteworthy that rainfall and temperature play crucial roles as climate parameters influence crop yield variability globally and nationally. Abbas and Dastgeer (2021) argued that maximum temperatures negatively affect plant development, leading to a decrease in the number of rice plants in Punjab, India. Additionally, rainfall positively impacts rice yield, particularly during the replanting and tillering phases.

Therefore, the above empirical review provides a brief highlight of the relationship between socioeconomic and environmental factors with food security among smallholder rice farmers. In short, the literature summarizes that gender, higher incomes, and better access to agricultural credit can improve food security. Likewise, farmers' education plays a crucial role in developing their awareness and understanding of sustainable agricultural practices. Higher levels of education are often accompanied by increased adoption of technologies and improved agricultural management techniques. On the other hand, farm size, especially land area, influences food security among smallholder rice farmers and increases production. It was also observed that larger families tended to have higher levels of food insecurity. Rainfall and temperature change patterns can also impact food security. Overall, the study aims to fill the gap in the literature by using multiple linear regression analyses on the socio-economic and other factors affecting food security among smallholder rice farmers in Kahama District, Tanzania. The study converted the questionnaire responses into numerical form to facilitate the calculation of the linear regression analysis, which makes our approach novel.

3. Materials and Methods

3.1. Materials

3.1.1. Description of the Study Area

Kahama District, situated in the Shinyanga Region of Tanzania, is a significant producer of rice, supplying not only the local market but

also neighbouring countries like Kenya, Uganda, Rwanda, Burundi, the Democratic Republic of Congo, and South Sudan (Badstue *et al.,* 2021; Nkwabi *et al.,* 2021). The National Population Census (URT, 2022) reported a total population of 523,806 in the district, with 256,463 males and 267,339 females residing across its 34 wards, all actively involved in rice cultivation.

3.1.2. Research Design and Sample Size

The study utilized a descriptive study approach with a cross-sectional design. The study respondents, specifically smallholder rice farmers, were selected using simple random sampling. Data collection was done through structured questionnaires. The sample selection process employed a multistage sampling technique as outlined by Taherdoost (2016). Initially, Kahama district was chosen due to its significance in rice production. Subsequently, four wards out of the total twenty (URT, 2013) were purposively selected based on rice production levels reported by the District Agriculture Officer. Two villages from each ward; Mwendakulima (Mwendakulima Kati and Busalala villages), Zongomera (Zongomera and Ilindi villages), Nyandekwa (Nyandekwa and Bujika villages), and Wendele (Wendele and Kahanga villages) were then purposively chosen. A sampling frame was created by compiling a list of smallholder rice farmers from each village with the assistance of the village office and township administration officials. Finally, smallholder rice farmers were randomly sampled from this list, resulting in a total of 460 respondents.

3.2. Methods

3.2.1. Data Analysis

Stata 17 was utilized for data analysis to investigate the relationship between farmers' socio-economic characteristics and food security among smallholder rice farmers. Chi-square tests were conducted to examine the association between the socio-economic factors and food security among smallholder rice farmers at a statistical significance of $p< 0.05$. Linear regression analysis was then employed to assess the impact of these socio-economic factors and other variables on food security. The socio-demographic characteristics of smallholder farmers were analysed using frequencies and percentages as outlined by Kumar *et al.* (2013). Factors such as age, gender, education level, farmer's income, farm size, household size, rice credit utilization, and climate change indicators (such as temperature fluctuations and rainfall) were taken into consideration.

3.2.2. Model specification

The study employed a linear regression model to investigate the influence of socio-economic factors on food security among smallholder rice farmers in Kahama District, Tanzania. The questionnaire responses were transformed into numerical data to enable the estimation of regression coefficients for evaluating the interrelationships among variables. This transformation allowed us to utilize regression coefficients in examining the impact of modifications in one variable (socio-economic factors) on changes in another variable (food security measured in terms of availability, accessibility, utilisation and stability). The Multiple Linear Regression (MLR) was specified as presented in Equation 1.

$$(Y)= \beta_0+ \beta_1X_1 + \beta_2X_2 + \beta_3X_3+ \beta_4X_4+ \beta_5X_5 + \beta_6X_6+ \beta_7X_7+ \beta_8X_8 +....\beta_iX_i + \mu \text{ .....Equation 1}$$

Where

Y is the continuous food security outcome variable measured by the FAO food security index (Household Food Insecurity Access Scale (HFIAS)).

β_0= constant, μ = error term

$\beta_1 .... \beta_i$= coefficient of variables and $X_1 \dots X_i$ are variables (sex, farm credit, age, income, marital status, education, household size, farm size, temperature, rainfall).

The sign of the coefficient was explained as follows:

- A positive β_1 indicates that as the independent variable (X) increases, food security (Y) also tends to increase (e.g., higher monthly income might lead to higher food security scores).
- A negative β_1 indicates that as the independent variable (X) increases, food security (Y) tends to decrease (e.g., increased rainfall might lead to lower food security).

The relationship between the variable selection was supposed to be explained in the conceptual framework (see Figure 1) and as justified by theoretical literature and other empirical research (Zhou et *al.,* 2019; Aidoo et *al.,* 2013; Lee et *al.,* 2024).

The MLR model was selected for the following reasons: (i) The model allows to examine how several independent variables simultaneously affect a single dependent variable (Hair *et al*., 2019). For instance, when predicting crop yield, factors like rainfall, temperature, fertilizer use, and soil quality all

play a role. Multiple linear regression can incorporate all these predictors into one model. (ii) This often leads to more accurate predictions of the dependent variable compared to a simple linear regression model that only uses one predictor (Montgomery *et al*., 2012). (iii) The model allows you to determine the individual effect of each independent variable on the dependent variable while controlling for the effects of the other predictors in the model (Tabachnick and Fidell, 2019). (iv) The model can be extended to include interaction terms, which allow to examine whether the effect of one independent variable on the dependent variable depends on the level of another independent variable (Aiken and West, 1991).

The study had the following assumptions on the used MLR model: (i) *Linearity:* The relationship between the independent variables and the dependent variable is linear. This means that a change in the independent variables is associated with a constant change in the dependent variable. (ii) *Independence of Errors*: The differences between the observed and predicted values are independent of each other. This means that the error for one observation should not influence the error for another observation. (iii) *Homoscedasticity:* The variance of the residuals is constant across all levels of the independent variable(s). (iv) *Normality of Residuals*: The residuals are normally distributed and (v) *No Multicollinearity*: The independent variables are not highly correlated with each other.

4. Results and Discussion

4.1. Socioeconomic and Environmental Characteristics of the Smallholder rice farmers

Results as presented in Table 1 show the summary of socio-economic characteristics of smallholder rice farmers in Kahama District. The results show that the majority of the respondents were male (74.2% and n = 341). The majority were aged between 46-55 years old category (n=152, 32.9%), while the minority were aged between 18-35 years old (n=64, 13.9%). The study found that the majority (n=355, 77.2%) of the respondents were married, while the least number were those who reported being separated (n=8, 1.8%) (Table 1).

The study revealed that 57.9% of respondents (n=266) had primary school education, while 25.5% (n=117) had not received any formal training (Table 1). The majority of participants came from households with 6 – 10 members (n=236, 51.3%). Additionally, 40.4% of the respondents indicated having a farm size exceeding 4 hectares (n=186), with 79.8% reporting a farm size of 2 hectares. The findings also indicated that most respondents had less than 20 years of experience in rice production (n=272, 59.3%), while only 18.1% reported having over 30 years of experience. Furthermore, 97.6% of the respondents claimed to have access to land for rice cultivation

.

Table 4: Socio-economic characteristics of the smallholder rice farmers in the study area

	Variable name	N (Total)	Percentage (%)
Sex	Male	341	74.2
	Female	119	25.8
Age	18-35	64	13.9
	36-45	128	27.9
	46-55	152	32.9
	56 and above	116	25.2
Marital status	Single (not entered into marriage)	15	3.3
	In a relationship	7	1.5
	Married	355	77.2
	Divorced	20	4.5
	Widow/widower	55	11.9
	Separated	8	1.8
Education levels	Not attended	117	25.5
	Primary education	266	57.9
	Secondary education	56	12.2
	Technical or Vocational education	12	2.7
	College/University Education	8	1.8
Household size	1-5	127	27.6

	Variable name	N (Total)	Percentage (%)
	6-10	236	51.3
	11-15	72	15.7
	16 and above	25	5.3
Farm size	Less than 2 acres	94	20.5
	2.0 – 3.9	180	39.2
	4.0 and above	186	40.4
Rice production experience (years)	Less than 20 years	272	59.3
	20-30	104	22.6
	30 years and more	84	18.1
Accessibility to land for rice production	Accessible	449	97.6
	Not accessible	11	2.4
Labour use	Hired	211	45.9
	Family	438	95.3
Farm management	Children	181	39.3
	Husband	379	82.4
	Wife	328	71.3
Household monthly income	Less than TZS 200,000	332	72.3
	Between TZS 200,000 to 500,000	115	24.9
	More than TZS 500,000	13	2.8
The kind of seeds used	Improved Seeds	26	5.6
	Local Seeds	399	86.7
	Not sure if improved or local	35	7.7

The results as presented in Table 1 show that the majority of the respondents (n = 399, 86.7%) use local seeds, while only a few (n = 26, 5.6%) use improved seeds. The income generated from rice production is influenced by the amount of rice produced, the farm size, and labour input. Despite having access to land, most respondents (n=332, 72.3%) earn less than TZS 200,000 monthly. Only a small number (n=13, 2.8%) of the respondents reported a monthly income exceeding TZS 500,000.

4.2. Socio-economic Factors and Food Security among Smallholder rice farmers

The study examined the association between socioeconomic and environmental factors and food security among smallholder rice farmers in Kahama District using the Chi-square test and the results are presented in Table 2. The analysis revealed that factors such as age, education, marital status, and gender did not show any significant association with food security among smallholder rice farmers, hence only significant associations were reported.

Table 2: Chi-square test of association

	The stock of rice for food security		
Sex	**Yes**	**No**	Total
Male	203	125	328
Female	77	55	132
Total	280	180	460
Pr= 0.480			
Household size	**Yes**	**No**	Total
1-5	92	93	185
6-10	137	64	201
11-15	39	17	56
16 and above	12	6	18
Total	280	180	460
Pr = 0.001***			
Farm size (acre**)**	**Yes**	**No**	Total
0.1 – 0.9	19	9	28
1.0 – 1.9	17	24	41
2.0 – 2.9	52	19	71

3.0 – 3.9	33	28	61
4.0 and above	105	31	136
Total	226	111	337
Pr = 0.000***			
Non-farm income	**Yes**	**No**	Total
10,000-49,000	26	13	39
50,000 and above	75	8	83
Total	101	21	122
Pr = 0.017**			
Use of rice farm credit	**Yes**	**No**	Total
Yes	24	3	27
No	256	175	431
Total	280	178	458
Pr = 0.002***			
High rainfall for paddy	**Yes**	**No**	Total
Yes	182	50	232
No	98	127	225
Total	280	177	457
Pr = 0.000***			
Shift in temperature	**Yes**	**No**	Total
Yes	170	61	231
No	110	117	227
Total	280	178	458
Pr = 0.000***			

Note: p< 0.05, p< 0.01*****

The results as presented in Table 2 indicate a significant association between household size and food security among smallholder rice farmers (p <0.01). This suggests that as household size increases, the prevalence of food insecurity among smallholder rice farmers also tends to increase, implying that larger families may struggle to ensure sufficient and consistent rice food supplies for all members, thus increasing the likelihood of food insecurity. Additionally, farm size is a key factor in determining household food security (Ruslan and Prasetyo, 2023), whereby this study's findings reveal a significant relationship between farm size and food security among smallholder rice farmers (p <0.01) (Table 2). This implies that smaller farms are often linked to higher levels of rice food insecurity among smallholder farmers. Furthermore, non-farm income sources such as off-farm employment and other non-agricultural activities play a vital role in enhancing household food security among smallholder rice farmers (Gebre *et al.,* 2023). This study's results demonstrate a significant association between non-farm income and food security among smallholder rice farmers (p < 0.05), indicating that an increase in non-farm income is significantly correlated with improved food security among smallholder rice farmers. Therefore, households with higher non-farm income are more resilient to market fluctuations and seasonal variations, enabling them to maintain food security even in times of economic uncertainty.

Access to agricultural credit plays a crucial role in influencing food security among smallholder rice farmers. The results as presented in Table 2 show a significant association between farm credit utilization and food security among smallholder rice farmers (p <0.05). Agricultural loans enable farmers to invest in agricultural inputs, technology, and infrastructure, ultimately leading to increased productivity and income (Wongnaa *et al*., 2023). This indicates that improved access to farm credit can enhance agricultural production, diversification, and commercialization, which are vital factors in ensuring food security among smallholder rice farmers in Kahama District.

High rainfall can have both positive and negative impacts on food security for rice paddies. On the one hand, sufficient and well-distributed rainfall is essential for the growth of rice plants, as it ensures optimal soil moisture and supports healthy plant development (Wimalasiri *et al*., 2022). The results as presented in Table 2 indicate a significant association between high rainfall and food security among smallholder rice farmers (p <0.01). This study suggests that moderate to high rainfall contributes to higher rice yields, leading to improved food security among smallholder rice farmers in Kahama District.

In addition, the relationship between temperature fluctuations and food security is a critical issue influenced by climate change. Changes in temperature patterns can have significant impacts on agricultural productivity, food availability, and ultimately food security at various levels (Kennedy *et al.,* 2023). Rising temperatures can lead to shifts in growing seasons, changes in crop yields, and alterations in the distribution of pests and diseases, all of which can impact food production. Extreme heat events can reduce crop yields, threaten food supplies, and affect food security among smallholder rice farmers (see Bernacchi *et al.,* 2023). The results as presented in Table 2 show that long-term temperature changes have a significant association with food security among smallholder rice farmers ($p < 0.001$). This result implies that smallholder farmers have adapted to changing climate conditions to ensure food security among smallholder rice farmers.

4.3. Socio-economic Factors Influencing Food Security among Smallholder rice farmers in Kahama District

This study employed multiple linear regression analysis to determine factors associated with food security in Kahama District and the results are presented in Table 3. The findings show that farm size, use of farm credit, age, high rainfall and long-term temperature variation have positive and statistically significant effects on increasing food security among smallholder rice farmers. Table 3. This result means that increases in farm size, use of farm credit, age and high rainfall are associated with increases in food security among smallholder rice farmers in Kahama District. Furthermore, household size and non-farm income have negative and statistically significant effects on food security. This evidence suggests that an increase in household size and non-farm income is associated with a decrease in food security. Larger household sizes often lead to increased demand for food within the household, which can strain available resources and impact food security. While non-farm income sources have the potential to improve food security, certain factors can have negative impacts. For example, fluctuations in non-agricultural income, such as irregular employment opportunities or fluctuations in income from non-agricultural activities can have an impact on the stability of household income and therefore food security (Gebre *et al.,* 2023).

Table 3: Linear regression of factors related to food security

Dependent variables (Rice stock for food security)						
Variables	Coefficient(β)	Std. error	T	p>t	[95% conf.	interval]
Sex	.0108	.046	0.23	0.81	-.081	.102
Use of farm credit	.258	.109	2.36	0.02**	.043	.473
Age	.045	.024	1.85	0.07*	-.002	.094
Non-farm income	-.085	.041	-2.04	0.04**	-.168	-.002
Marital status	.023	.024	0.96	0.34	-.025	.072
Education	-.042	.026	-1.59	0.11	-.095	.010
Household size	-.075	.032	-2.31	0.02**	-.139	-.011
Farm size	.151	.053	2.85	0.001***	.047	.256
No temperature shift	.115	.046	2.47	0.01**	.023	.206
High rainfall	.257	.046	5.54	0.000***	.165	.348
Constant	.262	.291	0.90	0.367	-.309	.835

Note: The notation *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively, with *** representing p < .01, ** representing p <.05, and * representing p <.10.

Moreover, there are various channels through which agricultural loans can improve food security. For example, agricultural loans allow farmers to invest in essential agricultural inputs such as seeds, fertilizers, equipment, and technology. Studies have shown that access to credit can lead to higher agricultural productivity, increased crop yields, and improved agricultural management practices, ultimately contributing to food security (Wongnaa *et al.,* 2023, Sesabo, 2024). Additionally, access to farm credit enables farmers to adopt innovative practices, technologies, and sustainable farming methods that can enhance efficiency, reduce environmental impact, and increase resilience to changing climatic conditions. By supporting investments in agricultural innovation, agricultural credit plays a crucial role in ensuring long-term food security and agricultural sustainability (Rehman *et al.,* 2024).

Farmer age can influence food security in various ways, impacting both agricultural

productivity and household well-being. For instance, older farmers accumulate knowledge and experience in agricultural practices over the years, which can positively affect farm productivity and efficiency. Studies have demonstrated that experienced farmers are more inclined to embrace sustainable farming techniques, manage resources efficiently, and confront environmental challenges, resulting in enhanced food security (Akhtar *et al.,* 2023). In addition, heavy rainfall has the potential to boost agricultural productivity and foster increased food production, ultimately bolstering food security (Wimalasiri *et al.,* 2022).

A stable temperature regime can also create favourable conditions for rice cultivation and lead to improved yields, crop resilience, and food security among smallholder rice farmers in Kahama District. Consistent temperatures enable better planning and selection of appropriate rice varieties that can withstand the prevailing climate, thereby contributing to increased resilience and food security (Hossain *et al.,* 2023). This study shows that food security among smallholder rice farmers increases when temperature fluctuations are minimized.

Overall, this study is consistent with previous research indicating that factors such as age, access to farm credit, farm size, high rainfall, and stable temperature regimes have a positive impact on food security among smallholder rice farmers (Akhtar *et al.,* 2023; Rehman *et al.,* 2024; Wongnaa *et al.,* 2023; Hossain *et al.,* 2023; Wimalasiri *et al.,* 2022, Sesabo, 2024).

5. Conclusion, Recommendations and Policy Implications

5.1 Conclusion

This study explores the impact of socioeconomic and environmental factors affecting food security of smallholder rice farmers in Kahama District, Tanzania. A random sampling technique was utilized to gather data from 460 smallholder rice farmers through structured questionnaires. Socio-demographic characteristics reveal that the majority of smallholder farmers are male (74.2%), have primary education (57.9%), fall in the age range of 46 to 55 years (32.9%), and earn a monthly income of less than TZS 200,000/= (72.3%). Additionally, most farmers cultivate rice using local seeds (86.7%). It is noted that approximately 55% of smallholder farmers do not produce rice for their consumption opting to sell it post-harvest (62%). Interestingly, 60.87% of farmers acknowledge the importance of maintaining an adequate rice stock for food security.

The results show a significant relationship between farm size and food security among smallholder rice farmers ($p < 0.01$). This means that smaller farms are often associated with higher food insecurity among smallholder rice farmers. Similarly, the results also show a significant association between high rainfall and food security among smallholder rice farmers ($p < 0.01$). This means that moderate to heavy rainfall contributes to higher rice yields, resulting in improved food security among smallholder rice farmers in Kahama District. The multiple linear regression results indicate that factors such as farm size, utilization of farm credit, age, high rainfall, and stable temperatures have a positive and statistically significant impact on enhancing food security among smallholder rice farmers. Conversely, household size and monthly non-farm income have a negative and statistically significant effect on food security.

5.2. Recommendations

Based on the study findings, smallholders are recommended to consider increasing their farm size and the best ways to access farm credit. These variables will enhance their rice production and hence, their food security. In addition, the best production will also contribute to environmental sustainability through climate change adaptation measures such as maintaining stable temperatures and benefiting from high rainfall. This study also recommends that the Government of Tanzania and development partners and other stakeholders supporting agricultural production should continue offering agricultural farm credit to small-scale farmers in rural areas to further bolster food security among smallholder rice farmers.

5.3. Policy Implications

It has been found that increasing farm size and ensuring access to farm credit are important policy considerations for improving food security in Kahama District. Therefore, policymakers should consider and implement land tenure and ownership policies that promote secure land tenure and equal access to land for smallholder farmers. Such policies can help increase farm size and promote sustainable rice farming practices. It has also been found that providing extension services and training programs to smallholder farmers can improve their ability to effectively manage larger farm sizes, introduce modern farming

techniques, and improve rice productivity. Therefore, since extension services in Tanzania are provided by the government, it has to ensure that they are accessible to smallholder rice farmers in the study area. On the other hand, policies that promote financial inclusion and increase access to affordable credit for farmers, especially smallholders should be assured. This can enhance rice farmers' ability to invest in agricultural inputs and technology. Therefore, strengthening financial institutions such as banks and cooperatives that provide farm credit can improve the availability and accessibility of credit to farmers, thereby contributing to greater food security. By incorporating these policy implications into agricultural development strategies, policymakers can support smallholder farmers to expand their farm sizes, access farm credit, and ultimately improve food security outcomes in Kahama District.

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References

Abay, K. A., Breisinger, C., Glauber, J., Kurdi, S., Laborde, D., and Siddig, K. (2023). The Russia-Ukraine war: Implications for global and regional food security and potential policy responses. *Global Food Security*, *36*, 100675.

Abbas, S., andDastgeer, G. (2021, November). Analysing the impacts of climate variability on the yield of Kharif rice over Punjab, Pakistan. In *Natural resources forum* (Vol. 45, No. 4, pp. 329-349). Oxford, UK: Blackwell Publishing Ltd.

Addai, K. N., Lu, W., and Temoso, O. (2021). Are Female Rice Farmers Less Productive than Male Farmers? Micro-evidence from Ghana. *The European Journal of Development Research*, *33*(6), 1997-2039. https://doi.org/10.1057/s41287-020-00342-4

Adeyeye, S. A. O., Ashaolu, T. J., Bolaji, O. T., Abegunde, T. A., and Omoyajowo, A. O. (2023). Africa and the Nexus of poverty, malnutrition and diseases. *Critical Reviews in Food Science and Nutrition*, *63*(5), 641-656.

Ahmed, U. I., Ying, L., Bashir, M. K., Abid, M., and Zulfiqar, F. (2017). Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PloS one*, *12*(10), e0185466.

Aidoo, R., Mensah, J. O., and Tuffour, T. (2013). Determinants of household food security in the Sekyere-Afram plains district of Ghana. *European Scientific Journal*, *9*(21).

Aiken, L. S., and West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.

Akhtar, S., Abbas, A., Faisal, M., Raza, M. H., Samie, A., Yu, M., and Lovell, A. (2023). Roles of personal, household, physical, and institutional factors on farmers' efficiency of hybrid maize production: Implications for food security. *Agriculture*, *13*(9), 1840.

Alais L., M and Magoti E., T. (2023). Technological Advancement in Food Production and Management and its Implications on Food Security: A Case Study of Rice and Maize Products in Tanzania REPOA.

Alamgir, M. S., Furuya, J., Kobayashi, S., Mostafiz, R. B., and Ahmed, M. R. (2021). Farm income, inequality, and poverty among farm families of a flood-prone area in Bangladesh: climate change vulnerability assessment. *GeoJournal*, *86*, 2861-2885.

Arifin, A., Biba, M. A., andSyafiuddin, S. (2021). The contribution of rain-fed rice farming to income and food security of farmers' households. *Journal of Socioeconomics and Development*, *4*(2), 180-188.

Arouna, A., Lokossou, J. C., Wopereis, M. C. S., Bruce-Oliver, S., and Roy-Macauley, H. (2017). Contribution of improved rice varieties to poverty reduction and food security in sub-Saharan Africa. *Global Food Security*, *14*, 54-60.

Asadullah, M. N., andKambhampati, U. (2021). Feminization of farming, food security

and female empowerment, *Global Food Security*, *29*, 100532.

Badstue, L., Farnworth, C. R., Umantseva, A., Kamanzi, A., andRoeven, L. (2021). Continuity and change: performing gender in rural Tanzania. *The Journal of Development Studies*, *57*(2), 310-325.

Bello, L. O., Baiyegunhi, L. J., Danso-Abbeam, G., andOgundeji, A. A. (2021).Gender decomposition in smallholder agricultural performance in rural Nigeria. *Scientific African*, *13*, e00875. https://doi.org/10.1016/j.sciaf.2021.e00875.

Bernacchi, C.J., Ruiz-Vera, U.M., Siebers, M., DeLucia, N.J., and Ort, D.R. (2023). Short- and long-term warming events on photosynthetic physiology, growth, and yields of field-grown crops. *Biochemical Journal, 480*, 999 - 1014.

Bjornlund, V., Bjornlund, H., and van Rooyen, A. (2022). Why food insecurity persists in sub-Saharan Africa: A review of existing evidence. *Food Security*, *14*(4), 845-864.

Cassimon, D., Fadare, O., andMavrotas, G. (2023). The impact of food aid and governance on food and nutrition security in Sub-Saharan Africa. *Sustainability*, *15*(2), 1417.

Charles, G., Otieno, S., Kimaro, M., Heriel, E., Mwakasisi, T. andMganga, J. (2023). Determinants of Multidimensional Poverty in Rural Tanzania. *Rural Planning Journal*, *25*(1), 81-96.

Durán-Sandoval, D., Durán-Romero, G., andUleri, F. (2023). How much food loss and waste do countries with problems with food security generate? *Agriculture*, *13*(5), 966.

FAO (2020). The state of food insecurity in the world: economic growth is necessary but not sufficient to accelerate the reduction of hunger and malnutrition. Rome, Italy: FAO Publisher.

FAO (2024). The State of Food Security and Nutrition in the World 2024. Financing to end hunger, food insecurity and malnutrition [1] in all its forms. Rome: FAO. https://doi.org/10.4060/cd1254en [2]

Gebre, G.G., Ashebir, A., andLegesse, T. (2023). Impact of income diversification on rural household food security in Ethiopia. *African journal of science, technology, innovation and development, 15*, 913 - 922.

Hadley, C., Lindstrom, D., Tessema, F., andBelachew, T. (2008). Gender bias in the food insecurity experience of Ethiopian adolescents. *Social science and medicine*, *66*(2), 427-438.

Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Halik, H. A., Salman, D., Darma, R., andArief, A. A. (2021). The dynamics mode of production structure in the Patorani community in Takalar district, In *IOP Conference Series: Earth and Environmental Science* (Vol. 788, No. 1, p. 012177). IOP Publishinghttps://doi.org/10.1016/j.socscimed.2007.08.025.

Hossain, M., Biswas, P., and Islam, R. (2023). Cold-tolerant and short-duration rice (Oryza sativa L.) for sustainable food security of the flash flood-prone haor wetlands of Bangladesh. *Sustainability*, *15*(24), 16873.

Huang, J., Antonides, G., andNie, F. (2020). Is mental accounting of farm produce associated with more consumption of own-produced food? *Journal of Behavioral and Experimental Economics*, *88*, 101594.

IPCC, 2013: Climate Change 2013*: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_all_final.pdf.

Kandel, G. P., Bavorova, M., Ullah, A., and Pradhan, P. (2024). Food security and sustainability through adaptation to climate change: Lessons learned from Nepal. International Journal of Disaster Risk Reduction, 101, 104279.

Kennedy, J., Hurtt, G.C., Liang, X., Chini, L.P., and Ma, L. (2023). Changing cropland in changing climates: quantifying two decades of global cropland changes. *Environmental Research Letters, 18*.

Kumar, M., Salim, A. T., and Ramayah, T. (2013). Business Research Methods. In *Business Research Methods*.

Lee, C. C., Zeng, M., and Luo, K. (2024). How does climate change affect food security? Evidence from China. Environmental Impact Assessment Review, 104, 107324.

Lu, H., and Carter, A. (2024). Social determinants of rural food security: Findings from Michigan's Upper Peninsula. *Journal of Rural Studies*, *107*, 103256.

Manikas, I., Ali, B. M., and Sundarakani, B. (2023). A systematic literature review of indicators measuring food security. *Agriculture and Food Security*, *12*(1), 10.

Mwalyagile, N., Jeckoniah, J. N., and Salanga, R. J. (2024). Gender differences in rice production participation among smallholder farmers in small-scale irrigation schemes in Mbarali district, Tanzania. *Journal of Agriculture and Food Research*, *18*, 101390.

Mishra, A. K., Khanal, A. R., andMohanty, S. (2017). Gender differentials in farming efficiency and profits: The case of rice production in the Philippines. *Land use policy*, *63*, 461-469. https://doi.org/10.1016/j.landusepol.2017.01.033.

Misra, A. K. (2014). Climate change and challenges of water and food security. *International Journal of Sustainable Built Environment*, *3*(1), 153-165.

Montgomery, D. C., Peck, E. A., and Vining, G. G. (2012). *Introduction to linear regression analysis* (5th ed.). John Wiley and Sons.

Mumin, Y., and Abdulai, A. (2022). Informing food security and nutrition strategies in sub-Saharan African countries: An overview and empirical analysis. *Applied Economic Perspectives and Policy*, *44*(1), 364-393.

Mwaseba, S., Dimoso, P. and Timoth, S. (2024). "Drivers of Small-Scale Farmers' Adoption of Mobile Phone Technology for Rice Production and Marketing in Dodoma Region". *Rural Planning Journal*, *26*(1).

Nkwabi, J., Sharma, R., Dev, K., and Sharma, S. (2021). Challenges for Small Scale Rice Farmers Case Study from Tanzania. *Economic Affairs*, *66*(1), 149-155.

Ogunniyi, A. I., Omotoso, S. O., Salman, K. K., Omotayo, A. O., Olagunju, K. O., andAremu, A. O. (2021). Socio-economic drivers of food security among rural households in Nigeria: Evidence from smallholder maize farmers. *Social Indicators Research*, *155*, 583-599.

Randell, H., Gray, C., andShayo, E. H. (2022). Climatic conditions and household food security: Evidence from Tanzania. *Food Policy*, *112*, 102362.

Rehman, A., Batool, Z., Ma, H., Alvarado, R., andOláh, J. (2024). Climate change and food security in South Asia: the importance of renewable energy and agricultural credit. Humanities and Social Sciences Communications, 11, 1-11.

Ruslan, K., and Prasetyo, O.R. (2023). Does Farm Size Matter for Food Security Among Agricultural Households? Analysis of Indonesia's Agricultural Integrated Survey Results. *Proceedings of the International Conference on Data Science and Official Statistics*.

Sadiq, S. M., Singh, P. I., and Ahmad, M. M. (2021). Productivity gap by gender among rice farmers in North-Central Nigeria. *Agricultural Socio-Economics Journal*, *21*(2).

Sesabo, J. K. (2024). Deciphering the drivers of food security in Tanzania: Non-experimental research design. *Science Mundi*, *4*(1), 12-24.

Sesabo, J. K. (2025). Technical Efficiency in Food Crop Production in Tanzania: Analysis of Selected Cereal Crops. Global Social Welfare, 1-12.

Tabachnick, B. G., and Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson Education.

Taherdoost, H. (2016). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research? *International Journal of Academic Research in Management (IJARM), 5 (2)*,18-27..

Timmer, C. P. (2000). The macro dimensions of food security: economic growth, equitable distribution, and food price stability. *Food policy*, *25*(3), 283-295.

TNBS (2020). Tanzania in Figures, The National Bureau of Statistics. Ministry of Finance and Planning – Dodoma.

Ullah, G. (2025). The Impact of Climate Change on Crop Yield and Agricultural Productivity. *Journal of Agricultural Science and Botany*, *9*(1), 278. https://www.alliedacademies.org/articles/the-impact-of-climate-change-on-crop-yield-and-agricultural-productivity-32096.html.

Umarjonovna, D. D., and Gulomjonovna, Y. Y. (2022). Challenges of food security. *Conference*, 505-507.

URT, (20198). Key Findings 2017/18 Household Budget Survey Tanzania Mainland. National Bureau of Statistics. Ministry of Finance. Dar es Salaam.

URT, (2022). 2022 Population and Housing Census - Administrative units Population Distribution and Age and Sex Distribution Reports. Tanzania National Bureau of Statistics.

Wang, X., Dou, Z., Feng, S., Zhang, Y., Ma, L., Zou, C., ... and Chen, X. (2023). Global food nutrients analysis reveals alarming gaps and daunting challenges. *Nature Food*, *4*(11), 1007-1017.

WFP (2022). World Food Program Tanzania Annual Report. Dar es Salaam, Tanzania: WFP.

Wimalasiri, E.M., Ampitiyawatta, A.D., Dissanayake, P.K., and Karunaratne, A.S. (2022). Impact of climate change adaptation on paddy yield in dry zone Sri Lanka: A case study using agricultural production systems simulator (APSIM) model. *IOP Conference Series: Earth and Environmental Science,* 1016*.*

Wongnaa, C. A., Abudu, A., Abdul-Rahaman, A., Akey, E. A., and Prah, S. (2023). Input credit scheme, farm productivity and food security nexus among smallholder rice farmers: evidence from North East Ghana. *Agricultural Finance Review*, *83*(4/5), 691-719.

Wudil, A. H., Usman, M., Rosak-Szyrocka, J., Pilař, L., andBoye, M. (2022). Reversing years for global food security: A review of the food security situation in Sub-Saharan Africa (SSA). *International Journal of Environmental Research and Public Health*, *19*(22), 14836.

Zerbian, T., and de Luis Romero, E. (2023). The role of cities in good governance for food security: lessons from Madrid's urban food strategy. *Territory, Politics, Governance*, *11*(4), 794-8

Zhou, D., Shah, T., Ali, S., Ahmad, W., Din, I. U., and Ilyas, A. (2019). Factors affecting household food security in the rural northern hinterland of Pakistan. *Journal of the Saudi Society of Agricultural Sciences*, *18*(2), 201-210.

Zhu, Y., Azami, M. R., Fazal, M., Khuram, D., Iannotti, L., Babulal, G., and Trani, J. F. (2024). The Association Between Women's Education and Employment and Household Food Security in Afghanistan. *The European Journal of Development Research*, *36*(4), 841-867.