Deciphering the Drivers of Food Security in Tanzania: Non-experimental Research Design

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ABSTRACT

Food security is a pressing global concern, particularly in developing countries such as Tanzania, where rural areas, predominantly inhabited by smallholder farmers, bear the brunt of its adverse effects. This study looks into the determinants of food security among smallholder farmers in Tanzania, utilising data from the agriculture sample census survey of 2019/20 conducted by the National Bureau of Statistics (NBS). Employing a Non-experimental research design, the study used a probit regression model to estimate key factors influencing food security. The results underscore the significance of factors such as irrigation (-0.906, p<0.01), extension services (-0.040, p<0.05), crop storage (-1.473, p<0.01), land ownership (-0.070, p<0.01), and female land ownership (-0.909, p<0.01) as crucial determinants of food security in Tanzania. The study advocates prioritising community-based irrigation for reliable water sources, expanding targeted extension programs, investing in modern crop storage, ensuring secure land tenure, implementing comprehensive seed subsidies, and adopting a holistic approach to soil fertility management. Policymakers are urged to support these measures to enhance food security among smallholder farmers in Tanzania, promoting resilience, productivity, and sustainability.

Keywords: Agribusiness, Extension Services, Food Security, Irrigation, Poverty, Tanzania

I. INTRODUCTION

Food security is a growing concern worldwide. According to estimates, over 1 billion individuals do not get enough energy from their diets, and at least twice as many have deficiencies in some micronutrients (Cafiero, 2019; Reincke et al. 2018). Statistics show that global food insecurity and malnutrition have increased recently, despite notable advancements made toward the 2030 Sustainable Development Goals objective of "zero hunger and malnutrition" across nations (Kitole et al. 2024b). Between 2014 and 2020, the percentage of people experiencing food insecurity rose by 7.80% points, from 22.6 to 30.4%. However, the increase during the Covid-19 pandemic in 2020 (3.80% points) was nearly equal to the increase during the five years prior, from 2014 to 2019 (Food and Agriculture Organization [FAO], 2023; 2020). As a result, improving food security is still a hot concern in the development and scientific communities (Gil et al., 2019; Getaneh et al. 2022).

In Africa, the number of people who are food insecure is still increasing (Mwanga, 2020). As a result, the COVID-19 pandemic, conflicts, export restrictions by the world's leading suppliers, and climate change have led to a rise in global food prices, which, in turn, significantly contributed to the rising food and nutrition insecurity across the globe (Enilolobo et al., 2023; International Food Policy Research Institute [IFPRI], 2022; Headey & Ruel 2020; World Bank [WB], 2020). Sub-Saharan African [SSA] countries are disproportionately affected by this unprecedented rise in global food insecurity and malnutrition due to the combined effects of the factors as mentioned earlier (Azomahou et al., 2022; Cassimon et al., 2022; Onyeaka et al., 2022). However, the potential impact of food security in African urban areas has received less attention than other elements that have been explored to address the food crisis (Dake, 2021).

Globally and particularly in developing countries like Tanzania, enhancing good security has remained to be an important topic in both scientific and development communities. For example, countries in the world are implementing various strategies to achieve Sustainable Development Goal 2 (SDG 2) of Zero Hunger focusing on ending Hunger by ensuring access to safe, nutritious, and sufficient food throughout the year by all people, in particular the poor and people in vulnerable situations, including infants. To achieve this goal, Tanzania as a country, via Five Year Development Plan III (FYDP III), have focused on Promoting investment in the production and consumption of diversified nutritious foods and increasing the production, distribution and consumption of local nutritious food (URT, 2021; Kitole & Utouh, 2023). In addition, the country has been implementing various

Productive Social Safety Net (TASAF-PSSN) intervention programmes to provide social funds to protect people experiencing poverty, not through relief or welfare handouts, but through investments, people chose to guard or improve their well-being (Kitole, 2023; Rukiko et al., 2023)

Despite various initiatives to address the problem in Tanzania, food security remains a persistent challenge. For example, according to the 2011/12 Household Budget Survey (HBS), the issue of food security was a major concern in rural areas (11.3%) compared to urban areas (8.7%), while in 2017/2018, the average food insecurity in Tanzania was 19.4%, with 24.6 and 10.6% for rural and urban areas respectively (NBS, 2020), and the proportional grew to 20.01% and 11.26% in 2022 (Kitole & Sesabo, 2024). As the situation of chronically food insecure people is becoming an increasingly severe living condition, these statistics indicate the intensity of the problem in the Tanzanian context.

The disparity in food insecurity between the rural and urban areas has been documented; however, there are limited studies conducted during the past COVID 19 pandemic. It is argued that the pandemic may exacerbate the pre-existing vulnerabilities to enhance the accessibility and inequalities in food security. Thus, it is crucial to identify the determinants of food security at the household level through a cross-sectional study based on households to design appropriate strategies to address the problem of food insecurity. Having data on the national food balance sheet is insufficient to understand the country's food security dynamics, especially in the rural areas (Saruni et al., 2018). Therefore, this paper aims to provide insight into the factors that contribute to food security in Tanzania. Specifically, the research aims to explore the dimension of food availability. This will provide important information which will serve as a crucial guiding principle for academics, decision-makers, aid organisations, and development professionals as they build sustainable and urgent development plans or interventions.

II. LITERATURE REVIEW

2.1 Empirical Literature Review

The empirical reviews offer insights into various aspects of food security, exploring different geographical locations and factors influencing it. Bawadi et al. (2012) conducted a cross-sectional study in Northern Jordan, emphasising the prevalence of food insecurity among women. The study highlighted the influence of education levels on food security in the Jordanian context. Moreover, other studies have also shown that demographic factors such as family size, age of the head of household, sex and marital status influence household food availability significantly (Mwanga, 2020; Fumbwe et al., 2021).

Moreover, Zainab (2023) examined how the crisis between Russia and Ukraine has affected food security in Africa, highlighting the continent's reliance on food imports. Using cutting-edge approaches, Mumuni and Aleer (2023) investigated how climate change affects African context food security. The study emphasised how closely temperature, precipitation, and carbon dioxide emissions relate to food security. Also, the study by Enilolobo et al. (2023) also found that agricultural imports and exports positively impacted food security. They emphasised the need for stable exchange rates to maintain the affordability of imported food.

Saruni et al. (2018) focused on the Tanzanian semi-arid region, using a binary logit model to identify factors affecting food security. The study highlighted the inverse relationship between household dependency ratios and food security. Regarding the effect of climate change on food security, the studies by Islam et al. (2022), Mekonnen et al. (2021), Randell et al. (2021), Erasto, (2021), and Randell et al., 2022 found that climate extremes negatively affect food security in Bangladesh, Ethiopia, Nepal, and Tanzania.

Also, Mutea et al. (2022) addressed shocks, socioeconomic status, and food security in Kenya, underscoring disparities and the impact of shocks on food security. Utonga et al. (2023) highlighted institutional determinants in the Singida Region, Tanzania, emphasising the significant impact of institutions on food security. Likewise, Yilmaz and Njora (2021) analysed the impact of agricultural policies on food security in Kenya, recommending subsidies, reduced taxation, and increased allocations to agriculture and food sectors.

The above studies have provided insights regarding various aspects of food security, exploring different geographical locations and influencing factors. These studies indicate that the factors influencing food security include external factors such as the Russia-Ukraine conflict, which impacted those African countries negatively depend on food imports (Zainab, 2023; Enilolobo et al., 2023) (ii) agricultural imports and exports which influence the domestic market prices (Yilmaz & Njora, 2021); climate change-related factors (Mekonnen et al. 2021; Islam et al., 2022; Randell et al. 2021; Randell et al. 2022); households characteristics such as household's dependent ratio and socio-economics status (Saruni et al., 2018; Mutea et al. 2022), institutional factors (Utonga et al. 2023), and agricultural policies (Yilmaz & Njora, 2021). While most studies have shown that food security is highly attributed by

social and demographic factors little has been explored on term of women resource ownership particularly land and the effects of remittances. Therefore, this study adds this information to the existing body of knowledge in analyzing factors influencing households' food security status in Tanzania.

2.2 Theoretical Framework

This study utilised the System Food Approach (SFA), a comprehensive theoretical framework encompassing a myriad of interconnected actors and value-adding activities within the entire food supply chain. The SFA comprises food products' production, distribution, consumption, and disposition (FAO, 2023). Additionally, it includes the social, economic and environmental factors that may affect the household's ability to produce and, hence, lower food security or directly affect food security. The household socioeconomic factors highlighted include education, income, family size and many others that describe household characteristics.

Therefore, the SFA integrates various dimensions of human life, translating into one's ability to access food within a given period. The system of food approach goes beyond the normal food poverty assessment because it even explains the institutional and government position on food security across households. The system argues that households are not the sole actor in the existence of food security as government and other institutions play crucial roles in shaping the status of food security in communities (Dekeyser & Rampa, 2021; FAO, 2023). Moreover, one of the SFAs is considered an important asset in explaining food security because it integrates many components that affect people's welfare, particularly regarding food security status. Therefore, SFA aligns with this study as it emphasize on the interrelation of number for components affecting household food security, moreover, it acknowledges the importance of socioeconomic, institutional and environmental factors that shapes food accessibility across households hence facilitating good understanding on factors influencing household food security in Tanzania.

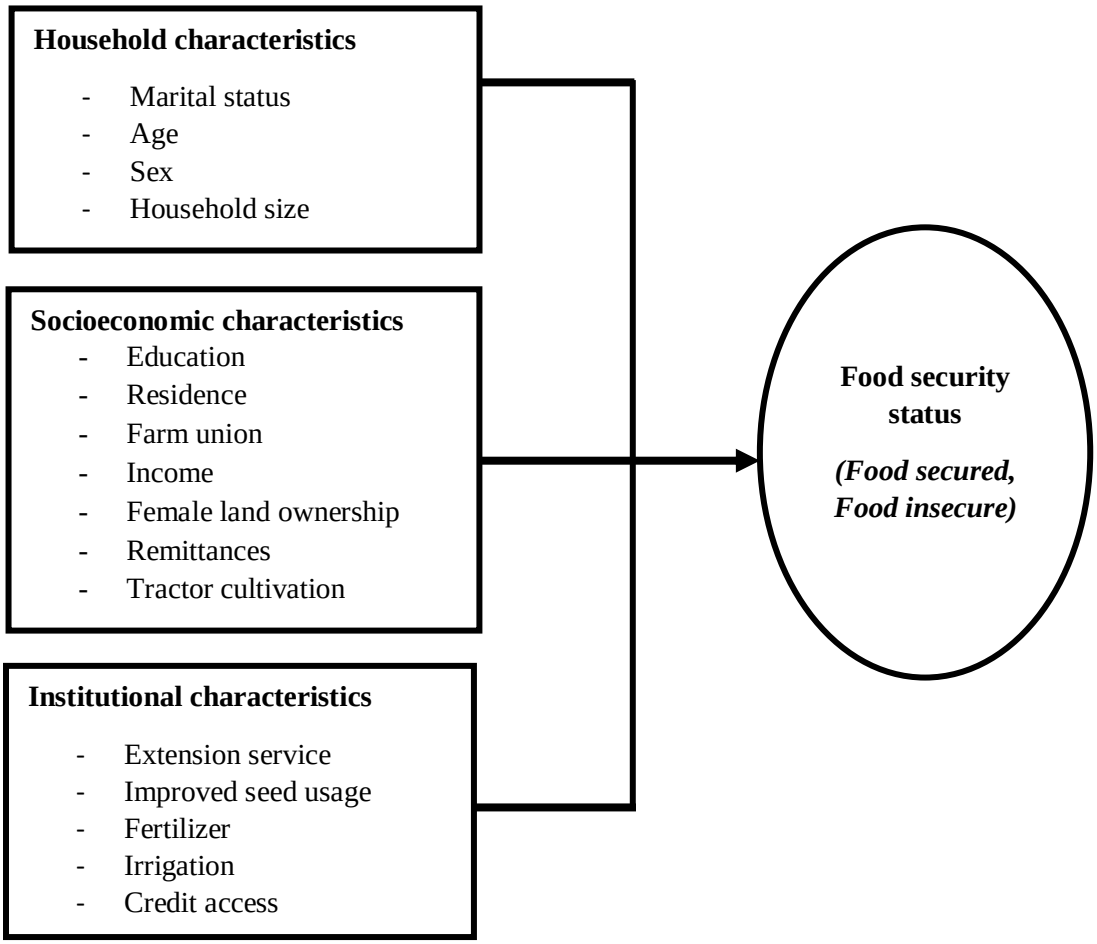

Figure 1

Conceptual Framework for Drivers of Food Security in Tanzania

Within the System Food Approach framework, particular attention is given to the socioeconomic characteristics of farmers. Therefore, drawn from an empirical and theoretical framework, factors influencing food security among households include socio-demographic factors (sex, age, household size, marital status, level of education); socio-economics factors, and institutional factors (Enilolobo et al., 2023; Saruni et al. 2018; Mekonnen et al. 2021). Therefore, Figure 1 presents a conceptual framework for the study.

III. METHOD

This study employs non-experimental research design due to its ability to handle variables without manipulating them (Kitole et al. 2023d; Kitole et al. 2024c). The non-experimental design does not allow the manipulation of variables, hence making it easier to get real results or information from respondents. (Kitole et al. 2024c; Kothari, 2019; Kitole et al. 2023a). The method is more convenient because of the use of secondary data that was sourced from the National Bureau of Statistics for wave five of the Agriculture National Census Survey 2019/20.

3.1 Modelling Household Food Security

In explaining factors influencing household food security in Tanzania by the use of the agriculture census survey data, the current study uses a probit regression model to explain the probability for which various factors influence Tanzania households towards food security (Webele & Greene, 2011; Dimoso & Andrew, 2021; Kitole et al., 2023c). The use of probability helps to enhance clarity on the likelihood of which various factors, including demographic, economic and institutional affect households in attaining food security status.

Therefore, for the probit model, the study considered an equation which describes the household food security status with the following relationship.

$$y_i^* = \beta w' + \mu_i \quad where\ \mu_i \sim (0, \delta^2) \ldots\ldots\ldots (1)$$

y_i^* is the dependent variable, which assumes unobservable status, β represents the independent variable, w' represents the coefficient of the independent variable and μ_i is the error term with standard normal distribution. Since y_i^* is unobservable; what we observe is y_i which takes only two values as described here under:

When $y_i^* > 0, y_i = 1\ if\ household\ is\ food\ secured$

When $y_i^* \leq 0, y_i = 0\ if\ household\ is\ food\ insecured$

Because the probability that the household is food-secured is greater than zero ($y^* > 0$)

$$prob(y = 1) = prob(y_i^* > 0) \ldots\ldots\ldots (2)$$

Or less than or equal to zero ($y^* \leq 0$)

$$prob(y = 0) = prob(y_i^* \leq 0) \ldots\ldots\ldots (3)$$

The likelihood of a household to be food-secured is herein presented by unobservable factors through the dependent variable as follows:

$$Food\ security = \begin{matrix} 1\ if\ Household\ is\ food\ secured^* > 0 \\ 0\ if Household\ is\ food\ insecured^* < 0 \end{matrix} \quad \ldots\ldots\ldots (4)$$

If $y_i^* = 0$ then $y = 1$ implying that household is food secured. Therefore, the probability that the household is food-secured assumes that the probability density function of e_i assumed being $f(\mu_i)$ which results in the creation of a new parameter:

$$Prob(y_i = 1|x|) = \int_{-\infty}^{x'\beta} f(\mu_i) du = F(x_i'\beta) \ldots\ldots\ldots (5)$$

$$Prob(y_i = 1|x|) = 2\pi^{-\frac{1}{2}} \exp\left((-\beta x_i)^{\frac{2}{2}}\right) \ldots\ldots\ldots (6)$$

Now, based on the variables used in this study the probit model is therefore presented as;

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 D_i + \mu_i \ldots\ldots\ldots (7)$$

Of which the β_0 is the constant term while β_1 and β_2 are the parameters that will be estimated in the probit equation. On the other hand, X_i are the covariates while D_i represents a group of all dummy variables used in this study. Now, since the probit model is well addressed under the marginal effects which help to explain the extent of effects, then equation 7 is therefore transformed into equation 8 to get the marginal variations in the repressors as shown in equation 8:

$$\frac{dy}{dx_i} = \beta_i \emptyset(\beta_1 + \beta_n) \quad \ldots \ldots \ldots (8)$$

Moreover, the variables employed in this study have been elucidated, and their measurements are presented in Table 1. This table provides a concise explanation of the measurement of each variable and outlines their utilisation in the study.

Table 1

Description and Measurement of Variables

Variable name	Operational definition	Expected sign
Food security	Household food availability status (1= yes, 0= no)	
Household size	Number of family members in a household	+/-
Age	Age in years	+/-
Residence	Category, 1=Rural, 2 =Urban	+/-
Sex	Category, 1 = Male, 2 = Female	+/-
Marital status	Marital status of the head of household (Married, never married, divorced, widowed)	+/-
Irrigation	Access to irrigation (1=yes, 0=otherwise)	+
Extension service	Dummy, 1=yes, 0= otherwise	+
Crop storage	Dummy, 1=yes, 0= otherwise	+
Improved seed usage	Dummy, 1=yes, 0=otherwise	+
Access to credit	Dummy, 1=yes, 0=otherwise	+
Farm union membership	Membership in farmers' organisation/union	+/-
Remittance	Dummy, 1=yes, 0=otherwise	+
Female land ownership	Dummy, 1=yes, 0=otherwise	+/-
Fertiliser usage	Dummy, 1=yes, 0=otherwise	+
Tractor cultivation	Dummy, 1=yes, 0=otherwise	+

IV. FINDINGS

The findings in Table 2 present the characteristics of smallholder farmers in Tanzania, focusing on various variables and their respective attributes. Findings indicate that 29.76% of smallholder farmers in Tanzania reported having sufficient food availability, while the majority, accounting for 70.24%, reported insufficient food availability. This suggests a significant portion of the smallholder farming population faces challenges in ensuring an adequate food supply. On the other hand, results show that 84.08 percent of households do not access irrigation schemes, while only 15.92% have access to irrigation schemes or services in their areas. This justifies the fact that most Tanzanian households depend on rain-fed farming.

Furthermore, results indicate that 96.13% of all households have no access to extension services, while only 3.87% have access to extension services. This justifies that most households do not receive agriculture production advice. In addition, 75.35% don't have crop storage facilities, while only 24.65% have crop facilities.

Table 2

Characteristics of Smallholder Farmers in Tanzania

Variables	Attributes	Frequency	Percentage
Food availability	Yes	41,891	29.76%
	No	98,872	70.24%
	Total	**140,763**	100.00%
Irrigation	Yes	22,409	15.92%
	No	118,354	84.08%
	Total	**140,763**	100.00%

Extension service	Yes	5,448	3.87%
	No	135,315	96.13%
	Total	**140,763**	100.00%
Crop storage	Yes	34,698	24.65%
	No	106,065	75.35%
	Total	**140,763**	100.00%
Female land ownership	Yes	30,616	21.75%
	No	110,147	78.25%
	Total	**140,763**	100.00%
Fertiliser usage	Yes	27,688	19.67%
	No	113,075	80.33%
	Total	**140,763**	100.00%
Improved seed usage	Yes	42,060	29.88%
	No	98,703	70.12%
	Total	**140,763**	100.00%
Tractor cultivation	Yes	23,395	16.62%
	No	117,368	83.38%
	Total	**140,763**	100.00%
Access to credit	Yes	15,019	10.67%
	No	125,744	89.33%
	Total	**140,763**	100.00%
Remittance	Yes	30,531	21.69%
	No	110,232	78.31%
	Total	**140,763**	100.00%
Marital status	Married	63,906	45.40%
	Never married	42,581	30.25%
	Divorced	20,819	14.79%
	Widowed	13,457	9.56%
	Total	**140763**	100.00%
Farm union membership	Members	23,550	16.73%
	Non-members	117,213	83.27%
	Total	**140,763**	100.00%

Besides, results on gender differences in land ownership have shown that most females do not own land (78.25%) as only 21.75% of females own land. This calls for equity in resource ownership across males and females. On the other hand, results have shown that only 19.67% of households utilised fertiliser while the majority 80.33% did not use fertilisers in their agricultural production. Likewise, the majority, representing 70.12% do not use improved seeds while only 29.88% use improved seeds.

Moreover, results in Table 2 show that 16.62% of farmers reported using tractors or animals in their farming practices, while 83.38% did not. It indicates a significant reliance on manual labour or traditional farming methods, which might affect efficiency and productivity. Nevertheless, only 10.67% of smallholder farmers reported access to credit, while the majority (89.33%) did not. Limited access to credit could hinder investments in farming inputs, technology, and other resources essential for agricultural development. On top of that, results indicate that 21.69% of farmers reported receiving remittances, while 78.31% did not. It suggests that a notable portion of smallholder farmers rely on external financial support, potentially indicating economic challenges within the farming community.

Regarding marital status, most smallholder farmers are married, with 63,906 individuals constituting 45.40% of the sampled population. The "never married" category includes 42,581 individuals, representing 30.25%, while 20,819 individuals (14.79%) are classified as divorced, and 13,457 individuals (9.56%) are widowed. For the union membership, the result shows that only 16.73 percent are members of the farm union, while 83.27 percent are non-members. This indicates that it is hard to convey some important information on agriculture as most are not members of the farmers union.

Table 3
Household Involvement in Farming Activities

Involvement in farming activities	Freq.	Percent	Cum.
Work full time on the farm	51210	36.38	36.38
Work part-time on a farm	6348	4.51	40.89
Rarely work on farm	23473	16.68	57.57
Never worked on the farm	59732	42.43	100.00
Total	**140,763**	**100.00**	

Results presented in Table 3 show that 36.38% of households are working on farms as their full-time income activities, while 4.51% are working part-time. Also, the results show that 16.68% of households rarely work on farms, and 42.43% have never worked on farms. This may indicate diversified income sources or additional non-farm occupations within these households. Furthermore, about 16.68% of households reported rarely working on the farm. This category suggests irregular or occasional involvement in farming activities, indicating a potential reliance on other income-generating activities or seasonal agricultural engagement. The majority, 42.43% of households, reported never working on the farm. This group likely relies on alternative sources of income, and their lack of involvement in farming activities may be attributed to various reasons, including non-agricultural occupations or urban lifestyles.

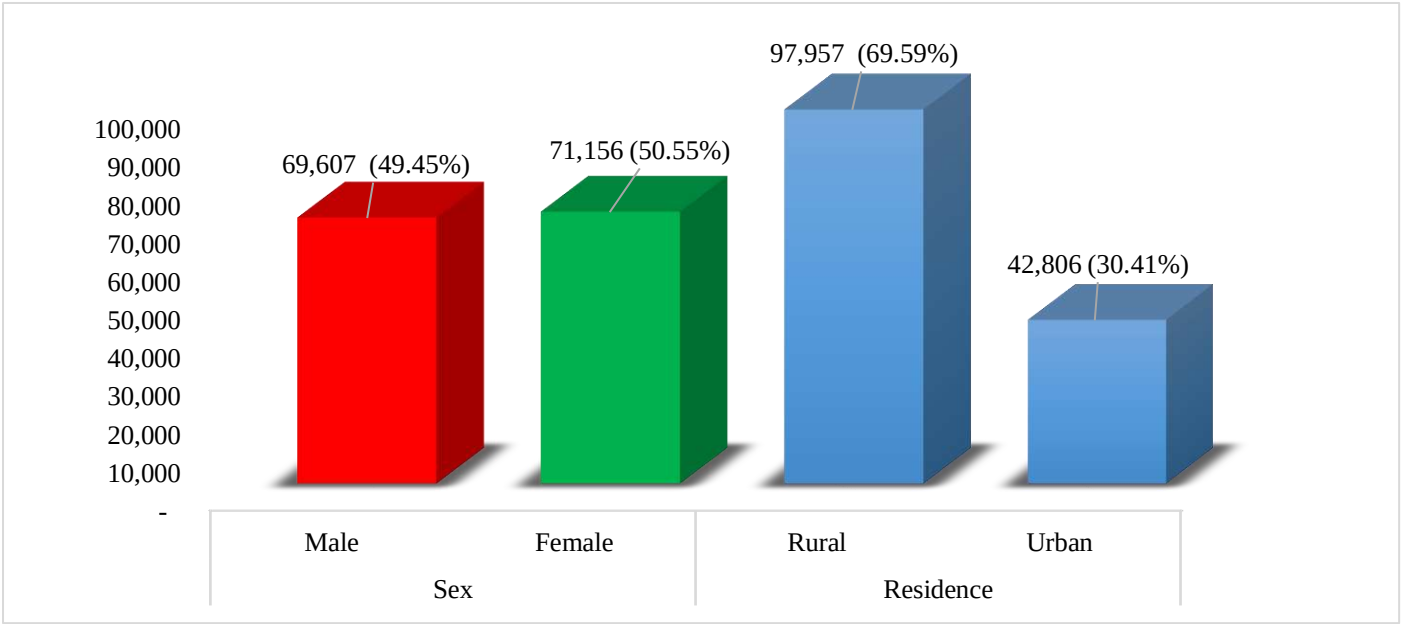

Figure 2
Distribution of Smallholder Farmers across Gender and Residence

Figure 1 illustrates the distribution of smallholder farmers based on gender and residence. Among the sampled population, 69,607 individuals, constituting 49.45%, are identified as male farmers, while 71,156 individuals, representing 50.55%, are female farmers. The data further delineates the distribution across residences, revealing that most smallholder farmers, comprising 97,957 individuals (69.59%), reside in rural areas. In contrast, 42,806 individuals (30.41%) are in urban areas. This distribution underscores the predominantly rural nature of smallholder farming activities, aligning with the common narrative that agriculture, mainly small-scale farming, is a cornerstone of rural livelihoods.

Table 4

Probit Regression on Factors Contributing to Food Security in Tanzania

Variable	Simple probit			Marginal effects		
	Coefficient	Standard error	P-values	dy/dx	Standard error	P-values
Sex (Male)	0.1965031	0.390311	0.164	0.345055	0.60631	0.640
Age	0.5407320	0.740228	0.359	0.463232	0.75230	0.431
Residence (Rural)	0.347317*	0.150852	0.067	0.294210	0.195075	0.163
Irrigation	-0.9064085***	0.0266118	0.000	-0.156624 ***	0.00729	0.000
Extension service	-0.0401233**	0.0207295	0.043	-0.003387 ***	0.00171	0.048
Crop storage	-1.47302***	0.0138913	0.000	-0.3018763***	0.00445	0.000
Land ownership	-0.0709893***	0.0136624	0.000	-0.00645***	0.00129	0.000
Female land ownership	-0.9094785***	0.0134312	0.000	-0.1450897***	0.00329	0.000
Improved seeds usage	-0.4243595	0.668594	0.526	-0.02517	0.02503	0.315
Fertiliser usage	-0.1872232**	0.8863544	-0.016	-0.0189609**	0.10411	0.031
Credit access	0.1228941	0.0946833	0.194	0.0095089	0.00654	0.146
Farm union	-0.160732**	0.031732	0.026	-0.096743***	0.00263	0.001
Remittances	0.0359841	0.046644	0.440	0.0030059	0.03378	0.426
Tractor cultivation	-0.3539828***	0.0160715	0.000	-0.039935***	0.00230	0.000
Number of observations		**140,763**				
Pseudo R^2		**0.4108**				
Chi square		**2943.06**				

**p<0.1, **p<0.05, ***p<0.01*

The probit regression analysis in Table 4 illuminates the intricate determinants of food security among smallholder farmers in Tanzania. Regarding gender, the coefficient for males is 0.1965 (p = 0.164), indicating a positive, albeit statistically insignificant, association with food security. The marginal effect of 0.3451 suggests that, on average, males exhibit a 34.51% higher probability of experiencing food security than females. Moving on to age, the positive but statistically insignificant coefficient of 0.5407 (p = 0.359) implies that, with each additional year of age, the probability of experiencing food security increases by 46.32% (marginal effect). In terms of residence, the positive and marginally significant coefficient of 0.3473 (p = 0.067) suggests that residing in rural areas is associated with a 29.42% higher probability of food security (marginal effect) compared to urban areas.

Irrigation emerges as a pivotal variable. The highly significant negative coefficient of -0.9064 (p<0.01) underscores the substantial influence of irrigation in reducing the likelihood of food insecurity. The corresponding marginal effect of -0.1566 indicates a 15.66% decrease in the probability of food insecurity with the presence of irrigation. Crop storage, another influential factor, exhibits a highly significant negative coefficient of -1.4730 (p<0.01). The marginal effect of -0.3019 suggests a notable 30.19% decrease in the probability of food insecurity when crop storage is employed.

Ownership of land is found to be significantly associated with food security. The negative coefficient of -0.0710 (p< 0.01) implies that land ownership is linked to a lower likelihood of food insecurity. The marginal effect of -0.0065 indicates a 0.65% decrease in the probability of food insecurity with land ownership. Female land ownership, specifically, emerges as a powerful determinant with a highly significant negative coefficient of -0.9095 (p< 0.01). The marginal effect of -0.1451 signifies a substantial 14.51% decrease in the probability of food insecurity when females hold land ownership.

Regarding agricultural practices, tractor cultivation is a robust factor in enhancing food security. The highly significant negative coefficient of -0.3539 (p< 0.01) indicates a strong positive impact on food security. The corresponding marginal effect of -0.0399 implies a 3.99% decrease in the probability of food insecurity with tractor

cultivation. Variables such as extension services, use of improved seeds, fertiliser usage, credit access, and remittances exhibit varying degrees of impact, though some are statistically insignificant.
Therefore, these findings shed light on the nuanced dynamics of food security among smallholder farmers, emphasising the substantial roles of irrigation, crop storage, land ownership (especially female land ownership), and tractor cultivation.

V. DISCUSSION

The probit regression analysis revealed insights into factors affecting food security among Tanzanian smallholder farmers. Irrigation showed a negative coefficient, consistent with studies highlighting the positive impact of reliable water access on crop yields and food security, suggesting investment in irrigation infrastructure is vital (Bwambale et al., 2023; Kitole, 2023). Similarly, the negative coefficient for extension services aligns with literature emphasising their role in knowledge transfer, supporting the argument for targeted extension programs to enhance food security (Jambo et al., 2021; Kitole et al., 2023b).

Negative coefficients for land ownership, especially female ownership, echo theories emphasising secure land tenure and gender empowerment's role in agricultural development (Kitole & Sesabo, 2022; Nyikahadzoi et al., 2013; Manda et al., 2023). This underscores the potential positive impact of policies promoting secure land tenure, particularly for women, on food security. However, despite some literature suggesting its positive impact, the non-significant coefficient for improved seed usage highlights the need for context-specific examination of factors influencing seed effectiveness in Tanzania (Chegere et al., 2020; Silambi et al., 2023).

Furthermore, while aligning with the literature on its role in improving soil fertility, the negative coefficient for fertiliser usage underscores the importance of considering contextual factors like soil type and crop choice (Masuku et al., 2023; Kitole et al., 2024a). The non-significant coefficients for bank loans/credit, remittances, and tractor cultivation may indicate differing influences in Tanzanian smallholder farming, emphasising the necessity for nuanced policy considerations (Jena & Tanti, 2023; Kitole and Sesabo, 2024; Erickson and Fausti, 2021). These findings underscore the complexity of factors influencing food security in Tanzania, necessitating further research to inform targeted policy interventions tailored to local conditions.

VI. CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusion

The current study investigates factors affecting household food security in Tanzania among the most important group of smallholder farmers who are the major producers of agriculture in the country. The study reveals that major factors influencing household food security among smallholder farmers in Tanzania are extension services, women land ownership, and crop storage. Moreover, despite remittance was nit found to be a significant factor affecting household food security among smallholder farmers, it had negative correlation with food security indicating household with poor or no remittance has higher likelihood of falling into food insecurity compared to those who receive remittances.

6.2 Recommendations

These results inform several policy implications that must be taken into consideration not only in Tanzania but in the entire developing world; these include the following:

First, increasing investment in the construction and expansion of irrigation schemes will help to increase the number of smallholder farmers to increase production and develop climate resilient strategy by having reliable sources of water instead of just depending on rainfed agriculture which is sometimes done just once in a year and as climate changes continue to grow in most of the developing countries they sometimes associated with the long dry seasons. Therefore, these strategies help increase production across farming societies and overcome food shortages that may lead to food insecurity.

Second, the government should enhance the provision of extension services to reach a large number of farmers in rural areas to improve farmer's production knowledge and be able to fight against diseases and understand the right time to use several production inputs including fertilisers, as results of the study have shown that the use of fertiliser reduces the likelihood of households falling into the food insecurity as it increases food production. These extension services are important because they enable farmers to understand the characteristics of various diseases and

how they change with time; therefore, it helps to find the right pesticide to use and the usage time, and increase production.

Last, policymakers must design mechanisms to enhance access to agricultural subsidised inputs such as fertiliser and pesticides to improve agricultural production for smallholder farmers. This will be a panacea to overcome the food shortage problem across these farming communities, especially rural ones. In achieving this, the government needs to establish agricultural input funds that facilitate the stabilisation of prices, especially for agricultural inputs, to reduce the burden of incurring costs related to agricultural production, which might impact the welfare of the smallholder farmers.

6.3 Limitations of the Study

Although the current study presents important information on the factors or determinants of household food security in Tanzania, several limitations have to be acknowledged as a result of the choice of data and methodology employed in the study. Relying on secondary data poses challenges related to limited control over the data collection process. Additionally, there is a need to ensure alignment of the problem to be studied for the data to be relevant and adequate regarding population and variables. It is acknowledged that the data may lack sufficient context to comprehend fully the factors contributing to food security in Tanzania. For instance, when examining farmers practising irrigation, determining the significant contribution of irrigation to food security solely based on their responses is challenging.

Similarly, assessing the contribution of crop storage to food security encounters difficulties due to limited responses from a few individuals. To enhance the quality of future studies, it is essential to thoroughly assess data sources, evaluate their quality, and address potential biases. This critical evaluation will improve the reliability and validity of research outcomes.

Statements and Declarations

Funding
Not applicable

Ethics approval
Not applicable

Availability of data
Data and all materials will be available upon reasonable request.

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