Age Differentiations and Poverty Status among Tanzanian Smallholder Maize Farmers: Perspectives on Income and Food Poverty

***Msengi, D.M. and A. Akyoo**

College of Economics and Business Studies, Department of Agriculture Economics and Agribusiness, Sokoine University of Agriculture, P.O. Box 3007, Morogoro, Tanzania

*****Corresponding author e-mail: *daudimsengi21@gmail.com*

Abstract

Understanding the intricate relationship between agricultural production and poverty is crucial for enhancing household welfare and societal development. However, research on poverty among different age groups of smallholder maize farmers is insufficient. In this study, employing a non-experimental approach, we examine the determinants of poverty status across 7,646 smallholder maize farmers using a logistic regression model. Our findings underscore the importance of factors like household head's gender, off-farm employment, household size, land use, fertilizer use, education, seed type, cooperative membership, and food security, influencing poverty status across various age groups concerning income and food poverty. The poverty status is significant influenced by education, Sex of household head, food security status, type seed used for both income and food. But cooperative membership, household size and land size were significant influence income poverty status only. These results have significant policy implications, highlighting the need for age-specific solutions in the smallholder maize sector. Also, emphasizes the policies to promote educational enhancements, improved maize seeds, and cultivate a sense of dignity in farming among the youth. Encouraging cooperative engagement and enhancing access to agricultural resources, along with optimizing land use, are critical steps toward economic empowerment and poverty alleviation.

Keywords: Maize, age groups, income poverty, food poverty and poverty status

Introduction

Background information

Tanzania's economy relies heavily on agriculture, which is crucial to food security and poverty reduction (Kim *et al*., 2021). Also in the agricultural sector, millions of people are employed and rural communities are provided with a means of livelihood (Nassary *et al.,* 2020). Furthermore, the sector contributes 30% of export earnings, 85% of total exports, and 26.9% of Gross Domestic Product (GDP), employing 65% of the labor force and providing 80% of the income for the population (Kafle *et al.,* 2019; Kim *et al.,* 2021; URT, 2021). Tanzanian smallholder farmers account for approximately 90% of the country's maize production, but they are faced with challenges such as low land productivity, with an average yield of 1.5 tons per hectare (Nassary *et al.,* 2020; URT, 2019). While these challenges exist, maize remains a foundation of the country's agriculture, accounting for 73% of crop production and around 20% of its GDP (Lindsjö *et al.,* 2020; Volk *et al.,* 2021).

However, climate change, limited credit access, high supply costs, low labor force participation, and inadequate market information plague the sector (Kinyondo and Magashi, 2017; Misaki *et al.,* 2019; Mutayoba, 2018; Volk *et al.,* 2021). As a result of these issues, the agricultural sector has been discouraging participation of youth (Lindsjö *et al.,* 2020). Several initiatives were undertaken to address this issue (URT, 2022a). These initiatives include the Tanzania Youth Involvement in Agriculture Strategy 2016-2021 and the Youth Initiative for Agribusiness (YIA) under Building a Better Tomorrow (BBT) 2022-

2030 (URT, 2022a). However, labour force participation including different age groups in agricultural sector is recorded to have declined from 86.5% in 2014 to about 83.0% by 2020 (URT, 2021b). Although age groups have been defined differently in different studies, in this study we have categorized them as youth (15-35), middle-aged farmers (36-64), and elderly farmers (65+) utilizing the Integrated Labour Force Survey (ILFS) definition (URT, 2022b).

Several studies on participation in agriculture and poverty in Sub-Saharan Africa have been conducted. These include study of Lindsjö *et al.* (2020), (2021) on agricultural intensification in Tanzania and Malawi. Work of Kassahun *et al.* (2022) on Analysis of rural household food and non-food poverty status in Ethiopia. Also work on occupation choices between agriculture and non-agriculture sector (Ochieng, 2020; Osabohien *et al.,* 2021). While previous study has thoroughly explored the general prevalence of poverty among smallholder farmers, there is a considerable gap in the literature in terms of a detailed understanding of household wellbeing, particularly as it relates to certain age groups. The existing body of research has mostly concentrated on general poverty status, ignoring the positive and negative aspects which influence household wellbeing across different age groups. However, limited research has been conducted on intergenerational relationships and rural livelihoods as well as poverty status including income and food poverty status in Sub-Saharan Africa (SSA) that considers different groups (Lindsjö *et al.,* 2021).

Thus, this study bridges the gap by examine the interconnection between age groups and poverty status by consider their income and food poverty status among Tanzanian households headed youth, middle-aged and elderly smallholder maize farmers. By addressing these issues, the study contributes to a deeper understanding of generation-specific determinants of poverty status by household heads of diverse age groups engage in maize farming, which will shape the agricultural policies and poverty reduction initiatives.

Literature review

In the theoretical part, we can examine poverty through the lenses of two theories. To begin, the individualistic theory of poverty emphasizes poverty as a natural attribute linked to an individual's capacities and cognitive ability (Kassahun *et al.,* 2022). In contrast, Sen's (1992) Capability Approach provides important insights into understanding the intricate interplay between poverty status and various socioeconomic determinants for households. At its foundation, this approach holds that individuals have a variety of capacities or potentials that are necessary for them to achieve their goals and desires. An individual's level of poverty is determined by their ability to transfer their capabilities into meaningful and useful effects (Alkire, 2005).

Within the discipline of poverty theories, the welfare school of thought contends that a society is in poverty when the essential requirements of economic well-being, as determined by societal standards, are not met. The basic needs school, on the contrary hand, defines poverty as a state in which an individual lacks the necessities for survival (Tesfaye, 2017). Poverty, on the other hand, is viewed as a measure of an individual's potential to succeed in a specified variety of occupations by the capability school (Yared, 2005). This study seeks to examine these aspects and identify the factors of poverty status among smallholder farmers, providing a specific focus within the scope of this research of age differences.

There is an increasing body of research has studied the various factors of poverty status among smallholder maize farmers in recent years, work such of Alabi *et al.* (2021), Geffersa *et al.* (2022), Olayemi *et al.* (2021), and Wang *et al.* (2021) conducted notable research that highlighted the considerable influence of many factors on poverty status. Irrigation use, cooperative participation, off-farm employment, land use, fertilizer application, seed type selection, and their consequent influence on poverty as measured by income and food security are among these issues.

The work of Alabi *et al.* (2021) and Addai *et al.* (2022) underlined the significant poverty-reducing benefit of off-farm employment among smallholder farmers, particularly in terms of increasing income and food security.

Furthermore, cooperative membership has been found to be positively connected to higher household income and lower poverty rates (Wang *et al.,* 2021; Zhang *et al.,* 2021), giving a dual benefit of increased income and food security. Land ownership and tenure security have also emerged as important predictors of poverty status, with bigger land sizes providing better opportunities for poverty alleviation (Lindsjö *et al.,* 2021; Olayemi *et al.,* 2021), positively impacting both income and food security. A prudent use of fertilizers has been identified as a powerful technique of increasing crop output and, as a result, decreasing poverty among smallholder farmers (Dwi Yennie *et al.,* 2021; Geffersa *et al.,* 2022), positively impacting income and improving food security. Furthermore, the type of seed used has a considerable impact on poverty dynamics, with the use of improved maize seeds exhibiting a significant influence on poverty reduction among smallholder farmers (Abdoulaye *et al.,* 2018), affecting both income and food security.

Notably, household-related characteristics have emerged as important determinants of poverty status. Kassahun *et al.* (2022), Lindsjö *et al.* (2021), and Olayemi *et al.* (2021) studied the impact of family structure, sex of the household head, age of the household head, household size and household head education level. Female-headed households, for example, frequently have greater poverty rates compare to male household headed (Olayemi *et al.,* 2021), hurting both income and food security. Household heads with a higher education level, on the other hand, manage to experience reduction in poverty (Kassahun *et al.,* 2022), affecting both income and food security. The interaction of these poverty drivers within diverse age groups of household heads, on the other hand, the understanding of age differences in relation to income and food security in subject matter is not much researched, creating a knowledge vacuum that this study covers.

Methodology

Study area

The study was conducted in Tanzania and it included significant maize production areas such as Ruvuma, Manyara, Tanga, Tabora, Songwe, Rukwa, Singida, and Dodoma. According to the data of agricultural census Survey of 2020, these Tanzania regions stand out as important maize growing hubs, providing approximately 3,224,191 tons, or roughly 60.85 percent of the nation's total maize production (URT, 2021). Figure 2 depicts the significant maize output in these specific sites, confirming their selection as the principal focus of our study.

Research design and data

A non-experimental research design was used in this study, as described Osabohien *et al.,* (2021). The study used secondary data from the National Bureau of Statistics (NBS), specifically the National Sample Census on Agriculture (NSCA) data for the 2019/2020 agricultural season. The sample consisted of 7,646 smallholder households engaged in maize farming throughout the mentioned agricultural period. Maize smallholders were purposefully chosen as the study's focus point due to their considerable representation, accounting for about 90% of maize farmers in Tanzania (URT, 2021). The information gathered included detailed information about household characteristics, farm characteristics, input use and socioeconomic characteristics.

Econometric model specification

The logit model was employed in the study to examine the determinants of poverty (food and income) among household heads in the youth, middle-aged, and elderly age groups involved in maize cultivating. In a similar work, previous researchers (e.g., Al-Bairmani and Ismael, (2021); Kassahun *et al.* (2022); Osabohien *et al.* (2020)) utilized the same model. Because the dependent variable, poverty status, was binary, the logit model was chosen. Poverty is assumed to be a function of socioeconomic and demographic variables, both theoretically and empirically. Let Y_1 represent the household head's response to their poverty status. Where Y_1=1 represent the poor in either income or food and Y_1=0 represent the non-poor in either income or food. The poverty status probability for the household head is then calculated using logistic regression.

$P(Y=1)/(X_1,)...,X_k)=f(X_1,...,X_k)$ .....(1)

The logistic distribution function is denoted by the function *f*.

$$P(Y = 1/X_1,\ldots,X_k) = \frac{\exp(\beta_0 + \beta_1 X_1 + \ldots\ldots + \beta_n X_n)}{1 + \exp(\beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n)} \quad \ldots\ldots(2)$$

The logistic distribution function, of course, transforms the regression into the interval (0,1). Logit(x) is defined further as

$$\text{Logit}(x) = \log\left(\frac{x}{1-x}\right) \quad \ldots\ldots(3)$$

The Logit model can be expressed as follows:

$$\text{Log}\left(\frac{p(y=1)}{1-p(y=1)}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i X_i \quad \ldots\ldots(4)$$

The extended empirical models for analyzing the effect of several explanatory variables on poverty status are as follows:

$Y_1=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3.....\beta_n X_n+\varepsilon_i$ .....(5)

Which can further write as

$Y_1=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5d_1+\beta_6d_2+\beta_7d_3+\beta_8d_4+\beta_9d_5+\beta_{10}d_6+\beta_{11}d_7$ .....(6)

$$Y = \begin{cases} 1 = \text{If the houshold head is Poor} \\ 0 = \text{If household head is Non} - \text{Poor} \end{cases}$$

Where Y is a dichotomous dependent variable, poverty status is explained as Y_1=1; if the household head of age groups (youth, middle-aged and elderly groups) is poor in either income or food and Y_0=0, if is non-poor in either income or food. While β_0= intercept and β_i are regression coefficients and X_i to X_n are explanatory variables. ε_i is error term follows the logistic distribution with mean zero and constant variance. Maximum likelihood estimation is the estimating methodology used. Table 1 depicts the variables used and their measures, which were guided by both theoretical and empirical literature. We use the World Bank (2011) definition of poverty line to define income poverty in our study. If household head farmers earning less than $2 per day are classified as poor. Furthermore, we used the Direct Calorie Intake Approach to measure food poverty status, with people consuming less than 2200 calories classified as poor, according to the poverty line established by Foster *et al.* (1984).

Results and Discussion

Distribution of smallholder maize farmers by their age groups

Figure 1 depicts the age-groups distribution of smallholder maize farmers. The dataset covers individuals into three major age groups: youth, middle-aged, and elderly. The study provides significant insights into the distribution of smallholder maize farmers across various age categories. Individuals in the middle age group account for the largest proportion, accounting for 60% of the total sample. The following significant category is the youth group, which accounts for 29% of the total population. The elderly, on the other hand, make up a smaller fraction, accounting for 11% of smallholder maize farmers. These findings reveal that middle-aged people are the most likely to participate in maize farming activities, followed by the youth group. Surprisingly, the combined contribution of these two age groups accounts for 89% of maize farming initiatives in the smallholder community.

This information is useful for understanding the age distribution among smallholder maize producers and its implications for the agricultural sector. The presence of middle-aged adults suggests that this age group plays an important role in maize farming, which could be attributed to their experience, acquired knowledge, and firm involvement in the agricultural domain. The considerable representation of the youth group, on the other hand, demonstrates an optimistic trend, demonstrating enthusiasm and involvement in maize farming. This could indicate the possibility of succession and

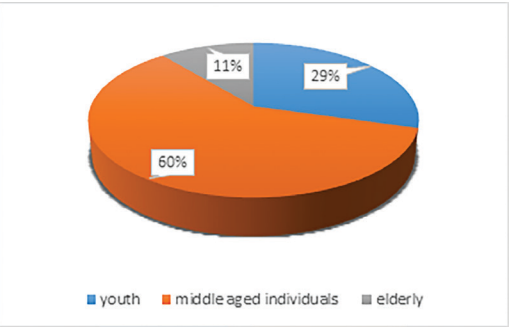

Figure 1: Distribution of smallholders' farmers by their age groups

Source: Research findings (2023)

continued interest in maize farming, ensuring the sector's long-term viability. The significantly lower proportion of elderly individuals involved in maize farming, on the other hand, may signal a potential shift in generational involvement or alternate livelihood options for this age group. Understanding these demographic trends is critical for developing targeted policies and interventions to boost productivity, promote sustainability, and improve intergenerational knowledge transfer among smallholder maize farmers.

Descriptive results of variables used in the analysis based on age groups

Table 1 presents the results of variables used in the analysis in three age groups of smallholder maize farmers: youth, middle-aged, and elderly. The study reveals significant trends in income poverty and food security across various demographics. Notably, a significant percentage of middle-aged maize farmers fall into both the non-poor and poor categories, particularly in terms of income, indicating a range of economic positions within this group, most likely influenced by financial obligations and economic objectives. When assessing poverty based on food access, the middle-aged population has a higher percentage of non-poor people, followed by youth and then the elderly. The elderly, on the other hand, have a higher incidence of food insecurity, stressing the disparities in economic constraints and resource access among age groups and emphasizing the need for age-targeted support systems. Another important finding is the substantial difference in cooperative participation across these groups. Middle-aged farmers outnumber both youth and the elderly in cooperative membership, probably due to experience, awareness, and perceived benefits, highlighting the importance of increasing cooperative movement, particularly among younger farmers.

The study also reveals household demographics, such as the large proportion of male-headed households across all age groups. However, the youth and middle-aged groups have a higher share of male-headed households than the elderly, indicating that household dynamics are changing because of socioeconomic shifts or demographic trends. Furthermore, the majority of middle-aged farmers employ local seeds, but they also show a stronger adoption of improved seeds, indicating an openness to improvements in technology. Furthermore, middle-aged farmers use fertilizers more than their youth and elderly farmers, demonstrating that knowledge and resource access differ across age groups. Notably, approximately 32% of middle-aged farmers work off-farm, emphasizing income diversification and its potential impact on agriculture production. However, an in-depth comparison of poverty rates, agricultural practices and socioeconomic indicators among young, middle-aged, and elderly smallholder maize farmers, on the other hand, emphasizes the importance of tailored measures to meet the specific needs of each age group within the agricultural sector.

Empirical results on the drivers of poverty status based on age groups of small-scale maize farmers

The results of logistic regression model on the drivers of poverty status are shown in Table 2. The model fit the data well across three age groups (youth, middle-aged, and elderly) as evidenced by statistically significant Chi-square values and associated probabilities [(Chi-square=132.5, p=0.000), (Chi-square=271.83, p=0.000), and (Chi-square=70.8, p=0.000)] respectively. Similarly, when examining food poverty status, our model revealed a compelling fit for the age groups of youth, middle age, and elderly, as evidenced by significant Chi-square values and associated probabilities [(Chi-square=705.8, P=0.000), (Chi-square=1311.6, p=0.000), (Chi-square=290.8, p=0.000)] respectively.

The results show that seven out of nine explanatory variables that were taken into consideration, have significant effects on income poverty status of smallholder farmers. The log-likelihood estimates in the logit regression model emphasizes that the likelihood of income poverty was inversely correlated with household head sex, household size, land size, household head education, and food security. On the other hand, among smallholder maize farmers, off-farm employment, seed use, and household

Table 1: Variables specification and summary statistics based on the distribution of age groups

Variable	Variable Label	Age of household head in Years		
		Youth (1)	Middle aged individuals (2)	Elderly (3)
Income poverty	Poverty status			
Non-Poor		1,518 (19.9)	2,666 (34.9)	466 (6.1)
Poor		737 (9.6)	1,885 (24.7)	374 (4.9)
Cooperative	Dummy for cooperative members.			
YES		261 (3)	894 (12)	116 (2)
NO		1,994 (26)	3,657 (48)	724 (10)
Hh_Sex	Dummy of sex of household head			
Male		1,948 (26)	3,758 (49)	584 (8)
Female		307 (4)	793 (10)	256 (3)
Food_security	Households run out of food.			
YES		968 (13)	1,929 (25)	350 (5)
NO		1,287 (17)	2,622 (34)	490 (6)
Seed_Used	Dummy for Seed used.			
Local seed		1,470 (19)	3,657 (48)	613 (8)
Improved seed		785 (10)	1,625 (21)	227 (3)
Off_employment	Dummy for employed in off-farm.			
YES		1,120 (15)	2,466 (32)	646 (8)
NO		1,135 (15)	2,085 (27)	194 (3)
Fertilizer_Use	Dummy for the use of fertilizer			
YES		1,196 (16)	2,226 (32)	551 (7)
NO		1,059 (14)	2,325 (30)	289 (4)
Food_Poverty	Dummy for the food poverty status			
Poor		520 (7)	1,006 (13)	187 (2.4)
Non-Poor		1,735 (23)	3,545 (46)	653 (9)

Notes: Number in brackets indicates percentages

size showed a positive association with income poverty. However, the study shows that five out of the nine explanatory factors significantly influencing the level of food poverty status among smallholder farmers. The log-likelihood estimates in the logit regression model highlight a negative relationship between the sex of the household head, cooperative membership, household education level, food security status, and the food poverty status. In contrast, among smallholder maize farmers, seed use showed a positive connection with food poverty.

Table 2 results shows a significant negative association between household head sex and poverty status, with significance level of 5% and 1% for youth and middle aged respectively. Male household heads belong to youth and middle-aged groups in maize farming reported 11.3% and 4.9% reduction in the probability of being poor on income poverty, respectively. In terms of food poverty, male household heads in the middle-aged group have a 3.2% lower probability of being categorized as poor. The results indicate that female maize farmers in their youth and middle-aged groups are more likely to be poor than their male counterparts. These

findings were consistent with those of Addai *et al.* (2022), but unexpectedly, being male-headed households revealed a significance and positive association with poverty status in the older age group, with a 14.5% and 6.3% increase in the likelihood of being poor in income and food, respectively. This meant that elderly male maize farmers were significantly poorer than female elderly maize farmers, which was consistent with the findings of Olayemi *et al.* (2021). These findings could be explained by cultural norms that favor male farmers in resource allocation and opportunities, resulting in higher income levels for male family heads. In contrast, factors such as failing health and restricted access to modern farming technologies may contribute to the increased risk of poverty reported among elderly male maize farmers.

Furthermore, results in Table 2 indicated a significant influence of off-farm employment on poverty status, with varying levels of significance. For middle-aged farmers, off-farm employment demonstrated a significant and negative association solely with income poverty status at 1% level of significance. This implies that a middle-aged household head engaged in off-farm employment is 3.5% less likely to experience poverty in terms of income compared to a middle-aged household head without off-farm employment, holding other factors constant. Conversely, for the elderly, off-farm employment was positively and significantly linked to income poverty status at the 1% level. This finding suggests that being an elderly household head engaged in off-farm employment increases the probability of being poor in terms of income poverty by 17.8%. Furthermore, concerning food poverty status and its relationship with off-farm employment, a positive and significant association was observed only among the youth at the 1% significance level. This implies that youth household heads engaged in off-farm employment have 17.8% higher chance of being with food poverty status compared to their counterparts without off-farm employment. These results are in line with prior research conducted by Addai *et al.* (2022) and Alabi *et al.* (2021). Possible explanations for

Table 2: Logit model results on the determinants of poverty status among smallholder farmers participating in maize production

	Age of household head in Years								
	Youth (1)			Middle-aged individuals (2)			Elderly (3)		
Pov_status Income_Poverty Food_Poverty	Coef.	St.Err.	Marginal effects	Coef.	St.Err.	Marginal effects	Coef.	St.Err.	Marginal effects
Hh_sex	-.609	.079	-0.113***	-.818	.069	-0.049**	1.831	.324	0.145***
	-.774	.132	-0.032	-.764	.081	-0.032**	2.025	.541	0.063***
Cooperative	-.947	.142	-0.012	-.772	.065	-0.062***	1.069	.24	0.017
	-1.92	.406	0.090***	-1.344	.161	-0.035**	-.448	.199	-0.063*
Offarm_employ	-.889	.086	-0.025	-.794	.052	-0.056***	2.13	.408	0.178***
	1.396	.174	0.039***	1.234	.108	0.023	1.374	.393	0.029
Land_Size	-.915	.032	-0.019**	1.007	.021	0.002***	1.089	.053	0.021*
	-1.13	.053	- 0.014**	-.852	.026	-0.018	-.952	.069	-0.005
food_security	-.531	.054	-0.134***	-.691	.045	-0.089***	1.143	.176	0.033
	- 20.2	3.179	-0.422***	-20.83	2.344	-0.420***	-18.28	4.773	-0.367***
Seed_used	.603	.06	0.112***	.516	.036	0.161***	.54	.098	0.152***
	3.41	.516	0.127***	.687	.067	0.044***	1.484	.486	0.036
fertilizer use	1.072	.107	0.015	-.834	.058	-0.044***	-.962	.162	-0.010
	1.704	.241	0.063	-.735	.069	-0.035***	1.494	.408	0.041
Hh_size	1.115	.022	0.023***	1.057	.011	0.013***	-.998	.029	-0.000
	1.041	.026	0.005	1.012	.015	0.001	-.993	.037	-0.001
HH_edulevel	-.971	.012	-0.006**	-1.046	.01	-0.011***	-1.054	.026	-0.013***
	-.924	.015	-0.009***	-1.023	.014	-0.003*	-.811	.034	-0.021***
Constant	.558			.734			.297		
	.012			.073			.033		
	Pseudo r-squared		0.05	Pseudo r-squared		0.04	Pseudo r-squared		0.07
			0.29			0.273			0.33
	Chi-square		132.51	Chi-square		271.93	Chi-square		70.80
			705.82			1311.62			290.83
	Observation		2,255	Observation		4,551	Observation		840
	Prob>chi2		0.000	Prob>chi2		0.000	Prob>chi2		0.000

*** *p<.01,* ** *p<.05,* * *p<.1* significant at the 1, 5 and 10 percent probability levels, respectively. **Notes**: The first row of each explanatory variable are results of effect of those variables on income poverty status while, the second row of each explanatory variables are results of their effects on food poverty status.

these findings include differences in earning potential, job security, and availability of necessary resources for individuals involved in off-farm activities. Furthermore, issues such as a lack of effective skill matching or limited possibilities for skill development in off-farm employment may contribute to the observed differences in poverty status based on age and off-farm labor participation.

Our findings show a 1% significant positive association between household size and income poverty status. This means that, when other characteristics remained constant, an increase in household size increased the risk of being poor by 2.3% and 1.3% in the youth and middle-aged age groups, respectively. This indicates that as the number of people in a household increase, so does the likelihood of living in being poor on income poverty. Possible explanations for this include more household resource demands, which include critical necessities such as food, shelter, and medical care, resulting in increased expenditures and an increased chance of falling into income poverty. These findings support studies by Balogun *et al.* (2021) and Kassahun *et al.* (2022).

Table 2 results show significant associations between land size use and income as well as food poverty status, especially among young, middle-aged, and elderly maize farmers. At the 5% level of significance, one additional acre of land size use was found to have a significant negative correlation with both income and food poverty status among young farmers. This means that additional acre of land used and being a young maize farmer reduces the likelihood of being poor by 1.9% in terms of income and 1.4% in terms of food poverty. The possible explanation for this finding is that increased land utilization by young farmers leads to increased agricultural productivity, hence increasing income and food security. In contrast, among middle-aged and elderly farmers, land size use revealed an unexpectedly positive and significant association with income poverty status. Holding other variables constant, each additional acre cultivated increased the likelihood of income poverty by 0.2% for middle-aged farmers and 2.1% for elderly farmers. This surprising result may be attributed to rising production costs associated with increasing land holdings, resulting in more financial constraints and a higher proclivity for income poverty. These findings are consistent with previous studies by Lindsjö *et al.* (2021) and Olayemi *et al.* (2021), which emphasized the multifaceted link between land size use and poverty status.

At the 1% level, fertilizer use was found to be negatively and significantly related to income and food poverty status, but only among the middle-aged group. Only being a middle-aged family head who uses fertilizer in maize cultivation reduces the risk of being poor by 4.4% for income poverty and 3.5% for food poverty, when all other factors are held constant. This means that middle-aged maize farmers who use fertilizer are substantially less likely to be poor than those who do not. The positive effect of fertilizer on agricultural productivity is one reason for this, it improves crop yields and quality by increasing soil fertility. Middle aged farmers who use fertilizer achieve better-quality and more quantity output, resulting in more income and better food access as we can compared with other age groups. This observation is in line with that of Kinyondo and Magashi (2017).

The study found that a household head's education level is crucial in affecting poverty status among farmers of various ages. The findings show a significant negative association between the education level of the household head and poverty status, with varied degrees of significance. Other factor held constant, one year increase in household head education level resulted in a 0.6% decrease in the likelihood of being poor in income poverty for youth farmers, 1.1% for middle-aged farmers, and 1.3% for elderly farmers. Furthermore, the results show that a one-year increase in the education level of the household head reduces food poverty status by 0.9% for youth, 0.3% for middle-aged farmers, and 2.1% for elderly farmers, while other factors remain constant. These findings are consistent with previous studies by Justin (2015) and Nassary *et al.* (2020). Possible explanations for these findings include education's contribution in improving decision-making abilities, planning skills, and adoption of new farming methods and technologies.

Higher education provides individuals with the knowledge to make informed decisions about income generation, good farming methods and the use of modern technology, thus reducing the possibility of being poor. These findings, however, contradict the findings of Ochieng (2020) and White (2012), who reported that farmers with higher education levels tend to migrate from agriculture and rural areas in search of better employment opportunities in non-agricultural sectors, resulting in a higher probability of being non-poor than those engaged in agricultural activities.

The effect of seed type use on income and food poverty status among household heads of various ages. The study found a positive and significant relationship between the use of local seed and poverty status at the 1% level. Specifically, the findings reveal that using local seed increases the likelihood of being poor in income poverty by 11.2%, 16.1%, and 15.2%, respectively, when all other variables are held constant. Similarly, when using local seed and holding other factor constant, the study finds a 12.7% and 4.4% increase in the probability of being poor for youth and middle-aged maize producers, respectively. These findings show that maize farmers of various ages who use local seed are much more vulnerable to poverty in both income and food dimensions than their counterparts who use improved seed. This finding agrees with recent studies by Geffersa *et al.* (2022) and Alabi *et al.* (2021). Despite this importance, the majority of smallholder maize farmers continue to use local seeds, as seen in Table 1. One possible explanation for this tendency could be the increased expenses, limited accessibility of improved seed, and lack of expertise associated with improved seed use. These factors may discourage smallholders from using improved seeds, resulting in lower yields hence failing in poverty (Geffersa *et al.,* 2022).

With different levels of significance, the research reveals a significant negative association between cooperative membership and food poverty status. The study emphasizes that being a youth, middle-aged, or elderly maize farmer and a member of a cooperative reduces the likelihood of experiencing food poverty by 1.2%, 6.2%, and 1.7%, respectively. This means that smallholder maize farmers who are members of cooperatives are less likely to be food poor than their counterparts who are not members of cooperatives. However, when it comes to income poverty, the findings show that only middle-aged farmers experience a 3.5% reduction in probability of being poor if they are members of cooperatives. These findings are supported by Wang *et al.* (2021) and Zhang *et al.* (2021). The findings are associated with the fact that cooperative membership provides several benefits to maize growers. Cooperative participation makes it easier to have access to pooled resources, shared knowledge, and coordinated efforts, which improves efficiency, production and income-generating prospects. Furthermore, cooperatives frequently provide market links and negotiation strength, resulting in higher pricing for farmers' produce, which benefits smallholder maize farmers.

Food security status was found to influence food and income poverty status among different age groups of smallholder farmers. The study found a significant negative association between food security and food poverty at the 1% level. According to the study, being a youth, middle-aged, or elderly maize farmer with food security reduces the likelihood of experiencing food poverty by 42.2%, 42%, and 36.7%, respectively. This means that smallholder maize farmers with food security are less likely to face food poverty than those without food security. In terms of income poverty, the findings show that only youth and middle-aged farmers have a significant decrease in the probability of being poor by 13.4% and 8.9% respectively if they have food security. Our findings are in line with studies of Ogunniyi *et al.,* (2021) and Kassahun *et al.* (2022). These findings emphasize on the importance of food security in decreasing poverty risks among maize farmers. These findings are explained by the tendencies include the underlying relationship between food security and economic stability. Farmers who have food security have consistent availability to adequate and nutritious food, which improves their general well-being and reduces the financial strain connected with food purchases. Furthermore, food security leads to improved

health and productivity, potentially leading to higher income creation, which benefits the youth and middle-aged demographics the most.

Conclusion and recommendation

Understanding the complex relationship between agriculture production and poverty status is critical for improving both household welfare and overall society development. However, scholarly interest in the examination of drivers of poverty status across various age groups among smallholder maize farmers has been inadequate. Given that a considerable proportion of smallholder farmers are poor, this study used a non-experimental study method to examine the determinants of poverty status among different age groups of 7,646 smallholder maize farmers. Using a logistic regression model, we examined the factors that influence income and food poverty status for these groups.

Our findings highlight the importance of various factors such as the sex of the household head, off-farm employment, household size, land use, fertilizer use, educational attainment, seed type use, cooperative membership, and food security, all of which have a distinct effect on poverty status across age groups in relation to income and food poverty. These findings have important policy implications, stressing the importance of age-specific solutions in the smallholder maize growing sector. Policy interventions should target educational improvements and programs that encourage the use of improved maize seeds, as well as creating a sense of dignity in farming among youth. It is critical to transmit the notion that devoting youthful energy to farming may be not only financially paying but also a dignified endeavor that contributes to personal well-being and the nation's agricultural growth.

This study emphasizes on encouraging cooperative membership engagement and enhancing access to agricultural resources such as high-quality seeds and fertilizers in poverty reduction. Furthermore, it emphasizes on need to creating off-farm employment opportunities, particularly for the youth and middle-aged farmers and maximizing land use as critical steps toward increasing economic empowerment and alleviating poverty. Our research delivers actionable insights, providing a sophisticated understanding of poverty within the agricultural sector, allowing for the creation of effective strategies to improve the economic well-being of smallholder maize farmers of various ages. Future research may investigate on drivers of poverty status among different age groups of smallholder maize farmers using longitudinal data and consider integrating multinational datasets to increase external validity of the findings.

Acknowledgment

We express our gratitude to the African Economic Research Consortium (AERC) for their generous funding assistance, which enabled this research. We also thank the National Bureau of Statistics (NBS) for providing Data for this Study. Their assistance was critical to the study's success.

References

Abdoulaye, T., Wossen, T., & Awotide, B. (2018). Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. Food Security, 10(2), 369–379.

Addai, K.N., Ng'ombe, J.N., & Lu, W. (2022). Disaggregated impacts of off-farm work participation on household vulnerability to food poverty in Ghana. *Journal of Economic Inequality.*

Al-Bairmani, Z.A.A., & Ismael, A.A. (2021). Using Logistic Regression Model to Study the Most Important Factors Which Affects Diabetes for the Elderly in the City of Hilla /2019. *Journal of Physics: Conference Series,* 1818(1).

Alabi, O.O., Madaki, M.J., David, H.S., Adewole, A.R., Ubandoma, G.A., Ogbole, E.O., Omole, E.B., Amkpa, R.N., Olusola, B.S., & Alabuja, F.O. (2021). Elements of rural off-farm economy: effects of off-farm income on productivity and poverty status of rural maize farming households in kaduna state, nigeria. *Russian Journal of Agricultural and Socio-Economic Sciences,* 114(6), 110–120.

Alkire, S. (2005). Valuing freedoms: Sen's capability approach and poverty reduction.

Oxford University Press, USA.

Balogun, O.S., Olorukooba, M.M., Balogun, O.L., Alabi, O.F., Tor Lawrence, G., Nwahia, O.C., & Bala, U.J. (2021). Welfare and poverty status among maize farming households in lere local government area of kaduna state, Nigeria. *Russian Journal of Agricultural and Socio-Economic Sciences,* 114(6), 85–96.

Dwi Yennie, R., Ferry, P., & Mohamad, K. (2021). Determinants of Household Poverty Status in Kediri City. *Journal of Indonesian Applied Economics,* 9(1).

Foster, J., Greer, J., & Thorbecke, E. (1984). A class of decomposable poverty measures. Econometrica, 52(3), 761–766.

Geffersa, A.G., Agbola, F.W., & Mahmood, A. (2022). Improved maize adoption and impacts on farm household welfare: Evidence from rural Ethiopia. *Australian Journal of Agricultural and Resource Economics,* 66(4), 860–886.

Justin, K.U. (2015). Factors influencing maize crop production at household levels: A case of Rukwa Region in the southern highlands of Tanzania. *African Journal of Agricultural Research,* 10(10), 1097–1106.

Kafle, K., Paliwal, N., & Benfica, R. (2019). Who works in agriculture? Exploring the dynamics of youth involvement in the agri-food systems of Tanzania and Malawi (Rui Benfica, Helen Gillman, Anja Lesa, & Sundeep Vaid (eds.); 1st ed.). International Fund for Agricultural Development .

Kassahun, T., Tessema, A., & Adbib, K. (2022). Analysis of rural household food and non-food poverty status in Ethiopia: The Case Study from Meskan District. Food and Energy Security, 11(2).

Kim, J., Mason, N.M., Mather, D., & Wu, F. (2021). The effects of the national agricultural input voucher scheme (NAIVS) on sustainable intensification of maize production in Tanzania. *Journal of Agricultural Economics,* 72(3), 857–877.

Kinyondo, A., & Magashi, J. (2017). Enhancing rural livelihoods in Tanza-nia : A small-holder farmers' perspective. *International Journal of Accounting and Economics Studies,* 5(2), 68.

Lindsjö, K., Djurfeldt, A.A., Isinika, A.C., & Msuya, E. (2020). Youths' participation in agricultural intensification in Tanzania. AIMS Agriculture and Food, 5(4): 681–699.

Lindsjö, K., Mulwafu, W., Andersson Djurfeldt, A., & Joshua, M.K. (2021). Generational dynamics of agricultural intensification in Malawi: challenges for the youth and elderly smallholder farmers. *International Journal of Agricultural Sustainability,* 19(5–6), 423–436.

Misaki, E., Apiola, M., & Gaiani, S. (2019). Developing a communication application system for Chamwino small-scale farmers in Tanzania: A participatory design research. 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2019 - Proceedings, 1368–1373.

Mutayoba, V. (2018). Assessing Tomato Farming and Marketing Among Smallholders in High Potential. *Int j Economics Commerce Manag,* VI (8): 577–590.

Nassary, E. K., Baijukya, F., & Ndakidemi, P. A. (2020). Productivity of intercropping with maize and common bean over five cropping seasons on smallholder farms of Tanzania. *European Journal of Agronomy,* 113.

Ochieng, N.A. (2020). Are youth moving towards or away from Agriculture? Analysis of farm and non-farm occupational choices among youth in rural Tanzania.

Ogunniyi, A.I., Omotoso, S.O., Salman, K.K., Omotayo, A.O., Olagunju, K.O., & Aremu, 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.

Olayemi, T., Olasehinde, B., & Oluseyi Olutoyin, O. (2021). Determinants of poverty status among farming households in odogbolu local government area, ogun state. *Journal of Economics and Allied Research,* 6.

Osabohien, R., Osuagwu, E., Osabuohien, E., Eseosa, U., Ekhator-Mobayode, Matthew, O., & Gershon, O. (2020). Household access to agricultural credit and agricultural

production in Nigeria : A propensity score matching model. *South African Journal of Economic and Management Sciences,* 23(1), 1–11.

Osabohien, R., Wiredu, A.N., Nguezet, P.M.D., Mignouna, D.B., Abdoulaye, T., Manyong, V., Bamba, Z., & Awotide, B.A. (2021). Youth participation in agriculture and poverty reduction in Nigeria. Sustainability, 13(14), 1–19.

Sen, A. (1992). The political economy of targeting. Washington, DC: World Bank.

Tesfaye, G., Fredu, N., & Manasebo, G. (2017). Rural Household's Poverty and Vulnerability in Amhara Region, Ethiopia: Case Study in Gubalafeto Woreda. *Journal of Poverty, Investment and Development,* 39, 22–34.

URT. United Republic of Tanzania. (2019). Household Budget Survey 2017-18. [http://www.nbs.go.tz] accessed 20/5/2022.

URT. United Republic of Tanzania. (2021). National Sample Census Of Agriculture (2019/2020). In United republic of Tanzania. [http://www.nbs.go.tz] accessed 25/4/2022.

URT. United Republic of Tanzania. (2022b). Integrated Labour Force Survey, Analytical Report 2020/21.[https://www.nbs.go.tz/index.php/en/census-surveys/labour-statistics/688-integrated-labour-force-survey-2020-21] accessed 20/10/2022.

URT. United Republic of Tanzania. (2022a). Youth Initiative for Agribusiness (BBT-YIA) 2022/2030. Ministry of Agriculture. [https://www.kilimo.go.tz/uploads/books/Building_a_Better_Tomorrow_Document_-_BBT-YIA_Booklet_2022.pdf] accessed 25/8/2022.

Volk, J., Gornott, C., Sieber, S., & Lana, M. A. (2021). Can Tanzania's adaptation measures prevent future maize yield decline? A simulation study from Singida region. Regional Environmental Change, 21(4).

Wang, M., He, B., Zhang, J., & Jin, Y. (2021). Analysis of the effect of cooperatives on increasing farmers' income from the perspective of industry prosperity based on the PSM empirical study in Shennongjia region. Sustainability (Switzerland), 13(23).

WB (World Bank) (2011). Introduction to poverty analysis. Institute of World Bank. [https://documents1.worldbank.org/curated/en/775871468331250546/pdf/902880WP0Box380okPovertyAnalysisEng.pdf] (assessed on 2/3/2023).

Yared, R. (2005). Poverty Persistence Urban Ethiop. Published master's Thesis, Dep. Econ. Addis Ababa University.

Zhang, C. hong, Benjamin, W.A., & Wang, M. (2021). The contribution of cooperative irrigation scheme to poverty reduction in Tanzania. *Journal of Integrative Agriculture,* 20(4): 953–963.